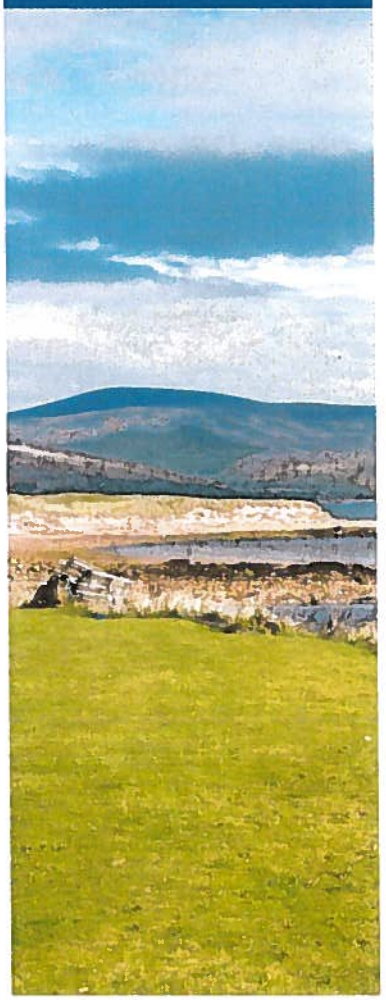
KNOWES WIND FARM

ENVIRONMENTAL STATEMENT

VOLUME 2: WRITTEN STATEMENT

May 2014



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Preface

The following Written Statement forms the second part of a three volume Environmental Statement, which presents the findings of the various assessments undertaken to address the potential environmental effects of the proposed development at Knowes, Dunning, Perth and Kinross, PH2 0RB.

Document	Title	Contents
Volume 1	Non-Technical Summary	Summary details of the proposal and conclusions of the individual EIA chapters
Volume 2	Written Statement	Full details of all assessments included within the EIA
Volume 2	Figures	Presentation of A3 figures referred to in Written Statement

This Environmental Statement has been prepared in accordance with the Environmental Impact Assessment (Scotland) Regulations 1999. These regulations state that a wind turbine project is a Schedule 2 development which would 'require an EIA if it is likely to have significant environmental effects because of factors such as its nature, size or location'. This development does require an EIA.

The volumes of the Environmental Statement are available at the Perth and Kinross Council Offices in Perth.

Additional copies can be purchased directly from Muirden Energy: printed copies are available at a cost of £350 or digital versions on CD-ROM are available for a cost of £50.

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CHAPTER 1

PROJECT DESCRIPTION

1 Project Description

1.1 Introduction

This chapter provides an overview of the Environmental Statement including details on the approach used when it was being undertaken. Details of the wind farm development proposal, associated ancillary development and decomissioning works proposed are described, as well as a review of the site selection process and iterative design stages undertaken before the final turbine locations were selected.

1.2 Details of Proposal

The application for nine wind turbines is made by Muirden Energy and David Myles who is a partner in the project. Muirden Energy is an Aberdeenshire based and owned company looking to undertake renewable energy projects with local landowners in the area.

A feasibility study has identified the proposed site as being suitable for a wind energy development with the proposed plan being for nine 0.85MW, three bladed wind turbines. Seven turbines would have a tip height of up to 81m and two would have a tip height of up to 74m. A desktop study has revealed that there is a high average wind speed at the site. At a height of 45m agl the wind speed is calculated to be 8.1m/s. A site appraisal also identified limited potential visual effects from the setting of the turbines.

The project would produce the equivalent amount of energy to supply up to 4,274 homes and would contribute to emission reductions of up to 8,644 tonnes of CO_2 a year[1].

A grid connection investigation is being undertaken with Scottish & Southern Energy and it is anticipated that there will be no issues connecting to the grid network. Ancillary development would include connecting the turbines into the existing network via underground cables and a control room. This single storey control building will measure 9.5m x 5m x 6m. No connecting wires will be required to be constructed above ground level. An existing access to the site will be utilised to enable construction vehicles to reach the proposed turbine locations.

1.3 Site Description

The applicants are looking at the opportunity to develop nine wind turbines at Knowes approximately 2.5km south of Dunning, Perth and Kinross.

The final selected location of the turbines has been decided based on the results of the scoping process, the environmental studies undertaken in this report and an iterative design process. The intended site for the turbines will be on moorland and livestock farmland. Exact locations and elevations are shown in Table 1.1.

The site location and layout is shown in Figures 1.1 and 1.2 in Volume 3.

[1] Emission reductions were calculated using calculations according to the BWEA Available at: www.bwea.com/edu/calcs.html

Table 1.1 Turbine Co-ordinates

Turbine	Easting	Northing	Elevation
T1	301050	711764	352
T2	301250	711625	342
T3	301001	711506	358
T4	301214	711387	343
T5	300906	711153	370
T6	301148	711153	346
T7	301403	711021	328
T8	301444	711285	323
T9	301494	711531	320

1.4 Iterative Design

A number of factors were taken into account when deciding where the wind turbine project would be located on the land at Knowes. The following factors were taken into account when attempting to choose the optimal location of the wind farm project:

- Wind Resource
- Grid Connection
- Site Access
- Environmental Impact
- Desired Energy Generation
- Aesthetic Considerations
- Land Take
- Aviation Restrictions

After consideration of the above factors a plan was created to erect nine wind turbines up to 81m to blade tip height and each with a generating capacity of up to 0.85MW.

1.4.1 Layout Evolution

From the initial site selection to submission for planning consent the wind farm layout has eveolved following feedback from consultation with Perth and Kinross Council and statutory consultees. The design process has led to a number of changes that can be grouped into three main iterations, as detailed in Table 1.2 and displayed on Figure 1.4 in Volume 3.

Table 1.2 Modifications to wind farm design

Application	Turbine details	Modification Rationale
Scoping Layout	7 turbines up to 80m to blade tip height	Initial design
Post-Scoping revision	11 turbines up to 80m to blade tip height	The results of early survey work enable the area of search to be increased resulting in an additional 4 turbines.
Layout submitted for planning consent	7 turbines up to 81m to blade tip and 2 turbines up to 70m to blade tip height	Pre-application assessment with NATS results in a requirement to remove 2 turbines and reduce the blade tip height of a further 2. Turbine model altered from Enercon E48 to Gamesa G52.

1.5 Need for and Benefit of the Project

Knowes is owned by David Myles. David is at least the seventh generation of the Davidson family to own Knowes Farm. Due to modern agricultural practices this 520 acre farm is not sustainable in the long term and diversification is therefore needed. This is particularly so as approximately 425 acres of this total is only able to support sheep. The family are currently living in Aberdeenshire and David is working as an agricultural contractor, however this diversification would allow them to move onto the farm to support the business. By utilising agricultural land to provide a clean, secure, renewable energy source, the environmental performance of the business would be enhanced providing a beneficial impact on a variety of issues, including climate change, rural economies, reducing carbon footprints and the provision of an enhanced distribution of energy generation.

There is a significant body of evidence illustrating that the Earth's atmosphere is being polluted at an unprecedented level since 1700 A.D, contributing to global climate change. The main driver of which is the anthropogenic demand for energy, most of which is met by fossil fuels. This releases large amounts of the greenhouse gas CO_2 which makes up ~80% of all such gases released into the atmosphere, playing a pivotal role in global climate change. The science is uncontroversial and is supported by the UN's Intergovernmental Panel on Climate Change (IPCC), as well as on a national scale by Scottish Natural Heritage (SNH), as demonstrated through their latest Climate Change Action Plan.

While providing green energy and providing additional farm income, wind turbine projects help to enable and guarantee a higher level of rural job security. In addition to the local economic and employment benefits, a recent report published by the Department of Energy and Climate Change (DECC), has suggested that a total 19GW of onshore wind energy could provide 24,100 jobs in the UK[3].

Research carried out by the Parliamentary Office of Science and Technology suggests that wind turbines have a very low operational carbon footprint (2% of life cycle CO_2 emissions)[4]. The majority of the operational carbon footprint is generated by routine maintenance inspection trips. The other carbon emissions generated by wind energy are from the manufacturing and construction phases, including the production of steel for the tower, concrete for the foundations and epoxy/fibreglass for the rotor blades. Overall wind energy has one of the lowest carbon footprints for generating electricity when compared to other alternative technologies.

In addition to which it only takes approximately between 3-6 months for a wind turbine to produce the amount of energy that goes into its manufacturing, installation, operation, maintenance and decommission over its 20-25 year lifetime (European Wind Energy Association)[5].

The benefits of the introduction of medium-scale wind turbine developments are made evident through the generation of "green" renewable energy and the decentralisation of energy production to where it is both required and generated. Renewable energy generation reduces the dependency on

[3] Biggar Economics. 2012. Onshore Wind, Direct and Wider Economic Impacts. Department of Energy and Climate Change and Renewable UK. [3] Greenpeace, 2010. Available at www.greenpeace.org.uk/climate/wind-power. Accessed: 05/01/2011

[3] Bell, J., and Booth, E. (2010) The economic benefits of on-farm wind energy clusters in Aberdeenshire. SAC Consulting.

[3] Biggar Economics. 2012. Onshore Wind, Direct and Wider Economic Impacts. Department of Energy and Climate Change and Renewable UK.

[4] Parliamentary Office of Science and Technology (2006) Carbon Footprint of Electricity Generation Issue 268

[5] European Wind energy Association; Wind Resource estimation

fossil fuels for energy production, which is pivotal in securing Scotland's long term energy security on both the local and a national scale, at the same time as targeting the 2020 Routemap for Renewable Energy in Scotland.

1.6 Turbine Specification (Indicative)

Turbine Model:	Gamesa G52
Rotor Diameter:	52m
Maximum Swept Area:	2,214 m²
Rotational Speed:	Variable, 1.44-30.8 rpm
Blade Number:	3
Blade Material:	GRP (epoxy resin); built-in lightning protection
Tower Type:	Modular, steel tower,cylindrical
Hub Height:	44-55m
Rated Power:	850 kW

1.7 Construction

Construction of the Gamesa G52 wind turbines is estimated to take place over a period of 3-5 months. However, the duration of the construction period may potentially be altered due to the final details of the scheme, weather or ground conditions at the site.

Project construction is effectively split up into two separate phases:

Phase 1

- Site survey and preparation
- Remedial works
- Construction of the wind turbine harstandings, foundations and access tracks
- Excavation of the cable trenches and electricity and communication cable lying
- Construction of control housing

Phase 2

- Delivery and erection of turbines
- Testing and commissioning of wind turbines
- Site restoration

Where possible a number of the construction processes will occur simultaneously in order to minimise the length of the construction programme.

1.7.1 Access Tracks

Access to the site will involve laying a new road to the turbine sites, as illustrated in Figure 1.2 in Volume 3.

The new road will be created to extend from the upgraded track to the crane hardstandings. The road will be designed to be capable of bearing the weight of large construction cranes, which can weigh up to 200 tonnes. The access corner radii will be determined by the size of the proposed delivery lorries.

The road will form a 4m wide track resurfaced using hardcore. This process will involve the removal of the vegetation and top soil of the required section of the field to a depth of 200mm. An example of an indicative access track is shown below in Figure 1.1. The extended access track will be left in place after construction of the wind turbines.

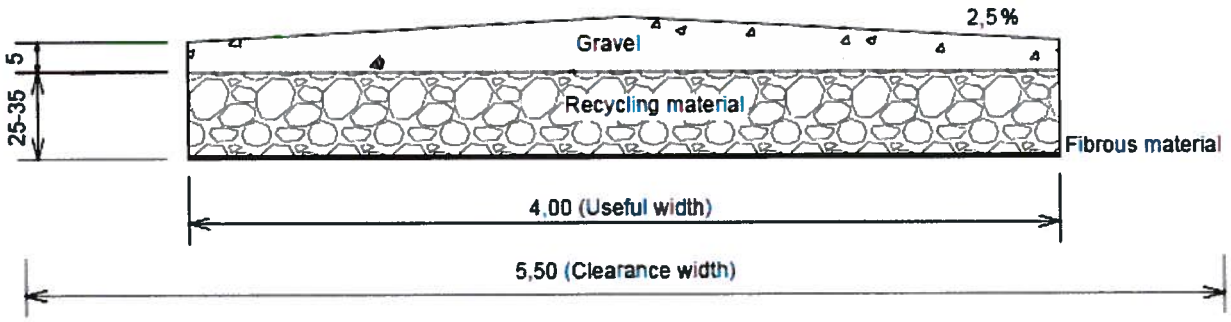

Figure 1.1 Indicative access track cross-section

1.7.2 Turbine Foundations

The design specification for the foundation of the turbines would depend on the following factors:

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

By carrying out a feasibility study of these factors it will be possible to determine the feasibility of the proposed location of the turbines and the need to microsite if required.

An area of hardstanding (30m x 20m) will be required to support the cranes used for the erection of the wind turbines. A temporary working/assembly area (30m x 15m) will also be required surrounding each crane hardstanding, an indicative example is shown in Figure 1.2.

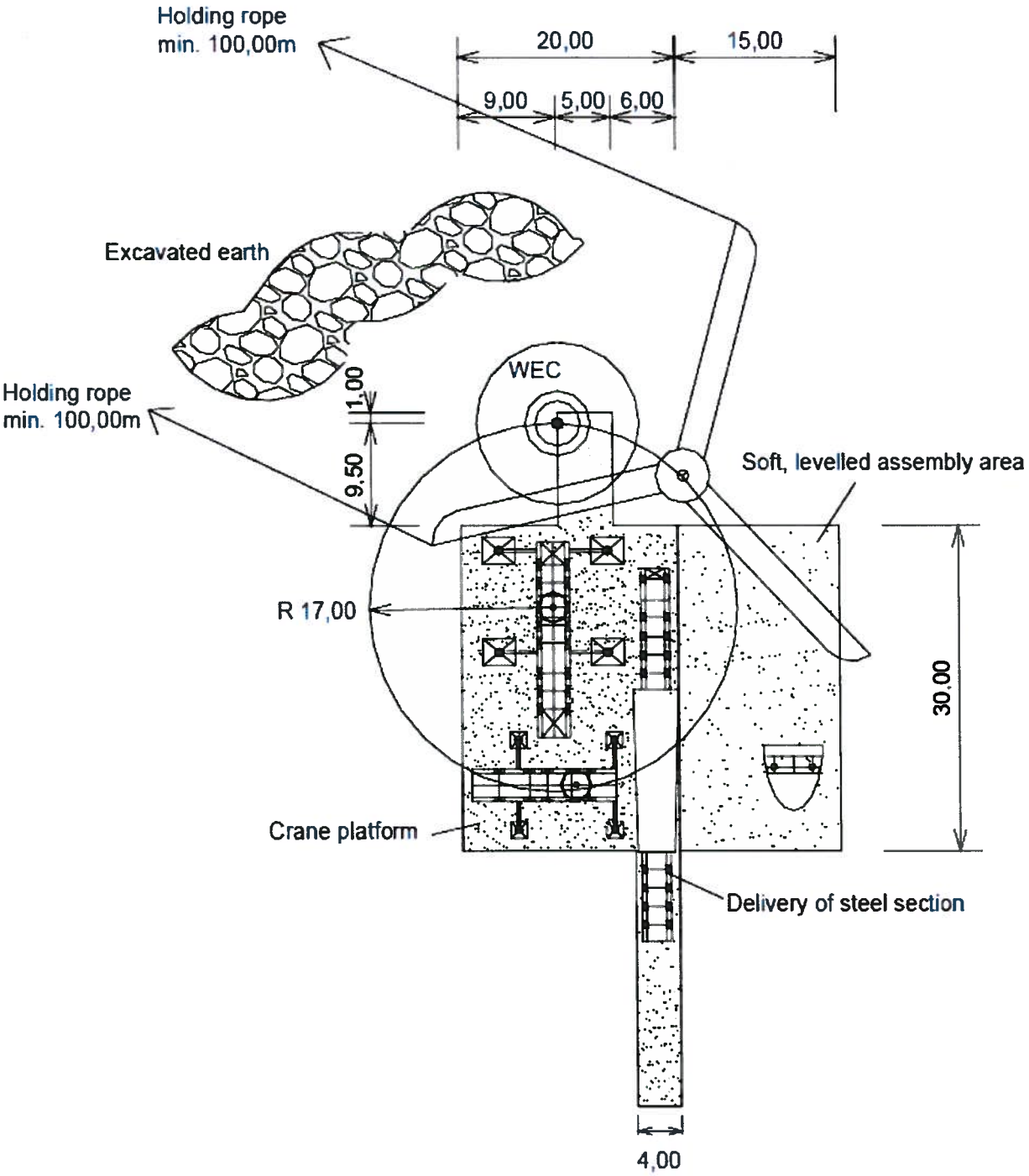

Figure 1.2 Indicative crane hardstanding and temporary working assembly area

Ground excavation would be undertaken as follows:

1. Topsoil/turf stripped and stored in order to be reused during site restoration
2. Subsoil stripped and stored being kept separate from topsoil/turf
3. Turbine foundations then excavated
4. Installation of steel reinforcement bars and casting of concrete
5. Turbine foundations backfilled with spoil after turbine installation

It is proposed that standard concrete gravity turbine foundations would be constructed on poured concrete with steel reinforcement. The turbine foundations and design will be specific to the site conditions, turbine model and the results of the feasibility study undertaken prior to construction. It is predicted that the foundations will be 1.8m deep and have a diameter of approximately 18m.

Material for the construction of the access roads, foundations and crane hardstanding would be brought from offsite.

In accordance with PAN 50 'Controlling the environmental effects of surface mineral workings'[6] the following factors included within the creation of the borrowpit would be considered before construction:

- Alterations to the surface over which water flows,
- Changes to the pattern of surface water flows
- For example,
  - Reductions because of lack of recharge from groundwater or seepage from the stream bed or decreased catchment ; or
  - Increases because of discharge or increased catchment which may increase scour and be too great for points of limited capacity downstream.
  - Changes to the quantity and physical and chemical quality of those flows.

Site restoration would be undertaken using the preserved topsoil or turf around 1m of the turbine tower base. A 1m wide gravel path would then be laid down around the tower base. Leftover excavated material can then be used for the landscaping of access tracks and any other necessary site infrastructure required.

1.7.3 Sustainable Drainage Systems

Drainage systems may be required to prevent impacts to existing waterways, the creation of flooding and to minimise the potential for pollution. Surface water drainage required from flows created by the crane hardstanding and the access tracks will be created to comply with principals set out by Sustainable Drainage Systems (SuDS). The following guidelines will be followed when designing the drainage system:

- PAN 61: Planning and Sustainable Urban Drainage Sytems
- CIRIA Guideline C697 'The SUDS Manual'

[6] Planning Advice Note PAN 50 Controlling the Environmental Effects of Surface Mineral Workings. The Scottish Office Development Department, October 1996.

- CIRIA Guideline C698 'Site Handbook for Construction of SUDS'

A potential permanent drainage solution that may be used at the site could be the creation of a swale running alongside the access tracks and hardstanding (see Figure 1.3, below).

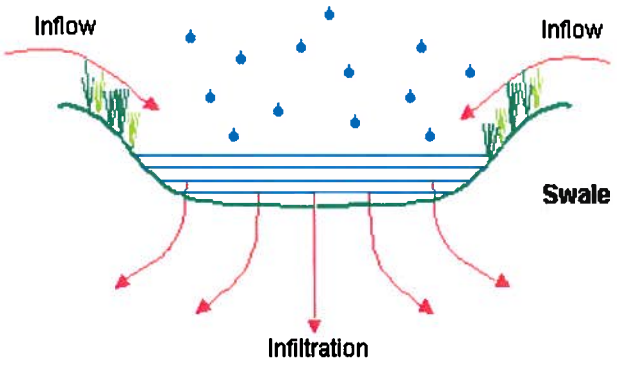

Figure 1.3 Drainage swale

If this technique is not practical at the site then drains can be installed along the access tracks and hardstanding that feed into a soakaway (see Figure 1.4, overleaf).

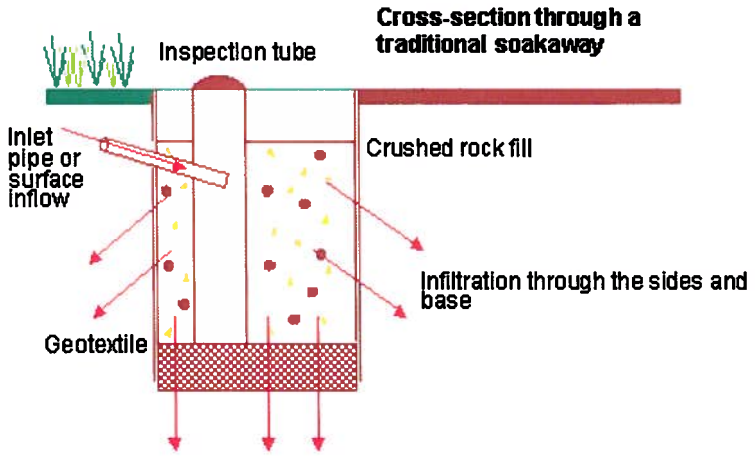

Figure 1.4 Traditional soakaway

The benefits of a soakway include:

- They provide storage for runoff. Storage is provided in an underground chamber, lined with a porous membrane and filled with coarse crushed rock.
- They enhance the natural ability of the soil to drain the water by providing a large surface area in contact with the surrounding soil, through which the water can pass.

A soakaway would also incorporate the treatment of runoff within the infiltration device by the following processes:

- Physical filtration to remove solids
- Adsorption onto the material in the soakaway, trench or surrounding soil

- Biochemical reactions involving micro-organisms growing on the fill or in the soil

The final design of the proposed drainage system will be designed by the civil contractor after ground investigations have been undertaken. Exact details on the system will be agreed with Perth and Kinross Council and the Scottish Environmental Protection Agency. Further consideration of potential construction effects on hydrology and hydrogeology is given in the Hydrology and Hydrogeology assessment.

1.7.4 Grid Connection

The wind turbines would be connected to the local grid network by Scottish and Southern Energy using a 33kV line. The connection would be made by underground cable. Trenches would be created for the cabling at a depth of 0.75m and 1.5m wide. On-site control housing will also be required; however, the location of the 9.5m x 5m x 6m substation building is currently being negotiated with Scottish and Southern Energy. An indicative location is shown in Figure 1.3 of Volume 3. The building will contain the main high voltage electrical switchgear and will be constructed out of conventional building materials with a matt green finish. Domestic wiring from the wind farm circuit will be used to provide all necessary heating and lighting associated with the building. Features within the substation building will include the computer base for controlling and monitoring the wind turbines. Figure 1.5 shows the design of an indicative substation building.

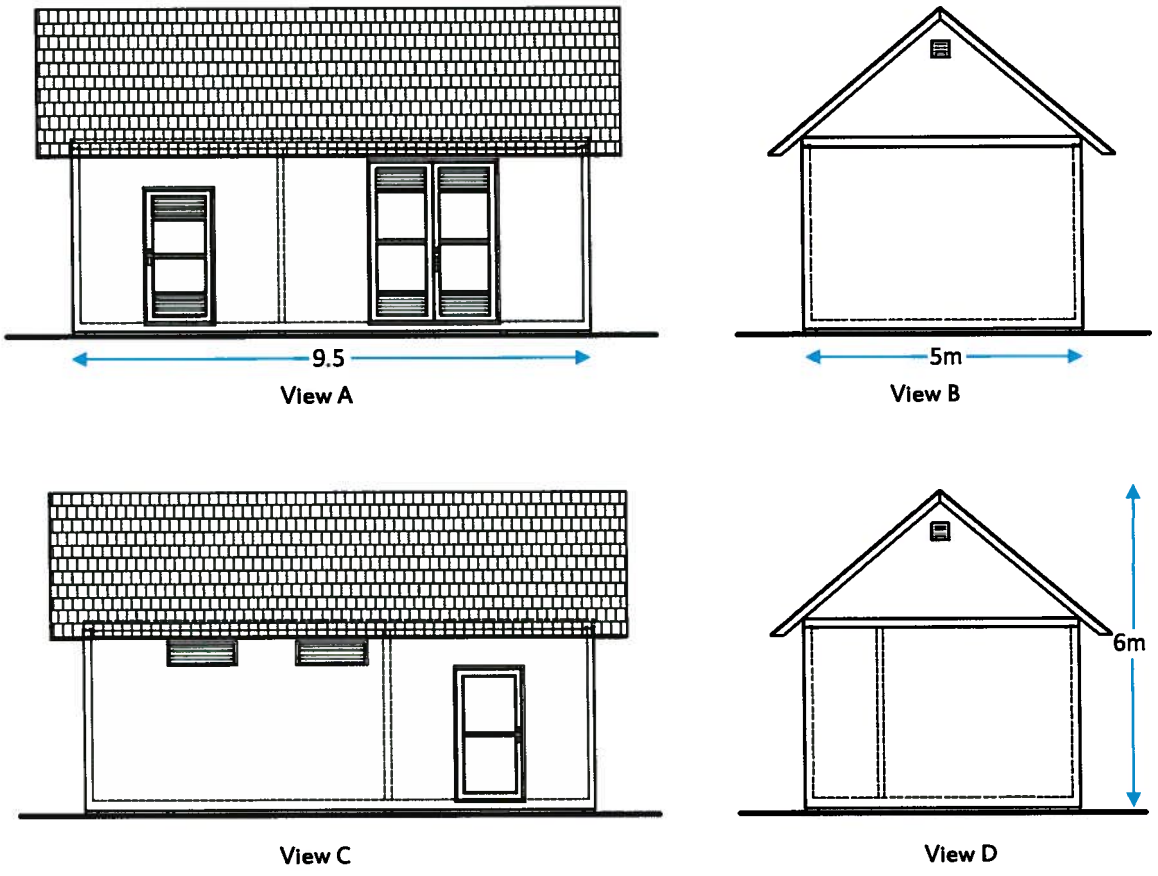

Figure 1.5 Indicative substation building

1.7.5 Construction Traffic

The components of the Gamesa G52 wind turbines will be transported to the site on articulated lorries. The articulated lorries would have extended trailers in order to deliver the turbine blades. Each turbine delivery is expected to be undertaken in seven articulated low loader deliveries: one for the nacelle, one for the blades, two for the tower, one for the blade hub and two for the generator/controller etc. In addition, construction traffic will be generated by the following activities:

- Delivery of electric cable for connection to the grid network
- Delivery of sand for the cable trenches
- Delivery of concrete for the turbine bases
- Delivery of formwork and reinforcing steel for the construction of the turbine base

The exact delivery route of the turbines is subject to change given the potential for changes in the transportation method suggested by the wind turbine supplier. The docking location of the turbines is not confirmed but Figure 1.6 shows the proposed delivery route of the turbines from Junction 6 of the M90. Further information on the feasibility of the access route of the site is provided within an 'Abnormal indivisible load investigations and route inspection' report carried out by Wynns Independent Transportation Consultants in Appendix 1.

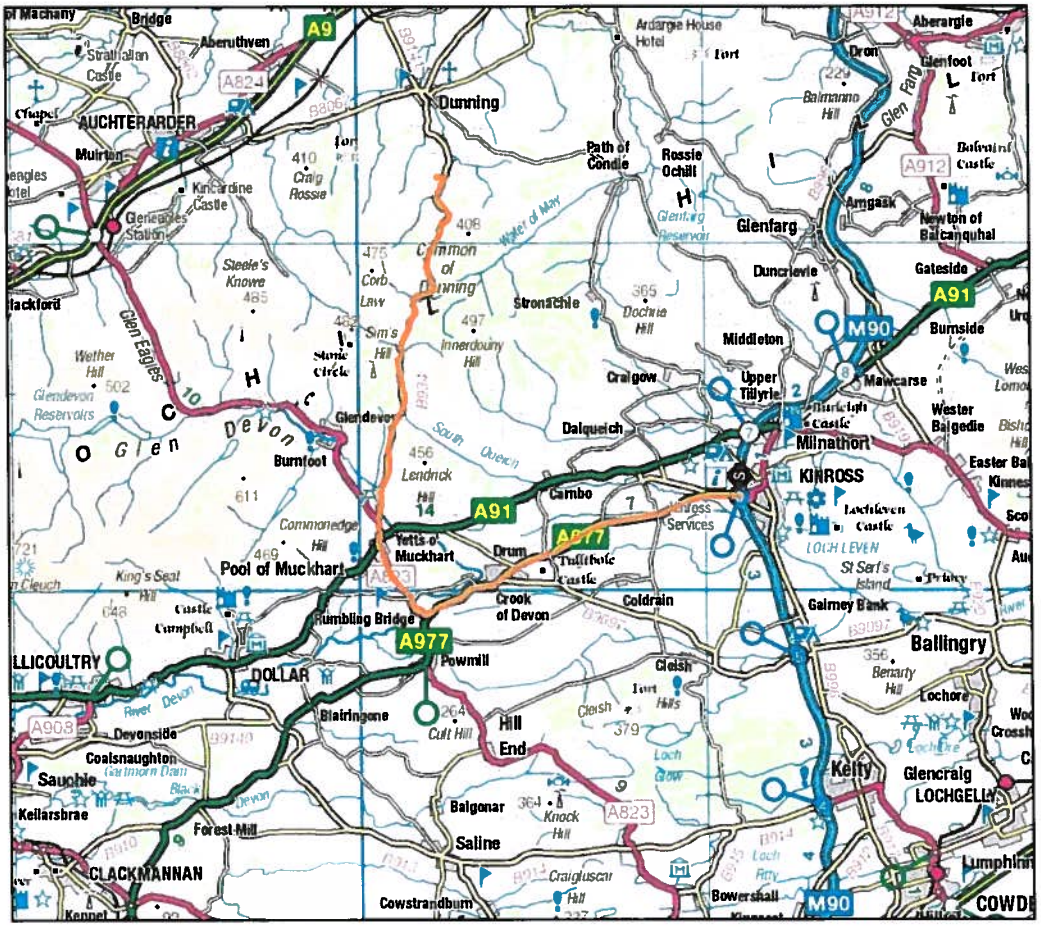

Figure 1.6 Proposed turbine delivery route to Knowes

The route is anticipated as:

- Exit the M90 at junction 6 for the A977

- Exit the A997 for the A823 northbound
- Exit A823 for the B934 and arrive at the site

1.7.6 Daily Hours of Construction

The daily construction timetable will be set within the hours of 07:00 – 19:00 between Monday to Saturday. There may be a need to work beyond the set working hours within crucial construction periods; however, if necessary these times would be agreed with Perth and Kinross Council.

1.8 Operation

The Gamesa G52 wind turbines would begin generating electricity when wind levels reach 3 m/s and would cut out at wind speeds between 28-34 m/s. The turbines would reach their maximum output at a wind speed of 13 m/s and would continue to generate at the rated output until the cut out wind speed is experienced.

1.9 Decomissioning

At the end of the turbines operational span, all major equipment and structures will be removed from the site at Knowes. In addition to this, the upper sections of the turbine foundations would be removed to a depth to allow the continuation of current agricultural land use practice. A schedule of works will be agreed with the Local Planning Authority to confirm the process to be undertaken. The decommissioning process would take place over a period of 2 months depending on specific details, weather and ground conditions.

CHAPTER 2

PLANNING POLICY

2 Planning Policy

An application for the development of a wind energy project in Scotland should be assessed in the context of planning policy guidance contained within National, Structural and Local Development Plans. This body of information is contained within a wide range of documents. The following summary includes the relevant planning guidance and policies that this project should be assessed against.

2.1 National Planning Policy

National Planning Policy Guidance

- Scottish Planning Policy (SPP, published in February 2010)

  States that '*Planning authorities should support the development of wind farms in locations where the technology can operate efficiently and environmental and cumulative impacts can be satisfactorily addressed. Development plans should provide a clear indication of the potential for development of wind farms of all scales, and should set out the criteria that will be considered in deciding applications for all wind farm developments including extensions. The criteria will vary depending on the scale of development and its relationship to the characteristics of the surrounding area, but are likely to include:*

  - *landscape and visual impact,*
  - *effects on the natural heritage and historic environment,*
  - *contribution of the development to renewable energy generation targets,*
  - *effect on the local and national economy and tourism and recreation interests,*
  - *benefits and disbenefits for communities,*
  - *aviation and telecommunications,*
  - *noise and shadow flicker, and*
  - *cumulative impact.'*

  Also, regarding cumulative impact '*planning authorities should take account of existing wind farms, those which have permission and valid applications for wind farms which have not been determined. Decisions should not be unreasonably delayed because other schemes in the area are at a less advanced stage in the application process. The weight that planning authorities attach to undetermined applications should reflect their position in the application process. Cumulative impact will largely relate to the scale and proximity of further development. The factors that will be taken into account when considering cumulative impact should be set out in the development plan or supplementary guidance.*'

- National Planning Framework for Scotland Two (NPF2)
- PAN 58 Environmental Impact Assessment
- PAN 73 Rural Diversification
- Renewables advice - onshore wind turbines, 2011

2.2 Local Planning Policy

The Perth and Kinross Strategic Development Plan 'TAYplan' was approved in June 2012 and provides a spatial strategy for the Perth and Kinross, Dundee, Angus and North Fife areas for sustainable development and growth. It is designed to deliver the many location-related components of sustainable economic development. Stretegic Development Plan policies relevant to the determination of the Knowes Wind Farm are outlined below:

- Policy 2: Shaping better quality places
  Development proposals should: *'integrate new development with existing community infrastructure and work with other delivery bodies to integrate, concentrate and co-locate additional new infrastructure to optimise its coverage and capability'.*

- Policy 3: Managing TAYplan's assets
  This policy aims to ensure responsible management of TAYplan's assets by: *'safeguarding habitats, sensitive green spaces, forestry, watercourses, wetlands, floodplains, carbon sinks, species and wildlife corridors, geodiversity, landscapes, parks, townscapes, archaeology, historic buildings and monuments and allow development where it does not adversely impact upon or preferably enhances these assets'.*

- Policy 6: Energy and/Waster/resource Management Infrastructure
  This policy aims to: *'deliver a low/zero carbon future and contribute to meeting Scottish Government energy and waste targets'.*

The Perth and Kinross Local Development Plan was adopted in February 2014 and seeks to promote sustainable economic growth and development while identifying and protecting valuable assets. The principle policy relevant to the determination of the Knowes Wind Farm is Policy ER1: Renewable and Low Carbon Energy Generation. This policy is detailed below with an assessment of the Knowes Wind Farm application provided against each factor of the policy.

Consideration of the Knowes Wind Farm against Policy ER1: Renewable and Low Carbon Energy Generation

Factors for consideration in ER1	Assessment
a. The individual or cumulative effects on biodiversity, landscape character, visual integrity, the historic environment, cultural heritage, tranquil qualities, wildness qualities, water resources, aviation, telecommunications and the residential amenity of the surrounding area.	*The Environmental Impact Assessment provides a full assessment of the Knowes Wind Farm and concludes there would be no unacceptable impacts or loss of amenity in the surrounding area.*
b. The contribution of the proposed development towards meeting carbon reduction targets.	*The Knowes Wind Farm would produce the equivalent amount of energy to supply up to 4,274 homes with a Carbon reduction of up to 8,644 tonnes a year.*
c. The effects on the elements listed in criterion 'a' of the connection to the electricity distribution or transmission system.	*Connection to the grid would be undertaken by SSE via underground cables to an existing connection point from a substation located on site. There would be no impacts to any of the criteria listed in ER1a.*
d. The transport implications, and in particular the scale and nature of traffic likely to be generated, and its implications for site access, road capacity, road safety, and the environment generally.	*A full site access analysis has been undertaken and Muirden Energy would work closely with local police to ensure minimal interruption during the construction phase of the development.*
e. The hill tracks and borrow pits associated with any development.	*There would be no adverse impacts from access tracks or an on-site borrow pit, if required.*
f. The effects on carbon rich soils.	*A peat assessment has been undertaken and there would be no significant impacts from the construction of the wind farm.*
g. Any positive or negative effects they may have on the local or Perth & Kinross economy including tourism and recreation interests either individually or cumulatively.	*There would be no adverse impact on local tourism. The local economy would benefit from the wind farm via a community benefit fund and possible job creation.*

h. In the case of large-scale onshore wind energy developments, their fit with the spatial framework for wind energy developments.	***This criteria is fulfilled by the proposed wind farm development.***

In addition to Policy ER1 there are a number of other policies in the Local Development Plan which may apply to the Knowes Wind Farm application. These include:

- Policy ER2: Electricity Transmission Infrastructure
- Policy ER5: Prime Agricultural Land
- Policy ER6: Managing Future Landscape Change to Conserve and Enhance the Diversity and Quality of the Area's Landscapes
- Policy EP1: Climate change, Carbon Reduction and sustainable Construction
  - *Policy EP1A*
- Policy EP2: New Development and Flooding
- Policy EP3: Water Environment and Drainage
  - *Policy EP3D: Surface Water Drainage*
  - *Policy EP3D: Reinstatement of Natural Watercourses*
- EP13: Airfield Safeguarding

In addition to the local development plan the Perth Area Local Plan cover Perth City and the surrounding countryside and villages and encloses an area of approximately 75,400 hectares. The Knowes Wind Farm falls within this catchment and relevant policies include:

- Policy 1: General Criteria
- Policies 5 & 53: Agriculture
- Policy 6: Agricultural Diversification
- Policies 11,11a, 12 & 54: Areas of Great Landscape Value
- Policy 16: National Scenic Area
- Policies 17 and 62: Historic Gardens and Designed Landscapes
- Policies 19, 20 & 55: Nature Conservation
- Policies 21-23 & 60-61: Archaeology
- Policies 24 & 58: Conservation Areas
- Policy 25: Listed Buildings

In addition to the local plan, Perth and Kinross Council has issued the following Supplementary Planning Guidance document;

- Supplementary Planning Guidance for Wind Energy Proposals in Perth and Kinross

Based on the above policy, we believe that the proposed project should meet the requirements set out and is appropriate to the location.

CHAPTER 3

LANDSCAPE AND VISUAL IMPACT

3 Landscape and Visual Impact

3.1 Introduction

This assessment considers the potential effects of the proposed Knowes Wind Farm on the landscape and visual character of the site and its surrounding areas. The landscape assessment considers the effects of the proposal on existing areas of landscape character, patterns and elements within or close to the site. The visual assessment considers the effects of the proposal on the views and the overall effect on visual amenity within the study area. Landscape and visual effects are of key concern to any wind energy development.

3.1.1 Study Area Description

Independent and cumulative study areas have been defined to encompass all areas considered to be sensitive to wind farm development of the size proposed at Knowes.

The independent study area has been based on Scottish Natural Heritage's 'Visual Representation of Windfarms: Good Practice Guidance'. The guidance suggests that for the size of the wind turbines proposed at Knowes an independent study area with a radius of 25km from the nearest turbine would be appropriate. The study area has then been narrowed to include only areas where theoretical visibility is predicted within this radius.

An initial cumulative study area of 60km has also been defined to identify wind farm development in the wider area. The cumulative assessment is then concentrated on assessing whether significant effects would occur from particular wind farm developments that are considered to relate with the Knowes Wind Farm, including operational and consented developments at Green Knowes, Burnfoot Hill and Extension, Rhodders and Lochelbank. Single wind turbine developments in the area are included where cumulative effects have the potential to be significant.

3.1.2 Effects Scoped Out

The LVIA has been undertaken in accordance with relevant guidance; however, professional judgement has also been used to scope out impacts where prior experience has deemed them to not be significant. Therefore, in line with the proposed study areas it has been considered that cumulative effects of the development in combination with wind turbines less than 50m to blade tip height beyond a 5km radius will not be included within the assessment. Cumulative effects from wind farm developments at a distance of greater than 30km have also been scoped out of the assessment due to the size of the project at Knowes and its potential to introduce significant cumulative effects at this distance.

3.2 Consultation

Initial consultation through project scoping was carried out with Perth and Kinross Council's Landscape Architect Douglas Cook in August 2012. Responses from Perth and Kinross Council and Statutory Consultees were later received and taken into consideration throughout the evolution of the project. A number of viewpoints and potentially sensitive relationships with neighbouring projects were agreed for consideration and have been used for the basis of the landscape and visual assessment.

3.3 Guidance and Legislation

The Landscape and Visual Impact Assessment for wind turbines usually forms one of the key components of the assessment process in order to comply with the various regulations, local and structure plans and best practice guidelines relating to the protection of the areas landscape resource.

This assessment will be prepared with reference to a number of 'best practice' documents and in particular, the following publications and guidelines:

- Guidelines for Landscape and Visual Impact Assessment, 3rd Edition, Landscape Institute and Institute of Environmental Management and Assessment, 2013[i];
- Guidelines on Environmental Impacts of Wind Farms and Small Scale Hydro Electric Schemes, Scottish Natural Heritage, 2001[ii];
- Visual Assessment of Wind Farms: Best Practice, University of Newcastle, Scottish Natural Heritage Report No. F01AA303A, 2002[iii];
- Landscape Character Assessment: Guidance for England and Scotland, The Countryside Agency and SNH, 2002[iv];
- Visual Representation of Windfarms: Good Practice Guidance, Scottish Natural Heritage, 2006[v];
- Strategic Locational Guidance for Onshore Wind Farms in Respect of the Natural Heritage, SNH, 2005[vi];
- Siting and Designing Windfarms in the Landscape, Scottish Natural Heritage, 2009[vii];
- Assessing the Cumulative Impact of Onshore Wind Energy Developments, Scottish Natural Heritage, 2012[viii];
- Constructed tracks in the Scottish Uplands. Scottish natural Heritage. Land Use Consultants, 2005[ix];
- Good practice during windfarm construction. Scottish Renewables, Scottish Natural Heritage, Scottish EnvironmentalProtection Agency and Forestry Commission Scotland, 2010[x];
- Photography and photomontage in landscape and visual impact assessment – Advice Note, Landscape Institute, 2011[xi];
- Cost Effective Landscape: Learning from Nature, The Scottish Office[xii];
- Tayside landscape character assessment. Scottish Natural Heritage Review. No.122. Land Use Consultants, 1999[xiii];
- The landscape of Kinross-shire: a landscape assessment of the Kinross Local Plan area. Scottish Natural Heritage Review. No.77[xiv];
- Supplementary Planning Guidance for Wind Energy Proposals in Perth & Kinross, Perth and Kinross Council, May 2005[xv];
- Landscape study wind farm development in the Ochil hills and part of southern Highland Perthshire. Report to: Perth and Kinross Council, Clackmannanshire Council and Scottish Natural Heritage. David Tyldesley and Associates, 2004;
- Guidance for the Preparation and Submission of Photographs and Photomontages to illustrate the impacts of Wind Energy Development. For inclusion in Planning Applications and Environmental Statements[xvi].

3.4 Supporting Visualisations

3.4.1 Visibility Maps

A number of maps showing the Knowes Wind Farm Zone of Theoretical Visibility (ZTV) have been created to give an indication of the potential influence of the development on the wider landscape and in conjunction with other wind turbine projects.

The following points should be considered when analysing the included ZTV maps:

- Each ZTV map has been created using the maximum height of the blade tips (unless stated otherwise) for assessment purposes. The ZTV maps do not take into account the screening produced by vegetation (unless otherwise stated) or buildings and therefore show the worst case scenario visual impact produced by the turbine. Consequently, there may be areas shown within the map that receive theoretical views but do not receive views in reality.
- Each ZTV is based on 50m grid data (OS Panorama Digital Terrain Model) and therefore exact fluctuations in the landscape topography are not always illustrated within the maps produced.
- The reduced visual effects that occur as distance increases away from the turbine development are not depicted on the ZTV maps. Therefore it can be presumed that the nature of effect when a wind turbine is visible from a distance of 25km will greatly differ to the effect experienced at a distance of 5km.
- Cumulative ZTVs do not show whether it is part or the whole of a development that is visible, or whether it is a small proportion of the turbine/s that are visible. Therefore there is potential for differences between what could be experienced in areas depicted as receiving visibility of a development.
- For these limitations within the ZTVs it is suggested that in order to fully justify conclusions it would be beneficial to check the findings of the ZTV in the field.

3.4.2 Photomontages

A photographic record and computer-generated wirelines have been produced for a number of selected viewpoints showing the project in isolation and cumulatively with neighbouring projects in line with guidance provided in the Scottish Natural Heritage (SNH) guidance document 'Visual Representation of Windfarms' (2006).

Photographs were taken using a canera with a full frame sensor, which were subsequently stitched together using ArcSoft Panorama Maker 6 software. The panorama was then imported into Resoft Wind Farm 4.2 software to overlay the wireframe and render the wind turbines onto the image.

In accordance with the good practice advice contained within SNH (2006) guidance all of the photomontages have been produced with the necessary field of view to capture the project and significant neighbouring projects. Each different field of view requires a different viewing distance to properly illustrate the view experienced at the viewpoint, and provide an indication of the visual context of the development. Recommended viewing distances were calculated using SNH guidance presented in Technical Appendix B of the 'Visual Representation of Windfarms' guidance. Specifically, the method recommended for calculating viewing distances of panoramas was used for the representation of the viewpoints.

3.5 Landscape Character Assessment

The 'Guidelines for Landscape and Visual Impact Assessment' (Third Edition, 2013) published by The Landscape Institute and the Institute of Environmental Management and Assessment includes the following concerns which are to be evaluated within the scope of a development's landscape assessment:

'how the proposal will affect the elements that make up the landscape, the aesthetic and perceptual aspects of the landscape and its distinctive character'

The landscape assessment therefore focuses on identifying the 'changes' to these elements and aspects of the landscape surrounding the proposal and assessing whether these potential changes will have significant adverse effects to the landscape baseline.

3.5.1 Landscape Assessment Methodology

3.5.1.1 Independent Landscape Assessment Methdology

The landscape assessment has been carried out in four separate stages and incorporates guidance set out within the 'Guidelines for Landscape and Visual Impact Assessment' (Third Edition, 2013).

- The scope of the assessment has been defined by a preliminary review of each landscape character type's potential to receive significant effects from the proposed development. The extent of visibility of the development and the proximity of the landscape character type to the site are key considerations at this stage. Landscape character types that are not considered to be at risk of significant landscape effects are omitted from further assessment.

- A description of the landscape baseline has then been produced for each landscape character type defined within the scope of the assessment. Local and surrounding landscape characteristics and features have been identified, as well as any local, regional and national landscape designations.

- An overall sensitivity of each landscape character type to wind turbine development has then been determined by combining the landscape's susceptibility to change and its value. The potential nature and magnitude of effects of the wind turbine development on the baseline landscape character and its sensitivities has then been assessed.

- The overall level of effect has then been reasoned through combining the separate judgements on the sensitivity of the landscape and the predicted magnitude of effects. This process is not reliant on a matrix, but acknowledges that it is helpful to use a matrix to show the likely significance of effect. The significance of the identified effects is then explained by drawing out the key issues.

3.5.1.2 Cumulative Landscape Assessment Methodology

The cumulative landscape assessment has been carried out in line with the independent landscape assessment and Scottish Natural Heritage's guidance document 'Assessing the Cumulative Impact of Onshore Wind Energy Developments' (2012). The following four stages form the process used to assess the level of potential cumulative effects created by the introduction of the wind turbine development:

- The landscape baseline has been utilised to inform the cumulative landscape assessment. Additionally, in order to inform the assessment a list of all commercial wind turbine projects that are proposed, consented and operational has also been produced.

- The capacity of each of the landscape character areas to absorb further wind turbine development has been evaluated.

- The potential nature, magnitude and significance of cumulative effects of the wind turbine development on the baseline local and surrounding landscape areas has been assessed to determine the suitability of the site. The assessment process has been undertaken taking into account cumulative Zone of Theoretical Visibility maps for the proposed wind turbine development in addition to other selected wind turbine projects and in some cases reinforced by photomontages.

- The overall level of effect has then been reasoned through combining the separate judgements on the criteria set out in 3.5.1.5 and 3.5.1.6. This process is not reliant on a matrix, but

acknowledges that it is helpful to use a matrix to show the likely significance of effect. The significance of the identified effects is then explained by drawing out the key issues.

3.5.1.3 Landscape Sensitivity

The 'Guidelines for Landscape and Visual Impact Assessment' (Third Edition, 2013) states that to make a judgement on the sensitivity of a landscape receptor an assessment of a landscape's susceptibility to change, in this case change associated with wind energy, has to be made and combined with the overall value attached to a landscape. This assessment of landscape effects therefore recognises each landscape's individual ability to accommodate wind energy developments before assessing the magnitude of effects upon it.

Susceptibility to change

Five criteria have been selected to evaluate the susceptibility of a landscape to change enforced by the introduction of a wind energy development, including the landscape's scale, complexity, condition, development and context. Table 3.1 illustrates how an assessment of these five criteria can aid judgement on a landscape's overall ability to accommodate change.

Table 3.1 Criteria to determine susceptibility to change

CRITERIA	Unlikely to be susceptible to change	Likely to be susceptible to change
Scale	Large scale	Small scale
Complexity	Simple and strong geometric, linear patterns	Complex and irregular patterns
Condition	Modified	Intact
Development	Industrial elements (e.g. masts, pylons, infrastructure) and contemporary settlement	No evidence of industrial elements and contemporary settlement
Context	LCT with little influence on neighbouring LCT	Landscapes acting as a backdrop or foreground to a characteristically different LCT

A detailed evaluation of each landscape character area included in the scope of the landscape assessment against the five criteria in Table 3.1 is detailed in Section 3.5.3 (Assessment of Landscape Effects). The information from the evaluations is then used to determine whether the landscape is of overall low, medium or high susceptibility to change. Table 3.2 defines the overall levels that are assigned to each landscape.

Table 3.2 Overall susceptibility of landscape to change

SUSCEPTIBILITY TO CHANGE	Definition
Low	Landscape characteristics are capable of absorbing change to wind energy development.
Medium	Landscape characteristics offer some potential to absorb change without alterations occurring to one or more of the key elements
High	Landscape characteristics offer very limited potential to absorb change without the key elements being subjected to major alterations

Landscape value

The value of a landscape can be obtained by referring to its level of local, national or international designation but also through the identification of its specific qualities. Scenic quality, rarity, conservational and recreational value of landscapes can be identified to varying levels. The level of value placed on a landscape in this assessment is illustrated in Table 3.3.

Table 3.3 Criteria to determine landscape value

CRITERIA	High	Medium	Low
Landscape Designation	National	Regional	No designation
Scenic Quality	An area of high scenic quality, unspoilt by inharmonious development with a clearly distinctive character.	An area of moderate scenic quality, reasonably unspoilt by inharmonious development with a distinct character.	An area of poor scenic quality, which has been subject to adverse changes to the landscape resulting in a loss of character.
Rarity	Rare	Some rare quality/qualities	Characteristics found commonly
Recreational Value	Recreational activities rely on the value of the landscape	Recreational activities benefit from the value of the landscape	Recreational activities do not gain necessary value from the landscape
Conservation Interests	Landscape contains A and B listed buildings, Scheduled Ancient Monuments and Designed Gardens and Landscapes.	Landscape contains C listed buildings and archaeological sites on the Sites and Monuments Record.	Landscape contains archaeological sites of lesser importance and non-inventory gardens and designed landscapes.
Perceptual Aspects	Remote, wild and sheltered	Modified, yet sparsely populated	Dynamic, windswept with presence of human influence

3.5.1.4 Magnitude of Landscape Effects

The Guidelines for Landscape and Visual Assessment (2013) states that:

*'the effects on landscape receptors needs to be assessed in terms of its **size or scale**, the **geographical extent** of the area influenced, and its **duration and reversibility**'.*

The size and scale of the effect should consider the following:

- The extent of existing landscape elements that will be lost, the proportion of the total extent that this represents and the contribution of that element to the character of the landscape;
- The degree to which aesthetic or perceptual aspects of the landscape are altered either by the removal of existing components or by adding new components;
- Whether the effect changes the key characteristics of the landscape, which are critical to its distinct character.

The geographical extent of effect is considered to identify the scale of the aforementioned effects. For example, whether the effects occur at the site level, at the level of the immediate setting of the site, at the scale of the landscape type or character area, or on a larger scale (e.g. over several landscape character areas).

The duration of an effect can be judged to be either short, medium or long term in relation to the construction and operational phases of the development. The division of classification is set at the following timescales:

- Short term is defined as effects that occur during the construction phase
- Medium term is defined as effects that occur for a portion of the operational phase
- Long term is defined as effects that occur for the development's entire period of operation

The reversibility of the effect is assessed to be reversible, partially reversible or permanent.

After these different aspects of the effects are evaluated the overall effect will be categorised to aid conclusions. The categories may be combined (i.e. Slight – Moderate). A description of the categories of magnitude of impact is given below:

- **Substantial** – total loss of or major alteration to key elements/ features/ charactersitics of the baseline
- **Moderate** – partial loss of or alteration to one or more key elements/features/charactersitics of the baseline
- **Slight** – Minor loss or alteration to one or more key elements/ features/ characteristics of the baseline
- **Negligible** – Very minor loss or alteration to one or more key elements/ features/ characteristics

3.5.1.5 Cumulative Landscape Capacity

The existing landscape resource has been evaluated to determine its capability to accommodate further wind turbine development within the study area. The landscape baseline and a list of operational and consented wind turbine projects in the area have been utilised to aid this process. Each landscape character area has been classified as having either of the following levels of capacity to accommodate further wind turbine development:

- **Low** – The landscape provides few opportunities for wind turbine development and may be at/or close to capacity. Potential wind turbine development would be required to be sensitive to the landscapes particular characteristics and confined to only a few specific areas. Development may be considered to be significant in the majority of areas.
- **Medium** - The landscape provides some opportunity for wind turbine development. Potential wind turbine development would be required to be sensitive to the landscape and confined to certain characteristic areas. Development may not be significant if sited and designed with consideration given to the landscapes specific sensitivities.
- **High** – The landscape provides opportunity for wind turbine development within many areas. The landscape is tolerant of change and sensitively sited and designed developments will not have a significant effect.

3.5.1.6 Magnitude of Cumulative Landscape Effects

The magnitude of change is categorised overall as Substantial, Moderate, Slight or Negligible. Additionally, in order to make a more detailed assessment these categories may also be combined (i.e. Slight – Moderate). A description of the categories of magnitude of impact is given below:

- **Substantial** – The capacity of the landscape is exceeded with wind turbine development becoming a dominant feature
- **Moderate** – The capacity of the landscape would not be exceeded but wind turbines may become locally dominant in a part of the landscape
- **Slight** – The capacity of the landscape would not be exceeded nor would key landscape characteristics be altered to a significant extent
- **Negligible** – The capacity of the landscape would not be exceeded and the additional development will not have a discernible increase in the visibility of wind turbine development

3.5.1.7 Significance of Effect

The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011 emphasise the requirement to identify 'significant' environmental effects created by a proposal.

Significant landscape effects occur when landscape elements or key landscape characteristics are altered, replaced or lost creating a localised area of landscape that is characterised by the

development. Consequently, the effects result in a newly defined landscape character area that is categorically separate to its original host landscape character area.

To correctly determine whether effects are significant a competent approach should be followed that is both proportional and appropriate to the scale of the development. The process therefore requires professional judgement to identify when the threshold of an effect is significant.

However, in addition to professional judgement it is helpful to show using a matrix (Table 3.4) how combinations of sensitivity and magnitude can result in significant effects and consequently where the threshold of significant effects may occur.

The overall significance of effect has been categorised as Major, Moderate, Minor or Negligible. The matrix in Table 3.4 provides a general scenario for the significance of predicted effects.

Table 3.4 Matrix of magnitude of change and sensitivity used to test the significance of landscape and visual impact.

MAGNITUDE	SENSITIVITY		
	High	Medium	Low
Substantial	Major	Moderate – Major	Moderate
Moderate	Moderate – Major	Moderate	Minor – moderate
Slight	Moderate	Minor – Moderate	Minor
Negligible	Negligible	Negligible	Negligible

3.5.2 Landscape Baseline

3.5.2.1 Scope of Landscape Assessment

There are thirteen landscape character types (LCTs) within the 25km study area that receive differing magnitudes of theoretical visibility of the wind farm (Figure 3.7). These landscape character types have been preliminarily reviewed in Table 3.5 to assess their potential to receive significant effects. Landscape character types that are assessed to be at risk to potential significant effects are assessed in more detail.

Table 3.5 Screening review of landscape character types

LANDSCAPE CHARACTER TYPE	Potential for significant effects
Igneous Hills	The host LCT receives limited visibility generally confined to the immediate local area. The wind farm is situated in the north of this LCT where visibility is largely contained, whereas views to the south are largely restricted. Localised effects require further assessment.
Broad Valley Lowland	Widespread visibility is predicted of the wind farm in parts of this LCT, in particular to the Strathearn area to the north and west of the closest section of the LCT. Although clearly separate in character from the Igneous Hills LCT effects to this landscape will be assessed further.
Lowland Hills	Some southern slopes of the Lowland Hills LCT situated above the Broad Valley Lowland LCT to the north of the wind farm are predicted to receive theoretical visibility of the wind farm. Situated over 5km away there is still potential for significant effects and thus this LCT will be assessed further.
Lowland River Corridors	Areas to the north and west of this LCT receive visibility in patches. The LCT is small-medium scale and semi-enclosed consequently making it sensitive to the influence of larger scale development but unlikely to be significantly affected. For the avoidance of doubt this LCT is assessed further.
The Uplands	Extremely limited visibility to the LCT is predicted around the Lomond Hills at a distance of over 20km from the wind farm. There is no potential for significant effects and consequently this LCT is not assessed any further.

Highland Glens	There are a few areas where visibility of the wind farm is predicted in the Lower Highland Glens LCT surrounding Crieff. It is considered that a combination of screening by extensive broadleaf and coniferous woodland and the LCT's distance of approximately 15km from the wind farm will limit the potential influence of the development on this LCT. Extremely limited visibility is also predicted to the Upper Highland Glens LCT at a distance of over 20km from the wind farm. Potential significant effects are not predicted to this enclosed landscape type. This LCT is not assessed any further.
Highland Summits and Plateau	Moderate visibility is predicted to this remote and wild landscape at a distance of over 19km from the wind farm. The LCT is sensitive to the introduction of development and although distant from the development it will be assessed further.
Firth Lowlands	The LCT would receive limited visibility of a varied proportion of the wind farm at a distance of over 21km. The LCT is well-settled with the A90 influencing parts of the landscape. Consequently, this human influenced LCT does not have potential to be significantly affected by the development.
Open Moorland Hills	There would be a small area of theoretical visibility to this LCT at a distance of over 24km from the wind farm. The wind farm would be seen within the same context as areas of the Broad Valley Lowlands and the Lowland Hills LCTs that are heavily modified by the A90 transport corridor and intermittent settlements. There is no potential for significant effects and consequently this LCT is not assessed any further.
Upland Slopes	A small area, but proportionately large extent of this LCT would receive theoretical visibility of the development. When reviewed in greater detail through the use of a hub height ZTV (Figure 3.5) it is identified that for the majority of the affected area only between one and three of the wind turbines will be visible to hub height. The extent of effects at this distance (17km) is not considered to be potentially significant.
Lowland River Basin	Extremely limited visibility to the LCT is predicted of between 1-3 wind turbines at a distance of over 22km from the wind farm. There is no potential for significant effects and consequently this LCT is not assessed any further.
Lowland Hills and Valleys	Extremely limited visibility to the LCT is predicted of between 1-3 wind turbines at a distance of over 14km from the wind farm. There is no potential for significant effects and consequently this LCT is not assessed any further.
Dolerite Hills	A small area within this slight LCT would receive theoretical visibility of the development. When reviewed in greater detail through the use of a hub height ZTV (Figure 3.5) it is identified that in the affected area only between one and six of the wind turbines will be visible to hub height. The extent of effects at this distance (17km) is not considered to be potentially significant.

3.5.2.2 Local Landscape Character Area

The landscape character area surrounding the development is assessed in a landscape study undertaken to assess the potential for 'windfarm development in the Ochil Hills and part of Southern Highland Perthshire' (David Tyldesley and Associates, 2004). The landscape sub-unit, Northern Hills: Black Hill of Kippen, was assessed across 5 criteria as to whether it has potential to accommodate windfarms. In 4 of the 5 criteria the landscape area is deemed to have a high potential to accommodate wind farms and consequently the study states that overall the area has a higher potential to accommodate windfarms. A criterion that was categorised to have lower potential to accommodate wind farms was related to a lack of evidence of 'modern settlement, buildings or structures'. The relationship between the development and this aspect of the landscape character area is therefore assessed in greater detail in this chapter.

According to the Tayside landscape character assessment [xvii] the development would be situated within the Igneous Hills landscape character type.

LANDSCAPE CHARACTER AREA		*Igneous Hills*
BASELINE DESCRIPTION		The proposed wind farm would be situated within the *Igneous Hills* LCT, which comprises The Ochil hill range. The hills short, steep glens formed by short rivers define a simple, medium scale landscape that is framed by more dramatic scarp slopes to the north of the hill range. The land contained within the LCT is not particularly fertile and consequently land use is predominantly made up of contrasting agricultural grazing and conifer plantations. The agricultural grazing land allows for an open landscape, whilst coniferous plantations, in particular to the south and southeast of Knowes, ensure that this landscape is more enclosed. Locally, the landscape surrounding Knowes comprises of the more open grazing land that typifies hills such as Black Hill of Kippen and Priest Knowe. Settlement in the area is generally sparse, although human influence can be seen closer to transport routes (A823 and B934) and the borders of the LCT with its neighbouring LCTs to the north and south.
CHARACTERISTICS	POSITIVE	- Open landscapes surrounding conical hill summits - Burns and rivers that flow from short steep glens - Distinctive scarp and dipslopes to the north and south of the Ochils - Limited settlement
	NEGATIVE	- A few modern influences, such as telecommunication masts - Plantation coniferous woodlands that locally enclose parts of the LCT

3.5.2.3 Neighbouring Landscape Character Areas

There are a few neighbouring landscape character areas that have the potential to theoretically receive significant effects from the proposed development. The areas that are additionally considered within the landscape assessment include the Broad Valley Lowlands, Lowland Hills, Lowland River Corridors and Highland Summits and Plateau landscape character types.

LANDSCAPE CHARACTER AREA		*Broad Valley Lowlands*
BASELINE DESCRIPTION		The *Broad Valley Lowlands* LCT is predominantly situated beneath The Ochil hill range to the north of Knowes with further areas situated to the north beyond the *Lowland Hills* LCT at a distance of approximately 6km. The broad straths provide an open and medium scale landscape that in less wooded areas allows for views to the neighbouring *Igneous Hills* and *Lowland Hills*. In particular, The Ochils to the south and the Gask Ridge to the north are often visible and enclose this LCT. Prominent characteristics within the LCT include the River Earn meandering across the flood plain, as well as the busy A9 dual carriageway and railway line between Auchterarder and Perth. Settlement is reasonably sparse with larger villages, such as Dunning and Forgandenny situated in between the River Earn and the *Igneous Hills* LCT. Overall, the landscape is a rich, well-wooded agricultural landscape with a noticeable transport corridor.
CHARACTERISTICS	POSITIVE	- Rich well-wooded agricultural landscape - Broad straths - River Earn meanders back and forth across the flood plain
	NEGATIVE	- Presence of busy A9 dual carriageway and railway line - Tree loss has weakened landscape character

LANDSCAPE CHARACTER AREA		*Lowland Hills*
BASELINE DESCRIPTION		The *Lowland Hills* LCT defines several strips of land to the north and to the west of Knowes. The LCT is characterised by pastoral and arable fields on its lower slopes and rough grazing and moorland on its higher ground. In addition to these land covers there is a considerable amount of geometric coniferous forestry in certain areas of the LCT. The varying land cover provides different levels of enclosure that can be greater within lower wooded areas and more open on higher ground. Historically rich in prehistoric remains, traditional settlements and castles the landscape is reasonably sensitive to untraditional development. However, the A9 dual carriageway climbs over the Gask Ridge introducing movement to a traditionally still landscape and some modern expansion to villages (e.g. Bankfoot) have occurred in recent years.
CHARACTERISTICS	POSITIVE	- Evidence of historic settlements
	NEGATIVE	- Influence of modern development to settlements - Presence of busy A9 dual carriageway

LANDSCAPE CHARACTER AREA		*Lowland River Corridors*
BASELINE DESCRIPTION		The *Lowland River Corridors* LCT is well defined with narrow corridors up to 3km wide. The LCT is situated to the north and northeast of Knowes at a distance of approximately 13km to its nearest areas. The river valleys fluctuate in size and in some parts, particularly to the west and north of the LCT, they are enclosed with steep slopes that are clothed in deciduous woodland. The LCT is largely undisturbed by settlement but the location of the LCT near to gateways to the Highlands and the city of Perth has meant that a number of mill settlements and historical houses and designed landscapes have been introduced. Outward views beyond the LCT would be constrained to the upper slopes of the valleys where woodland does not provide screening.
CHARACTERISTICS	POSITIVE	- Well defined river corridors with meandering - Peaceful and undisturbed - Presence of historic houses and designed landscapes
	NEGATIVE	- Declining presence of hedge networks and hedgerow trees

LANDSCAPE CHARACTER AREA	*Highland Summits and Plateau*
BASELINE DESCRIPTION	The West Highlands hills within the Highland Summits and Plateau LCT comprise a number of upland hills that separate the principal glens of the area. The hills provide a large scale landscape that offers panoramic views from exposed elevated positions. The land cover is generally heather moorland below 600m AOD and above this height an alpine zone of screes and rock outcrops is present. Human settlement is very limited with only the remains of old shielings and droving roads identifiable as a result of human development. Other influences from patterns created from the burning of heather and the introduction of upland plantation conifer

		plantations are also noticeable. Overall, the LCT comprises one of the wildest landscapes in the UK that is sensitive to all types of development.
CHARACTERISTICS	POSITIVE	- Distinct hill summits and hill ranges - Extremely limited development - One of the remotest and wildest landscapes in the UK
	NEGATIVE	- Managed landscape

3.5.2.4 Scottish Natural Heritage Sensitivity Criteria

Scottish Natural Heritage has categorised Scotland into three zones depending on their natural heritage sensitivity. The criteria that separates the three different zones is explained below.

- **Zone 1**: Lowest natural heritage sensitivity identifies areas at the broad scale with least sensitivity to wind farms, with the greatest opportunity for development, within which overall a large number of developments could be acceptable in natural heritage terms, so long as they are undertaken sensitively and with due regard to cumulative impact.
- **Zone 2**: Medium natural heritage sensitivity identifies areas with some sensitivities to wind farms. However, by careful choice of location within these areas there is often scope to accommodate development of an appropriate scale, siting and design (again having regard to cumulative effects) in a way which is acceptable in natural heritage terms.
- **Zone 3**: High natural heritage sensitivity identifies areas of greatest sensitivity to wind farms, which place the greatest constraint on their development, and where, in general, proposals are unlikely to be acceptable in natural heritage terms. There may, however, be some sites in this zone where wind farm development of appropriate scale and careful design could be accommodated if potential impacts on the natural heritage are fully explored and guarded against by employing the highest standard in siting and design.

The Knowes Wind Farm is situated within an area classified as Zone 1. The surrounding area therefore presents the greatest opportunity for wind turbine development where a large number of developments may be acceptable .

3.5.2.5 Landscape Designations

Supplementary Guidance on landscape is currently being developed by Perth and Kinross Council and therefore until this is published the Council state the following regarding the assessment of development proposals:

Until it is possible to assess the acceptability of development proposals against Perth and Kinross-wide Supplementary Guidance on Landscape, priority will be given to safeguarding and enhancing the landscape of National Scenic Areas. The Tayside Landscape Character Assessment will be used for assessing development proposals, along with other material considerations.

The assessment of designated landscapes has therefore focused on National Scenic Areas in the study area, as well as designated Gardens and Designed Landscapes within a 10km radius of the wind farm.

There are no National Scenic Areas (NSA) situated within the study area. The nearest NSA is the River Earn (Comrie to St Fillans) NSA situated approximately 26km to the west of Knowes. The development at Knowes will not significantly affect the special qualities of this NSA due to it receiving limited visibility of the wind farm and its sufficient distance from the site. The River Tay (Dunkeld) NSA is also situated at a distance of approximately 26km to the north of Knowes. Similarly, the development at

Knowes will not significantly affect the special qualities of this NSA due to it receiving limited visibility of the wind farm and its sufficient distance from the site. These two NSAs are consequently not assessed in any further detail within this chapter.

Three Gardens and Designed Landscapes are situated within a 10km radius of the proposal. The Garden and Designed Landscape at Gleneagles to the west of Knowes would receive no visibility of the proposed wind farm and has consequently been scoped out of further assessment. The two other identified Garden and Designed Landscapes, Invermay and Dupplin Castle, would receive theoretical visibility of the wind farm and are consequently assessed in greater detail in the Environmental Statement.

3.5.2.6 Wind Turbine Developments

A list of operational, consented and proposed commercial wind turbine projects within 60km of the proposed project are listed in Table 3.6. The wind turbines listed have been used for the basis of the cumulative landscape and visual assessments.

Table 3.6 A list of operational, consented and proposed wind turbine projects within 60km of the proposal

Wind Turbine Development	Size of Project	Distance to Wind Turbine Development (km)
OPERATIONAL PROJECTS		
Green Knowes	18	6km
Lochelbank	12	9km
Burnfoot Hill	13	13km
FMC Technologies	1	27km
Little Raith	9	27km
Braes of Doune	36	28km
Noble Foods	1	29km
Calliacher	14	34km
Craigengelt	8	35km
Griffin Forest	68	37km
Methil Offshore Demo	1	37km
Glenhead	1	37km
Earlsburn	14	38km
Fintry	1	38km
Scotson Hill	1	43km
Ark Hill	7	46km
Torrance	3	46km
Netherton	2	47km
Grendykeside	2	48km
Wester Hassockrigg	1	50km
Bartlett	1	50km
Michelin Tyre Factory	2	51km
Pates Hill	7	52km
Tealing	1	52km
Braiden Hill	1	52km
CONSENTED PROJECTS		
Rhodders	15	14km
Feddal Farm	1	19km
Pitcairlie	1	20km
Wester Cambushinnie Farm	1	22km
Westfield OCCS	5	23km
Kirkton Farm	1	23km
Mossmoran	2	27km
Clentrie Cluster	3	29km
Wester Strathmore	1	29km
Asda Bankside	1	31km
Pitbladdo Farm	1	34km
Gardrum	1	37km
Dundee Cold Store	1	40km

Burnhead Moss	13	43km
Easter Glentore	1	44km
Greengairs	1	45km
Bellstane Farm	1	47km
AG Barr	1	48km
Orchardton Road	1	49km
Bonerbo, Balmonth and Drumrack	3	52km
Kenly	5	53km
Climpy Road	1	55km
CURRENT APPLICATIONS		
Glenfarg	2	9km
Bogside	1	19km
Demperston	1	20km
Goathill Quarry	1	27km
Noble Foods	1	29km
Creag A' Bhaird	13	29km
Skeddoway Farm	1	29km
Calliacher North	7	35km
East Fife Football Club	1	37km
Callendar Estate	10	37km
Torrance Ext	4	46km
Ormiston	1	46km
Easterton	8	47km
The Corb	1	47km
Tullymurdoch	7	46km
Pearie Law	6	51km
Gartverrie	1	51km
Springlaw	1	53km

3.5.3 Assessment of Landscape Effects

3.5.3.1 Local Landscape Character Area

An assessment of the significance of potential independent and cumulative landscape effects associated with the introduction of the proposal to the local landscape character areas is given below.

LANDSCAPE CHARACTER AREA		*Igneous Hills*
LANDSCAPE SENSITIVITY	*Scale*	The landscape is medium scale.
	Complexity	Generally smooth, open hill tops with some glens that are covered by plantation woodland and cut by rivers, roads and tracks.
	Condition	The landscape is in good condition with some areas altered by commercial forestry.
	Development	Largely unsettled with farmsteads mainly situated along or near to the A823 and the B934 roads.
	Context	The Igneous Hills LCT is elevated above neighbouring LCTs providing a backdrop to the surrounding area.
	Susceptibility to change	The overall susceptibility to change is medium-high.
	Value	The LCT is not designated, but is of high scenic quality with some rare qualities. Recreational activities within the LCT, such as hill walking rely on the landscape's qualities. There are no Category A listed buildings but there are a number of Scheduled Monuments in the LCT. Although generally managed and disturbed some localised areas are less disturbed than others and retain a greater sense of naturalness. The value of the landscape is considered to be medium-high.
	Overall Sensitivity	Sensitivity to wind turbine development is medium-high.
LANDSCAPE		There are currently three operational wind farms in the Ochil Hills at

CAPACITY		Green Knowes, Lochelbank and Burnfoot Hill and two consented wind farms at Burnfoot Hill Extension and Rhodders. Intervisibility between Lochelbank and the developments to the west is limited due to screening from the rolling topography of the landscape. There is therefore potential for further sensitive development within the Ochil Hills where cumultive effects are limited if this does not result in a detriment to the wider landscape character.
		The level of capacity for further wind turbine development within this LCT is medium.
NATURE OF EFFECTS	*Independent*	Areas affected by the development would largely be localised and confined to small sections to the north and east of the LCT, whilst a few elevated summits to the south and southwest may receive partial visibility of a limited number and proportion of the turbines. The greatest potential for significant effects to the integrity of the LCT would be in the immediate local surroundings, smaller scale areas and areas that are managed yet undeveloped by characteristic farmsteads and dwellings. Knowes wind farm would be set atop medium scale hills within reasonable proximity to one of two significant transport routes through the Ochils and not far from the influence of the more developed Broad Valley Lowlands LCT. Locally, the development will have a significant effect on the wind farm site due to the scale of the wind turbines and it is predicted that the characteristics of this small area will be altered. However, overall the wind turbines are considered to be appropriate in size for the scale of the LCT and are not situated within the more sensitive areas identified.
	Cumulative	There would be limited intervisibility between Knowes and nearby wind farm projects situated within the Ochil Hills. In particular, Green Knowes and Burnfoot Hill plus its Extension to the west and southwest would only be theoretically intervisible intermittently from elevated summits to the west, south and east and very occasionally distant successive views on the minor road between Forteviot and Glenfarg. There is potential for combined visibility occasionally from these limited areas to the southwest and east of the LCT. Intervisibility between Lochelbank and Knowes is also limited to localised areas surrounding Lochelbank where the proposed turbine at Templehill will also be visible and intermittently from elevated summits to the south and east. Overall, a limited extent of the LCT would receive cumulative views of local wind turbine projects that are generally at a distance where the associated level of effect can be accommodated by the LCT.
MAGNITUDE OF EFFECTS	*Independent*	The magnitude of effect to the LCT would be locally major but slight overall. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
	Cumulative	The magnitude of cumulative effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
SIGNIFICANCE OF EFFECTS		Overall, the predicted landscape effects on the Igneous Hills LCT would be moderate and not significant. However, significant effects would occur to the landscape of the development site.

3.5.3.2 Neighbouring Landscape Character Areas

An assessment of the significance of potential independent and cumulative landscape effects associated with the introduction of the proposal to the neighbouring landscape character areas is given below.

LANDSCAPE CHARACTER AREA		*Broad Valley Lowlands*
LANDSCAPE SENSITIVITY	*Scale*	The landscape is medium scale and generously proportioned.
	Complexity	Broad straths are generally simple with locally complex topography including outwash terraces, eskers and dry valleys.
	Condition	The landscape is reasonably intact but has been modified for agriculture and transport (A9).
	Development	Small villages, market towns and scattered rural dwellings along with transport routes influence landscape character.
	Context	The LCT provides a foreground to views beyond to the Igneous Hills LCT.
	Susceptibility to change	The overall susceptibility to change is low-medium.
	Value	The LCT is not designated and is of moderate scenic quality comprising fairly widespread characteristics. Recreational activities do not generally depend on the quality of the landscape; however, there are a significant number of nationally designated cultural and heritage features that are appreciated. Movement along transport corridors reflects a moderate level of human intervention. The value of the landscape is considered to be low-medium.
	Overall Sensitivity	Sensitivity to wind turbine development is low-medium.
LANDSCAPE CAPACITY		There are currently no operational or consented wind turbine developments in this LCT within the study area. However, the LCT does receive peripheral views of the wind farm at Lochelbank that may locally limit the landscape's capacity to accommodate further development to the east near Bridge of Earn and Forgandenny. More limited influences occur to the west of the LCT from the wind farms at Green Knowes, Bankfoot and Rhodders.
		The level of capacity for further wind turbine development within this LCT is medium.
NATURE OF EFFECTS	*Independent*	The wind turbines at Knowes would be visible from a large portion of this LCT, in particular to the immediate north and also to the northwest within Strathearn. Visibility of the development in many parts would be of at least the hub and the blades of all the turbines; however, in the western areas of the LCT visibility is reduced to fewer of the wind turbines. The wind farm will be clearly separate from this LCT due to the contrasting land form of the Ochil hills LCT, yet accommodated by the simple and reasonably developed landscape that sits within the broad straths.
	Cumulative	The greatest potential for cumulative effects within the LCT is from the relationship between Knowes and the five consented and operational developments in the western Ochil hills outwith the LCT at Green Knowes, Burnfoot Hill and Extension and Rhodders. Indirect cumulative effects are generally confined to the northwestern parts of Strathearn to the north of Auchterarder. Each of these developments is situated at a distance greater than 5km from this area of the LCT and consequently their individual effects to the Broad Valley Lowland LCT are limited but when seen in the same arc of view within the Ochil hills the overall potential for effects is increased.

		Knowes would add to the baseline of well-spaced wind farm developments visible from within the LCT and would be seen separate and elevated from the Broad Valley Lowlands in a different context reducing each of the wind farms influence on this LCT.
MAGNITUDE OF EFFECTS	*Independent*	The magnitude of effect to the LCT would be moderate. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
	Cumulative	The magnitude of cumulative effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
SIGNIFICANCE OF EFFECTS		Overall, the predicted landscape effects on the Broad Valley Lowlands LCT would be moderate and not significant.

LANDSCAPE CHARACTER AREA		*Lowland Hills*
LANDSCAPE SENSITIVITY	*Scale*	The landscape is medium scale.
	Complexity	Generally smooth and well-rounded, open hills with geometric coniferous forestry plantations.
	Condition	The landscape remains reasonably intact with modification from changing agricultural use and woodland plantation.
	Development	Settlement is sparse with growth occuring primarily among villages along transport routes. The A9 dual carriageway, electricity pylons and telecommunication masts are present in a few modified areas.
	Context	The LCT provides a foreground to views beyond to the Igneous Hills LCT.
	Susceptibility to change	The overall susceptibility to change is medium.
	Value	The LCT is not designated and is of moderate scenic quality comprising fairly widespread characteristics. Certain recreational activities can depend on the quality of the landscape. There are a significant number of nationally designated cultural and heritage features that are appreciated within a landscape with reasonably little human intervention. The value of the landscape is considered to be medium.
	Overall Sensitivity	Sensitivity to wind turbine development is medium.
LANDSCAPE CAPACITY		Within the study area wind turbine developments are located in two separate areas of this LCT. An area of the LCT approximately 14km to the southwest of Knowes comprises the operational Burnfoot Hill, consented Burnfoot Hill Extension and Rhodders developments. Approximately 22km to the west of Knowes in a separate area of the same LCT the consented development at Feddal Farm is also located. This area of the LCT also receives peripheral views of the wind farms at Lochelbank, Green Knowes, Burnfoot Hill and Extension and Rhodders from a distance of over 5km. Given the sensitivity of the landscape and the proportion of the LCT that is influenced by wind turbine development at close range there is further scope to develop wind turbines sensitively.
		The level of capacity for further wind turbine development within this LCT is medium.
NATURE OF EFFECTS	*Independent*	The more elevated Lowland Hills LCT would be theoretically influenced by the Knowes Wind Farm to a moderate extent in areas to the north and to a lesser extent distantly to the west. From the

		north the LCT provides panoramic vistas to the south of the Ochil hills over the Broad Valley Lowlands from distances varying between 6 and 25km. It is considered that vistas will show the development occupying a proportionately small area within the context of the large scale Ochil hills. The magnitude and extent of effects to the west will be reduced given the smaller number of turbines from the wind farm that will be visible. To the southwest parts of the Knowes wind farm will be seen from a few elevated summits within the context of this LCT and also the Igneous Hills LCT. Overall, the effects to the LCT will be small scale over a moderate extent of the areas, in particular to the north.
	Cumulative	The addition of Knowes to the cumulative baseline would result in limited and some minor distant cumulative effects to this LCT. Specifically, areas situated in close proximity to the turbine at Feddal Farm would receive a very distant minor addition of a varying portion of the Knowes development. Areas of the LCT to the southwest would be intermittently influenced from elevated summits by Knowes in addition to the wind farms at Burnfoot Hill and Rhodders. The effects of these wind farms would be limited in area and would not provide a new characteristic element to the landscape. From a distance (over 5km), areas of this LCT to the north of Knowes will also be influenced to a moderate extent by the other wind farms situated in the Ochil hills. Knowes would add to the baseline of well-spaced wind farm developments and would be seen in a separate context to this LCT.
MAGNITUDE OF EFFECTS	*Independent*	The magnitude of effect to the LCT would be moderate. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
	Cumulative	The magnitude of cumulative effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
SIGNIFICANCE OF EFFECTS		Overall, the predicted landscape effects on the Lowland Hills LCT would be moderate and not significant.

LANDSCAPE CHARACTER AREA		*Lowland River Corridors*
LANDSCAPE SENSITIVITY	*Scale*	The landscape is small-medium scale.
	Complexity	Varies between reasonably complex broader lowland landscapes to very complex narrow corridors with extensive semi-natural woodland.
	Condition	Generally in good condition with few uncharacteristic alterations to the LCT.
	Development	A large number of historic houses, landscaped estates and castles are situated within the LCT.
	Context	The LCT is enclosed by its valley slopes with limited opportunities to influence neighbouring LCTs.
	Susceptibility to change	The overall susceptibility to change is high.
	Value	The LCT is not designated and is of high scenic quality comprising a distinctive character with development from a range of different historic time periods. Certain recreational activities can depend on the quality of the landscape, whilst there are a significant number of nationally designated cultural and heritage features that are appreciated. The value of the landscape is considered to be medium.

	Overall Sensitivity	Sensitivity to wind turbine development is medium-high.
LANDSCAPE CAPACITY		There are no wind turbine developments situated in areas of this LCT in the study area. The influence of wind turbine development from outwith this LCT is considered to be limited. However, capacity for wind turbine development is constrained by the scale of the landscape and its distinctive characteristics. The size and number of future wind turbine developments would therefore have to be sensitive in location, size and number.
		The level of capacity for further wind turbine development within this LCT is low.
NATURE OF EFFECTS	*Independent*	The LCT would receive moderate distant visibility of the wind farm on the higher parts of its south facing slopes. Where visible on these slopes the wind farm would appear as a minor addition to the landscape baseline covering a narrow extent of the broad scarp slopes of the Ochils. The small scale appearance of the wind farm at this distance would be suited to the characteristics of this LCT reducing the potential for effects to the integrity of the landscape. However, a large proportion of these areas are extensively covered by semi-natural woodland with views limited by the screening it presents. The area is also enclosed with views tending to be focused on the valley corridors where the movement of the rivers draws the eye. The potential for views and associated effects in this LCT is therefore limited.
	Cumulative	The potential for cumulative effects is limited given the absence of any consented and operational wind turbines in the LCT. Cumulative effects to the LCT are therefore likely to occur as a result of the relationship between the wind farm at Knowes and the closest wind turbine developments to this LCT or those within a similar arc of view. The nearest project to the LCT is the proposed wind farm at Mull Hill. Effects between Knowes and Mull Hill would be limited due to two reasons, specifically distance between the two projects (21km) and the different view directions required to see both wind farms from the LCT. Other potential effects include the distant views of the elevated wind farm developments that are visible within the Ochil hills. These developments are situated at a distance of approximately 13km from the LCT and would similarly be seen as small scale elements within a small scale landscape.
MAGNITUDE OF EFFECTS	*Independent*	The magnitude of effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
	Cumulative	The magnitude of cumulative effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
SIGNIFICANCE OF EFFECTS		Overall, the predicted landscape effects on the Lowland River Corridors LCT would be minor and not significant.

LANDSCAPE CHARACTER AREA		*Highland Summits and Plateau*
LANDSCAPE SENSITIVITY	*Scale*	The landscape is large scale.
	Complexity	A simple mountainous landscape with distinctive changes in land cover relating to height. Heather burning and plantation woodland also introduces varied land use patterns.

	Condition	A partially managed landscape at lower elevation that has only been lightly modified. Higher and more remote areas have wilderness qualities.
	Development	Development is extremely limited with old shielings and droving roads visible within the landscape.
	Context	The LCT provides a backdrop to the lower settings of neighbouring LCTs.
	Susceptibility to change	The overall susceptibility to change is low-medium.
	Value	Areas of this remote and wild LCT within the study area are not designated for the quality of the landscape or for cultural heritage features but do offer high scenic quality. Recreational activities, such as walking, rely on the value of the landscape. Overall, the value of the landscape is considered to be medium-high.
	Overall Sensitivity	Sensitivity to wind turbine development is medium.
LANDSCAPE CAPACITY		There are no operational or consented wind turbines within the area of this LCT in the study area; however, a wind farm is proposed at Mull Hill. The influence of wind turbine development from outwith this LCT is considered to be limited. However, capacity for wind turbine development is constrained by its unspoilt characteristics. The size and number of future wind turbine developments would therefore have to be sensitive in location, size and number.
		The level of capacity for further wind turbine development within this LCT is medium.
NATURE OF EFFECTS	*Independent*	Two areas of this LCT are situated at a distance of over 19km from Knowes Wind Farm. In these two areas visibility of the wind farm is fairly widespread on southeast facing slopes of the hills. The wind farm will be a minor feature within a distant landscape that is set across a variety of medium scale, reasonably open landscapes between the Igneous Hills LCT and the Highland Summits and Plateau LCT.
	Cumulative	The potential for cumulative effects is limited given the absence of any consented and operational wind turbines in the LCT. Cumulative effects to the LCT are therefore likely to occur as a result of the relationship between the wind farm at Knowes and the closest proposed, consented and operational turbine developments to this LCT or those within a similar arc of view. There is some intervisibility between Knowes and the proposed Mull Hill project in the LCT; however, effects are likely to be limited given the distance between the two projects. The seven other projects that would be visible are all reasonably distant and are also only minor additions to the cumulative landscape baseline of the LCT.
MAGNITUDE OF EFFECTS	*Independent*	The magnitude of effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
	Cumulative	The magnitude of cumulative effect to the LCT would be slight. Effects from the wind turbines would be long term but reversible at the end of the operational phase.
SIGNIFICANCE OF EFFECTS		Overall, the predicted landscape effects on the Highland Summits and Plateau LCT would be minor and not significant.

3.5.3.3 Landscape Designations

Following the intial baseline review of designated landscapes within the study area only two designated Gardens and Designed Landscapes at Invermay and Dupplin Castle required further assessment. The two sites are assessed in detail in the Cultural Heritage chapter (8.5.4) and consequently an assessment has not been included in this chapter.

3.6 Visual Assessment

The 'Guidelines for Landscape and Visual Impact Assessment' (Third Edition, 2013) published by The Landscape Institute and the Institute of Environmental Management and Assessment includes the following concerns which are to be evaluated within the scope of a development's visual assessment:

'how the surroundings of individuals or groups of people may be specifically affected by changes in the content and character of views as a result of the change or loss of existing elements of the landscape and/or introduction of new elements'.

The visual assessment therefore focuses on identifying the 'changes in the content and character' to key views surrounding the proposal and assessing whether these potential changes will have significant adverse effects to the visual baseline.

3.6.1 Visual Assessment Methodology

3.6.1.1 Independent Visual Assessment Methodology

The visual assessment has been carried out in three separate stages in accordance with guidance set out within the 'Guidelines for Landscape and Visual Impact Assessment' (2013).

- Firstly, a desktop study was undertaken to identify the visual envelope of the project by generating turbine hub height and blade tip Zones of Theoretical Visibility with Resoft WindFarm software Version 4.2. The resultant maps enabled the study area of the visual assessment to be confirmed, as well as the identification of specific sensitive receptors. Consequently, the identified sensitive receptors informed the selection of viewpoints for assessment, including settlements and route corridors.

- A number of viewpoints were consequently selected and a subsequent field assessment was undertaken to undertake photography and establish the visual baseline. Photomontages and wireframes were then produced to illustrate the development within the landscape and setting.

- The overall level of effect has then been reasoned through combining the separate judgements on the criteria set out in 3.6.1.4 and 3.6.1.5. This process is not reliant on a matrix, but acknowledges that it is helpful to use a matrix to show the likely significance of effect. The significance of the identified effects is then explained by drawing out the key issues.

3.6.1.2 Cumulative Visual Assessment Methodology

Cumulative visual effects may be caused by 'combined visibility' and/or 'sequential effects'. The Scottish Natural Heritage (2012) guidance document on 'Assessing the Cumulative Impact of Onshore Wind Energy Developments' (SNH, 2012) defines these effects as follows:

'Combined visibility occurs where the observer is able to see two or more developments from one viewpoint. Assessments should consider the combined effect of all windfarms which are (or would be) visible from relevant viewpoints. Combined visibility may either be in combination (where several windfarms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various windfarms).

And,

'Sequential effects occur when the observer has to move to another viewpoint to see different developments. Sequential effects should be assessed for travel along regularly-used routes like major roads, railway lines, ferry routes, popular paths, etc. Sequential effects may range from frequently sequential (the features appear regularly and with short time lapses between) to occasionally sequential (long time lapses between appearances) depending on speed of travel and distance between the viewpoints.'

The cumulative visual assessment has been undertaken with consideration of these potential effects and with further consideration to the guidance set out by Scottish Natural Heritage. As such the assessment has followed a three step process:

- The establishment of a cumulative base plan, including existing development (either built or under construction), approved development and proposals awaiting determination within the planning process.
- The identification of a cumulative study area encompassing other wind turbine developments likely to interact with the proposal and local and regional transport routes requiring assessment of potential sequential cumulative effects.
- An assessment of the potential cumulative visual effects and their significance, which takes into consideration both the sensitivity of the receptor and the magnitude of change to the visual baseline. This process is not reliant on a matrix, but acknowledges that it is helpful to use a matrix to show the likely significance of effect. The significance of the identified effects is then explained by drawing out the key issues.

3.6.1.3 Visual Receptor Groups

The visual assessments have considered the following potentially sensitive visual receptor groups: travellers, residents, visitors/tourists and workers.

Travellers

All transport route corridors have been considered within the study area when selecting viewpoints for the visual assessment. The travellers considered during the selection process are those using roads, railway lines, cycle routes and footpaths. Although not all routes have been assessed the assessment has considered key corridors that traverse the study area as well being highlighted throughout the ZTV mapping. Other factors influencing inclusion within the assessment are route classification, traffic volume and the proximity of the network to the development.

Settlements and Residents

Receptors from settlements and individual residential buildings are considered to have high sensitivity to wind farm development. In particular where principal views are potentially affected it is likely that a long term interference may occur to the current visual baseline. Secondary views are likely to be less sensitive as they will not receive the same duration of viewing over the projects operational lifetime. Principal views are illustrated in Viewpoints 2,3,4,5,6,9,10,11 and 12.

Visitors/Tourists

Included within this receptor group are those that derive enjoyment from the surrounding landscape whilst undertaking recreational pursuits, cultural visits and sporting activities. There is potential for variation in sensitivity to changes caused by development between the various activities included. For instance, hill walking derives vast enjoyment from the surrounding scenery, whereas more skill based

activities may provide less opportunity for viewing the surrounding scenery. The assessment has included key walking routes in the local area.

Workers

Receptors at their place of work are not considered to depend on the appreciation of the landscape and are therefore considered to be less sensitive to visual effects than other receptors. Potential effects on workers are considered in Viewpoint 5.

3.6.1.4 Visual Receptor Sensitivity

Both the susceptibility of a visual receptor to change and the value attached to a view has been taken into account in the criteria to assess visual sensitivity. The criteria, defined as high, medium or low, have been summarised in Table 3.7 to assess how sensitive a particular viewpoint would be to a wind turbine development in terms of potential visual effects.

Table 3.7 Criteria used to assess visual sensitivity

	SENSITIVITY		
	High	Medium	Low
VISUAL RECEPTORS	Receptors including those from strategic recreational footpaths, dwellings (principal views), community path networks, important landscape features, beauty spots, picnic areas and cultural and heritage buildings or structures.	Receptors including dwellings (secondary views) and those recreational users who derive enjoyment from the landscape, such as visitors to castles, users of secondary footpaths, road users or other methods of transport where views are important.	Receptors including those recreational users who do not depend on the appreciation of the landscape, such as places of work and road users or methods of transport where views are not important.

3.6.1.5 Magnitude of Visual Impact

In accordance with the Guidelines to Landscape and Visual Impact Assessment (2013) the magnitude of visual effects should be evaluated in terms of its 'size and scale, the geographical extent of the area influenced, and its duration and reversibility'.

The size and scale of the effect takes into account:

- The scale of the change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the proposed development;
- The degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line, height, colour and texture;
- The nature of the view of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

The geographical extent of effect takes into account the distance of the viewpoint from the proposed development and the extent of the area that the development will occupy within the view.

The duration of an effect can be judged to be either short, medium or long term in relation to the construction and operational phases of the development. The division of classification is set at the following timescales:

- Short term is defined as effects that occur during the construction phase
- Medium term is defined as effects that occur for a portion of the operational phase

- Long term is defined as effects that occur for the development's entire period of operation

The reversibility of the effect is assessed to be either reversible, partially reversible or permanent.

After these different aspects of the effects are evaluated the overall effect will be categorised to aid conclusions. The categories may be combined (i.e. Slight – Moderate). A description of the categories of magnitude of impact is given below:

- **Substantial** – total loss of or major alteration to key elements/ features/ characteristics of the baseline
- **Moderate** – partial loss of or alteration to one or more key elements/features/characteristics of the baseline
- **Slight** – Minor loss or alteration to one or more key elements/ features/ characteristics of the baseline
- **Negligible** – Very minor loss or alteration to one or more key elements/ features/ characteristics

3.6.1.6 Significance of Effect

The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2011 emphasise the requirement to identify 'significant' environmental effects created by a proposal.

Significant visual effects occur when a view is defined by the presence of the development based on the experience of the assessor who believes that the effects are equivalent to the 'significant effects' referred to in the Regulations.

To correctly determine whether effects are significant a competent approach should be followed that is both proportional and appropriate to the scale of the development. The process therefore requires professional judgement to identify when the threshold of an effect is significant.

However, in addition to professional judgement it is helpful to show using a matrix (Table 3.4) how combinations of sensitivity and magnitude can result in significant effects and consequently where the threshold of significant effects may occur.

The overall significance of effect has been categorised as Major, Moderate, Minor or Negligible. The matrix in Table 3.8 provides a general scenario for the significance of predicted effects.

Table 3.8 Matrix of magnitude of change and sensitivity used to test the significance of landscape and visual impact.

MAGNITUDE	SENSITIVITY		
	High	Medium	Low
Substantial	Major	Moderate – Major	Moderate
Moderate	Moderate – Major	Moderate	Minor – moderate
Slight	Moderate	Minor – Moderate	Minor
Negligible	Negligible	Negligible	Negligible

3.6.2 Viewpoint Assessment

An assessment of viewpoints from settlements, local dwellings, key transport corridors and sensitive cultural and historic sites has been undertaken to provide a good overview of the context that the project will be situated.

A cumulative viewpoint assessment has also been produced to describe, visually represent and assess the ways in which the proposal would have additional impacts when considered together with wind turbine projects situated close to the proposed location of the wind turbine project.

3.6.2.1 Viewpoint Selection

A range of viewpoints were selected where significant views of the project were predicted using the the Knowes wind Farm hub and blade tip Zones of Theoretical Visibility generated. Views from a variety of angles and distances are shown so that the assessment is representative of different areas and receptor groups. The viewpoints were chosen to show views received at significant transport corridors, settlements, visitor/tourist destinations and cultural features and also to provide key cumulative vistas.

The final selected viewpoints and the potential receptors are given in Table 3.9 with exact locations shown on Figure 3.22 in Volume 3.

Table 3.9 Viewpoints considered throughout the LVIA

Viewpoint		Grid References	Distance and direction to the nearest turbine	Receptor
VP1	A9	301446, 717802	6.1km	Travellers
VP2	Dunning	302038, 713923	2.4km	Residents
VP3	Forteviot	304632, 717818	7.0km	Residents and travellers
VP4	Clathymore	301033, 721031	9.3km	Residents
VP5	Aberuthven	298256, 715781	4.9km	Residents, travellers and workers
VP6	St David's	294685, 719867	10.3km	Residents
VP7	A90	312931, 719597	14km	Travellers
VP8	Kinnoull Hill	313677, 722841	16.7km	Visitors and tourists
VP9	Fowlis Wester	292764, 723944	14.7km	Residents
VP10	Keillour	297762, 725247	13.9km	Residents
VP11	Methven	302940, 725869	14.2km	Residents
VP12	Crieff	286966, 721980	17.4km	Residents and travellers
VP13	Innerdouny Hill	303222, 707316	4.1km	Visitors and tourists
VP14	Scone Palace	311422, 726491	18.0km	Visitors and tourists

3.6.2.2 Data collection

Baseline data collection has been undertaken during the period of Summer and Autumn 2013 and Spring 2014. The baseline photographs therefore illustrate the environment during both periods where trees are in leaf and also during periods where leaf cover may be reduced. In order to comply with best practice and allow for these considerations all photographs have the date of their capture included.

A site visit was undertaken to accurately identify and confirm the viablity of the selected viewpoints in June 2013. Subsequently, the photography was undertaken over the following 8 months.

3.6.2.3 Limitations

Limitations of the visual assessment were considered to be the difficulties in accessing all sensitive receptors of the surrounding area, including private residential properties and land. However, a large number of appropriate viewpoints have been chosen taking into account suggestions from Perth and Kinross Council, which combine to produce a comprehensive suite of assessment material.

3.6.2.4 Assessment of Effects to Selected Viewpoints

Each of the 14 selected viewpoints have been assessed to identify the potential visual and cumulative visual effects of the wind farm. Detailed consideration and a description of the visual baseline as well as the predicted magnitude of change to the view has been utilised to derive the eventual overall significance of effect of the development on the views. The following tables detail the findings of the viewpoint assessment and should be used in conjunction with the wirelines and photomontages displayed in Volume 3.

VIEWPOINT 1 LOCATION	A90
FIGURE	3.23
DISTANCE FROM DEVELOPMENT	6.1km
SELECTION JUSTIFICATION	Viewpoint 1 is representative of mid-range peripheral views to the south across Strathearn received by road users of the A9 when travelling in a westerly or easterly direction across the Gask Ridge between Perth and Auchterarder. The A9 is one of the main tansport corridors in Scotland and consequently has sustained high levels of traffic. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view illustrates the two different and distinctive landscape character types of the Broad Valley Lowlands in the fore and mid-ground and the Igneous Hills in the background. The Broad Valley Lowlands are characterised by the basin of the River Earn and its mixed land use of agriculture and deciduous woodland. Settlement is generally sparse, whilst poly tunnels from agricultural practices introduce a man-made element into the view. The Igneous Hills comprise steep slopes that are clearly visible beyond the flat foreground and mid-ground of the view. The steep slopes are partly wooded but primarily with coniferous plantations and have few discordant elements that detract from their scenic quality. Settlement is generally sparse in most places although some development is visible on hill slopes to the east of the view. The view is representative of views received by road users and consequently the sensitivity of the viewpoint is **medium**.
MAGNITUDE OF CHANGE	The Knowes Wind Farm would introduce a new characteristic into the landscape within a reasonably narrow extent of the view. Differing proportions of the wind turbines would be visible on the skyline with those located to the north of the wind farm more visible than those located to the south. This provides a less uniform layout from this view; however, the scale of the wind turbines and the extent that they occupy is accommodated by the large Ochils landform, as well as the varied land use pattern in both the Igneous Hills and the Broad Valley Lowlands. The Knowes Wind Farm would introduce a **moderate** magnitude of effect that is both **long term** and **reversible**.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 2 LOCATION	Dunning
FIGURE	3.24
DISTANCE FROM DEVELOPMENT	2.4km
SELECTION JUSTIFICATION	Viewpoint 2 is representative of primary and secondary views to residents of the nearest settlement to the wind farm: the village of Dunning. Parts of Dunning, situated beneath the Ochil hills, are locally designated by Perth and Kinross Council as a conservation area and would receive short range views to the south of the wind farm. However, Viewpoint 2 has been taken outwith the designated area to ensure the view is not obstructed by buildings providing a worst-case scenario.
BASELINE DESCRIPTION AND SENSITIVITY	The view comprises a transitional landscape situated between the more distinctive areas of Broad Valley Lowlands and the Igneous Hills. The foreground and mid-ground comprise of livestock farmland with a mixture of linear and clustered deciduous woodland and plantation woodland throughout. The background of the view typifies the more elevated characteristics of the Igneous hills comprising the hills of Black Hill of Kippen, Priest Knowe and Chapel Hill. The overall landscape has been heavily influenced and recently modified by agriculture and commercial woodland planting and felling; however, the landscape is generally free of discordant features and possesses a reasonably high level of scenic quality. The view is representative of primary and secondary views to residents on the fringes of Dunning and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	The wind farm would introduce a new characteristic element to the landscape and would occupy a moderate extent of the view. Of the nine wind turbines three are visible in their near entirety, whilst four others are visible from just below their hub height and two visible only by their blade tips. The potential magnitude of effect from the introduction of the wind farm is therefore lessened to a degree. The introduction of the wind farm would be accommodated to an extent by an ever evolving landscape that is subject to changes from woodland felling. However, from this reasonably short distance the wind turbines would be viewed against the skyline resulting in a distinct alteration from the baseline view. A **moderate-substantial** magnitude of effect that is both **long term** and **reversible** would occur as a result of the development of the Knowes Wind Farm.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the deveplopment on the viewpoint is considered to be **major** and **significant**.

VIEWPOINT 3 LOCATION	Forteviot
FIGURE	3.25
DISTANCE FROM DEVELOPMENT	7.0km
SELECTION JUSTIFICATION	Viewpoint 3 provides mid-range views from northeast of Knowes close to the settlement of Forteviot. Similar views to the selected view may be received from residential dwellings in and around the settlement and from the local road network, in particular the B934. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view illustrates the contrasting landscape characters of the Broad Valley Lowlands and the Igneous Hills. The foreground and mid-ground comprises flat agricultural land bordered by linear plantations of deciduous woodland and the dispersed settlement of Forteviot that follows the local road network. In contrast the Ochil hills are pronounced in the background and appear to have been subject to little development. The hills are characterised on their northern slopes by their steep slopes and the prevalence of conifer woodland plantation patterns. Overall the view is varied with focus being drawn to the scattering of dwellings and field margins on the valley floor. The view is representative of views to road users and secondary views to residents of Forteviot and consequently the sensitivity of the viewpoint is **medium.**
MAGNITUDE OF CHANGE	The wind farm would be visible in its near entirety with the upper sections of the wind turbines seen against the skyline. The wind farm appears to relate to the landform and the skyline in accordance with 'Siting and Designing windfarms in the landscape' (SNH, 2009) guidance. As a consequence of the wind farm's linear appearance the wind farm occupies a wider extent of the view than at other angles, but it is still only a small portion of the expansive stretch of the Ochil hills. The wind turbines are viewed within the context of a reasonably developed foreground and mid-ground and consequently the degree of contrast between the development and the view is minor. Overall, a **slight** magnitude of effect that is both **long term** and **reversible** would occur as a result of the development of the Knowes Wind Farm.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the deveplopment on the viewpoint is considered to be **minor-moderate** and **not significant.**

VIEWPOINT 4 LOCATION	Clathymore
FIGURE	3.26
DISTANCE FROM DEVELOPMENT	9.3km
SELECTION JUSTIFICATION	Viewpoint 4 is taken from the new residential housing development of Clathymore near Findo Gask. This area of the Lowland Hills LCT has potential for panoramic mid-range views of the Ochil hills, as well cumulative views of wind turbine developments situated within the hills. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view from the northern edge of the settlement of Clathymore is limited by intervening wooded hills that are situated between Knowes Wind Farm and the viewpoint. The foreground comprises livestock farmland, whilst the background comprises both linear deciduous woodland that follows the ridge of the hill and plantation conifer woodland. The view is representative of primary and secondary views to residents of the settlement and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	According to the wireframe drawing a limited number of wind turbines would be visible to varying degrees from the viewpoint. The wind turbines would be screened by woodland on the ridge of the hill resulting in no effects to the view. The screening is both deciduous and conifer and it is considered that even during winter the conifer trees will provide screening to the wind farm. Overall, a **negligible** magnitude of effect that is both **long term** and **reversible** would occur as a result of the development of the Knowes Wind Farm.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **negligible** and **not significant**.

VIEWPOINT 5 LOCATION	Aberuthven
FIGURE	3.27
DISTANCE FROM DEVELOPMENT	4.9km
SELECTION JUSTIFICATION	Viewpoint 5 is taken from Aberuthven Enterprise Park to the north of the settlement next to the A9 dual carriageway. The mid-range view has been chosen to supplement the assessment of visual effects to the transport route but also to be representative of views from the settlement. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view comprises both the A9 dual carriageway and the Aberuthven Enterprise Park in its foreground. Beyond these features the landscape typifies the Broad Valley Lowlands until it reaches the scarp slopes of the Ochil hills. Features that are not present beyond the foreground that influence the quality of the view include the Aberuthven Enterprise Park, the A9 and its associated lamp posts. These features influence the quality of the view but are unlikly to be viewed if driving along the A9 dual carriageway and are therefore discounted from the assessment of effects from the road but included in the assessment of effects from Aberuthven. The view is representative of views to road users and workers using the Enterprise Park and consequently the sensitivity of the viewpoint is **medium**.
MAGNITUDE OF CHANGE	Seven of the nine wind turbines would be visible to varying degrees beyond Craig Rossie from the viewpoint. The visible wind turbines appear to generally relate to the landform and the skyline in accordance with 'Siting and Designing windfarms in the landscape' (SNH, 2009) guidance. When viewed from Aberuthven the wind farm is accommodated by the urban environment that is present within the foreground of the view and it does not detract from the existing Ochils hills landform. However, when viewed without these detractions from the view the wind farm occupies a fairly narrow extent of the landscape and is seen within a less spoilt scenic context. Within this context the wind farm would introduce a **slight-moderate** magnitude of effect that is both **long term** and **reversible**.
CUMULATIVE IMPACT	There is potential for sequential cumulative visibility with four of the operational wind turbines from the Green Knowes Wind Farm. Only small sections of the Green Knowes wind turbines can be seen whilst in a separate context within the landscape. The Green Knowes Wind Farm is separated from Knowes Wind Farm clearly by Ben Effrey and Beld Hill ensuring that the effects are limited. Overall, the introduction of the Knowes Wind Farm would introduce a **slight** magnitude of cumulative effect to the visual baseline.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 6 LOCATION	St David's
FIGURE	3.28
DISTANCE FROM DEVELOPMENT	10.3km
SELECTION JUSTIFICATION	Viewpoint 6 is taken from the rural hamlet of St David's to the northwest of the proposed wind farm. This residential area of the Lowland Hills LCT has potential for panoramic mid-range views of the Ochil hills, as well cumulative views of wind turbine developments situated within the hills. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view comprises livestock farmland in the foreground with a partial view of the more elevated sections of the Ochil hills beyond in the background. There are few noteable characteristics within the view, apart from telegraph poles running west to east. Significantly, the reduction in the extent of the view to the Ochil hills reduces the level of human influence that is visible within the landscape, apart from distant views of plantation coniferous woodland. The view is representative of those received by road users and primary and secondary views to residents of the settlement and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	Each of the nine wind turbines would be visible to varying degrees from Viewpoint 6. From a distance of 10km the wind farm would occupy a narrow extent of the view, whilst being viewed against the skyline. Although the view is generally simple, the introduction of the wind farm is aided by the vertical telegraph poles and fence posts that can be seen in the foreground of the view. Overall, a **slight** magnitude of effect would be introduced to the view that is both long term and reversible.
CUMULATIVE IMPACT	There is potential for combined cumulative visibility with seventeen of the eighteen operational wind turbines from the Green Knowes Wind Farm. Green Knowes would be seen as a linear pattern, similar to Knowes, occupying a reasonable extent of the view and within a similar context to Green Knowes. However, the two projects would be clearly separate due to more prominent hills between the projects. Overall, from a distance of over 10km the level of cumulative effect on the view would be **slight-moderate**.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 7 LOCATION	M90
FIGURE	3.29
DISTANCE FROM DEVELOPMENT	14km
SELECTION JUSTIFICATION	Viewpoint 7 is taken from the M90 between Bridge of Earn and Perth. The view is representative of mid-range peripheral views received by road users travelling on the dual carriageway between Edinburgh and Perth. The M90 is one of the main tansport corridors in Scotland and consequently has sustained high levels of traffic. The viewpoint is not situated within a locally or nationally designated area. The view is representative of those received by road users and consequently the sensitivity of the viewpoint is **medium**.
BASELINE DESCRIPTION AND SENSITIVITY	The view is taken from a transitional landscape character area between the Broad River Lowlands and the Lowland Hills. The position consequently provides extensive views towards parts of the Ochil hills and over parts of the Strathearn. The foreground and mid-ground comprise of modified arable farmland that is dissected by deciduous woodland along field margins, as well as deciduous woodland clusters around rural settlement. In the background the Ochil hills are visible to the south, whilst electricity pylons run across Strathearn. The view is complex.
MAGNITUDE OF CHANGE	According to the wireframe drawing one wind turbine is theoretically visible in its near entirety and a blade of another turbine is theoretically visible. Conifer plantation woodland screens views of one of the wind turbines and consequently only one blade tip would be visible. From a distance of 14km this blade tip would introduce a **negligible** level of effect to the view that is both long term and reversible.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **negligible** and **not significant**.

VIEWPOINT 8 LOCATION	Kinnoull Hill
FIGURE	3.30
DISTANCE FROM DEVELOPMENT	16.7km
SELECTION JUSTIFICATION	Viewpoint 8 is taken from the viewpoint by Kinnoull Tower on the popular core plan walking route on Kinnoull Hill. The view comprises expansive vistas of the surrounding area that are received by visitors to the location and tourists. The view consequently allows for an assessment of cumulative visual effects within the area, albeit from a significant distance. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The view comprises an area of the Firth Lowlands LCT in the foreground. Here the M90 dual carriageway crosses the River Tay and further to the west industrial buildings and residential homes of the city of Perth can be seen. In the mid-ground of the photo the landscape is more rural although still influenced by settlement and telecommunication masts on ridgelines. In the background Strathearn provides a broad valley topography with signs of settlement beneath the expansive Ochils hill range. Overall, the landscape is characterised by rolling hills that generally comprise of a tapestry of agricultural fields, woodlands and modest settlements at lower elevations and less settled higher elevations that accommodate woodland and livestock farmland. The view is representative of those received by recreational users who derive enjoyment from the landscape, as well as visitors and tourists who use the core path and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	Although the foreground and mid-ground of the view have been influenced by the settlement of Perth the wind farm would be seen separately within the context of the Ochil hills and Strathearn. Knowes Wind Farm would be seen from a distance of over 16km and would consequently occupy a narrow extent of the view as a small scale feature. The wind turbines would appear of modest scale and would be nearly completely backclothed by the interior of the Ochil hills reducing their prominence. Overall, the wind farm would introduce a **slight** magnitude of effect to the view that is both **long term** and **reversible**.
CUMULATIVE IMPACT	A number of wind turbine projects, including Lochelbank, East Blair Farm, Green Knowes, Burnfoot Hill, Rhodders, Feddal Farm and Wester Cambushinnie Farm, would be visible from the viewpoint in addition to Knowes. The projects are generally clustered in three groups. The projects to the east, Lochelbank and East Blair are seen within the context of the Ochil hills but are clearly separate from the group surrounding Knowes. The projects surrounding Knowes, Green Knowes, Burnfoot Hill and Rhodders, are seen within a limited extent of the overall Ochil hill range. Knowes Wind Farm would be seen within the group's existing framework of wind farm development and consequently would not increase the extent of cumulative effects. However, the Knowes Wind Farm may attribute a greater prominence to this group given its location on the northern periphery of the Ochils. The third group that consists of Feddal Farm and Wester Cambushinnie Farm have a very minor cumulative influence on the view and as such the cumulative effect generated by the introduction of Knowes would be minimal. Overall, a **slight** magnitude of cumulative effect would be introduced to

	the view by Knowes Wind Farm.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant.**

VIEWPOINT 9 LOCATION	Fowlis Wester
FIGURE	3.31
DISTANCE FROM DEVELOPMENT	14.7km
SELECTION JUSTIFICATION	Viewpoint 9 is taken from the small rural hamlet of Fowlis Wester to the northwest of the proposed wind farm. This residential area of the Lowland Hills LCT has potential for panoramic long range views of the Ochil hills, as well cumulative views of wind turbine developments situated within the hills. Fowlis Wester is a conservation area designated by Perth and Kinross Council.
BASELINE DESCRIPTION AND SENSITIVITY	Viewpoint 9 comprises views across the Lowland Hills LCT and beyond to the Igneous Hills LCT. The land use in the foreground and mid-ground is generally complex, which can be attributed to the mixture of hedgerow and tree lined farmland, modest woodlands and scattered farmsteads. Telegraph poles are also located within the view. The presence of the rolling Lowland Hills in the foreground and mid-ground reduces the prominence and contrast of the steep slopes of the Ochils in the background. The viewpoint is representative of views from dwellings, as well as those received by road users and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	Each of the nine wind turbines would be visible to varying degrees from Viewpoint 9. From a distance of 14km the wind farm would occupy a narrow extent of the view, whilst being partially viewed against the skyline. The wind farm although noticeable on the horizon is accommodated by the varied landscape that can be seen within the view. The magnitude of effect to the view is consequently **slight**, whilst being both **long term** and **reversible.**
CUMULATIVE IMPACT	Knowes Wind Farm will be viewed in conjunction with Lochelbank and Green Knowes wind farms. From a distance of over 20km from the viewpoint the Lochelbank development would have an extremely limited cumulative influence with the proposed wind farm at Knowes. The development at Green Knowes is situated in closer proximity and has the potential to be seen in combination with Knowes Wind Farm. The two wind turbine projects appear of a similar scale and although appearing clearly separate will increase the extent of wind turbine development upon the landscape. However, the wind turbines are of a scale that does not dominate the broad Ochils landform and does not alter the characteristics of the landscape significantly, whereby key components of the view are lost. A **slight-moderate** magnitude of cumulative effect would be introduced to the view.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant.**

VIEWPOINT 10 LOCATION	Keillour
FIGURE	3.32
DISTANCE FROM DEVELOPMENT	13.9km
SELECTION JUSTIFICATION	Viewpoint 10 is taken from the south of Keillour Castle to provide representative views of those received from the castle and its gardens. The view is long range and provides panoramic views from the Lowland Hills LCT. The viewpoint is situated near to the designated Garden and Designed Landscape at Keillour Castle.
BASELINE DESCRIPTION AND SENSITIVITY	Viewpoint 10 comprises views across the Lowland Hills LCT and beyond to the Igneous Hills LCT. The foreground reveals an agricultural landscape with no settlement, whereas the mid-ground, although topographically similar, is heavily wooded with scattered settlement. The background is dominated by the broad Ochil hills landform. The viewpoint is representative of views from Keillour Castle and the local road network and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	Each of the nine wind turbines would be visible to varying degrees from Viewpoint 10. From a distance of 13km the wind farm would occupy a narrow extent of the view, whilst being partially viewed against the skyline. Minor screening to part of the wind farm may not be representative of the entire area surrounding the viewpoint, although it is present in places; therefore, for the purpose of this individual viewpoint assessment screening is not considered a form of mitigation. By virtue of its scale and the distance of the viewpoint from the development the wind farm would not dominate the Ochils landform and although modified would not result in a major alteration or loss of the key characteristics of the landscape. The magnitude of effect to the view is consequently **slight**, whilst being both **long term** and **reversible.**
CUMULATIVE IMPACT	Knowes Wind Farm will be viewed in conjunction with East Blair Farm, Green Knowes, Burnfoot Hill and Extension and Rhodders wind farms. From a distance of approximately 20km from the viewpoint the East Blair Farm development would have an extremely limited cumulative influence with the proposed wind farm at Knowes given its scale and separation. The development at Green Knowes is situated in closer proximity and has the potential to be seen in combination with Knowes Wind Farm. The two wind turbine projects appear of a similar scale and although appearing clearly separate will increase the extent of wind turbine development upon the landscape. In addition to the project at Green Knowes the group of wind turbine projects that includes Burnfoot Hill and Extension and Rhodders, although backclothed, may be seen in combination with Green Knowes Wind Farm. Knowes would consequently increase the extent of sequential wind turbine developments that are visible along the northern periphery of the Ochil hills. Overall, a **moderate** magnitude of cumulative effect would be introduced to the view by the Knowes Wind Farm.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 11 LOCATION	Methven
FIGURE	3.33
DISTANCE FROM DEVELOPMENT	14.2km
SELECTION JUSTIFICATION	Viewpoint 11 is taken from the large village of Methven, situated along the A85 between Crieff and Perth. The southern fringes of the village have potential to receive long range views of the wind farm. The viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	Viewpoint 11 primarily comprises of views of the Lowland Hills LCT, which is generally undulating and agricultural with occasional farmsteads. Woodland is limited in the view with the only notable features being telegraph poles that run both north to south and east to west. The rolling landscape restricts views beyond the foreground with only the more elevated Ochil hills visible in the distance. The viewpoint is representative of views from dwellings, as well as those received by recreational users of the park and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	The introduction of Knowes Wind Farm would result in a narrow extent of the view being altered with all of the wind turbines partially visible (the three most eastern turbines' towers are screened). The wind turbines would be seen as three minor clusters partially visible against the skyline resulting in some minor visual prominence. Overall, the wind turbines appear to be set within an open context that accomodates vertical structures (telegraph poles) and consequently results in a **slight** magnitude of effect to the visual baseline that would be both **long term** and **reversible**.
CUMULATIVE IMPACT	Knowes Wind Farm will be viewed in conjunction with Green Knowes, Burnfoot Hill and Extension and Rhodders wind farms. All of the developments have the potential to be seen in combination with Knowes Wind Farm. The developments at Knowes, Burnfoot Hill and Extension and Rhodders are primarily backclothed when viewed from Methven reducing their prominence and the majority of each of the turbine towers of the Green Knowes project are screened by landform. The wind farms will be seen together creating a wider extent of influence on the landscape; however, it is envisaged that these effects will not be significant due to the screening of portions of the wind farms and the distance of the viewpoint from the developments. Overall, a **moderate** magnitude of cumulative effect would be introduced to the view by the Knowes Wind Farm.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 12 LOCATION	Crieff
FIGURE	3.34
DISTANCE FROM DEVELOPMENT	17.4km
SELECTION JUSTIFICATION	Viewpoint 12 is situated a significant distance to the northwest of Knowes within the Highland Glens LCT. Parts of Crieff are locally designated by Perth and Kinross Council as a conservation area and have potential for long range views of the wind farm.
BASELINE DESCRIPTION AND SENSITIVITY	Viewpoint 12 comprises views of parts of southeast Crieff in the foreground, whilst views beyond extend over an area of the Broad Valley Lowlands LCT and a small portion of the Lowland Hills LCT towards the ridgeline of the Igneous Hills LCT. The view is influenced by development associated with the settlement of Crieff, including extensive housing development, electricity pylons and television aerials along the skyline. Less settled areas in the midground are diverse in land use with woodland and farmland visible in equal measure. In the background the Ochil hills are equally mixed in their land use with a large amount of plantation forestry set amongst upland grassland and heather moorland. The viewpoint is representative of both road users and principal views from residential dwellings and consequently the sensitivity of the viewpoint is **high**.
MAGNITUDE OF CHANGE	The introduction of Knowes Wind Farm would result in a narrow extent of the view being altered with all of the wind turbines partially visible. The wind turbines although not entirely cohesive with the surrounding landform due to its slightly varied turbine heights would not be emphasised at a distance of over 17km. The wind turbines would also be seen within a partially urban context that would accommodate the introduction of similar vertical structures of a small scale. The wind farm would only result in a minor alteration to the visual baseline and have a **slight** magnitude of effect to the view that would be both **long term** and **reversible**.
CUMULATIVE IMPACT	The introduction of Knowes Wind Farm would result in a cumulative scenario that includes both Lochelbank and Green Knowes wind farms. The three wind farms would be evenly spaced with reasonable separation between them. The primary opportunity for cumulative effects would concern the relationship of Knowes with Green Knowes, whilst Lochelbank appears only as a minor feature presenting only very minor potential for cumulative effects. The visual baseline presents a few discordant features that break the continuity of the distant skyline where both Knowes and Green Knowes would be visible. This results in a reduced sensitivity to the introduction of development along the skyline that when combined with the limited extent of effects is not significant to the view. Overall, a **slight** cumulative effect would be introduced to the view.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant**.

VIEWPOINT 13 LOCATION	Innerdouny Hill
FIGURE	3.35
DISTANCE FROM DEVELOPMENT	4.1km
SELECTION JUSTIFICATION	Viewpoint 13 is taken from the summit of Innerdouny Hill in the south of the Ochil hills. Although the hill is generally wooded, the summit provides elevated views of the Ochil hills and to areas beyond. Views of the wind farm would be mid-range and the viewpoint is not situated within a locally or nationally designated area.
BASELINE DESCRIPTION AND SENSITIVITY	The viewpoint allows expansive views firstly over the Ochil hills in the foreground and mid-ground and beyond across the Broad Valley Lowlands and Lowland Hills LCTs to the distant, more prominent and elevated Highland Summits and Plateaux. The Ochil hills in the foreground are a mixture of upland grassland and moorland and geometric conifer plantations. This landscape is undeveloped in terms of settlement but appears heavily modified by the commercial forestry that introduces an element of complexity to an otherwise simple landscape of broad, rolling hills. Views beyond the Ochil hills are uninterrupted and distant due to the low lying landscape that is situated to the north. Consequently, the viewpoint offers views of good scenic quality that are valued by visitors to the hill. The viewpoint is representative of views received by recreational users who derive enjoyment from the landscape, but it is not a core path, and consequently the sensitivity of the viewpoint is **medium**.
MAGNITUDE OF CHANGE	The development will be seen within the context of the far reaching views that benefit the summit of Innerdouny Hill to varying degrees and in doing so will add a characteristic new element to a small section of the view. In particular, the wind turbines will be seen amongst linear conifer plantations and beneath the impressive skyline. The surrounding topography and screening by mature conifer forestry limit visibility to lower and some higher tower sections to the east of the wind farm but overall a large proportion of the wind farm is still visible. Visible turbines do not appear uniform in height; however, this is widely accommodated by the irregularity of the surrounding forestry patterns and its punctuated introductions along the ridgeline. Overall, the wind farm would be well proportioned with appropriate design considerations; however, it would also be conspicuous and would partially alter the baseline characteristics of the view. Consequently, a **moderate** magnitude of effect to the view that would be both **long term** and **reversible** would be introduced by Knowes Wind Farm.
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within Viewpoint 13b. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change. When the viewing angle is widened to encompass a more westerly 180° view (Viewpoint 13c) it is possible to see the cluster of projects that includes Green Knowes in the foreground and Rhodders, Burnfoot Hill and Extension in the background. Knowes would introduce a sequential cumulative effect to the view that would increase the extent of wind turbine development on the landscape. Overall, a **slight-moderate** magnitude of cumulative effect would occur as a

	result of the development.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **moderate** and **not significant.**

VIEWPOINT 14 LOCATION	Scone Palace
FIGURE	3.36
DISTANCE FROM DEVELOPMENT	18.0km
SELECTION JUSTIFICATION	Viewpoint 14 is taken from within the Scone Palace gardens. The view is representative of those that would be received within the Palace and those from the gardens. Potential views towards the wind farm would be distant yet sensitive due to the designated Category A listing of the building and the Designed Landscape and Garden.
BASELINE DESCRIPTION AND SENSITIVITY	Viewpoint 14 comprises of a levelled landscaped garden in the foreground that features 18th century boundary walls. In the mid-ground deciduous and conifer woodland provides screening to outward southwesterly views that are illustrated in the early spring when screening from foliage is at its lowest. Views beyond the mid-ground are generally limited to minor glimpses of Perth and its surroundings. The viewpoint is representative of views received by visitors and tourists to the Palace and its gardens and consequently the sensitivity of the viewpoint is **high.**
MAGNITUDE OF CHANGE	The wireframe drawing shows that theoretical visibility of four wind turbine blades would be visible. Screening from intervening woodland does not allow for views of these blades and consequently the level of effect to the view would be **negligible** in the **long term.**
CUMULATIVE IMPACT	There is no predicted visibility of any other wind turbine projects within the view. The introduction of the Knowes Wind Farm would therefore result in a **negligible** cumulative magnitude of change.
SIGNIFICANCE OF EFFECT	The effect of the development on the viewpoint is considered to be **negligible** and **not significant.**

3.6.2.5 Visual Effects on Settlements

The assessment of effects to significant local settlements has been addressed using blade tip ZTVs with no consideration taken of woodland screening and therefore is based on a worst case scenario. Settlements that may potentially receive full or partial views of the wind turbines and an analysis of the impacts are listed in Table 3.10.

Table 3.10 Visual effects on significant local settlements

Settlement	Distance from site	Predicted theoretical visibility
Dunning	2.5km	Full visibility
Aberuthven	5km	Full visibility
Auchterarder	6km	No visibility
Forteviot	7km	Full visibility
Forgandenny	10km	Partial visibility to southwest
St David's	11km	Full visibility
Blackford	11km	No visibility
Glenfarg	12km	No visibility
Madderty	12km	No visibility
Milnathort	13km	No visibility
Kinross	13km	No visibility
Bridge of Earn	13km	No visibility
Tibbermore	13km	No visibility
Keillour	14km	Full visibility
Methven	14km	Full visibility
Perth	14km	Very limited visibility to west and southeast
Dollar	14km	No visibility
Fowlis Wester	15km	Full visibility
Muthill	15km	Full visibility of between 4-6 turbines
Huntingtower	15km	Partial visibility to west
Almondbank	15km	Full visibility
Tillicoutry	16km	No visibility
Greenloaning	18km	No visibility
Harrietfield	19km	Full visibility
Scone	19km	Full visibility
Alloa	21km	No visibility
Ballingry	21km	No visibility
Kelty	21km	No visibility
Newburgh	23km	No visibility
Dunblane	24km	No visibility

There is visibility of the wind farm predicted at a few settlements within 10km of the development assessed in Table 3.10, including Dunning, Aberuthven, Forteviot and Forgandenny. Of these settlements representative viewpoint assessments have been included of Dunning, Aberuthven and Forteviot. No significant effects were predicted to the settlements, apart for Dunning. Forgandenny was not assessed within the viewpoint assessment but it is considered that the viewpoint at Forteviot presents a similar, maybe worse, scenario of the effects that it would receive. Consequently, no significant effects are predicted to Forgandenny.

The village of Dunning is situated at a distance of 2.5km from the wind farm and is considered to receive significant effects from the viewpoint assessed in 3.6.2.4. This viewpoint provides an uninterrupted view from the outer edge of the village and is therefore not entirely representative of the effects that would be received to the settlement as a whole. It is noteworthy that the area of the village that is designated by Perth and Kinross Council as a Conservation Area is centrally located and is

therefore often influenced by modern development around its perimeter. Consequently the wind farm if predicted to be visible may be screened by modern development. However, there are a few opportunities around the perimeter of the Conservation Area where visibility of the wind farm will be possible without modern interference and these areas will consequently be subject to effects. Central areas that have been designated for their conservation value are likely to be screened by neighbouring or adjacent buildings limiting the potential effects to the setting of the village. Overall, it is considered that a small number of properties situated on the southern periphery of the village are likely to receive significant effects, whereas on the whole views towards Knowes will be screened and visibility of the wind farm limited.

Beyond 10km the settlements of St David's, Keillour, Methven, Perth, Fowlis Wester, Almondbank, Muthill, Huntingtower, Harrietfield and Scone are all predicted to receive visibility. Representative viewpoints have been taken from these locations or close to these locations and no potential for significant effects are predicted.

Overall, a number of distant settlements will receive visibility of the wind farm at Knowes with significant effects restricted to a small number of properties on the periphery of Dunning.

3.6.2.6 Visual Effects on Route Corridors

ZTV and viewpoint photomontages have been created to assess the impact of the proposed wind farm on local route corridors. Major transport routes within the study area are listed below in Table 3.11 along with the potential visibility of the wind farm from the routes.

Table 3.11 Visual effects on route corridors

Route	Predicted theoretical visibility
B934	Extensive visibility along road to the north of the site. No visibility to the south of the site.
B9141	Full visibility along road.
B8062	Visibility along eastern section of the road with less visibility to the west close to Auchterarder.
A823	Minor partial visibility to the northwest of road.
B935	Visibility between Forteviot and Forgandenny.
B9112	Extensive visibility along road.
A824	Visibility on north-eastern section of road between Aberuthven and Auchterarder.
A9	Visibility on northern sections between Aberuthven and Perth and intermittent between Perth and Bankfoot.
M90	Extremely limited with minor visibility to the south of Perth.
A90	Extremely limited partial visibility between St Madoes and Kilspindie.
A822	Visibility to the north between Muthill and Crieff and some minor partial visibility to the south.
A91	No visibility.
A977	No visibility.
A912	No visibility.
A85	Extensive distant visibility between Perth and Crieff.
A93	Extensive distant visibility between Perth and Stanley.
B8063	Intermittent distant visibility near Harrietfield and Chapelhill.

Local roads to the north of the wind farm situated within Strathearn will experience extensive theoretical visibility of the wind farm in places, in particular along the B934, B914 and B9112. Beyond the immediate local area the busier A9 and A85 roads to the north of the wind farm also have areas where extensive visibility will be received. Representative viewpoints have been assessed for each of these roads and effects were considered to not be significant.

In contrast to roads to the north of the wind farm there is no visibility predicted to roads to the southwest, south and southeast of the wind farm.

Overall, a moderate level of effect will be introduced to roads to the north of the wind farm, whilst roads to the south of the wind farm will be subject to no effects.

3.6.2.7 Core Paths

There are a number of core paths in Perth and Kinross that have been outlined by the Core Paths Plan. The paths are identified to help members of local communities to enjoy the countryside but there is no specification to which they have to adhere. Consequently, the range of core paths is diverse.

The scope of the Core Path assessment has been to identify paths that are situated within 2km of the wind farm which have potential to receive effects. The identified paths and the potential theoretical visibility along the route are listed below in Table 3.12

Table 3.12 Visual effects on core paths

Route	Predicted theoretical visibility
DNNG/143	Extensive visibility predicted along path.
DNNG/120	No visibility predicted along path.
DNNG/105	Extensive full and partial visibility predicted along path.
DNNG/125	Visibility predicted to minor section of the route. Woodland is predicted to screen views of wind farm.
DNNG/104	Extensive visibility predicted along path.
DNNG/100	Extensive visibility predicted along path.

One core path (DNNG/143) is located within the planning application boundary. This path is situated away from the proposed access route to the wind farm and would not receive any direct effects from the development. However, visibility of the wind farm is predicted and consequently effects to its setting would be received. Four other core paths would receive varying levels of visibility of the wind farm and would consequently be subject to effects that may affect their setting. Key panoramic views to the north would importantly not be interrupted.

3.6 Conclusions

Table 3.13 Summary of landscape and visual effects

Potential effect	Level of effect	Significance of effect
Operational effects to Igneous Hills LCT	Overall, moderate but locally major	Overall, not significant but significant locally
Operational effects to Broad Valley Lowlands LCT	Moderate	Not significant
Operational effects to Lowland Hills LCT	Moderate	Not significant
Operational effects to Lowland River Corridors	Minor	Not significant
Operational effects to Highland Summits and Plateaux	Minor	Not significant
Visual effects to Viewpoint 1: A90	Moderate	Not significant
Visual effects to Viewpoint 2: Dunning	Major	Significant
Visual effects to Viewpoint 3: Forteviot	Minor-moderate	Not significant
Visual effects to Viewpoint 4: Clathymore	Negligible	Not significant
Visual effects to Viewpoint 5: Aberuthven	Moderate	Not significant
Visual effects to Viewpoint 6: St David's	Moderate	Not significant
Visual effects to Viewpoint 7: M90	Negligible	Not significant
Visual effects to Viewpoint 8: Kinnoull Hill	Moderate	Not significant
Visual effects to Viewpoint 9: Fowlis Wester	Moderate	Not significant
Visual effects to Viewpoint 10: Keillour	Moderate	Not significant
Visual effects to Viewpoint 11: Methven	Moderate	Not significant
Visual effects to Viewpoint 12: Crieff	Moderate	Not significant
Visual effects to Viewpoint 13: Innerdouny Hill	Moderate	Not significant
Visual effects to Viewpoint 14: Scone Palace	Negligible	Not significant

3.6.1 Landscape Effects

The wind farm at Knowes would introduce localised significant direct and indirect effects to the development site landscape due to the introduction of the wind turbines and the associated road and sub-station building. Indirect landscape effects outwith the development site would be largely confined to areas north of the Ochil hills; however, no significant effects are predicted to occur to any of the LCTs within the study area. No significant landscape effects are also predicted to occur to any designated landscape within the study area.

3.6.2 Visual Effects

Visual effects are predicted to be received from an extensive area up to 25km from the development to the north, northwest and northeast of the wind farm, whilst visibility to the south, southeast and southwest is largely confined to a few elevated summits. Overall, visual effects are considered to be negligible to moderate at worst in all of the viewpoints assessed except one. The village of Dunning (Viewpoint 2) is predicted to receive significant effects that alter the key characteristics of views to the south. The effects to the village will be primarily confined to more recently developed areas around the villages periphery rather than the traditional central areas that are more sensitive to changes in their setting. However, a few traditional areas may still be subject to views of the wind farm. Overall, the wind farm is of a scale that is not considered intrusive to views in the wider area but may alter existing views to the south within 3km of the development.

3.6.3 Cumulative Effects

Knowes Wind Farm is situated with a moderate separation from other wind turbine developments in the Ochil hills, such as Greeen Knowes and Lochelbank, and a large separation distance from all other wind turbine developments within the study area. The separation between other projects ensures that cumulative views are primarily from a distance greater than 5km where the level of effects is minimised. When seen in combination the wind turbine development around Knowes generally appears evenly spaced and of a similar scale that can be accomodated by the landform of the Ochil hills. No significant cumulative effects are predicted.

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[i] Landscape Institute and the Institute of Environmental Assessment (2013) Guidelines for Landscape and Visual Impact Assessment, 3rd Edition, Routledge.

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[iii] University of Newcastle (2002) Visual Assessment of Wind Farms: Best Practice. Scottish Natural Heritage Report No. F01AA303A.

[iv] The Countryside Agency and Scottish Natural Heritage (2002) Landscape Character Assessment: Guidance for England and Scotland.

[v] Scottish Natural Heritage (2006) Visual Representation of Windfarms, Good Practice Guidance. Prepared by Horner & Maclennan / Envision.

[vi] Scottish Natural Heritage (2002, updated 2009) Policy Statement No 02/02: Strategic Locational Guidance for Onshore Windfarms in Respect of the National Heritage.

[vii] Scottish Natural Heritage (2009) Siting and Designing Windfarms in the Landscape.

[viii] Scottish Natural Heritage (2012) Assessing the cumulative impact of onshore wind energy development.

[ix] Scottish Natural Heritage (2005) Constructed Tracks in the Scottish Uplands.

[x] Scottish Natural Heritage (2010) Good Practice During Windfarm Construction.

[xi] Landscape Institute Advice Note 01/11 Photography and photomontage in landscape and visual impact assessment.

[xii] The Scottish Office (1998) Cost Effective Landscape: Learning from Nature.

[xiii] Land Use Consultants (1999) Tayside landscape character assessment. Scottish Natural Heritage Review No.122.

[xiv] David Tyldesley and Associates (1995) The landscape of Kinross-shire: a landscape assessment of the Kinross Local Plan area. Scottish Natural Heritage Review. No.77.

[xv] Perth and Kinross Council (2005) Supplementary Planning Guidance for Wind Energy Proposals in Perth & Kinross.

[xvi] Perth and Kinross Council Guidance for the Preparation and Submission of Photographs and Photomontages to illustrate the impacts of Wind Energy Development for inclusion in Planning Applications and Environmental Statements

[xvii] Land Use Consultants 1999. Tayside landscape character assessment. Scottish Natural Heritage Review No. 122.

CHAPTER 4

NOISE

4. Noise

4.1 Overview

This section will consider the potential noise impacts and effects associated with the operation and construction of the potential project at Knowes. Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The impact of noise can therefore be a material consideration in the determination of planning applications.

A best practice assessment, in accordance with British and international standards, has been undertaken to assess noise levels at noise sensitive receptors.

4.2 Guidance and Legislation

Guidance and legislation for assessing operational noise from wind turbines is given in:

- Scottish Planning Policy
- 'Renewables Advice – Onshore Wind Turbines 2011'
- 'ETSU-R-97: the Assessment and Rating of Noise from Wind Farms' (1997), The Department of Trade and Industry (usually referred to as the Noise Working Group Recommendations).
- 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise', Institute of Acoustics (May, 2013)
- PAN 1/2011: Planning and Noise
- BS5228:2009 Code of practice for noise and vibration control on construction and open sites

4.2.1 Noise Limits

In accordance with the ETSU-R-97 methodology separate noise limits are applied for daytime and night-time.

Limits are set in relation to existing background noise levels measured at the noise sensitive properties. Specifically, the daytime and night-time limits are set at 5dB above the background noise levels, apart from where the background noise levels are very low (e.g. 25-30dB(A)). Where background noise levels are very low a fixed lower limit is defined to enable assessment.

At night-time ETSU-R-97 recommends a fixed lower limit of 43dB(A) that was initially derived from World Health Organization (WHO) guidance but is now stated within planning guidance in Scotland. During daytime hours a lower fixed limit is set within the range of 35 to 40dB(A). Whether the limit is set at the higher end of this range is dependent on factors relating to the number of dwellings in the neighbourhood of the wind farm, the effects of noise limits on the number of kWh generated and the duration and level of exposure of the nearby residences.

The specific daytime noise limit chosen will consequently be the result of consideration of the wind farm development's planning merit and the characteristics of the surrounding area.

Properties with occupants that have a financial interest in the development are permitted to allow a higher level of noise at their property. This level has been set at 45dB by ETSU-R-97.

Alternatively, if it can be demonstrated that noise conditions can be met without an increase in background noise with wind speed until quite high wind speeds, then ETSU-R-97 recommends a 'simplified assessment'. This 'simplified assessment' can be used if at wind speeds up to 10m/s the noise levels at sensitive receptors do not exceed an $L_{A90,\ 10min}$ of 35dB(A). If the development fulfils these criteria then it is considered that sufficient protection of amenity would be experienced.

4.3 Operational Noise Assessment

4.3.1 Scope of independent and cumulative operational noise assessment

Noise sensitive receptors surrounding the development site have been identified. A list of the noise sensitive receptors identified for consideration surrounding the site is shown in Table 4.1.

Table 4.1 Noise sensitive receptors

ID	Noise Sensitive Receptor	Easting	Northing	Distance from closest turbine (km)	Elevation (m)
H1	Knowes	302067	711484	0.6	272
H2	Quilts	302476	712002	1.1	222
H3	Cockersfauld	302524	710978	1.1	277
H4	Blaeberry Toll	302378	710265	1.2	318
H5	Unknown	302715	712530	1.6	161
H6	Pitmeadow	302509	712810	1.6	158
H7	Unknown	301860	712806	1.3	141
H8	Baadhead	300533	712686	1.1	161
H9	Balquhandy House	303345	711720	1.9	266
H10	Unknown	301978	709588	1.5	321
H11	Greenhill	301998	709407	1.7	315
H12	Littlerig	301264	707031	4	288
H13	Coulshill 1	297976	709293	3.5	242
H14	Coulshill 2	297930	709281	3.5	236

A cumulative noise assessment will also include immissions from the operational wind farm at Green Knowes (04/01651/FUL).

4.3.2 Propagation Model

In accordance with recommendations made in the IOA Good Practice Guide, the propagation method used in this assessment is the octave band prediction method of the International Standard ISO9613-2. The ISO9613-2 Standard allows noise levels to be predicted for short-term downwind conditions (i.e. wind blowing from the proposed turbines towards the noise sensitive receptors). This method therefore presents a worst case scenario as all receptors will not be downwind of the turbines at the same time. Noise levels would therefore be significantly reduced in reality when the wind is blowing in the opposite direction.

The ISO9613-2 propagation model takes into account reduction in noise due to distance, atmospheric losses, screening effects (if present) and miscellaneous noise losses. Importantly, noise levels can be increased or reduced by the interaction of sound waves with the ground. Sound pressure levels at specific locations can be measured in octave frequency bands by subtracting a number of attenuation factors.

The noise level in the each octave band can be represented by the following equation:

$$\textbf{Predicted Noise Level } L_{90} = L_{W(eq)} - \textbf{Attenuation factors } (A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}) - 2dB$$

Where A_{gr} is geometrical divergence, A_{atm} is atmospheric absorption, A_{gr} is ground effect, A_{bar} is the effects of barriers and A_{misc} is miscellaneous other effects.

It is also stated within ETSU-R-97 that Windfarm $L_{A90,10min}$ values are typically 1.5dB to 2.5dB lower than $L_{Aeq,10min}$ and therefore they can be converted to their $L_{A90,10min}$ values by subtracting 2dB, so this also accounted for in the equation.

Advice within Good Practice Guide will be adhered to within the following operational noise assessment. In particular, the guidance states that the ISO9613-2 model inputs should be specified with the following included in the methodology:

1- **The turbine sound power levels used as input.**

Expressed in decibels to a reference sound power of one picowatt (1 pW).

2- **The atmospheric conditions assumed.**

An atmospheric attenuation coefficient should be used that depends strongly on the frequency of the sound, the ambient temperature and the relative humidity of the air. Values should be based on the average ambient weather of the locality.

3- **The ground factors G_s, G_m, G_r assumed.**

An attenuation value representative of local ground surface, which takes into account the different effects of sound, reflected on varying surfaces should be utilised. Hard ground, including all surfaces with a low porosity (e.g. paving, water and concrete), should be given the value G=0. Porous ground, including ground covered by grass or other vegetation or ground suitable for farming, according to the International Standard ISO 9613-2 would have a value G=1.

4- **The effects of barriers.**

Barrier attenuation should generally not be used within wind turbine calculations using ISO 9613-2, unless there is no line of sight between the receptor and the highest point of the rotor. Where there is no line of sight a 2dB barrier attenuation can be assumed. A higher barrier attenuation of more than 2dB should be fully justified.

ISO9613 Propagation Model Inputs

- Broadband sound power levels and octave band spectra have been made available by the manufacturer for the Gamesa G52 wind turbines proposed at Knowes. In particular, Gamesa G52 unwarranted measured broadband and unwarranted measured octave band levels for the two different hub heights have been obtained for the assessment.

- A typical confidence interval of 2dB has been added to the measured values provided on the manufacturers datasheet, which will ensure a conservative assessment is undertaken. The sound power levels used for the assessment are shown in Tables 4.2 and 4.3.

Table 4.2 Broadband sound power levels including 2dB uncertainty value for Gamesa G52 with a 44m or 55m hub height

Turbine Type	Standardised Wind Speed (m/s) at 10m height	5	6	7	8	9	10
Gamesa G52	A-Weighted Noise Level dB L_{WA} [dB(A)]	99.0	103.1	104.8	105.6	105.7	105.7

Table 4.3 Octave band spectra for Gamesa G52 with a 44m or 55m hub height (10ms^{-1} v_{10} wind speed)

Octave Band Centre Frequency (Hz)	*A-Weighted Sound Power Level (dB(A))*
63	86.7
125	93.6
250	98.6
500	100.2
1000	99.8
2000	97.3
4000	91.8
8000	81.0

- For the cumulative assessment broadband sound power levels have been made available by the manufacturer for the operational wind turbines at Green Knowes. In particular, Acciona AW-70 guaranteed measured broadband levels have been obtained for the assessment.
- Octave band noise levels were not available from the manufacturer and consequently representative Nordex N80 octave band noise levels have been scaled to the sum of the Acciona AW-70 guaranteed broadband levels for the purpose of the assessment.
- The sound power levels used for the assessment are shown in Tables 4.4 and 4.5.

Table 4.4 Broadband sound power levels including uncertainty value for Acciona AW-70 with a 58.5m hub height

Turbine Type	Standardised Wind Speed (m/s) at 10m height	5	6	7	8	9	10
Acciona AW-70	A-Weighted Noise Level dB L_{WA} [dB(A)]	102.0	103.5	104.5	104.9	105.4	105.4

Table 4.5 Octave band spectra for Acciona AW-70 with a 58.5m hub height (10ms^{-1} v_{10} wind speed)

Octave Band Centre Frequency (Hz)	*A-Weighted Sound Power Level (dB(A))*
63	92.2
125	98.8
250	99.6
500	97.4
1000	97.1
2000	96.2
4000	92.6
8000	84.7

- Atmospheric conditions as preferred by the guidance have been assumed to be 10°c and 70% relative humidity. These conditions give low levels of atmospheric attenuation, shown below in Table 4.6.

Table 4.6 Atmospheric absorption coefficients used for assessment

Octave Band Centre Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Atmospheric Absorption Coefficient (dB/m)	0.00012	0.00041	0.00104	0.00193	0.00366	0.00966	0.03280	0.11700

- In accordance with the IOA Good Practice Guide a ground attenuation factor of 0.5 is assumed in the noise propagation calculations with guaranteed sound power levels with an allowance for uncertainty.
- Barrier attenuation has not been included in the assessment and no account has been taken of local topography.

- All noise sensitive receptor heights have been set to a height of 4m.

4.3.3 Operational Screening Assessment

4.3.3.1 Independent Operational Screening Assessment Noise Levels

The calculated operational noise levels for the wind turbines at Knowes using the ISO9613-2 propagation model inputs described in Section 4.3.2 are listed in Table 4.7.

Table 4.7 Independent Operational Noise Levels at Noise Sensitive Receptors

ID	*Noise Sensitive Receptor*	*Wind speed*
		10m/s
H1	Knowes	42.7
H2	Quilts	37.0
H3	Cockersfauld	37.4
H4	Blaeberry Toll	35.5
H5	Unknown	33.6
H6	Pitmeadow	33.4
H7	Unknown	35.9
H8	Baadhead	36.8
H9	Balquhandy House	32.1
H10	Unknown	33.4
H11	Greenhill	32.4
H12	Littlerig	23.6
H13	Coulshill 1	25.2
H14	Coulshill 2	25.0

4.3.3.2 Cumulative Operational Assessment Noise Levels

The calculated cumulative noise levels for the proposed Knowes project and the operational wind farm project at Green Knowes are listed in Table 4.8.

Table 4.8 Cumulative Operational Noise Levels at Noise Sensitive Receptors

ID	*Noise Sensitive Receptor*	*Wind speed*
		10m/s
H1	Knowes	42.8
H2	Quilts	37.2
H3	Cockersfauld	37.6
H4	Blaeberry Toll	36.0
H5	Unknown	33.9
H6	Pitmeadow	33.7
H7	Unknown	36.1
H8	Baadhead	37.0
H9	Balquhandy House	32.6
H10	Unknown	34.4
H11	Greenhill	33.7
H12	Littlerig	32.6
H13	Coulshill 1	36.1
H14	Coulshill 2	36.2

4.3.3.3 Summary of screening results

Following the independent operational screening assessment it was identified that 6 properties would be above the 'Simplified assessment method' threshold of 35dB set by ETSU-R-97. Cumulative noise levels at 8 of the 14 identified noise sensitive receptors are also above this threshold.

Of these 8 properties H1 (Knowes) is financially involved in the Knowes Wind Farm project. The residential property will therefore be subject to ETSU-R-97's increased financially involved cumulative noise limit of 45dB. The cumulative and independent noise levels at this property are under the increased financially involved limit and therefore it does not require further background noise assessment.

4.3.3.4 Assessment recommendations

Seven properties require further assessment against ETSU-R-97 noise limits, which is considered to be relatively few for a project of the scale proposed. Noise levels at these propoerties are only marginally over the 35dB simplified criterion at a wind speed of 10m/s. It is therefore recommended that the daytime fixed lower limit is set slightly above the lowest extent of the range suggested by ETSU-R-97 at 38dB, whilst the night-time fixed lower limit is set at 43dB.

Details of the background noise monitoring locations, their surrounding environments and the measurement methodology is given in section 4.3.4.

4.3.4 Baseline Noise Conditions

In order to determine the baseline background noise levels surrounding the site background noise level monitoring was undertaken at two properties. The properties were agreed with Perth and Kinross Council prior to undertaking measurements and the exact monitoring locations are displayed in Table 4.9.

Table 4.9 Noise Assessment Locations

Location	Easting	Northing	Characteristics
Quilts	302423	712012	The noise kit was located away from reflective surfaces, approximately 40m from the residential property. The house and farm steadings are surrounded by few trees with potential background noise sources likely to be generated by the minor road (B934) to the east.
Greenhill	301855	709421	The noise kit was located to the far side of the property from the B934 road away from all reflective surfaces. The property is surrounded by open farmland, as well as mixed deciduous and conifer woodland. Leaf cover was consequently limited in November during the measurement period.

Background monitoring at the two locations took place during November 2013.

The noise monitoring equipment used to measure the background noise at each location included a Rion NL-52 Sound Level Meter, Rion UC-59 Microphone and Rion NC-74 Calibrator. In accordance with BS EN 61672-1:2003 all equipment is Class 1 with calibration certificates shown in Appendix 2. The sound level meters were calibrated on site prior to and following monitoring with no deviations noted. Microphones enclosed in enhanced performance wind shields (Rion WS-15) were mounted on a pole of 1.2m in height and attached to the noise kit outdoor casing. Noise measurements were undertaken continuously with measurements logged at ten minute intervals.

As agreed with Perth and Kinross Council a meteorological mast was erected on the site (301494, 711531) with an anemometer mounted at a height of 10m. Wind shear was then subsequently taken into account in the assessment by shifting the turbine noise levels by 2m/s along the wind speed axis in accordance with guidance outlined in the IOA Good Practice Guide's 'Supplementary Guidance Note 4: Wind Shear'.

Average wind speeds were measured at ten minute intervals in order to correlate with noise monitoring intervals. A tipping bucket rain gauge was also set to monitor the presence of rainfall by logging data over the same 10 minute periods. Recorded 10 minute periods of rainfall and corresponding background noise levels were discarded, as well as the data from the preceding 10 minute period.

The background noise regression analysis is further illustrated in Appendix 2. A line of best fit for the L_{A90} at both of the monitoring locations for quiet daytime and night-time periods is provided in Table 4.10.

Table 4.10 Derived background noise polynomials at monitoring locations

Location	Time Period	Measured Polynomial
Quilts	Amenity Hours	$y = -0.0018x^4 + 0.0428x^3 - 0.174x^2 + 0.8577x + 22.538$
	Night-time Hours	$y = -0.016x^3 + 0.4393x^2 - 1.2119x + 21.853$
Greenhill	Amenity Hours	$y = -0.0035x^4 + 0.0816x^3 - 0.4376x^2 + 1.1184x + 28.471$
	Night-time Hours	$y = -0.0116x^3 + 0.3372x^2 - 0.9907x + 28.794$

Resultant background noise levels calculated using the measured polynomials are shown in Table 4.11 for wind speeds between 5m/s and 10m/s.

Table 4.11 Background Noise Levels

		5	6	7	8	9	10
Quilts	Daytime	26.7	28.3	30.4	32.8	35.6	38.5
	Night-time	24.8	26.9	29.4	32.1	34.9	37.7
Greenhill	Daytime	31.5	32.9	34.9	37.4	40.2	43.2
	Night-time	30.8	32.5	34.4	36.5	38.7	41.0

4.3.4 Operational Noise Limits

Noise level limits have been set in accordance with ETSU-R-97 guidance. Table 4.12 shows the criteria to be used for Quiet Daytime and Night time periods, as well as the variations in noise limits for financially involved properties.

Table 4.12 Noise level criteria

Period	Time	Set Criteria
Quiet Daytime	All evenings from 18:00-23:00 hours Saturday afternoon 13:00-18:00 hours Sunday 07:00-18:00 hours	38dB(A) lower fixed limit or 'background + 5dB', whichever is greater Or, if financially involved 45dB
Night-time	23:00-07:00 hours	43dB(A) minimum or 'background + 5dB', whichever is greater Or, if financially involved 45dB
Quiet Daytime Cumulative	All evenings from 18:00-23:00 hours Saturday afternoon 13:00-18:00 hours Sunday 07:00-18:00 hours	38dB(A) lower fixed limit or 'background + 5dB', whichever is greater Or, if financially involved 45dB
Night-time Cumulative	23:00-07:00 hours	43dB(A) lower fixed limit or 'background + 5dB', whichever is greater Or, if financially involved 45dB

Table 4.13 shows the derived independent and cumulative operational noise level criteria for the wind farm at Knowes.

Table 4.13 ETSU-R-97 Independent and Cumulative Noise Limits

Receptor	Location	Proxy Monitoring Location		Independent Operational Noise Level Criteria (dB L_{A90} at Wind Speeds (m/s) at 10m Height)					
				5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
H2	Quilts	Quilts	Day	38.0	38.0	38.0	38.0	40.6	43.5
			Night	43	43	43	43	43	43
H3	Cockersfauld	Greenhill	Day	38.0	37.9	39.9	42.4	45.2	48.2
			Night	43	43	43	43	43.7	46
H4	Blaeberry Toll	Greenhill	Day	38.0	37.9	39.9	42.4	45.2	48.2
			Night	43	43	43	43	43.7	46
H7	Unknown	Quilts	Day	38.0	38.0	38.0	38.0	40.6	43.5
			Night	43	43	43	43	43.7	43
H8	Baadhead	Quilts	Day	38.0	38.0	38.0	38.0	40.6	43.5
			Night	43	43	43	43	43.7	43
H13	Coulshill 1	Greenhill	Day	38.0	37.9	39.9	42.4	45.2	48.2
			Night	43	43	43	43	43.7	46
H14	Coulshill 2	Greenhill	Day	38.0	37.9	39.9	42.4	45.2	48.2
			Night	43	43	43	43	43.7	46

4.4 Impact Assessment

4.4.1 Independent Operational Assessment Noise Levels

The calculated operational noise levels for the Knowes Wind Farm using the ISO9613-2 propagation model inputs described in Section 4.3.2 are listed in Table 4.14.

Table 4.14 Operational Noise Levels at Noise Sensitive Receptors, dB $L_{A90,(10mins)}$

ID	*Noise Sensitive Receptor*	*Wind speed*					
		5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
H2	Quilts	36.1	36.9	37.0	37.0	37.0	37.0
H3	Cockersfauld	36.5	37.3	37.4	37.4	37.4	37.4
H4	Blaeberry Toll	34.6	35.4	35.5	35.5	35.5	35.5
H7	Unknown	35.0	35.8	35.9	35.9	35.9	35.9
H8	Baadhead	35.9	36.7	36.8	36.8	36.8	36.8
H13	Coulshill 1	24.3	25.1	25.2	25.2	25.2	25.2
H14	Coulshill 2	24.1	24.9	25.0	25.0	25.0	25.0

4.4.2 Cumulative Operational Assessment Noise Levels

The overall cumulative noise immisions including the operational project at Green Knowes are listed below in Table 4.15.

Table 4.15 Overall Cumulative Operational Noise Levels at Noise Sensitive Receptors, dB $L_{A90,(10mins)}$

ID	*Noise Sensitive Receptor*	*Wind speed*					
		5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
H2	Quilts	36.30	37.08	37.20	37.20	37.20	37.20
H3	Cockersfauld	36.70	37.47	37.60	37.60	37.60	37.60
H4	Blaeberry Toll	35.10	35.86	36.00	36.00	36.00	36.00
H7	Unknown	35.20	35.98	36.10	36.10	36.10	36.10
H8	Baadhead	36.12	36.90	37.02	37.02	37.02	37.02
H13	Coulshill 1	35.10	35.54	36.09	36.09	36.09	36.09
H14	Coulshill 2	35.18	35.61	36.17	36.17	36.17	36.17

4.4.3 Assessment of operational noise levels with derived noise level criteria

4.4.3.1 Assessment of independent noise levels with derived noise level criteria

Table 4.16 shows the margin that the noise immisions from the Knowes wind turbines would be below the set criteria.

Table 4.16 Independent Margin below ETSU-R-97 Noise Limits

Receptor	Location		Margin below independent noise limit (dB)					
			5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
H2	Quilts	Day	1.9	1.1	1.0	1.0	3.6	6.5
		Night	6.9	6.1	6.0	6.0	6.0	6.0
H3	Cockersfauld	Day	1.6	0.7	2.6	5.0	7.9	10.8
		Night	6.6	5.8	5.7	5.7	6.4	8.7
H4	Blaeberry Toll	Day	3.4	2.5	4.4	6.8	9.7	12.6
		Night	8.4	7.6	7.5	7.5	8.2	10.5
H7	Unknown	Day	3.0	2.2	2.1	1.9	4.7	7.7
		Night	8.0	7.2	7.1	7.1	7.8	7.1
H8	Baadhead	Day	2.1	1.3	1.2	1.0	3.8	6.8
		Night	7.1	6.3	6.2	6.2	6.9	6.2
H13	Coulshill 1	Day	13.7	12.9	14.7	17.2	20.0	23.0
		Night	18.7	17.9	17.8	17.8	18.5	20.8
H14	Coulshill 2	Day	13.9	13.1	14.9	17.3	20.2	23.1
		Night	18.9	18.1	18.0	18.0	18.7	21.0

4.4.3.2 Assessment of cumulative noise levels with derived noise level criteria

Table 4.17 shows the margin that the noise immisions from the Knowes and Green Knowes wind turbines would be below the set criteria.

Table 4.17 Cumulative Margin below ETSU-R-97 Noise Limits

Receptor	Location		Margin below cumulative noise limit (dB)					
			5m/s	6m/s	7m/s	8m/s	9m/s	10m/s
H2	Quilts	Day	1.7	0.9	0.8	0.8	3.4	6.3
		Night	6.7	5.9	5.8	5.8	5.8	5.8
H3	Cockersfauld	Day	1.3	0.4	2.3	4.8	7.6	10.6
		Night	6.3	5.5	5.4	5.4	6.1	8.4
H4	Blaeberry Toll	Day	2.9	2.1	3.9	6.4	9.2	12.2
		Night	7.9	7.1	7.0	7.0	7.7	10.0
H7	Unknown	Day	2.8	2.0	1.9	1.7	4.5	7.4
		Night	7.8	7.0	6.9	6.9	7.6	6.9
H8	Baadhead	Day	1.9	1.1	1.0	0.8	3.5	6.5
		Night	6.9	6.1	6.0	6.0	6.7	6.0
H13	Coulshill 1	Day	2.9	2.5	3.8	6.3	9.1	12.1
		Night	7.9	7.5	6.9	6.9	7.6	9.9
H14	Coulshill 2	Day	2.8	2.4	3.7	6.2	9.0	12.0
		Night	7.8	7.4	6.8	6.8	7.5	9.8

4.4.4 Assessment of Potential Operational Effects

Potential noise from wind turbines may be emitted in two ways.

Aerodynamic noise is a broad band noise, with characteristic modulation, which is produced by the movement of the rotating blades. Aerodynamic noise is generally heard when wind speeds are low because the noise can be potentially masked at higher wind speeds by the wind blowing through landscape features. However, it is likely that aerodynamic noise will not be heard when wind speeds are very low as the blades do not rotate with great speed.

Mechanical noise may also be generated by components within the nacelle of the turbine. This noise has been reduced by modern design to levels that are considered to be **negligible.**

4.4.4.1 Potential Independent Operational Noise Effects

The noise levels at each of the identified noise sensitive receptors are below the independent Quiet Daytime and Night-time noise level criteria set for each of the assessed wind speeds.

4.4.4.2 Potential Cumulative Operational Noise Effects

The noise levels at each of the identified noise sensitive receptors are below the independent Quiet Daytime noise level criteria set for each of the assessed wind speeds.

4.4.4.3 Other Potential Operational Noise Issues

Other issues for consideration in the operational noise assessment include the effects of low frequency noise.

Low frequency noise can be described generally as sound energy below 200 Hertz (Hz), where human hearing is considered to be less sensitive. Research has been undertaken by the Hayes McKenzie Partnership (2006), who were commissioned by the Department of Trade and Industry, to review a complaint made against the effects of low frequency noise immissions. The study revealed that the wind turbine at the chosen study sites emitted low frequency noise at measurable levels, however, below DEFRA Night time Low Frequency Noise Criterion and also below low frequency noise associated with traffic.

Infrasound is generally described as sound at frequencies below 20Hz. Infrasound noise immissions were also determined to be below recognised threshold of perception for acoustic energy within the frequency range. This study in addition to 'Community Noise' guidance by the World Health Organization (1999) suggests that infrasounds below the hearing threshold do not produce physiological or psychological effects. Bowdler et al. (2009) agreed that there is:

'no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farm, generally has adverse effects on wind farm neighbours'.

Amplitude Modulation of aerodynamic noise describes a greater than normal degree of regular fluctuation at blade passing frequency, typically once a second. The Scottish Government's (2011) Renewable Advice for Onshore Wind Turbines states that there is no evidence of effects from Amplitude Modulation or other low frequency noise associated with operational wind turbines.

4.4.5 Mitigation

The effects of barrier attenuation were not taken into account within the ISO9613-2 methodology utilised within the assessment. It is considered that potential barriers in between the receptors and the highest point of the rotor are likely to influence the impact of noise from the Knowes wind turbines.

Guidance presented within the IOA Good Practice Guide suggests that an attenuation of 2dB could be assumed for properties where there is no line of sight between the receptor and the highest point of the turbines rotors. A higher barrier attenuation could also be considered in cases where a landform barrier is positioned very close to the receptors. No barrier attenuation, however has been used in the assessment.

4.4.6 Summary of Potential Operational Effects

A number of noise sensitive receptors have been identified near to the site of the proposed wind turbines. Each of the identified receptors has been assessed against independent and cumulative

operational noise effects. All noise levels at noise sensitive properties surrounding Knowes would receive noise levels below the established ETSU-R-97 derived criteria.

4.5 Construction Noise Assessment

Noise sensitive receptors surrounding the site should be protected from the potential noise and vibration associated with the construction of wind turbines. It is therefore important to assess the likely associated noise levels expected to occur during the various construction activities planned. Noise levels will be assessed against acceptable limits so that they do not impact upon the amenity of residential properties surrounding the site. It is anticipated that the construction of the access tracks, the excavation of foundations, the turbine foundation build and turbine erection will make up the basis of the construction noise assessment.

4.5.1 Methodology and Guidance

The construction noise assessment methodology has been carried out in accordance with the British Standard BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise'.

Calculations of the noise impact of the combined plant required on the site have been undertaken using the 'Method for activity L_{Aeq}' outlined in Annex F of BS 5228-1:2009.

The methodology has assumed all plant will be operating consecutively and continuously for the full 12 hour daily construction period required by BS 5228-1:2009. It has also been assumed that all plant will be situated at the closest location to where construction works will take place to the noise sensitive receptors surrounding the site. Using these assumptions a worst-case scenario will be predicted. In practice mobile plant will move locations and will not always operate simultaneously.

It is possible to estimate the noise impact of each typical plant used during the development of the wind turbines by using sound pressure level values taken from Annex C of BS 5228-1:2009.

There are no legal limits for construction noise levels being received at surrounding noise sensitive receptors; however, guidance allows for threshold criteria to be developed. In the case of this assessment example criteria outlined in BS 5228-1:2009 for *'use when ambient noise levels are less than the given thresholds'* are to be used. The daytime criteria set adhere to guidance presented from the World Health Organisation's Community Noise document and PAN 50.

A significant noise impact will be deemed to occur if assessed noise levels at the nearest residential properties exceed the thresholds given below in Table 4.18.

Table 4.18 Construction noise level limits at noise sensetive receptors

Assessment period (L_{Aeq})	Threshold Value (dB)
Night-time (23.00-07.00)	45
Evenings and weekends	55
Daytime (07.00-19.00) and Saturdays (07.00-13.00)	65

4.5.2 Calculations

Individual calculations of the various stages of the construction process have been undertaken and are presented in Table 4.19. Full calculations made in accordance with BS 5228-1:2009 can be found in Appendix 2.

Table 4.19 Predicted construction noise levels at noise sensitive receptors

Noise sensitive receptor	Distance (m) from Wind Turbine Construction Activity	Distance (m) from Access Road Construction Activity	Predicted Construction Noise Levels $dBL_{Aeq,12\ hour}$			
			Access tracks	Foundation excavation	Turbine foundation build	Turbine erection
Quilts	1089	460	49.4	32.1	31.1	27.1
Cockersfauld	1121	715	44.6	31.8	30.8	26.8
Blaeberry Toll	1233	1100	40.0	30.7	29.7	25.7
Unknown	1319	1300	38.1	30.0	29.0	25.0
Baadhead	1057	1040	40.6	32.4	31.4	27.4

4.5.3 Mitigation

The predicted noise levels at sensitive receptors are within limits and are therefore not significant. However, there are additional measures that would be undertaken to reduce noise levels further.

- Construction activities carried out on site will adhere to best practice guidance presented by BS 5228
- Activities that may give rise to noise at noise sensitive receptors will be limited to periods between 07.00 and 19.00 on Monday to Fridays and 07.00 and 13.00 on Saturdays. If possible, activities will be separated from residential properties by the maximum distance possible.
- Construction equipment will be maintained in good working order and any associated noise attenuation, such as engine casing and exhaust silencers, will not be removed at any time.
- Plant will be selected with consideration to their noise emissions and their collective effects.

If a complaint is received by Perth and Kinross Council alleging that construction activities are creating a vibration problem it will be investigated using standards and procedures available, such as BS 6472 and BS 7385.

4.5.4 Summary of Potential Construction Effects

Noise levels predicted from the four stages of construction at each of the five closest properties are all below the 65dB $dBL_{Aeq,12\ hour}$ threshold for daytime periods set by BS 5228-1:2009. The highest noise level predicted would be at Quilts where a noise level of 49.4 dB $dBL_{Aeq,12\ hour}$ was calculated for the period during the construction of the access tracks. This noise level would only be experienced for a short period as the calculation only represents the noise level created by construction at the nearest part of the access road to the property. The noise levels at the property are well below the thresholds set and consequently noise impacts from all construction processes are considered to be satisfactory at all properties. No construction works will be undertaken during night hours and therefore construction noise levels at Quilts will also fulfil the night-time criteria.

The 12 hour period that the assessment has assumed will be reviewed and exact construction times will be agreed with Perth and Kinross Council before any work commences. Any requirement to work outside of these hours will also be agreed with Perth and Kinross Council. In addition to the chosen plant fulfilling the noise criteria specified, all plant will be chosen with regard to its noise output and any potential for noise level reductions will be utilised.

CHAPTER 5

SHADOW FLICKER

5 Shadow Flicker

5.1 Overview

This chapter looks at the proposed wind farm at Knowes in the context of possible effects on local amenity caused by shadow flicker. The assessment was carried out using ReSoft WindFarm 4.2 computer modelling software. The computer generated assessment will show which, if any, houses might be affected by shadow flicker.

The chapter presents the relevant guidance and legislation associated with shadow flicker. Describes the conditions under which shadow flicker occurs and sets out the assessment methodology used. An assessment of the potential effects of shadow flicker at the site is presented and conclusions drawn.

5.2 Guidance and Legislation

Renewables Advice – Onshore Wind Turbines 2011[1] provides information and advice on wind power, the significant planning issues likely to arise and how these can be addressed. Addressing shadow flicker, the advice note describes the conditions under which shadow flicker is likely to occur (conditions listed below in 5.3). Renewables Advice – Onshore Wind Turbines 2011 suggests that shadow flicker should not pose problems beyond 10 rotor diameters. Additionally, information regarding shadow flicker contained in 'Onshore Wind Energy Planning Conditions Guidance Note – A report for the Renewables Advisory Board and Berr' (2007) states that

'Only dwellings within 130 degrees either side of north relative to a turbine can be affected and the shadow can be experienced only within 10 rotor diameters of the wind farm.'[2]

5.3 Shadow Flicker Effects

Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as 'shadow flicker'. It only occurs inside buildings where the flicker appears through a narrow window opening. Shadow flicker effects will occur when a certain combination of conditions coincide in specific locations at particular times of the day and year.

Factors determining the occurrence and/or perception of shadow flicker effects to a receptor include:

- Time of day and year;
- Weather conditions – e.g. 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 a property;
- Size of windows and their facing direction;
- The occurrence of mitigating factors, such as screening vegetation
- Height of the turbine and rotor diameter;
- Distance of the turbine from the property – shadow flicker effect diminishes with distance.

[1] The Scottish Government, Web Based Renewables Advice: 'Onshore Wind Turbines' – updated February 25th 2011 – http://www.scotland.gov.uk/Resource/Doc/212607/0114118.pdf

[2] 'Onshore Wind Energy Planning Conditions Guidance Note – A report for the Renewables Advisory Board and Berr' – October 2007 http://www.berr.gov.uk/files/file35240.pdf

There are several reasons for this:

- There are fewer times when the sun is low enough to cast a long shadow;
- When the sun is low it is more likely to be obscured by either cloud on the horizon or intervening buildings and vegetation; and,
- The centre of the rotor's shadow passes more quickly over the land reducing the duration of the effect.

5.4 Assessment Methodology

The objectives of the assessment have been to identify whether any shadow flicker effects would occur at any sensitive receptors and to calculate the approximate times of day and year that these effects would occur.

In accordance with the Scottish Government's Renewables Advice – Onshore Wind Turbines (2011) all properties within 520m (10 rotor diameters) of the turbine locations have been taken into consideration in the assessment. It is also considered that throughout the UK due to the path of the sun across the sky that only properties within 130° either side of north, relative to the turbine can be affected.

Calculations were undertaken using Resoft WindFarm 4.2 software. The software calculates the times throughout a year when turbine rotors viewed from sensitive receptors are in line with the sun and there is potential for shadow flicker. The calculation process takes into account the suns changing position in relation to the sensitive receptors and the turbine.

The following factors have been assumed for the shadow flicker assessment:

- Each house has a 4m x 4m window facing the closest turbine
- There is no screening in front of the windows e.g. trees
- The sun is visible in a clear sky
- The turbine rotor is always facing each house
- The rotor is always turning

Calculations of potential shadow flicker effects using the factors assumed present a worst case scenario.

5.5 Baseline Conditions

Figure 5.1 in Volume 3 shows the zone of sensitivity boundary that has been used as baseline for the analysis. All shadow flicker sensitive properties within 520m of the proposed turbine locations have been identified. It can be seen on the map in Figure 5.1 in Volume 3 that there are no properties situated less than 10 rotor diameters away from the turbines in the zone of sensitivity to shadow flicker.

5.6 Assessment of Potential Effects

No properties are situated within the zone of sensitivity to shadow flicker and consequently no property will experience significant shadow flicker effects.

The climate in the northeast of Scotland is typically cloudy with relatively high levels of rainfall and on average will receive approximately 1,400 hours of sunshine annually. Shadow flicker effects will be greatly reduced in overcast skies and will not occur during periods of full cloud cover so in reality shadow flicker events will be reduced in number.

Site specific factors, such as intervening hedgerows, trees and bushes may also reduce any potential shadow flicker effects.

The turbine rotors will not always rotate due to periods of low wind and occasionally during maintenance works. Additionally, the angle of the blades will not always be facing directly toward properties.

5.7 Mitigation

No shadow flicker effects are predicted and therefore no mitigation measures will be required to reduce shadow flicker effects.

5.8 Summary of Potential Effects

A conservative model was used to assess the potential impact of shadow flicker at the occupied properties within 520m from the nearest turbine. The result of the assessment highlights that shadow flicker is not an issue with this site as there are no potentially sensitive receptors.

CHAPTER 6

ECOLOGY AND ORNITHOLOGY

HEL
HERITAGE ENVIRONMENTAL LIMITED

Knowes Wind Farm: Ecological Impact Assessment (Ecology)

February 2014

A Report to Muirden Energy

	DATE	PREPARED	REVIEWED	REMARKS
ISSUE 1	05/12/13	SG/DD	SK/MB	-
REVISION 1	03/02/14	SG/DD	SK/MB	Minor revisions, inclusion of cumulative assessment
REVISION 2	04/02/14	SG/DD	SK/MB	Project design revision to ensure avoidance of juniper
REVISION 3				

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1 SUMMARY AND CONCLUSIONS

1.1 Introduction

1.1.1 This independent report by Heritage Environmental Ltd. (HEL) presents an Ecological Impact Assessment (EcIA) in relation to the proposed Knowes Wind Farm, near Dunning, Perth and Kinross. A further EcIA has been prepared for the wind farm in relation to ornithology. A Confidential Appendix is provided in support of this EcIA, containing sensitive information on the locations of badger setts and should not be made widely available beyond Perth and Kinross Council (P&KC) and Scottish Natural Heritage (SNH). The EcIA has been prepared on behalf of Muirden Energy.

1.2 Summary of Site Proposals

1.2.1 The proposed wind farm would be centred on Ordnance Survey National Grid Reference: NO 012 115. Access would be taken from the B934 via Knowes Farm. Niine turbines, 80m to blade tip height, are proposed. Figure 1 in Appendix A.4 shows the location and layout of the proposed wind farm.

1.3 Scope of Assessment

1.3.1 The scope of the ecological assessment includes consideration of effects on the following:

- Statutory designated sites for conservation, including, Special Areas of Conservation (SACs) and Biological Sites of Special Scientific Interest (SSSIs);
- Non statutory designated sites for conservation;
- Sites listed on the Ancient Woodland Inventory (AWI);
- Vegetation;
- Bats;
- Otter *Lutra lutra*;
- Great crested newt *Triturus cristatus*;
- Pine marten *Martes martes*;
- Badger *Meles meles*;
- Water vole *Arvicola amphibius*;
- Red squirrel *Sciurus vulgaris*; and
- Freshwater pearl mussel *Margaritifera margaritifera*.

1.4 Impact and Mitigation Summary

1.4.1 The project design has ensured that the access track does not coincide with the location of a single juniper *Juniperus communis* (included on the Scottish Biodiversity List as a species of principal importance for biodiversity conservation in Scotland and as a Priority Species on the Tayside LBAP) and no direct effects have been predicted. However, in recognition of the relatively small separation distance to the track (approximately 8 m) a cautious approach will be undertaken to mitigate any unforeseen, unplanned actions in the vicinity of the juniper bush. This will involve the installation of appropriate fencing to a distance of 5m from the bush's outer edge which will be maintained throughout the construction phase.

1.4.2 No significant pre-mitigation effects are predicted on groundwater dependent terrestrial ecosystems (GWDTEs). However, best practice construction procedures are required in order to reduce predicted impacts to a minimum, *e.g.* "Good Practice During Wind Farm Construction" (Scottish Renewables 2010).

1.4.3 The contractor will follow best construction site practices at all times and during all stages of the project construction. These include Scottish Environment Protection Agency (SEPA) guidelines outlined in http://www.sepa.org.uk/about_us/publications/guidance/ppgs.aspx

1.4.4 It is expected that the Construction Management Statement and/or Environmental Management Plan would include measures for full and appropriate restoration of habitats following construction.

1.4.5 Mitigation measures presented in Section 0 are summarised in Table 1: Schedule of Environmental Commitments, below. Given the level of mitigation, it is considered that there will be no significant residual impacts as a consequence of the proposed development.

Table 1: Schedule of Environmental Commitments

Potential Effect	Environmental Measure	Type of Measure	Monitoring Requirements (if any)	Means through which Environmental Measures may be Secured
Construction Phase				
Effects on habitats and GWDTEs	Compliance with Best Practice	Compliance	~	Watching brief throughout construction
Loss of juniper	Compliance with track design; maintenance of protection buffer 5 m from bush.	Avoidance	~	Watching brief during track construction

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2 INTRODUCTION

2.1 Ecological Impact Assessment (EcIA)

2.1.1 This independent report by Heritage Environmental Ltd. (HEL) presents an Ecological Impact Assessment (EcIA) in relation to the proposed Knowes Wind Farm near Dunning, Perth and Kinross. A further EcIA has been prepared for the wind farm in relation to ornithology. A Confidential Appendix is provided in support of this EcIA, containing sensitive information on the locations of badger setts and should not be made widely available beyond Perth and Kinross Council (P&KC) and Scottish Natural Heritage (SNH). The EcIA has been prepared on behalf of Muirden Energy.

2.1.2 All work undertaken to produce this EcIA, including survey and authorship, has been completed by appropriate specialists in their respective fields who are members of the Chartered Institute of Ecology and Environmental Management (MCIEEM).

2.2 Project Description

2.2.1 The proposed wind farm would be centred on Ordnance Survey National Grid Reference: NO 012 115. Access would be taken from the B934 via Knowes Farm. Nine turbines, 80m to blade tip height, are proposed. Figure 1 in Appendix A.4 shows the location and layout of the proposed wind farm.

2.3 Policy and Guidance

2.3.1 This EcIA has been undertaken with specific regard to recommendation and legislative requirements given in the following:

- The Environmental Impact Assessment (Scotland) Regulations 1999;
- The Conservation (Natural Habitats &c.) Regulations 1994 (as amended in Scotland);
- EC Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (The Habitats Directive);
- Nature Conservation (Scotland) Act 2004 (NCSA);
- Wildlife and Countryside Act 1981 (WCA);
- The Protection of Badgers Act 1992;
- Scottish Executive interim Guidance of European Protected Species, Development Sites and the Planning System, 2001;
- Scottish Planning Policy;
- The Scottish Biodiversity List (SBL);
- UK Biodiversity Action Plan (BAP);
- Tayside Local Biodiversity Action Plan (LBAP);
- Institute of Ecology and Environmental Management; Guidelines for Ecological Impact Assessment, 2006; and
- A Handbook on Environmental Impact Assessment, SNH 2009.

2.3.2 Appendix A.1: Policy & Guidance provides further details of the relevant legislation used to inform this report.

2.4 Scope of Ecological Assessment

2.4.1 The scope of the ecological assessment includes consideration of effects on the following (refer Appendix A.1 :Policy & Guidance for further details):

Statutory Designated Sites

- European Sites (Natura 2000 Sites);
- Biological Sites of Special Scientific Interest (SSSIs);
- National Parks (NPs);
- National Nature Reserves (NNRs); and
- Local Nature Reserves (LNRs).

Non-statutory Designated Sites

- Royal Society for the Protection of Birds (RSPB) sites;
- Scottish Wildlife Trust (SWT) sites;
- National Trust for Scotland (NTS) sites.

Protected Species

- European Protected Species; and
- Nationally Protected Species.

Habitats and Species of Importance

- Habitats listed as Priority and Non-priority within the Habitats Directive;
- Habitats and species recognised through the SBL and LBAP;
- Ancient and semi-natural woodland (identified by the Nature Conservancy Council [NCC] and held/updated by Scottish Natural Heritage [SNH]); and
- The Vascular Plant Red Data List for Great Britain (Cheffings and Farrell 2005).

3 ECOLOGICAL ASSESSMENT METHODOLOGY

3.1 Introduction

3.1.1 The following details the approach used in this EcIA.

3.2 Initial Site Walkover Survey

3.2.1 A walkover of the proposed wind farm site, and up to 500 m beyond, was undertaken during August 2012 in order to identify any key constraints and also to establish/confirm the requirements for detailed ecological surveys. This included preliminary searches for potential bat roosts, freshwater pearl mussel *Margaritifera margaritifera* scoping assessment, great crested newt *Triturus cristatus* habitat assessment and the identification of potentially important vegetation communities. The results of the walkover survey were used to help define the scope of assessment.

3.3 Consultation

3.3.1 Following completion of walkover surveys (refer 3.2.1, above), the following organisations were asked for opinion on the proposed scope of assessment and methods.

Perth and Kinross Council, as Planning Authority

3.3.2 A method statement, detailing proposed methodologies of ecological surveys and assessments, was sent, via e-mail to Mr G. Dimeck of Perth and Kinross Council on 16 October 2012. A further request, via e-mail, was sent on 3 February 2014. No formal response has been received to date.

Scottish Natural Heritage

3.3.3 A method statement, detailing proposed methodologies was sent, via e-mail to the SNH Tayside and Grampian office on 16 October 2012. Jonathan Agnew of SNH replied, via e-mail on 29 October 2012, stating that the methodologies proposed following walkover assessment were adequate for the site.

3.4 Scottish Environment Protection Agency

3.4.1 A method statement, detailing proposed methodologies was sent, via e-mail to Planning (South East), Scottish Environment Protection Agency (SEPA) on 16 October 2012. Stephanie Balman, SEPA Planning Officer responded via e-mail on 17 October 2012 providing guidance on the assessment of wetland and peatlands, including employing National Vegetation Classification (NVC) surveys within such areas and to a distances of 100 m from any proposed tracks and 250 m from borrow pits and turbine foundations.

3.4.2 The scope of this EcIA has been modified to include a NVC survey to the required distances stated above (refer 3.7 Vegetation).

3.5 Desk Study

3.5.1 A desk study was completed during November 2013 and included review of:

- SNH database of designated sites for nature conservation; and
- National Biodiversity Network (NBN) Gateway which collates and maintains a database of protected species and ecological features of conservation importance. It should be noted that this source was used to provide a background context (and thus help define the scope of assessment) and was not used in any way as a primary data source.

3.5.2 Results from the desk study are included in Section 4 Description and Evaluation of Baseline, where appropriate.

3.6 Study Areas

3.6.1 The following study areas, including the proposed wind farm site[1], plus adjacent land[2] to distances detailed have been considered:

- Desk study: up to 5 km;
- For Special Areas of Conservation (SACs) and Biological SSSIs consideration was given to separation distances and the sites' respective qualifying features as to whether these could be affected by the proposed wind farm site;
- LNRs, SWT reserves and RSPB reserves: 1 km;
- Sites listed on the Ancient Woodland Inventory (AWI): Immediate boundaries;
- Vegetation: 250 m[3];
- Bats (activity): 50 m from maximum turbine envelope;
- Bats (potential roost sites): 200 m from turbine locations;
- Otter *Lutra lutra* and pine marten *Martes martes*: 200 m;
- Great crested newt: 500 m;
- Badger *Meles meles*: 100 m;
- Water vole *Arvicola amphibius* and red squirrel *Sciurus vulgaris*: 50 m;
- Reptiles: Proposed development area only; and
- Freshwater pearl mussel: 500 m.

3.6.2 The above study areas have been defined in recognition of current guidelines (noted in the relevant, following sections, where appropriate) and are considered to be appropriate in assessing any potential effects on ecology arising from the proposed development.

3.7 Vegetation

3.7.1 Following the results of the walkover surveys and also in light of the consultation response from SEPA (refer 3.4.1), a National Vegetation Classification (NVC) survey of wetland and peatlands within the study area was completed in summer 2013.

3.7.2 All areas within the study site were surveyed according to the NVC scheme described in *British Plant Communities* (Rodwell,1991, et seq.).

3.7.3 All homogenous stands of vegetation were mapped onto a 1:5,000 scale aerial photograph by eye and classified according to one of the 286 community types found throughout Britain, based on the species assemblage and their constancy, as per the standard survey methodology for the NVC scheme.

3.7.4 Where the vegetation is present as a mosaic of types the proportion of each NVC community or type within the mosaic was recorded. Where the vegetation present was not a good fit with published NVC communities or sub-communities a description of the vegetation and the differences from the published communities is given.

[1] Defined as maximum turbine envelope and access tracks (refer Figure 1 in Appendix A.4).

[2] Where access was available and where there were no apparent barriers to movement dispersal of groups and species.

[3] The vegetation survey was extended out to 250 m beyond the wind farm site to meet the requirements of SEPA Guidance Note 4.

3.7.5 Extensive use was also made of target notes in order to provide descriptive information and the location of rare or localised species and/or habitats. The location of target notes was assessed using hand-held GPS, allowing provision of 12-figure grid references. An assessment of individual areas of the main semi-natural habitats was made by fieldworkers as the survey progressed. This assessment involved consideration of each habitats' naturalness, size, rarity, diversity and position in an ecological unit, based on Ratcliffe (1977).

3.7.6 The Phase 1 Habitat Survey (JNCC, 2007) method was employed to survey all areas where NVC classification was inappropriate. The Phase 1 Habitat Classification was used in preference to NVC in situations where the vegetation types were man made (e.g. arable fields) or modified to such an extent (such as lowland woodland plantations) so that classification to NVC type was incompatible.

3.7.7 The nature conservation appraisal of all habitats and plant species takes account of UK and European legislation, and SBL and LBAP Priority Habitats and Species.

3.7.8 Plant species of conservation significance were also recorded when encountered.

3.7.9 It is considered that the vegetation survey was not subject to any significant limitations.

3.8 Bats

3.8.1 An assessment of bats within the study area was undertaken according to current guidance as detailed in *Bat Surveys – Good Practice Guidelines 2nd Edition 2012* produced by the Bat Conservation Trust. Following the initial site walkover[4] and in due consideration of the Guidelines, it was considered that the proposed wind farm site represented a *Low Risk* to bat activity and the activity survey intensity undertaken has been based on this assessment. The surveys are not considered to be subject to any significant limitations.

3.8.2 In terms of bat roost potential relative to bat activity/collision risk, no actual or potential roost sites were noted within 200 m of proposed turbine locations. With regard to potential disturbance, no assessment of potential roosts in proximity to proposed access tracks (where they pass in vicinity to Knowes farm) has been undertaken.

3.8.3 All surveys requiring the recording of bat echolocation for later analysis were completed using Anabat units. Whilst these units are generally regarded as being less effective than others (*e.g.* Songmeter 2 units) at detecting and recording echolocation they possess an advantage in certain criteria such as physical deployment, power usage and data manipulation. They are therefore well suited for long term field surveys on wind farm sites.

3.8.4 The detectable range of Anabat units varies considerably, principally due to the physical call characteristics of bat echolocation and weather conditions. The presence of brown long-eared bat *Plecotus auritus* (in suitable habitat) is difficult to detect through the recording of echolocation alone, due to the extremely weak calls of this species. They have therefore potentially been under-recorded during surveys, although this limitation is not considered to be significant, as they are regarded as a species at low risk of direct impacts (collision and barotrauma) from wind turbines (Natural England, 2012).

[4] The site walkover noted that potential for bat activity is limited given that the majority of the study area comprises open, relatively upland moorland. In addition, species considered to be at high risk from interaction with wind turbines (Rydell *et al.* 2010) (*i.e. Nyctalus* spp. and Nathusius' pipistrelle *Pipistrellus nathusii*) were considered unlikely to be present within the geographical area.

Ground Based Activity Surveys

3.8.5 Ground based activity surveys are focussed towards identifying potential adverse impacts on foraging areas and commuting routes as a result of windfarm construction and operation, whilst also providing a general indication of species present and therefore at risk from interactions with turbines. The ground based activity surveys involved a combination of manual (transect based) surveys and fixed point continuous monitoring surveys, as detailed in the relevant sections below. Data from ground based activity surveys is used in Section 4.5 to provide information on species assemblage; relative frequency of site use by different species; and, spatial and temporal distribution of activity and species.

Ground Level Manual Surveys

3.8.6 Ground level manual surveys (walked transect routes) were undertaken once per season during 2013 (spring, summer and autumn) on 29 May, 08 July and 18 September. Surveys were completed primarily in the 3 hour period following sunset.

3.8.7 Notes were made of the nature of activity of any bats encountered (for example feeding or commuting), where this was possible.

3.8.8 Transect routes were devised that cover all suitable areas of the maximum turbine envelope. All open habitats and edge habitats were included in the transect routes. The routes were walked at a constant, slow steady pace, with the surveyor carrying both a heterodyne/frequency division detector and Anabat recorder. The Anabat recorder was coupled with a GPS device so that records were geo-referenced.

3.8.9 Figure 6 in Appendix A.4 shows the transect routes undertaken.

Ground Level Static Surveys

3.8.10 Static detectors (Anabat) were deployed at 4 fixed points throughout the study area to allow for a minimum of 5 consecutive nights data at each point per season (spring, summer and autumn).

3.8.11 As turbine locations were unknown at the time of survey, the 4 fixed points were chosen to enable data collection across the range of habitat types found within the turbine envelope. Fixed point locations are presented in Figure 6 in Appendix A.4. A brief description of each detector location and habitat type is presented below:

- Static Point 1: Detector placed facing (microphone) east on high ground (320 m above sea-level) between confluence of burns Surrounding habitat mosaic composed of rush-pasture, dry heath and acid grassland;
- Static Point 2: Detector placed facing north (370 m above sea-level) within dry heath;
- Static Point 3: Detector placed facing east (350 m above sea-level) at habitat transition between dry heath and rush-pasture; and
- Static Point 4: Detector placed facing north (280 m above sea-level) at top of west bank of small burn *c.* 35 m from coniferous plantation block. Surrounding habitat mosaic composed of rush-pasture, dry heath and bracken *Pteridium aquilinum*.

3.8.12 Activity levels from static detector recordings have been used to generate relative activity levels (registration rates) to inform on potential risks to the species identified through monitoring.

Activity at Height

3.8.13 Recording bat activity at height was not considered necessary for the proposed wind farm, as the likelihood of encountering aerial hawking species (*e.g. Nyctalus*) was assessed to be very low (this assertion has subsequently been borne out by the absence of such species from activity surveys, refer Section 4.5).

Data Analysis

3.8.14 Analysis of all survey data collected by Anabat units was undertaken using the *AnalookW* software for bat call analysis and was completed by experienced surveyors. During analysis it is not always possible to definitely attribute recorded bat calls to species. This is discussed in the following paragraphs.

3.8.15 Registrations are defined as separate files produced by the recording device (Anabat unit) that contain bat echolocation. Registrations containing very weak and/or very short call structures can sometimes be impossible to attribute to genus level. Where such registrations have been encountered they have simply been labelled 'bat'.

3.8.16 It is not possible to definitely attribute registrations with calls >49 and <51 kHz to either common pipistrelle *Pipistrellus pipistrellus* (typical characteristic frequency of 45 kHz) or soprano pipistrelle *Pipistrellus pygmaeus* (typical characteristic frequency of 55 kHz). Call sequences (registrations) within these parameters have thus been labelled as pipistrelle species *Pipistrellus* sp.

3.8.17 It is not possible to definitely attribute the majority of *Myotis* calls to species level with absolute certainty. The species potentially present in the geographical area (whiskered bat *Myotis mystacinus*, Daubenton's bat *Myotis daubentonii* and Natterer's bat *Myotis nattereri*) have extremely similar call characteristics. Registrations from these species should only ever be described as possessing characteristics of call that are most typical of a specific species. For the purposes of clarity within this report, all registrations of this genus have been attributed to *Myotis* sp. All species within this genus are at low risk from the impacts of wind turbines (Natural England 2012).

3.9 Mammals (other than bats)

3.9.1 Given their geographical and historical distributions, the following species were considered following identification of suitable habitat during the initial walkover survey:

- Otter;
- Pine marten;
- Red squirrel;
- Water vole; and
- Badger.

3.9.2 Walkover surveys of the respective study areas was undertaken during August and September 2013. A number of areas of dense bracken presented a limitation to survey at this time and these were re-surveyed in November 2013 following die-back of the fronds.

3.9.3 As well as sightings of protected mammal species, evidence of the presence/recent presence of species including prints, paths, droppings, places of shelter (including holes, setts, holts, dens, roosts, nest sites) and feeding remains were recorded and mapped where encountered. The surveys are not considered to be subject to any significant limitations.

3.10 Great Crested Newt

3.10.1 The walkover survey recorded no standing waterbodies with the potential to support breeding great crested newt. Therefore this species has been scoped out of assessment and will not be considered further.

3.11 Reptiles

3.11.1 The open habitats of the site provide good potential habitat for reptiles and will require survey and assessment. It is proposed to survey those areas/ habitats that will be directly impacted (*i.e.* lost to land take) following consent and pre-construction to ensure that the project is legally compliant under the WCA with regards to reptiles.

3.12 Freshwater Pearl Mussel

3.12.1 No water courses within the study area were noted to provide suitable habitat for freshwater pearl mussel. The main watercourse within the study area (the Thorter Burn) is a narrow (1 m to 1.5 m), tumbling burn which appears to be subject to high energy spates. This is considered to preclude freshwater pearl mussel due to lack of stabilised sands and gravels. The burn is also subject to stock poaching in places which would further reduce suitability. Freshwater pearl mussel, therefore, has been scoped out of assessment and will not be considered further.

3.13 Assessment of Effects

3.13.1 The process of EcIA has been undertaken by consideration of best practice guidance (*e.g.* Institute of Ecology and Environmental Management guidelines [IEEM 2006]) and professional judgement, in order to provide a methodology that is robust and fit for purpose for this project. The following provides an outline of the methodology used to provide a structured approach to determining potential adverse effects of the project. The assessment involves the following process:

- Evaluation of nature conservation value;
- Impact assessment of project; and
- Provision of mitigation measures.

Evaluation of Nature Conservation Value

3.13.2 The first stage of ecological impact assessment involves applying a nature conservation value to each ecological feature or receptor (*i.e.* species or group) present within the defined study areas. Ecological receptors are assigned a nature conservation value based on evaluation criteria adapted from existing guidelines and professional judgement. Table 2 shows the level of values and examples that are used as a guide in the evaluation process. Thus, ecological receptors are assigned a value according to a scale of *Negative* to *International Value*.

Impact Assessment of Project

3.13.3 In order to define the implications of the proposed development on ecology and nature conservation an impact assessment of the project is completed. Methods of impact prediction used in this assessment include direct measurements and expert opinion. Published information is also used to determine impacts. Impacts are considered in relation to the probability of the impact occurring, whether they are predicted to be direct, indirect, temporary, permanent, reversible or irreversible.

3.13.4 For each potential impact of the project, an assessment of impact magnitude and effect significance is provided based on the guidelines given in Table 3: Guidelines for Assessing Impact Magnitudes and Table 4: Matrix for Assessing Significance of Effects.

3.13.5 The magnitude of an impact is assessed in conjunction with the nature conservation value of the receptor (see Table 2) to provide an indication of effect significance (see Table 4). Impact magnitude is ranked according to a scale of *None* to *High*, based on increasing magnitude. In recognising a continuum of effect significance, these are ranked according to a scale of *None* to *Major*, based on increasing adverse impact. A *Positive* category is also provided to indicate where there is a predicted increase in conservation status compared to the base-line.

3.13.6 For the purpose of this assessment a *significant effect* on ecology or nature conservation is defined here as any impact of moderate or major significance. Definitions of these terms are provided in Table 4: Matrix for Assessing Significance of Effects.

Mitigation Measures

3.13.7 Mitigation measures have been recommended where it is anticipated that a significant impact may result without measures being implemented or in accordance with Best Practice guidelines, or to fulfil legal obligations. An assessment of post-mitigation effects is provided to show the overall effect of the proposed development.

Table 2: Guideline Nature Conservation Evaluation Criteria

Level of Value	Examples
International (European or Global)	• Habitats and/or species that meet published criteria for international designation such as World Heritage Sites, Biosphere Reserves, Biogenetic Reserves, RAMSAR Sites or sites of EU importance i.e. SPA's or SAC's. • Outstanding examples of ecological features in a European context (*i.e.* high quality, good extent, viable areas of habitats and high density, core part of species population, etc.) of habitat types and species listed in Annex I and Annex II of the Habitats Directive.
National (UK or Scotland)	• Habitats and/or species that meet published criteria for national designation such as SSSI's, NNR's or MNR's. • Outstanding examples of ecological features in a national context (i.e. high quality, good extent, viable areas of habitats and high density, core part of species population, etc.) of habitat types and species listed in Schedules 1, 5 & 8 of the WCA and UK BAP Priority Species and Habitats.
Regional (SNH Natural Heritage Zone No. 16: Eastern Lowlands)	• Habitats and/or species not satisfying international (*e.g.* SAC, SPA, *etc.*) or national (*e.g.* SSSI *etc.*) designation criteria, but are good examples of the following: ▪ areas of priority habitat and important populations of priority species included on the UK BAP; ▪ sites containing regionally important numbers of a single species (*e.g.* >1% of SNH Natural Heritage Zone population for birds); and ▪ species outlined in a Local BAP to be of regional rarity or localisation.
District (Perth and Kinross Local Plan: Perth Area)	• Viable areas of habitat or species identified in an LBAP. • Good population sizes and/or assemblages of Red/Amber List birds. • Extant areas of semi-natural ancient woodland. • Sites meeting the criteria for Local District Authority area designation (*e.g.* SINC's or LNR's).
Local Proposed wind farm site and 5 km beyond	• Those ecological features considered to enrich the natural resource within the local environs, *e.g.* linear features such as hedgerows or boundary trees. • Certain examples of habitats of conservation concern which are fragmentary and in poor condition. • Non-critical habitat elements (*e.g.* a non-natal/temporary place of shelter or limited area of foraging resource) of certain widespread and/or abundant ecological features of conservation concern.
Negligible	• Sites and/or specific examples of habitats of limited ecological value; including agriculturally intensified land (excluding species-rich margins), and other low grade and/or common and widespread habitats. • Very common and abundant species.
Negative	• Invasive and/or alien flora/fauna which have a deleterious ecological effect *e.g.* those animals and plants species scheduled under Section 14, Schedule 9 to the WCA.

Table 3: Guidelines for Assessing Impact Magnitudes

Impact Magnitude	Guidelines
High Negative	A negative, fundamental change to the ecological baseline . Impact(s) that have a substantial effect on ecological feature(s) with regard to magnitude, extent and duration. For example complete or substantial, • loss of an ecological feature; • reduction in population viability.
Medium Negative	A negative, material change to the ecological baseline. Impact(s) that have a moderate effect on ecological feature(s) with regard to magnitude, extent and duration. For example moderate, • deterioration in habitat quality; • reduction in population distribution.
Low Negative	A negative change of limited scale to the ecological baseline. Impact(s) that have a limited effect on ecological feature(s) with regard to magnitude, extent and duration. For example limited, • short term reduction in species diversity; • habitat loss of temporary duration.
Negligible Negative	A very slight, detectable negative change to the ecological baseline. Impact(s) that have a very limited effect on ecological feature(s) with regard to magnitude, extent and duration. For example very limited, • disturbance of a temporary nature to species/habitats; • impacts that would not affect the viability or carrying capacity of the site.
None	No detectable impact(s) on the ecological baseline.
Positive	Impact(s) resulting in positive effect(s) on the ecological baseline.

Table 4: Matrix for Assessing Significance of Effects

		Magnitude of Impact			
		High Negative	**Medium Negative**	**Low Negative**	**Negligible Negative**
Value of Ecological Feature	**International**	Major	Major	Moderate	Minor
	National	Major	Major	Moderate	Minor
	Regional	Major	Moderate	Minor	Minor
	District	Moderate	Moderate	Minor	Negligible
	Local	Minor	Minor	Negligible	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

Significance: Significant Impact | Non-significant

4 DESCRIPTION AND EVALUATION OF BASELINE

4.1 Introduction

4.1.1 The following details the results of ecological surveys undertaken within the respective study areas, and relevant desk study records.

4.2 Designated Sites

Non-Statutory Designations

4.2.1 A stand of ancient woodland listed as Ancient (of semi-natural origin) on the Ancient Woodland Inventory (AWI) abuts the site's northern boundary (refer Figure 2 in Appendix A.4). Given that the nearest development infrastructure would be approximately 300 m from the stand, no significant effects are predicted and this stand of ancient woodland is not considered further in this assessment.

4.3 Desk Study

Mammals

4.3.1 At 1 km grid square resolution or greater, NBN Gateway has records of otter, red squirrel, common pipistrelle, soprano pipistrelle and brown long-eared bat within the 10m km grid square NO 01 in which the proposed development is located. No records are located within the study areas for the species involved; information from the NBN Gateway therefore indicates that the species listed above are present in the local area of the study site and should be considered during field survey.

Vegetation

4.3.2 At 1 km grid square resolution or greater, NBN Gateway has records within the 10 km grid square NO 01 in which the proposed development is located of the following species included on the SBL:

- Scarlet pimpernel *Anagallis arvensis* subsp. *arvensis* . The nearest record is 4 km to the north east. The plant is listed on the Conservation Action Needed category of the SBL; and
- Sun spurge *Euphorbia helioscopia.* The nearest record is 1 km to the north. The plant is listed on the Conservation Action Needed and Avoid negative Impacts categories of the SBL.

4.4 Vegetation

Vegetation Communities

4.4.1 Table 5 lists the NVC types and Phase I Habitat types recorded from the study area and the corresponding EU Habitats Directive Annex I, SBL and Tayside LBAP habitat types. Figure 3 in Appendix A.4 shows the extent and location of the NVC vegetation types for the site, and Figure 4 in Appendix A.4 shows the assessed values of the vegetation types present.

4.4.2 Appendix A.2 includes a brief description of each habitat type along with floristic tables of the samples recorded where appropriate. The following provides an overview of the vegetation communities recorded within the study area and also provides a description of the NVC vegetation types that have been assessed to be of *District Value* or above.

4.4.3 The study area can largely be considered as two distinct zones, with a more lowland, agriculturally improved zone occupying the northern parts of the study area, including the area through which the main access to the site will be routed, and a larger more southern zone which extends into the Ochil Hills, and will be the location for the turbines (refer to

Figure 1 in Appendix A.4). The high point of the site is approximately 430 m above sea-level (asl), on the hill at the south of the study area, with a low point of 230 m asl, located at the start of the access track on the B924. A majority of the infrastructure, including the turbines, is located above 300 m asl.

4.4.4 The Thorter Burn and associated headwater tributaries are the main watercourses draining the site, with a tributary of the Thorter Burn forming a bowl within the core of the site surrounding by rounded hills such as the Black Hill of Kippen and Casken Hill.

4.4.5 Three core vegetation types constitute an overwhelming majority of the vegetation present within the upland part of the site, which includes the entire turbine envelope. The three vegetation types are as follows:

- Dry heath dominated by heather *Calluna vulgaris* – NVC types H12;
- Species-poor acid grassland – NVC types U4 and U5; and
- Rush-pasture dominated by sharp-flowered rush *Juncus acutiflorus* – NVC type M23a.

4.4.6 The heather dominated *Calluna vulagris – Vaccinium myrtillus* H12 vegetation tends to predominate on the hill tops and gentle slopes, though is also present on the steep north-facing slope to the north of the turbine array. Heather is often wholly dominant forming a continuous sub-shrub canopy resulting in few associates. Blaeberry *Vaccinium myrtillus* is the most frequent associate and in places, presumably as a result of recent management, can be quite abundant. Other vascular associates include wavy hair-grass *Deschampsia flexuosa*, crowberry *Empetrum nigrum subsp. nigrum* and heath bedstraw *Galium saxatile*, all present at a low cover. Pleurocarpous bryophytes are frequent and again in places can be abundant. The most common species are *Hylocomium splendens* and *Pleurozium schreberi*. Vegetation as described above with heather overwhelmingly dominant has been classified as the *Calluna vulgaris* sub-community, H12a. Where grasses provide a more consistent element to the community the vegetation has been classified as the *Galium saxatile – Festuca ovina* sub-community, H12c.

4.4.7 The *Calluna-Vaccinium* H12 heath present within the study area can be considered to represent examples of EU Habitats Directive Annex I, Tayside LBAP and SBL habitats. However, the stands of dry heath within the study area are not very extensive or particularly diverse. The dry heath present at Knowes does however present an important resource within the Perth area and as such the study area is assessed to be of *District Value* for Dry heath (H12).

4.4.8 Vegetation best described as the *Calluna vulgaris-Eriophorum vaginatum* blanket bog, M19, is of limited occurrence within the study area, the largest area occurring in mosaic with dry heath (H12) and wet heath (M15) vegetation in proximity to turbine 3. Heather is the dominant species though the consistent presence of hare's-tail cottongrass *Eriophorum vaginatum*, though often at quite a low frequency, identifies this as bog vegetation. Along with the heather and hare's-tail cottongrass there is usually some crowberry and cross-leaved heath *Erica tetralix*. Bryophytes are abundant including *Sphagnum capillifolium*, *Pleurozium schreberi* and *Hypnum* sp.

4.4.9 Stands of this vegetation type can be considered to represent examples of EU Habitats Directive Annex I,), Tayside LBAP habitat types and SBL habitats. The stands of blanket bog within the study area are not very extensive or particularly diverse, lacking a diversity or abundance of sphagna more typical of blanket bog of high nature conservation value. The blanket bog present at Knowes does however represent an important resource within the Perth area and as such the study area is assessed to be of *District Value* for blanket bog (M19).

4.4.10 Wet heath is very restricted in extent within the study area, limited to a small stand in the northern part of the study area and also occurring in mosaic with blanket bog (M19) and dry heath communities (H12) in a single area in the northern half of the turbine envelope.

4.4.11 The area of wet heath to the north appears heavily modified (possibly through grazing and drainage) and is dominated by a mix of purple moor-grass *Molinia caerulea*, heather and blaeberry with a lesser element of deergrass *Trichophorum cespitosum*, heath rush *Juncus squarrosus*, wavy hair-grass and mat grass. Bryophytes area also frequent particularly *Pleurozium schreberi* and *Hypnum* sp. This vegetation fits well into the *Trichophorum cespitosum-Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community, M15d.

4.4.12 The wet heath vegetation recorded in mosaic with both H12 and M19 is dominated by heather with frequent *Sphagnum capillifoilum* present beneath the heather canopy. Associate species include purple moor-grass, cross-leaved heath and *Aulacomnium palustre*. This vegetation is characteristic of the Typical sub-community, M15b.

4.4.13 In common with the communities with which the M15b vegetation is associated with at Knowes, stands of this vegetation type can be considered to represent examples of EU Habitats Directive Annex I, Tayside LBAP habitat types and SBL habitat. However, the stands of wet heath within the study area are not very extensive or particularly diverse, and the majority show signs of modification through past drainage and grazing impacts. The wet heath present at Knowes does however present an important resource within the Perth area and as such the study area is assessed to be of *District Value* for wet heath (M15).

Table 5: NVC communities and associated conservation status

NVC/Phase I Code	NVC/Phase I Habitat Type	Value	Annex I	Tayside LBAP	SBL	SBL Categories for action	GWDTEs
H12	*Calluna vulgaris – Vaccinium myrtillus* heath	District	European dry heaths	Upland heath	Upland heathland	Conservation action needed Avoid negative impacts	-
M15	*Tricophorum cespitosum – Erica tetralix* wet heath	District	Northern Atlantic wet heaths with *Erica tetralix*	Upland heath	Upland heathland	Conservation action needed Avoid negative impacts	Moderately
M19	*Calluna vulagris – Eriophorum vaginatum mire*	District	Blanket bog	Upland heath	Blanket bog	Conservation action needed Avoid negative impacts	-
M23	*Juncus effusus/acutiflorus – Galium palustre* rush-pasture	Local	-	-	Upland flushes, fens and swamps	Watching brief only	Highly
***Carex disticha* mire**	*Carex disticha* mire	Local	-	-	Upland flushes, fens and swamps	Watching brief only	Highly
M6	*Carex echinata – Sphagnum fallax* mire	Local	-	-	Upland flushes, fens and swamps	Watching brief only	Highly
MG1	*Arrhenatherum elatius* grassland	Local	-	-	-	-	-

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NVC/Phase I Code	NVC/Phase I Habitat Type	Value	Annex I	Tayside LBAP	SBL	SBL Categories for action	GWDTEs
MG6	*Lolium perenne – Cynosurus cristatus* grassland	Negligible	-	-	-	-	-
MG9	*Holcus lanatus – Deschampsia cespitosa* grassland	Local	-	-	-	-	Moderately
MG10	*Holcus lanatus –Juncus effusus* grassland	Negligible	-	-	-	-	Moderately
U4	*Festuca ovina – Agrostis capillaries – Galium saxatile* grassland	Local	-	-	-	-	-
U5	*Nardus stricta – Galium saxatile* grassland	Local	-	-	*Nardus stricta – Galium saxatile* grassland	Watching brief only	-
U20	*Pteridium aquilinum – Galium saxatile* community	Local	-	-	-	-	-
W7	*Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland	Local	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*	-	Upland mixed ashwoods	Conservation action needed Avoid negative impacts	Highly
W9	*Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland	Local	*Tilio-Acerion* forests of slopes, screes and ravines	-	Upland mixed ashwoods	Conservation action needed Avoid negative impacts	-

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NVC/Phase I Code	NVC/Phase I Habitat Type	Value	Annex I	Tayside LBAP	SBL	SBL Categories for action	GWDTEs
W21	*Crataegus monogyna – Hedera helix* scrub	Local	-	-	-	-	
W22	*Prunus spinosa – Rubus fruticosus* scrub	Local	-	-	-	-	
W23	*Ulex europaeus – Rubus fruticosus* scrub	Local	-	-	-	-	
OV25	*Urtica dioica – Cirsium arvense* scrub	Negligible	-	-	-	-	
A1.1.2	Broad-leaved plantation	Local	-	-	-	-	
A1.2.2	Conifer plantation	Negligible	-	-	-	-	

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Groundwater Dependent Terrestrial Ecosystems

4.4.14 Figure 5 in Appendix A.4 shows the distribution of groundwater dependent terrestrial ecosystems (GWDTE's) present across the study area. The definition of GWDTE's is based on the information contained within SEPA Guidance Note 4, Planning Guidance on windfarm developments, Version 6, March 2012. Areas shown as 'partial' on Figure 5 are areas where any of the communities listed above form a minority element of a vegetation mosaic with other communities that are not considered to be GWDTE's.

4.4.15 The following communities present within the study area, as identified in Table 5 above, are considered to be GWDTE's:

- M15 – Moderately groundwater dependent;
- M23 – Highly groundwater dependent;
- *Carex disticha* mire (form of M23) – Highly groundwater dependent;
- M6 – Highly groundwater dependent;
- MG9 – Moderately groundwater dependent;
- MG10 – Moderately groundwater dependent; and
- W7 – Highly groundwater dependent.

Flora

4.4.16 A single plant of spignel *Meum athamanticum* is present within the moorland, on slopes above a tributary of the Thorter Burn, BNG: NO 01052 11033. Spignel is classed as Near Threatened on The Vascular Plant Red Data List for Great Britain (Cheffings & Farrell 2005) and is also Nationally Scarce, *i.e.* known from 16 – 100 hectads in Great Britain. Spignel appears quite widespread through central and southern Scotland (Preston *et al.* 2006) with records for the Ochils included on the NBN Gateway (nearest record: 5 km to the south in OS Grid Square NO 0006). Though known from the local area, given the conservation status of spignel the study area is assessed to be of *District Value* for the species.

4.4.17 A single juniper *Juniperus communis* bush is located within the moorland at BNG: NO 01034 11164. Juniper is included on the SBL as a species of principal importance for biodiversity conservation in Scotland and as a Priority Species on the Tayside LBAP. Though of widespread distribution in Scotland and regionally in Tayside there are not many records for Juniper from the Ochils (source: NBN Gateway). Given the status of juniper and the limited records in the Ochils the study area is assessed to be of *District Value* for the species.

4.5 Bats

Roost Surveys

4.5.1 All trees within the study area were assessed from the ground in respect of the suitable features they offer, or may offer if not possible to view, for roosting bats. Six trees (refer Table 14 in Appendix A.3) within the study area (two at Knowes Farm) were considered to provide suitable features for roosting bats. As all six trees are located outwith the proposed development boundary and are over 200 m from any proposed turbine location, no further survey (*e.g.* tree climbing survey) was considered necessary with respect to the wind farm infrastructure (except access tracks). Should the positions of turbines be relocated from those assessed within this EcIA, further survey may be considered necessary.

4.5.2 Farm and residential buildings at Knowes Farm, and two trees (refer Section 4.5.1), provide suitable features for roosting bats. No further survey or assessment of potential roosts in proximity to proposed access tracks has been undertaken.

Ground Level Static Surveys

4.5.3 Static recording was completed seasonally (refer Section 3.8) during spring, summer and autumn 2013. Data presented in Table 10 in Appendix A.3 translates to 153.87 hours of detector time at each point across the entire survey period. At no time was a minimum of five consecutive nights data not achieved at any point for any month.

4.5.4 All registrations found to contain bat echolocation calls on analysis are presented in Table 11 in Appendix A.3. As previously stated within the methodology, registrations relate to a short discrete burst of echolocation from a passing bat that has been picked up by one of the detectors. Registrations therefore do not necessarily directly relate to actual numbers of bats. For example, a single bat foraging close to a detector is likely to result in multiple registrations.

Summary of Ground Level Static Survey Data

4.5.5 No species considered to be at high risk (Natural England, 2012) of interaction with wind turbines were identified through ground level static surveys.

4.5.6 Soprano pipistrelle and common pipistrelle were the most commonly recorded species within the study area, being recorded at all static points and for the majority, in all seasons of recording also (no registrations recorded from July survey at static point 2). Approximately twice as many soprano pipistrelle registrations as common pipistrelle registrations were recorded.

4.5.7 *Myotis* species registrations were recorded from all static survey points. Although a number of *Myotis* registrations possess call parameters that are considered most similar to those of Natterer's bat, it is not possible to ascribe species level to *Myotis* genus Anabat recordings with certainty. *Myotis* species are considered to be at low risk of direct effects from wind turbines (*e.g.* Natural England, 2012).

4.5.8 Activity from all bat species shows a correlation between the habitat types present and registrations recorded. There is considered to be an association between all bat species recorded and habitat of perceived higher forage quality, including woodland edge and boundary feature/edge habitat. Almost 70% of registrations were recorded from static point 4 at the northern boundary of the proposed wind farm development site. The local area of this static point possesses the most diverse habitat types of the four points, including woodland edge habitat.

4.5.9 Activity from all bat species does not show a correlation between the time of year and registrations recorded for all species. Seasonal registration rates can be derived from the data presented within Tables 10 and 11 in Appendix A.3. These indicate that the activity rate of soprano pipistrelle at all points combined increased over the three static survey periods from *c.* 0.994 registrations/hour in May/June to 1.728 in July and to 2.917 in September.

Transect data

4.5.10 Transects were completed 3 x on a seasonal basis (refer Section 3.8.6). Table 13 in Appendix A.3 shows the data analysis results of registrations of bat echolocation recorded during the transect surveys. Locations of registrations are displayed on Figure 6 in Appendix A.4.

4.5.11 No species considered to be at high risk (Natural England, 2012) of interaction with wind turbines were identified through ground level transect surveys.

4.5.12 Only four registrations were recorded during transect surveys: one common pipistrelle and three soprano pipistrelle. No registrations were recorded during the transect survey undertaken in September.

4.5.13 Although the incidence of bat activity recorded during transect surveys is low, it is nevertheless comparable with the lower end of registration rates (registrations/hour) recorded from the static surveys: *i.e.* 0.33 registrations/hour of transect survey (4 registrations from 12 hours survey) in comparison with rates within Table 11in Appendix A.3.

Evaluation of All Bat Data

4.5.14 No roosts have been recorded through survey work undertaken.

4.5.15 No species considered to be at high risk (Natural England, 2012) of interaction with wind turbines were identified through any survey type.

4.5.16 The registration rates of common pipistrelle, soprano pipistrelle and *Myotis* are considered to be within a range to be expected for similar habitat types (including altitude) in Scotland. A brief comparison analysis, for reference, is presented in Table 6 below. Due to the sensitivity of data ownership, exact locations of comparison sites cannot be disclosed. All comparison points presented are from similar habitat types of moorland or coniferous plantation edge, and have been derived from similar long-term monitoring studies in accordance with survey methodologies undertaken for this assessment.

Table 6: Comparison sites - bat registrations per hour (all months combined)

Site	Species/registrations hr^{-1}				
Knowes	***Myotis***	***Pipistrellus***	**Common pipistrelle**	**Soprano pipistrelle**	**All pipistrelle combined**
Point 1 (moorland)	0.058	0.039	0.390	0.968	1.397
Point 2 (moorland)	0.026	0.058	0.338	0.539	0.935
Point 3 (moorland)	0.058	0.130	0.396	1.150	1.676
Point 4 (plantation edge)	0.110	0.234	3.120	5.628	8.982
Comparison site 1 (Perthshire)					
Point 1 (moorland)	0.002	0.002	0.292	0.584	0.878
Point 2 (plantation edge)	-	0.009	1.975	0.691	2.675
Point 3 (plantation edge)	0.007	0.460	9.018	7.595	17.073
Comparison site 2 (Inverness-shire)					
Point 1 (moorland)	-	0.0228	0.2329	0.0685	0.324

Point 2 (moorland)	-	-	0.0228	0.0457	0.069

4.5.17 *Pipistrellus* species (common and soprano pipistrelle) were the most frequently recorded species during all survey types and across the range of habitat types present. Both species are common and widespread in Scotland with a combined Scottish population estimate of 550,000 (Harris *et al.* 1995). The study area is considered to be of *Local Value* for common and soprano pipistrelle.

4.5.18 *Myotis* species were identified during static detector surveys (no *Myotis* species were recorded during transect surveys within the study area). Some registrations show call parameters more associated with Natterer's bat than other *Myotis* species, and it is considered likely that the majority would belong to Natterer's bat given the habitats present where registrations have been recorded (*e.g.* lack of open water foraging habitat associated with Daubenton's bat) and geographical range (*e.g.* scarcity of whiskered bat *Myotis mystacinus* in the region). Natterer's bat is widely distributed in Scotland with a pre-breeding population estimate of 17,500 (*ibid.*). The study area is considered to be of *Local Value* for *Myotis*/Natterer's bat.

4.6 Mammals (other than bats)

Otter

4.6.1 Evidence of otter presence was recorded in two locations along the Thorter Burn within the study area (refer Figure 6 in Appendix A.4 and Table 15 in Appendix A.3). A sprainting site was identified on an in-stream boulder, and a couch site was located amongst dense bracken. Both sites were found downstream of Thorter Bridge (road bridge), within the study area for the proposed access track. No evidence of otter was found within the proposed wind farm site.

4.6.2 Given the recorded presence of this EPS, the study area is considered to be of *Local Value* for otter.

Badger

4.6.3 Locations and details of badger evidence are presented within the Confidential Appendix.

4.6.4 Two single-hole badger setts were identified within the north of the study area, but outwith the proposed wind farm site. Although no evidence of recent use was recorded at either sett, and both are considered to be outliers, a well used latrine with several pits containing fresh dung was present outside the entrance of one of these setts.

4.6.5 A seven hole main sett was identified 75 m to the south east of the proposed southern access track route and a single hole outlier (although outwith the study area) located 75 m south of the main sett. An active latrine site was also recorded to the north of the Thorter Burn, near Thorter Bridge.

4.6.6 Although it is considered likely that the majority of the proposed wind farm development site is not utilised by badger, given the survey evidence and the habitats locally available, the presence of badger within the study area is considered to be of *District Value*.

Pine Marten, Red Squirrel and Water Vole

4.6.7 No evidence of pine marten, red squirrel or water vole was recorded in their respective study areas, no effects are predicted and they have been scoped out of assessment.

5 ASSESSMENT OF PRE-MITIGATED EFFECTS

5.1 Introduction

5.1.1 The following provides an assessment of pre-mitigated effects on ecology and nature conservation, in relation to key project activities. Consideration is given to the both construction phase and operational phase impacts of the project.

5.1.2 The main aim of presenting pre-mitigation effects is in order to:

- Define potential significant effects associated with the proposed project; and

PROVIDE A RATIONAL BASIS FOR REQUIREMENT AND SCALE OF MITIGATION MEASURES PROPOSED TO MINIMISE RESIDUAL EFFECTS (REFER TO SECTION 0

- Mitigation).

5.1.3 Section 7 provides an assessment of ecological effects on the mitigated project, identifying predicted residual effects.

5.2 Construction Phase Effects

Vegetation

5.2.1 The following provides a list of the potential key impacts on vegetation during the construction phase of the project, which are then considered in detail below:

- Direct habitat loss within the footprint of the turbines, access tracks and other infrastructure;
- Indirect habitat loss/degradation due to impacts on hydrology as a result of construction (included under consideration of GWDTEs); and
- Direct and indirect impacts on flora.

Direct Habitat Loss

5.2.2 The principal habitat in which infrastructure (tracks, foundations, hardstandings, *etc.*[5]) is located within the moorland section of the study area is dry heath (H12). Of the approximately 3.7 km of the total length of the proposed access track, approximately 1.3 km is routed through H12 vegetation communities. In addition 7 of the 9 hardstanding areas associated with turbines, and 6 of the 9 turbine foundations are located in or partially within H12 dry heath vegetation. This equates to a direct habitat loss of approximately 1 ha of dry heath vegetation. This compares to the approximately 75 ha of ground within which H12 is the principal vegetation type included within the study area. The predicted loss of approximately 1 ha of dry heath is considered to be of a *Low Negative Magnitude* and as such predicted impacts on dry heath are assessed to be non-significant at the *Minor* level.

5.2.3 One turbine foundation and associated hardstanding is located within an area of vegetation that is a mosaic of dry heath (H12), blanket bog (M19) and wet heath (M15) vegetation. Given the complexity of vegetation pattern within this area it is not possible to state which of these vegetation types would be directly impacted. However, given the limited extent of additional direct habitat loss (approximately 0.08 ha) it is considered that direct impacts on wet heath/blanket bog would also be *non-significant.*

Value: **District**

Magnitude: **Low Negative**

Significance: **Minor**

5.2.4 Other vegetation types to be directly impacted are U4, U5, M23, MG6 and MG10, all of which are assessed as either of *Local* or *Negligible Value*. The extent of predicted direct habitat is limited (approximately 1.2 ha) and as such are considered to be of a *Negligible Magnitude* and as such direct impacts on vegetation communities are assessed to be *non-significant.*

Value: **Negligible to Local**

Magnitude: **Negligible Negative**

Significance: **Negligible**

Indirect Habitat Loss/Groundwater Dependent Terrestrial Ecosystems

5.2.5 Indirect habitat impacts, primarily as a result of local changes in hydrology, are likely to be most evident for communities classified as GWDTE's, see Table 5. In addition, blanket bog communities (represented by M19 within the study area) are also particularly susceptible to adverse impacts from local changes in peatland hydrology.

5.2.6 The M19 blanket bog present within the study area is limited in extent and is largely found as small pockets within larger areas of dry and wet heath. Whereas there may be some localised small scale drying of peats as a result of infrastructure construction there may also be overwetting of peats. It is considered that these small-scale potential changes in hydrology will not have a significant adverse impact on the blanket bog and heath communities present.

5.2.7 The principal GWDTE within the study area which will be subject to potential indirect impacts as a result of proximity to wind farm infrastructure is NVC type M23. As with direct impacts the extent of indirect impact on this rush-pasture community is considered to be limited with respect to the extent of similar vegetation within the study area and beyond. Also, the M23 present within the study area is relatively species-poor and of only *Local Value*.

5.2.8 The other vegetation communities within the study area classified as GWDTEs are NVC types MG9, MG10 and W7. The areas of MG9 and MG10 are very localised and restricted in extent and neither community is of particular conservation value, being considered to be of *Local Value* and *Negligible Value* respectively. The W7 woodland is present within the valley of the Thorter Burn which is within approximately 60 m of the access track at its closest point and the access track crosses the burn approximately 90 m upstream of the woodland. Given these separation distances from the valley woodland it is considered that any potential impacts would be of a *Low Magnitude*.

5.2.9 Overall the magnitude of indirect impacts on vegetation communities is considered to be *Low* resulting in non-significant *Negligible* impacts.

Value: **Negligible to District**

Magnitude: **Low Negative**

Significance: **Negligible to Minor**

Flora

5.2.10 Spignel is located approximately 130 m distant from the nearest wind farm infrastructure and therefore there are not considered to be any impacts on this species.

Value: **District**

Magnitude: **None**

Significance: **None**

5.2.11 The single juniper bush is located within approximately 8 m of the centre line of the access track and there are not considered to be any direct impacts on this species.

Value: **District**

Magnitude: **None**

Significance: **None**

[5] No borrow pit locations have been assessed.

Bats

Direct and indirect impacts on bats

5.2.12 No known roosts will be directly affected (*e.g.* destruction and/or disturbance) by construction works associated with the proposed wind farm.

5.2.13 There are not considered to be any significant adverse impacts on bat species due to the loss of foraging resource or habitat severance. The area of direct habitat loss (including tracks, turbine bases and other infrastructure) is less than 3 ha. Areas of direct habitat loss are therefore minimal in the context of the study area, and it is predicted that there would be no material change in the available foraging bat resource.

5.2.14 Development impacts on this receptor of *Local Value* are assessed to be of Negligible negative magnitude. Therefore, a non-significant negligible effect of the proposed wind farm development on bats and their foraging habitat is predicted.

Value: **Local**

Magnitude: **Negligible Negative**

Significance: **Negligible**

Badger

Direct and indirect impacts on badger

5.2.15 No setts will be directly affected (*e.g.* destruction and/or disturbance) by construction works associated with the proposed wind farm development.

5.2.16 There are not considered to be any significant adverse impacts on badger due to the loss of foraging resource or habitat severance. Areas of direct habitat loss are minimal in the context of the study area.

5.2.17 Development impacts on this receptor of *District Value* are assessed to be of negligible negative magnitude. Therefore, a non-significant negligible effect of the proposed wind farm development on badger and their habitats is predicted

Value: **District**

Magnitude: **Negligible Negative**

Significance: **Negligible**

Otter

Direct and indirect impacts on otter

5.2.18 No places of shelter will be directly affected (*e.g.* destruction and/or disturbance) by construction works associated with the proposed wind farm development, with all identified places of shelter (1 couch) being >100 m from the wind farm.

5.2.19 There are not considered to be any significant adverse impacts on otter due to the loss of foraging resource or habitat severance.

5.2.20 Development impacts on this receptor of local value are assessed to be of negligible negative magnitude. Therefore, a non-significant negligible effect of the proposed wind farm development on bat habitat is predicted

Value: **Local**

Magnitude: **Negligible Negative**

Significance: Negligible

5.3 Operational Phase Effects

Vegetation

5.3.1 There are not considered to be any predicted impacts on vegetation as a result of the operation of the proposed wind farm development.

Value: **Negligible - District**

Magnitude: **None**

Significance: **None**

Groundwater Dependent Terrestrial Ecosystems

5.3.2 There are not considered to be any predicted impacts on GWDTE's as a result of the operation of the proposed wind farm development.

Value: **Negligible - District**

Magnitude: **None**

Significance: **None**

Flora

5.3.3 There are not considered to be any impacts on flora as a result of the operation of the proposed wind farm development.

Value: **Negligible - District**

Magnitude: **None**

Significance: **None**

Bats

Collision risk

5.3.4 In the absence of recognised published guidance linking pre-construction baseline information and post-construction operational impacts, this assessment provides an indication of collision risk determined from all data collected and professional judgement.

5.3.5 When referred to throughout this assessment, the statement 'collision risk' is intended to include actual bat collision with turbines and the risk of barotrauma to bats from operating wind turbines (*i.e.* physical damage to bats caused by sudden variances in local atmospheric pressure caused by rotating turbines).

5.3.6 The data collected from the study area (based on current guidance requirements, e.g. BCT 2012) are from ground level. It is recognised that assessing bat activity levels from ground level detectors only can be misleading (Collins *et al.* 2009 and Mathews F. 2012 pers. comm.) particularly for certain high-risk species that are considered most likely to be at risk from wind turbines high-risk species. Although no high risk species were identified from the study area, two species considered to be of medium risk of collision with wind turbines (*i.e.* soprano pipistrelle and common pipistrelle), have been recorded, albeit that the population threat from such perceived risk level is considered low (Natural England, 2012). *Myotis* species (including Natterer's bat and Daubenton's bat) are

considered to be at low risk of collision with an associated low threat to their populations (*ibid*). Therefore, these species are not considered any further within the assessment of collision risk.

5.3.7 Ground level data have provided a general indication of bat presence and activity across the study area. Ground level data have also been used to determine associations, or lack of, activity and habitat type and in comparing data with other non-related wind farm assessments for the purposes of assessing significance of effects (including cumulative effects).

5.3.8 Activity levels of all species recorded from static survey from the wind farm site are highest at the northern boundary, and are considered to be partly associated with the habitat type of woodland edge (refer Section 4.5). Despite this, as *c.* 30 % of activity was recorded across the open moorland habitats, it is recognised that there remains a risk of turbine interaction for common pipistrelle and soprano pipistrelle, and an impact of medium negative magnitude is predicted.

5.3.9 Given the common and widespread status of common and soprano pipistrelle in Scotland, and neither species has been identified as being at high risk (Natural England, 2012), it is considered that mortality through collision will not result in an ecologically significant effect.

Value: **Local**

Magnitude: **Medium Negative**

Significance: **Minor**

Badger

5.3.10 There are not considered to be any predictable operational phase effects of the proposed wind farm development on badger.

Value: **District**

Magnitude: **None**

Significance: **None**

Otter

5.3.11 There are not considered to be any predictable operational phase effects of the proposed wind farm development on otter.

Value: **Local**

Magnitude: **None**

Significance: **None**

5.4 Decommissioning Phase Effects

5.4.1 Decommissioning impacts are not considered at this stage. There is an anticipated time lag of at least 25 years before decommissioning occurs. Therefore, survey in order to inform on assessment of decommissioning effects will be undertaken at an appropriate stage and involving an appropriate suite of ecological receptors.

5.5 Summary

5.5.1 Table 7 provides a summary of the pre-mitigated assessment of impacts on ecology.

Table 7: Summary of pre-mitigated effects

Receptor	Impact	Magnitude	Significance
Construction Impacts			
Vegetation	Direct habitat loss	Low Negative	Minor
GWDTEs	Indirect habitat loss	Low Negative	Negligible to Minor
Spignel	None	None	None
Juniper	None	None	None
Bats	Habitat loss, disturbance	Negligible Negative	Negligible
Badger	Habitat loss, disturbance	Negligible Negative	Negligible
Otter	Habitat loss, disturbance	Negligible Negative	Negligible
Operational Impacts			
Vegetation	None	None	None
GWDTEs	None	None	None
Flora	None	None	None
Bats	Collision/barotrauma	Medium Negative	Minor
Badger	None	None	None
Otter	None	None	None

6 MITIGATION

6.1 Introduction

6.1.1 Mitigation measures are recommended for the project where a significant ecological impact has been predicted without measures being implemented (refer Table 7), or in accordance with Good Practice Measures, or to fulfil legal obligations. An assessment of post-mitigation or residual effects is provided in section 7, to show the overall effect.

6.2 Construction Phase

Vegetation communities/GWDTEs

6.2.1 There is no mitigation required to reduce predicted impacts to non-significant levels. However, best practice construction procedures are required in order to reduce predicted impacts to a minimum, *e.g.* "Good Practice During Wind Farm Construction" (Scottish Renewables 2010).

6.2.2 The contractor will follow best construction site practices at all times and during all stages of the project construction. These include **SEPA's guidelines outlined in** http://www.sepa.org.uk/about_us/publications/guidance/ppgs.aspx

6.2.3 It is expected that the Construction Management Statement and/or Environmental Management Plan would include measures for full and appropriate restoration of habitats following construction.

Flora

6.2.4 The project design has ensured that the access track does not coincide with the location of juniper and no direct effects have been predicted. However, in recognition of the relatively small separation distance to the track (approximately 8 m) a cautious approach will be undertaken to mitigate any unforeseen, unplanned actions in the vicinity of the juniper bush. This will involve the installation of appropriate fencing to a distance of 5m from the bush's outer edge which will be maintained throughout the construction phase.

7 ASSESSMENT OF POST-MITIGATED EFFECTS

7.1 Introduction

7.1.1 Table 8 provides a summary of post-mitigated or residual effects of the Project on ecology. Table 9 provides a summary of environmental commitments.

Table 8: Summary of Post-mitigated effects

Receptor	Impact	Magnitude	Significance
Construction Impacts			
Vegetation	Direct habitat loss	Low Negative	Minor
GWDTEs	Indirect habitat loss	Low Negative	Negligible to Minor
Spignel	None	None	None
Juniper	None	None	None
Bats	Habitat loss, disturbance	Negligible Negative	Negligible
Badger	Habitat loss, disturbance	Negligible Negative	Negligible
Otter	Habitat loss, disturbance	Negligible Negative	Negligible
Operational Impacts			
Vegetation	None	None	None
GWDTEs	None	None	None
Flora	None	None	None
Bats	Collision/barotrauma	Medium Negative	Minor
Badger	None	None	None
Otter	None	None	None

Table 9: Summary of Environmental Commitments

Potential Effect	Environmental Measure	Type of Measure	Monitoring Requirements (if any)	Means through which Environmental Measures may be Secured
Construction Phase				
Effects on habitats and GWDTEs	Compliance with Brest Practice	Compliance	~	Watching brief throughout construction
Loss of juniper	Compliance with track design; maintenance of protection buffer 5 m from bush.	Avoidance	~	Watching brief during track construction

7.1.2 The following provides an assessment of residual impacts according to each of the receptors considered in this EcIA.

7.2 Construction and Operational Impacts

Vegetation Communities/GWDTEs

7.2.1 There is no change in assessment post mitigation on vegetation communities and GWDTEs.

Direct and Indirect Habitat Loss

Value: **Negligible to District**

Magnitude: **Low Negative**

Significance: **Negligible to Minor**

Flora

7.2.2 Micro-siting of the access track will ensure that the juniper is avoided and there will be no significant impacts on flora.

Value: **District**

Magnitude: **Negligible**

Significance: **Negligible**

7.3 Cumulative Impacts

Vegetation (including GWDTEs)

7.3.1 Predicted post mitigated impacts on vegetation (habitats, flora and GWDTEs) as a result of the proposed wind farm are considered not to be significant. Given the restricted extent of predicted impacts any adverse effects will only be detectable in the immediate environs of the works.

7.3.2 The predicted impacts reported for the proposed wind farm (including a loss of habitats assessed as District Value totalling less than 1.4 ha) will only contribute marginally to any assessment of cumulative impacts on vegetation. As such no detailed quantitative cumulative assessment with respect to vegetation has been considered.

7.4 Protected Mammals

7.4.1 Although the presence of protected mammals (bats - *Myotis* and *Pipistrellus* species; otter and badger) has been confirmed within the respective study areas, predicted post mitigated impacts as a result of the proposed wind farm are considered not to be significant. No places of shelter would be directly or indirectly affected and loss of habitat would not be significant. In the case of bats, mortality through collision with the turbine blades is not predicted to be ecologically significant.

7.4.2 The predicated impacts of the proposed wind farm will only contribute marginally to any assessment of cumulative impacts on protected mammals. As such no detailed quantitative cumulative assessment with respect to protected mammals has been considered.

8 STATEMENT OF SIGNIFICANCE

8.1.1 The proposed wind farm supports vegetation that would be expected from a site on the upland fringes of the Scottish Highlands, with both moorland and lowland farmed habitats.

8.1.2 The study area two distinct zones, with a more lowland, agriculturally improved zone occupying the northern regions, including the area through which the main access to the site will be routed. Habitats in the more intensely managed part of the study area have been assessed as being of Negligible Value in terms of nature conservation. The southern zone which extends into the Ochil Hills, and will be the location for the turbines and supports upland heath and bog habitats assessed as being of Local to District Value. Given the limited extent of effects on these habitats (direct loss of less than 1.4 ha), no significant effects are predicated.

8.1.3 Much of the proposed wind farm's infrastructure would be located outwith GWDTEs and no significant effects are predicted.

8.1.4 Two plants of nature conservation significance have been recorded; juniper and spignel; both are assessed as District Value. Spignel is outwith any working area; micrositing of a track will ensure that juniper is not affected.

8.1.5 Badger and otter were confirmed within their respective study areas. However, no places of shelter were recorded within the proposed working area or within potential disturbance distance of works. Other effects, such as habitat loss or severance are not considered to be significant.

8.1.6 No bat species considered to be high risk species in terms of potential collision with turbines were identified from the study area. However, two species considered to be of medium risk (*i.e.* soprano pipistrelle and common pipistrelle), have been recorded. Given the common and widespread status of both species in Scotland, it is considered that mortality through collision will not result in an ecologically significant effect.

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APPENDICES

A.1 Policy & Guidance

The Environmental Impact Assessment (Scotland) Regulations 1999

A.1.1 The Regulations implement Council Directive No. 85/337/EEC (now amended by Directive 97/11/EC 14 March 1999) on the assessment of the effects of certain public and private projects on the environment.

A.1.2 The Directive's main aim is to ensure that the authority giving the primary consent for a particular project, makes its decision in the knowledge of any likely significant effects on the environment. The Directive therefore sets out a procedure that must be followed for certain types of project before they can be given 'development consent'. This procedure - known as Environmental Impact Assessment (EIA) - is a means of drawing together, in a systematic way, an assessment of a project's likely significant environmental effects. This helps to ensure that the importance of the predicted effects, and the scope for reducing them, are properly understood by the public and the relevant competent authority before it makes its decision.

EC Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (The Habitats Directive);

A.1.3 The Habitats Directive was adopted by the EC in 1992. The Habitats Directive is implemented in the UK through the Wildlife and Countryside Act 1981 (as amended) and The Habitats Regulations.

A.1.4 The 189 habitats listed in Annex I of the Directive and the 788 species listed in Annex II, are to be protected by means of a network of sites.

A.1.5 European Protected Species (EPS) are protected under the EC Habitats and Species Directive. The Directive is transposed in UK law by the Conservation (Natural Habitats &c.) Regulations 2004 (as amended in Scotland), which gives an enhanced level of protection beyond that conferred by the Wildlife and Countryside Act 1981 (as amended) (WCA). It is an offence to deliberately disturb any EPS anywhere (not just in its place of shelter), and to damage or destroy a breeding or resting site whether deliberately or not. This legislation means that EPS are fully protected in Britain, and that planned activity, which may affect them, requires prior consultation with the statutory nature conservation organisation, Scottish Natural Heritage(SNH).

The Conservation (Natural Habitats & c) Regulations 1994 (The Habitats Regulations)

A.1.6 The Conservation (Natural Habitats, &c.) Regulations 1994 as amended apply to European Sites. Where reserved matters (within the meaning of Schedule 5 of the Scotland Act 1998) are concerned, certain provisions of the Conservation of Habitats and Species Regulations 2010 as amended apply instead. Both sets of regulations require an equivalent process in relation to the assessment of plans and projects with the potential to affect European sites, including SACs.

A.1.7 The requirements are summarised in Circular 6/1995 as amended June 2000 and include, at paragraph 12, "The Regulations require that, where an authority concludes that a development proposal unconnected with the nature conservation management of a Natura 2000 site (which includes SACs) is likely to have a significant effect on that site, it must undertake an appropriate assessment of the implications for the conservation interests for which the area has been designated."

A.1.8 The need for appropriate assessment extends to plans or projects outwith the boundary of the site in order to determine their implications for the interest protected within the site.

A.1.9 Under regulation 48 of the 1994 Habitats Regulations (or regulation 61 of the 2010 Regulations in respect of reserved matters), this means that the competent authority has a duty to:

- determine whether the proposal is directly connected with or necessary to site management for conservation; and, if not,
- determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects; and, if so, then
- make an appropriate assessment of the implications (of the proposal) for the site in view of that site's conservation objectives.

A.1.10 In Scotland, the most significant amendment to The Habitats Regulations is The Conservation (Natural Habitats & c) Amendments (Scotland) Regulations 2007 which came into force on the 15th February 2007. The amendment has removed EPS from Schedule 5 of the WCA. This includes bats (all species), otter, great crested newt and wildcat. In addition, all but two of the defences in Regulation 40 (exceptions from Regulation 39, The Conservation (Natural Habitats & c) Regulations 1994) have been removed. In particular, the defence if the works are "as an incidental result of a lawful operation" has been removed.

Wildlife and Countryside Act 1981 / The Nature Conservation (Scotland) Act 2004

A.1.11 Enhanced statutory protection is afforded to those species protected under Schedule 5 of the Wildlife and Countryside Act (WCA). Species listed under Schedule 5 include red squirrel, pine marten, freshwater pearl mussel and water vole. This makes it an offence to kill, injure or take any such species or to intentionally damage, destroy or obstruct access to any place used for shelter or breeding. Disturbance to Schedule 5 species in their place of shelter also constitutes an offence of the Act. The Act furthermore prohibits certain methods of killing, injuring, or taking of wild animals.

A.1.12 Part 3 and Schedule 6 (Part 5) of the *Nature Conservation (Scotland) Act 2004 (NCSA)* amends the Wildlife and Countryside Act 1981. Species protection now includes reckless acts. In addition, as well as those carrying out unlawful acts, anyone permitting unlawful acts is guilty of an offence.

A.1.13 Water vole varies from other Schedule 5 listed mammals in that in Scotland it is afforded enhanced statutory protection under Schedule 5 – in respect of section 9 (4) only. This makes it an offence to disturb or damage any water vole resting place or habitat, but the animals themselves are not protected. This legislation means that water vole habitat is comprehensively protected in Britain, and that any planned activity which might affect this species requires prior consultation with the appropriate statutory conservation organisation (SNH).

A.1.14 The Act also provides for the notification of Sites of Special Scientific Interest (SSSIs) – areas of special scientific interest by reason of their flora, fauna, or geological or physiographical features – by the country agencies. The Act also contains measures for the protection and management of SSSIs. The undertaking of agricultural or forestry operations on land within National Parks which has been either moor or heath for 20 years, without consent from the relevant planning authority is also prohibited by the Act.

The Protection of Badgers Act 1992

A.1.15 The legislation makes it an offence to:

- Willfully kill, injure, take, posses or cruelly ill treat a badger or to attempt to do so;

- To interfere with a sett by damaging or destroying it;
- To obstruct access to, or any entrance of a badger sett; and
- To disturb a badger when it is occupying a sett.

A.1.16 *The Nature Conservation (Scotland) Act* 2004 updates the Protection of Badgers Act 1992, raising the allowance for imprisonment from a term not exceeding six months to a term not exceeding 3 years for a serious offence. Where an offence is committed under this act by a corporate body, the individual (as well as the corporate body, Scottish partnership or unincorporated association) is guilty of the offence and is liable to be proceeded against and punished accordingly.

A.1.17 The Protection of Badgers Act 1992 allows licensing, for the purposes of development, of activities that would otherwise be prohibited. This allows developments, as defined in the Town and Countryside Planning (Scotland) Act 1997, to interfere with a Badger sett within an area specified in the licence by any means so specified. Licences must be applied for from SNH.

The UK Biodiversity Action Plan 2007

A.1.18 The following account is taken from the Joint Nature Conservation Committee webpage: http://jncc.defra.gov.uk/page-5155

A.1.19 The UK Biodiversity Action Plan (UK BAP) was published back in 1994, and was the UK Government's response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro.

A.1.20 Following the creation of the UK BAP, devolution, in 1998, led the four countries of the UK (England, Northern Ireland, Scotland and Wales) to develop their own country strategies for biodiversity and the environment, allowing conservation approaches to differ according to the different environments and priorities within the countries. In 2007, however, a shared vision for UK biodiversity conservation was adopted by the devolved administrations and the UK government, and is described in 'Conserving Biodiversity – the UK Approach'.

A.1.21 The 'UK Post-2010 Biodiversity Framework' now (July 2012) succeeds the UK BAP and 'Conserving Biodiversity – the UK Approach', and is the result of a change in strategic thinking following the publication of the CBD's 'Strategic Plan for Biodiversity 2011–2020' and its 20 'Aichi targets', at Nagoya, Japan in October 2010, and the launch of the new EU Biodiversity Strategy (EUBS) in May 2011. The framework demonstrates how the work of the four countries and the UK contributes to achieving the 'Aichi targets', and identifies the activities required to complement the country biodiversity strategies in achieving the targets.

The Scottish Biodiversity List

A.1.22 The following account is taken from the Scottish Biodiversity Forum webpage: www.biodiversityscotland.gov.uk/advice-and-resources/scottish-biodiversity-list/

A.1.23 The Scottish Biodiversity List is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland.

A.1.24 The purpose of the list is to help public bodies carry out their Biodiversity Duty by identifying the species and habitats which are the highest priority for biodiversity conservation in Scotland. It is also a useful source of information for anyone interested in nature conservation in Scotland.

A.1.25 Four categories of action have been defined

- Conservation action needed
- Avoid negative impacts
- Watching brief only; and
- Communicating with the public

A.1.26 In terms of resource, only the first three categories have been considered. Definitions of these categories and their implications are as follows:

Conservation action needed

A.1.27 These include species in Scotland in most urgent need of conservation action. These species fall into two categories:

- Significant decline in Scotland; and
- Rare or restricted distribution and under threat

A.1.28 As recommendations, it is suggested that '*managers of public land, buildings and transport infrastructure should look for opportunities to enhance these habitats and species on their land*'. Also, '*planners and developers should look for opportunities to make space for biodiversity in development through specific species targeted work or by creating open space habitats that link to local habitat networks*'.

Avoid negative impacts

A.1.29 Regulatory authorities need to give particular consideration to avoiding significant negative impacts to these habitats and species. These habitats and species fall into three categories:

- International obligations - protected species or habitats
- Rare or restricted distribution, and/or
- Significant decline in Scotland

A.1.30 Species and habitats protected by law. These are European Protected Species and European habitats and species covered by the Environmental Liability Directive. Statutory requirements and procedures are in place to protect these habitats and species from adverse impacts of development.

A.1.31 Rare or restricted distribution. Particular consideration should be given to avoiding significant negative impacts at locations where species occurs. Often these species will be well known about and protected by Sites of Special Scientific Interest or given specific protection under the Wildlife and Countryside Act. Occasionally rare species occur without specific protection and consideration should be given to raising their profile within the local planning process by giving their sites Local Nature Conservation Site (LNCS) status.

A.1.32 Significant decline in Scotland. Consideration should be given to avoiding significant negative impacts at locations where these species and habitats occur. Many of these habitats and are widespread in Scotland and their decline is linked to land use change and habitat fragmentation over the last 60 years. Planners and developers can help to reverse this trend by looking for opportunities to make space for biodiversity in development and help to enhance habitat networks and green networks where ever possible

Watching brief only

A.1.33 There is less concern for these habitats and species, which only require monitoring for now. These habitats and species fall into two categories:

- On the UK BAP list but not considered to be at particular risk in Scotland; and
- Species with international obligations not picked up in the other two categories for action.

A.1.34 On the UK BAP list. Not all of the habitats and species that are on the UKBAP list are under threat in Scotland. Some are on the list because they are declining, rare or threatened in other parts of the UK. Where widespread species are increasing or stable or habitats are thought to be in generally good condition in Scotland, they have been included in this category.

A.2 Vegetation Descriptions

H12: *Calluna vulgaris – Vaccinium myrtillus* heath

A.2.1 Dry heath in which heather *Calluna vulgaris* is dominant over a variety of slope conditions is widespread within the study area. Heather is often wholly dominant forming a continuous sub-shrub canopy resulting in few associates. Blaeberry *Vaccinium myrtillus* is the most frequent associate and in places, presumably as a result of recent management, can be quite abundant. Other vascular associates include wavy hair-grass *Deschampsia flexuosa*, crowberry *Empetrum nigrum subsp. nigrum* and heath bedstraw *Galium saxatile*, all present at a low cover. Pleurocarpous bryophytes are frequent and again in places can be abundant. The most common species are *Hylocomium splendens* and *Pleurozium schreberi*. Vegetation as described above with heather overwhelmingly dominant has been classified as the *Calluna vulgaris* sub-community, **H12a**.

A.2.2 In several locations the continuous canopy of heather is broken and there are stands of grassland between the heather and also grasses make a more consistent contribution to the heath community. Heather is still abundant, though not overwhelmingly dominant, and both blueberry and crowberry are also frequent. Grasses provide a much more consistent element to the sward particularly wavy hair-grass, sheep's-fescue *Festuca ovina*, brown bent *Agrostis canina,* sweet vernal-grass *Anthoxanthum odoratum* and less frequently mat-grass *Nardus stricta*. Bryophytes are still an important component of the community. Where grasses provide a more consistent element to the community the vegetation has been classified as the *Galium saxatile – Festuca ovina* sub-community, **H12c**.

A.2.3 The *Calluna-Vaccinium* heath present within the study area can be considered to represent examples of EU Habitats Directive Annex I, Tayside LBAP habitat types and SBL habitats. However, the stands of dry heath within the study area are not very extensive or particularly diverse. The dry heath present at Knowes does however present an important resource within the Perth area and as such the study area is assessed to be of *District Value* for Dry heath (H12).

TN No.	11	12	15	20	25	32	7	19
Easting	300874	301106	301534	300931	301049	301838	301378	301150
Northing	710753	710734	711139	711238	711719	710913	710534	711344
Species/ Sub-community	a	c	a	c	a	a	a	a
Calluna vulgaris	95	50	60	50	99	20	50	50
Vaccinium myrtillus	3	5	30	3	3	80	5	2
Deschampsia flexuosa	5	20	2	10	1	3	3	-
Hylocomium splendens	60	30	30	20	-	30	20	-
Empetrum nigrum	2	20	-	5	-	-	20	10
Pleurozium schreberi	-	20	-	20	-	40	30	-
Galium saxatile	-	2	2	3	-	2	-	-
Sphagnum capillifolium	-	-	10	-	-	-	30	80
Agrostis canina	-	3	1	10	-	-	-	-
Festuca ovina	-	3	-	10	-	2	-	-
Polytrichum commune	-	-	3	-	-	-	10	3
Eriophorum angustifolium	-	-	-	-	-	-	5	20
Aulacomnium palustre	-	-	-	-	-	-	5	10
Nardus stricta	-	3	-	-	-	-	-	1
Carex nigra	-	-	-	-	-	-	2	3

Potentilla erecta	-	2	-	-	-	-	2	-
Hypnum sp.	-	-	-	-	30	-	-	-
Anthoxanthum odoratum	-	-	-	10	-	-	-	-
Juncus acutiflorus	-	-	-	-	-	-	3	-
Carex binervis	-	-	-	2	-	-	-	-
Dicranum scoparium	-	-	-	-	2	-	-	-
Dryopteris dilatata	-	-	-	-	-	1	-	-

M15: *Trichophorum cespitosum – Erica tetralix* wet heath

A.2.4 Wet heath is restricted in extent within the study area, limited to a small stand in the northern part of the study area and also occurring in mosaic with blanket bog (M19) and dry heath communities (H12) in a single area in the northern half of the turbine envelope, the two areas being quite different in character.

A.2.5 The area of wet heath to the north appears heavily modified (possibly through grazing and drainage) and is dominated by a mix of purple moor-grass *Molinia caerulea*, heather and blaeberry with a lesser element of deergrass *Trichophorum cespitosum*, heath rush *Juncus squarrosus*, wavy hair-grass and mat grass. Bryophytes area also frequent particularly *Pleurozium schreberi* and *Hypnum* sp. The dry nature and species mix recorded here means this vegetation fits well into the *Vaccinium myrtillus* sub-community, **M15d.**

A.2.6 The wet heath vegetation recorded in mosaic with both H12 and M19 is dominated by heather with frequent *Sphagnum capillifoilum* present beneath the heathy canopy. Associate species include purple moor-grass, cross-leaved heath *Erica tetralix* and *Aulacomnium palustre*. This vegetation is characteristic of the Typical sub-community, **M15b**.

A.2.7 In common with the communities with which the M15b/d vegetation is found associated with at Knowes stands of this vegetation type can be considered to represent examples of EU Habitats Directive Annex I, Tayside LBAP habitat types and SBL habitats. However, the stands of wet heath within the study area are not very extensive or particularly diverse. The wet heath present at Knowes does however present an important resource within the Perth area and as such the study area is assessed to be of *District Value* for wet heath (M15).

TN No.	**28**	**37**
Easting	**301419**	**300987**
Northing	**711615**	**712063**
Species/ Sub-community	**b**	**D**
Calluna vulgaris	80	15
Molinia caerulea	10	40
Sphagnum capillifolium	40	-
Vaccinium myrtillus	-	25
Pleurozium schreberi	-	20
Aulacomnium palustre	10	-
Hypnum sp.	-	10
Deschampsia flexuosa	-	5
Nardus stricta	-	5
Tricophorum cespitosum	-	5
Juncus squarrosus	-	5
Empetrum nigrum	3	-
Erica tetralix	2	-

Carex binervis	2	-

M19: *Calluna vulgaris – Eriophorum vaginatum* blanket mire

A.2.8 As with the M15 wet heath vegetation described above, the extent of vegetation best described as blanket bog is of limited occurrence within the study area. Heather is again the dominant species though the consistent presence of hare's-tail cottongrass *Eriophorum vaginatum*, though often at quite a low frequency, identifies this as bog vegetation. Along with the heather and hare's-tail cottongrass there is usually some crowberry and cross-leaved heath. Bryophytes are abundant including *Sphagnum capillifolium*, *Pleurozium schreberi* and *Hypnum* sp.

A.2.9 The full variation of vegetation within M19 is not fully described within the NVC (*Averis et al.* 2004) though here vegetation in which cross-leaved heath is present has been classified as the *Erica tetralix* sub-community, **M19a**, and the remainder is classified as the *Empetrum nigrum* sub-community, **M19b**.

A.2.10 As with the wet heath and dry heath vegetation, stands of this vegetation type can be considered to represent examples of EU Habitats Directive Annex I, Tayside LBAP habitat types and SBL habitats. As with these other communities, the stands of blanket bog within the study area are not very extensive or particularly diverse, lacking a diversity or abundance of sphagna. The blanket bog present at Knowes does however present an important resource within the Perth area and as such the study area is assessed to be of *District Value* for blanket bog (M19).

TN No.	**10**	**22**	**26**	**27**
Easting	**300826**	**301017**	**301017**	**301315**
Northing	**710802**	**711095**	**711482**	**711662**
Species/Sub-community	**b**	**a**	**a**	**a**
Calluna vulgaris	80	50	50	70
Eriophorum vaginatum	10	30	10	10
Empetrum nigrum	2	3	5	3
Sphagnum capillifolium	70	50	-	30
Pleurozium schreberi	5	10	20	-
Erica tetralix	-	5	5	10
Hypnum sp.	10	-	-	30
Molinia caerulea	-	-	10	5
Polytrichum strictum	-	-	20	-
Carex nigra	-	-	5	-
Aulacomnium palustre	-	-	-	5
Deschampsia flexuosa	3	-	-	-
Vaccinium myrtillus	3	-	-	-
Carex echinata	-	-	-	3
Juncus squarrosus	-	-	-	1

M23: *Juncus effusus/acutiflorus – Galium palustre* rush-pasture

A.2.11 Vegetation in which sharp-flowered rush *Juncus acutiflorus* is dominant is widespread throughout the site, occupying shallow bowls and valleys between the areas of heath and grassland. Sharp-flowered rush tends to be abundant and is joined by a range of herbs at low frequency. Herbs present within the rushes include meadow buttercup *Ranunculus acris*, common sorrel *Rumex acetosa*, marsh thistle *Cirsium palustre,* greater bird's-foot trefoil *Lotus pedunculatus*, marsh willowherb *Epilobium palustre*, marsh cinquefoil *Potentilla palustris*, fen bedstraw *Galium uliginosum* and ragged-robin *Lychnis flos-*

cuculi. Grasses are also frequent particularly Yorkshire-fog *Holcus lanatus*, red fescue *Festuca rubra* and brown bent. Vegetation of this type in which sharp-flowered rush is dominant is classified as the *Juncus acutiflorus* sub-community, **M23a**.

A.2.12 This type of vegetation is widespread throughout sub-montane Scotland, though does add to the floral diversity of the study area and as such is assessed to be of *Local Value*.

TN No.	5	13	18	31
Easting	300670	300943	301211	301833
Northing	710420	710985	711161	711019
Species/Sub-community	a	a	a	a
Juncus acutiflorus	80	70	60	60
Rumex acetosa	3	5	3	3
Ranunculus acris	5	3	3	2
Holcus lanatus	5	-	10	5
Festuca rubra	3	5	3	-
Agrostis canina	3	-	3	3
Cirsium palustre	2	2	1	-
Lotus pedunculatus	-	-	20	20
Epilobium palustre	2	3	-	-
Deschampsia cespitosa	-	-	2	3
Potentilla palustris	2	3	-	-
Galium uliginosum	2	2	-	-
Lychnis flos-cuculi	2	2	-	-
Calliergonella cuspidatum	10	-	-	-
Holcus mollis	-	10	-	-
Rhytidiadelphus squarrosus	10	-	-	-
Carex disticha	3	-	-	-
Juncus effusus	-	-	-	3
Galium palustre	-	3	-	-
Anthoxanthum odoratum	-	-	-	2
Carex flacca	-	-	-	2
Cerastium fontanum	2	-	-	-
Luzula multiflora	-	-	2	-
Stellaria alsine	-	-	-	2
Taraxacum officinalis agg.	-	1	-	-

Carex disticha mire

A.2.13 There is a small stand of vegetation within the study area that is similar in type to the M23 rush-pasture vegetation described above though the sharp-flowered rush is replaced by brown sedge *Carex disticha*. Greater bird's-foot trefoil is the most abundant associate and there is also frequent soft-rush *Juncus effusus* and Yorkshire-fog with less frequent marsh thistle *Cirsium palustre*, marsh bedstraw *Galium palustre* and common sorrel.

A.2.14 Vegetation dominated by brown sedge does not appear to be represented in the NVC and so this vegetation has simply been termed a *Carex disticha* mire. In essence this vegetation is another form of the M23 rush-pasture, though dominated by the sedge, and has been assessed similarly, i.e. of *Local Value*.

M6c: *Carex echinata – Sphagnum fallax* mire; *Juncus effusus* sub-community

A.2.15 Vegetation classified as NVC type **M6c** is very restricted in distribution within the study site, occurring as a small element within stands of M23.

A.2.16 These stands of vegetation tend to be very species poor being dominated by soft-rush with a ground carpet of *Sphagnum fallax*. This vegetation tends to pick out areas of greater lateral water movement, or flush lines.

A.2.17 Vegetation of this type is very widespread throughout the region and further afield and as such is assessed to be of *Local Value*.

MG1: *Arrhenatherum elatius* grassland

A.2.18 Tall rank grassland in which false oat-grass *Arrhenatherum elatius* is abundant is only present in a few number of small stands in the lowland agricultural part of the study area, associated with field edges and rides.

A.2.19 Grasses including false oat-grass, cock's-foot *Dactylis glomerata*, tufted hair-grass *Deschampsia cespitosa* and Yorkshire-fog are all abundant and there is a paucity of herbs.

A.2.20 This vegetation is widespread in similar situations and is assessed to be of *Local Value*.

MG6: *Lolium perenne – Cynosurus cristatus* grassland

A.2.21 This is the characteristic vegetation of the improved grassland pastures within the more lowland agricultural element of the study area. This pasture vegetation is very limited in diversity and ecological interest and as such is assessed to be of *Negligible Value*.

MG9: *Holcus lanatus – Deschampsia cespitosa* grassland

A.2.22 Vegetation in which tufted hair-grass forms a key and conspicuous component of the vegetation is present as a small element of vegetation mosaics within the moorland section of the site. Tufted hair-grass is usually dominant and there is often some sweet vernal-grass, red fescue and brown bent. Herbs are scarce though include tormentil *Potentilla erecta* and germander speedwell *Veronica chamaedrys*.

A.2.23 Given the dominance of tufted hair-grass in this vegetation is has been included as a form of the *Holcus lanatus – Dechampsia cespitosa* grassland, **MG9**.

A.2.24 This type of vegetation is common in a lowland setting and the stands present here are species-poor and limited in extent and therefore the study area has been assessed to be of *Local Value.*

MG10: *Holcus lanatus – Juncus effusus* rush-pasture

A.2.25 Stands of species-poor, rank vegetation dominated by soft-rush are restricted to small areas within improved fields close to the farm that form a patchwork with stands of grazed improved grassland (MG6). Soft-rush is dominant and associates are limited to grasses, such as sweet vernal-grass and crested dog's-tail, and a few poor herbs including creeping buttercup *Ranunculus repens*, common sorrel and common mouse-ear *Cerastium fontanum.*

A.2.26 This type of vegetation is very limited in diversity and ecological interest and as such is assessed to be of *Negligible Value.*

U4: *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland

A.2.27 Acid grassland in which sweet vernal-grass, fescue and bent grasses are the dominant species is common throughout the study area, often being found in mosaic with heath communities, rush dominated communities and also grassland in which mat-grass *Nardus stricta* is more prominent.

A.2.28 The Typical sub-community, **U4a**, is most widespread which has no particular distinguishing species, being dominated by the grasses noted above and usually with some heath bedstraw and abundant mosses, particularly *Rhytidiadelphus squarrosus*.

A.2.29 The *Holcus lanatus-Trifolium repens* sub-community, **U4b**, grassland in which species indicative of agricultural improvement are prevalent is present in fields around the farm and also as small preferentially grazed patches within the moorland. One or both of Yorkshire-fog and creeping soft-grass is frequent in the sward and there is also usually some common sorrel.

A.2.30 There are also much more restricted areas of U4 grassland which supports a wider range of herbs including lady's lady's bedstraw *Galium verum*, glaucous sedge *Carex flacca* and quaking-grass *Briza media*. Though more species-rich this grassland is still best described as NVC type **U4a**. There is also the restricted occurrence of U4 grassland in which the moss *Hylocomium splendens* is abundant and this has been described here as the *Luzula multiflora- Rhytidiadelphus loreus* sub-community, **U4d**.

A.2.31 The *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland as recorded from the study area are grassland types that are widespread throughout the upland and upland fringes of Britain. As such this grassland is assessed to be of *Local Value*.

TN No.	3	14	16	17	21	33	35
Easting	300583	301630	301519	301639	300907	301694	301522
Northing	710733	711171	711126	710996	711210	710728	711242
Species/Sub-community	d	b	b	a	a	a	a
Anthoxanthum odoratum	20	3	20	10	10	10	5
Festuca rubra	40	10	20	60	40	-	40
Holcus lanatus	-	10	20	-	2	5	5
Potentilla erecta	2	2	-	2	-	3	3
Agrostis capillaris	-	-	20	-	40	40	20
Galium saxatile	-	-	-	2	3	3	3
Agrostis canina	10	2	-	30	-	-	-
Nardus stricta	30	-	-	-	-	5	10
Rhytidiadelphus squarrosus	-	-	-	-	10	40	-
Festuca ovina	-	-	-	-	-	20	5
Rumex acetosa	-	3	10	-	-	-	-
Galium verum	-	-	2	-	-	-	5
Deschampsia cespitosa	-	-	3	-	-	-	3
Carex binervis	-	-	-	1	2	-	-
Cirsium palustre	-	1	-	-	-	-	1
Holcus mollis	-	60	-	-	-	-	-
Hylocomium splendens	50	-	-	-	-	-	-
Lathyrus pratensis	-	20	-	-	-	-	-
Deschampsia flexuosa	-	-	-	-	-	5	-
Ranunculus acris	-	-	5	-	-	-	-
Carex flacca	-	-	-	-	-	-	5
Carex pilulifera	3	-	-	-	-	-	-
Luzula multiflora	3	-	-	-	-	-	-
Briza media	-	-	-	-	-	-	3
Plantago lanceolata	-	-	-	-	-	-	3
Juncs effusus	-	2	-	-	-	-	-
Oxalis acetosella	-	2	-	-	-	-	-
Ranunculus repens	-	2	-	-	-	-	-
Trifolium repens	2	-	-	-	-	-	-
Vaccinium myrtillus	-	-	-	2	-	-	-
Viola riviniana	-	-	-	-	-	-	2

Veronica chamaedrys	-	-	-	-	-	-	2
Cardamine pratensis	-	-	1	-	-	-	-
Cerastium fontanum	1	-	-	-	-	-	-

U5: *Nardus stricta – Galium saxatile* grassland

A.2.32 As with the U4 grassland described above, grassland in which mat-grass is abundant is widespread throughout the moorland element of the study area often recorded in mosaic with a range of other habitat types.

A.2.33 Two sub-communities of U5 have been recorded from the study site. The most common sub-community recorded is the species-poor sub-community, **U5a**. Mat-grass tends to be overwhelmingly dominant though there is also usually some brown bent and wavy hair-grass. Bryophytes are abundant in the sward, particularly *Pleurozium schreberi*.

A.2.34 The *Calluna vulgaris-Danthonia decumbens* sub-community, **U5d**, in which patches of heather are frequent through a background of mat-grass dominated grassland is present in the moorland and probably represent a transition between the heath and grassland communities.

A.2.35 The U5 grassland as recorded from the study area is a widespread community in the moorland environment within Britain and as such is assessed to be of *Local Value*.

TN No.	**1**	**4**	**23**	**24**
Easting	**300541**	**300704**	**300890**	**300948**
Northing	**710462**	**711165**	**711558**	**711615**
Species/Sub-community	**a**	**d**	**a**	**d**
Nardus stricta	80	40	80	40
Pleurozium schreberi	40	50	-	10
Agrostis canina	5	5	10	5
Deschampsia flexuosa	3	5	3	3
Galium saxatile	3	2	3	2
Luzula multiflora	2	1	2	2
Anthoxanthum odoratum	3	-	5	5
Vaccinium myrtillus	2	3	-	2
Calluna vulgaris	-	40	-	40
Rhytidiadelphus squarrosus	-	-	-	20
Festuca ovina	2	-	3	-
Potentilla erecta	3	-	3	-
Juncus squarrosus	1	-	2	-
Hypnum sp.	-	30	-	-
Hylocomium splendens	-	-	-	20
Carex pilulifera	3	-	-	-
Empetrum nigrum	2	-	-	-
Carex panicea	-	-	2	-

U20: *Pteridium aquilinum – Galium saxatile* community

A.2.36 Bracken *Pteridium aquilinum* dominated communities are limited to the slopes associated with the Thorter Burn and also the steep north facing slopes to the north of the Black Hill of Kippen. Bracken tends to be overwhelmingly dominant though there is often a sparse covering of grasses beneath the bracken canopy and therefore has been assigned to the *Anthoxanthum odoratum* sub-community, **U20a**.

A.2.37 The **U20** vegetation present within the study area is assessed to be of *Local Value*.

W7: *Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland

A.2.38 Semi-natural broadleaved woodland generally is very restricted in extent within the study area, limited to the valley associated with the Thorter Burn and also part of the valley associatde with the Long Burn in the northern extreme of the study area.

A.2.39 Woodland attributable to the *Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* **W7** woodland is present as a narrow band along the Thorter Burn. The woodland canopy is either dominated by hazel *Corylus avellana* or grey willow *Salix cinerea*. Where hazel dominates there are often other species present including wych elm *Ulmus glabra* and goat willow *Salix caprea*. Largely the ground-flora is dominated by grasses, particularly tufted hair-grass. In places herbs can be more frequent and there can be some soft-rush along with occasional common nettle *Urtica dioica*, meadowsweet *Filipendula ulmaria*, yellow pimpernel *Lysimachia nemorum* and wild angelica *Angelica sylvestris*. In wet runnels opposite-leaved golden-saxifrage *Chrysosplenium oppositifolium* can be abundant.

A.2.40 The valley woodland in which tufted hair-grass is dominant or abundant has been classed as the *Deschampsia cespitosa* sub-community, **W7c**, which is the most prevalent of the communities present. Where opposite-leaved golden-saxifrage is abundant in runnels and there are more herbs present the woodland has been classed as the *Urtica dioica* sub-community, **W7a**.

A.2.41 W7 woodland of the type found here can be considered to be included within the Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* Annex I habitat type and also the Upland Mixed Ashwoods SBL habitat type. However, the extent of woodland is very restricted in extent and fundamentally is not very species-rich and as such has been assessed to be of *Local Value*.

W9: *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland

A.2.42 A tributary of the Thorter Burn forms a short narrow gorge within the limits of the study area that supports hazel dominated woodland along with wych elm and grey willow. The ground flora within the gorge is diverse supporting a range of ferns including male-fern *Dryopteris filix-mas*, oak fern *Gymnocarpium dryopteris*, common polypody *Polypodium vulgare* and occasional hard shield-fern *Polystichum aculeatum*. Herbs are also frequent and include dog's-mercury *Mercuriallis perennis*, woodruff *Galium odoratum*, wood sorrel *Oxalis acetosella*, greater stitchwort *Stellaria holostea* and herb-robert *Geranium robertianum*. This type of woodland has been classed as the Typical sub-community, **W9a**.

A.2.43 W9 woodland of the type found here can be considered to be included within the Tilio-Acerion forests of slopes, screes and ravines Annex I habitat type and also the Upland Mixed Ashwoods SBL habitat type. However, the extent of woodland is very restricted in extent and as such has been assessed to be of *Local Value*.

W21: *Crataegus monogyna – Hedera helix* scrub

A.2.44 Hawthorn dominated scrub is restricted to stands along the Thorter Burn on the eastern fringes of the study area and forms the edge of more extensive woodland that extends beyond the limits of the study area.

A.2.45 The area of hawthorn scrub within the study area is very limited and as such has been assessed to be of *Local Value*.

W22: *Prunus spinosa – Rubus fruticosus* scrub

A.2.46 Vegetation in which blackthorn *Prunus spinosa* forms a dense scrub is limited to a small stand on the northern limits of the study area within the valley formed by the Long Burn.

A.2.47 The area of blackthorn scrub within the study area is very limited and as such has been assessed to be of *Local Value*.

W23: *Ulex europaeus – Rubus fruticosus* scrub

A.2.48 Gorse *Ulex europaeus* dominated scrub is present along the steep slopes associated with the Thorter Burn and also has colonised some of the pasture land on the upland fringes included within the study area.

A.2.49 Gorse scrub has been assessed to be of *Local Value*.

OV25: *Urtica dioica – Cirsium arvense* community

A.2.50 Vegetation in which tall ruderal species, in particular common nettle, are dominant is present in the corner of a field that has been subject to some form of farm management. This vegetation has been classed as the *Urtica dioica – Cirsium arvense* community, **OV25** and has been assessed to be of *Negligible Value*.

A.3 Mammal Survey Results

Bat Activity Surveys

Table 10: Minutes detector recording per point based on a potential occupancy/recording period of hours of darkness (i.e. sunset - sunrise).

Dates/Minutes	27 May - 03 June '13	03 July - 08 July '13	03 Sep. - 10 Sep. '13
	2853	1953	4426

Table 11: All static data (registrations of species per point per month)

Point	Month (2013)	bat	*Myotis*	*Pipistrellus*	Common pipistrelle	Soprano pipistrelle	Grand Total
1	May/Jun	-	2	-	15	26	**43**
	Jul	-	3	1	8	34	**46**
	Sep	-	4	5	37	89	**135**
1 Total		-	**9**	**6**	**60**	**149**	**224**
2	May/Jun	-	1	2	4	3	**10**
	Sep	-	3	7	48	80	**138**
2 Total		-	**4**	**9**	**52**	**83**	**148**
3	May/Jun	-	-	2	6	12	**20**
	Jul	-	-	-	1	3	**4**
	Sep	1	9	18	54	162	**244**
3 Total		**1**	**9**	**20**	**61**	**177**	**268**
4	May/Jun	-	2	23	132	148	**305**
	Jul	-	3	11	186	188	**388**
	Sep	1	12	2	162	530	**707**
4 Total		**1**	**17**	**36**	**480**	**866**	**1400**
Grand Total		**2**	**39**	**71**	**653**	**1275**	**2040**

Table 12: Registrations per survey hour (rate) per point

Point	bat	*Myotis*	*Pipistrellus*	Common pipistrelle	Soprano pipistrelle	All pipistrelle combined
1	-	0.058	0.039	0.390	0.968	1.397
2	-	0.026	0.058	0.338	0.539	0.935
3	0.006	0.058	0.130	0.396	1.150	1.676
4	0.006	0.110	0.234	3.120	5.628	8.982

Table 13: Registrations of bats during transect surveys

Month	Common pipistrelle	Soprano pipistrelle
May 2013	-	1
July 2013	1	2
September 2013	-	-

Table 14: Potential bat roosts

Target Note	Grid Reference	Description
1	NO 01690 11817	Mature ash provides potential suitability for roosting bats in knotholes and snags.
2	NO 01694 11807	Mature ash provides potential suitability for roosting bats in knotholes.
3	NO 01719 11794	Mature ash provides potential suitability for roosting bats in cavity formed by large wound (missing limb) on main stem.
4	NO 01498 11985	Dead standing Scot's pine stem provides potential suitability for roosting bats in woodpecker holes.
5	NO 02044 11461	Mature ash provides potential suitability for roosting bats in knotholes and broken limb.
6	NO 02024 11486	Mature ash provides potential suitability for roosting bats.
7	NO 02060 11490	Knowes Farm buildings (including dilapidated farm house) provide numerous opportunities for roosting bats.

Otter

Table 15: Otter evidence

Target Note	Grid Reference	Description
1	NO 02372 11347	Very fresh spraint on instream boulder.
2	NO 02335 11347	Couch site amongst dense bracken on river bank.

A.4 Figures

Figure 1: Location and Extent of Development

Figure 2: Ancient Woodland and Notable Flora

Figure 3: Vegetation Communities

Figure 4: Value of Vegetation Communities

Figure 5: Groundwater Dependent Terrestrial Ecosystems (GWDTE)

Figure 6: Protected Mammal Survey

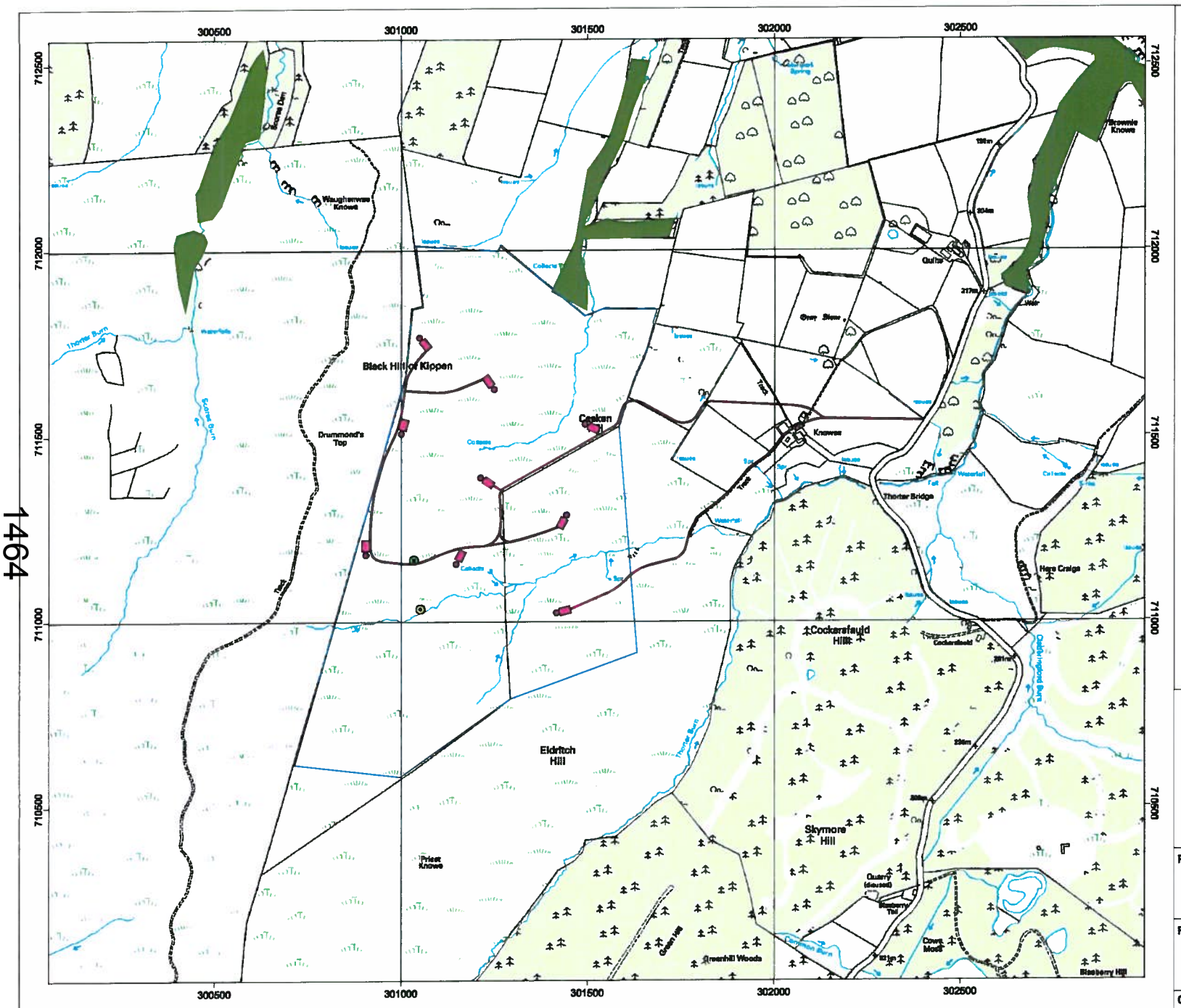

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FIGURE

Figure 2: Ancient Woodland and Notable Flora

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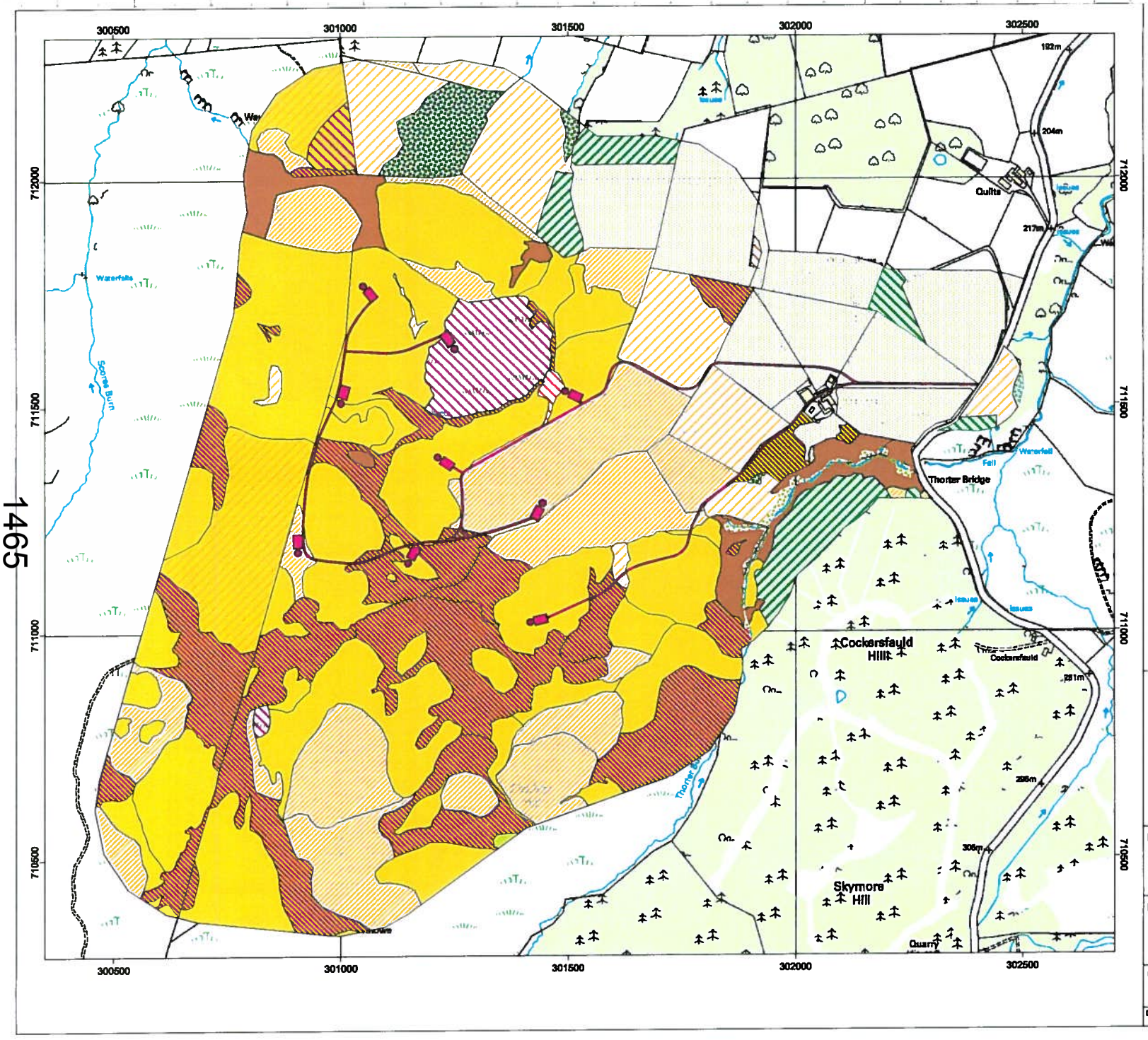

Carex disticha mire
Conifer plantation
Broadleaved plantation
H12a
M6c
M15d
M19a
M19b
M23a
M23b
OV25
U20
U4a
U4b
U5a
U5d
MG1
MG6
MG9b
MG10a
W7c
W7a/c
W21
W22
W23

Proposed Access Track
Proposed Turbine Foundation
Proposed Hardstanding

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FIGURE
Figure 3: Vegetation Communities

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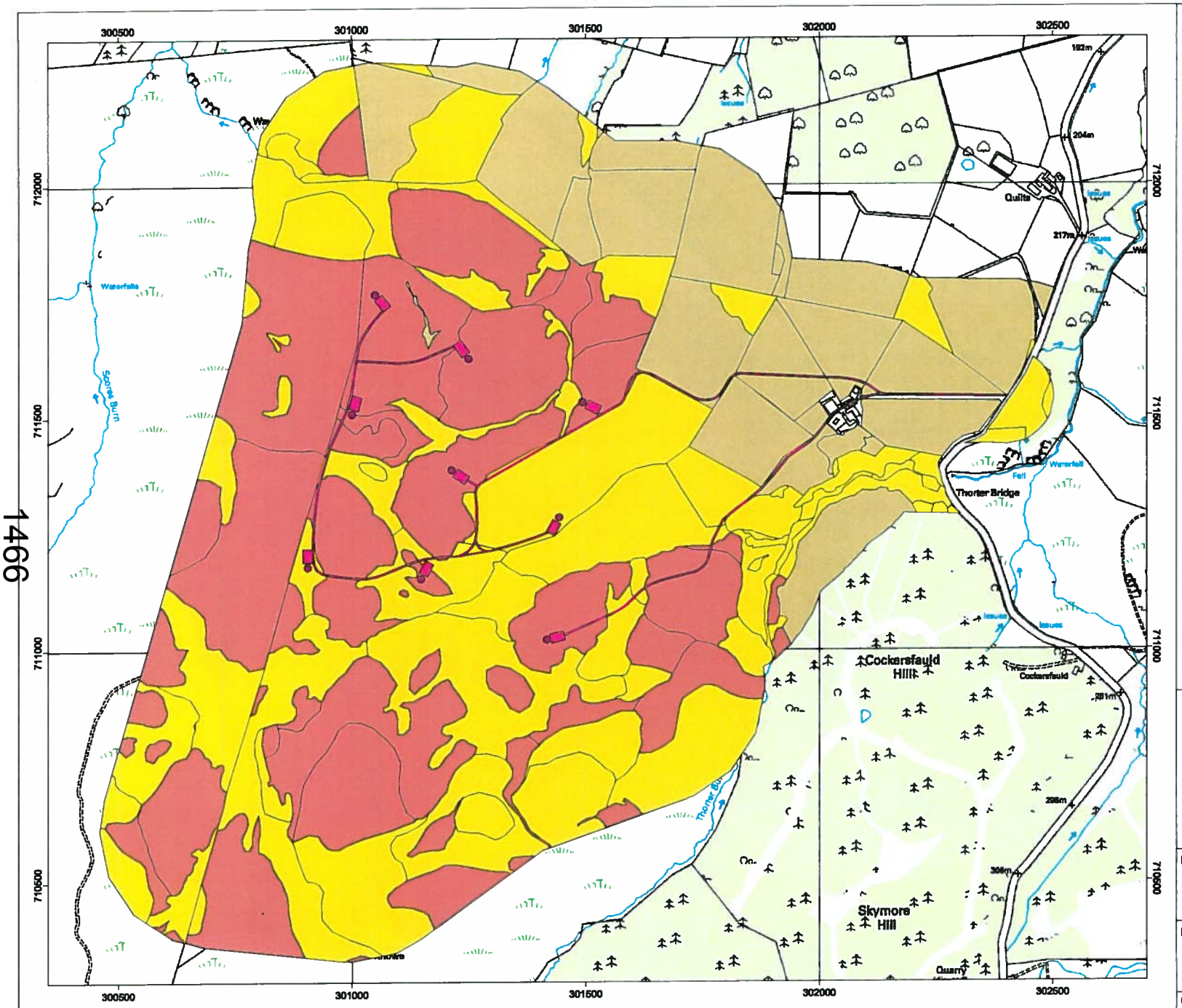

District Value
Local Value
Negligible Value

Proposed Access Track
Proposed Turbine Foundation
Proposed Hardstanding

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FIGURE
Figure 4: Value of Vegetation Communities

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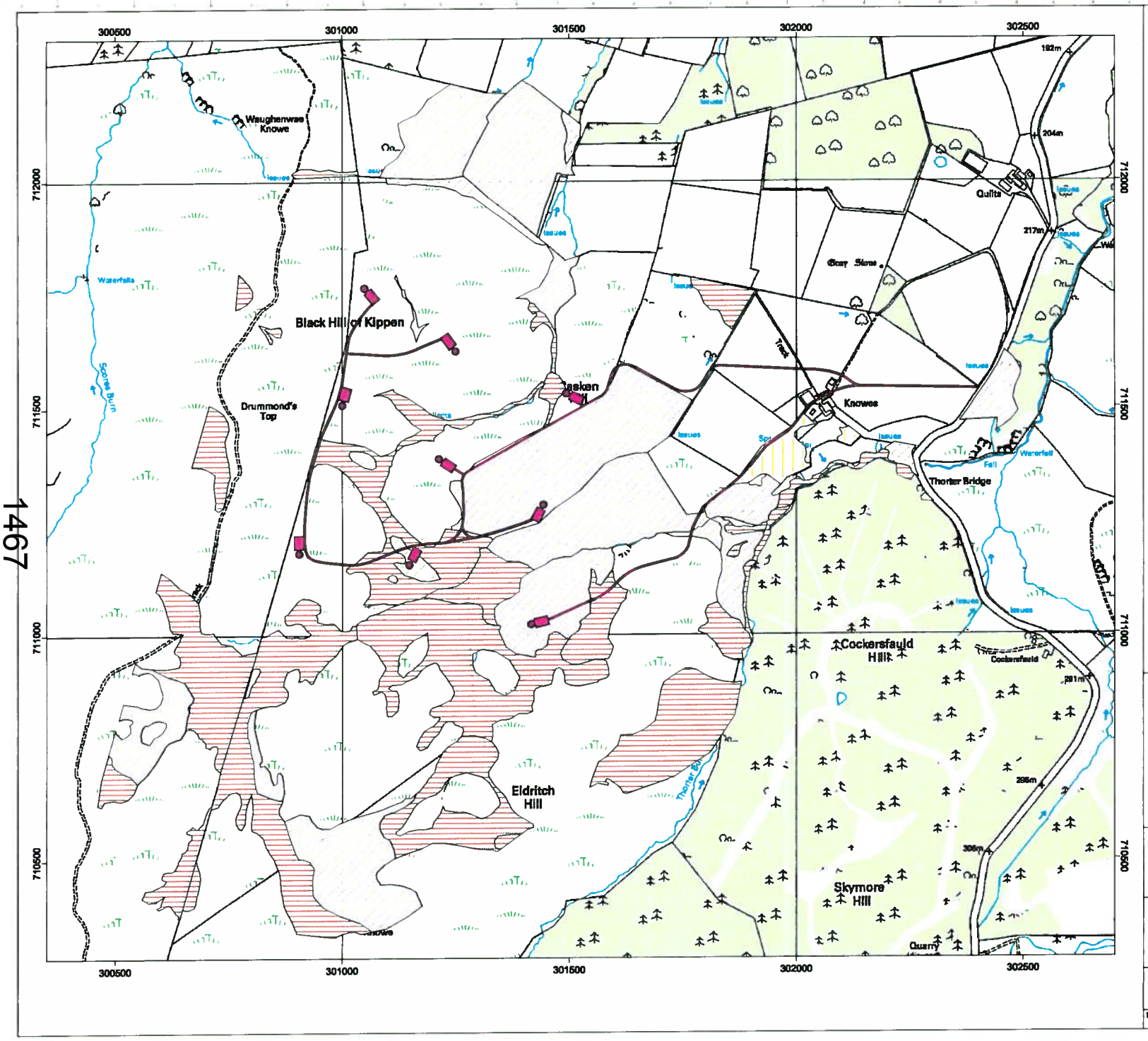

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FIGURE

Figure 5: Groundwater Dependent Terrestrial Ecosystems (GWDTE)

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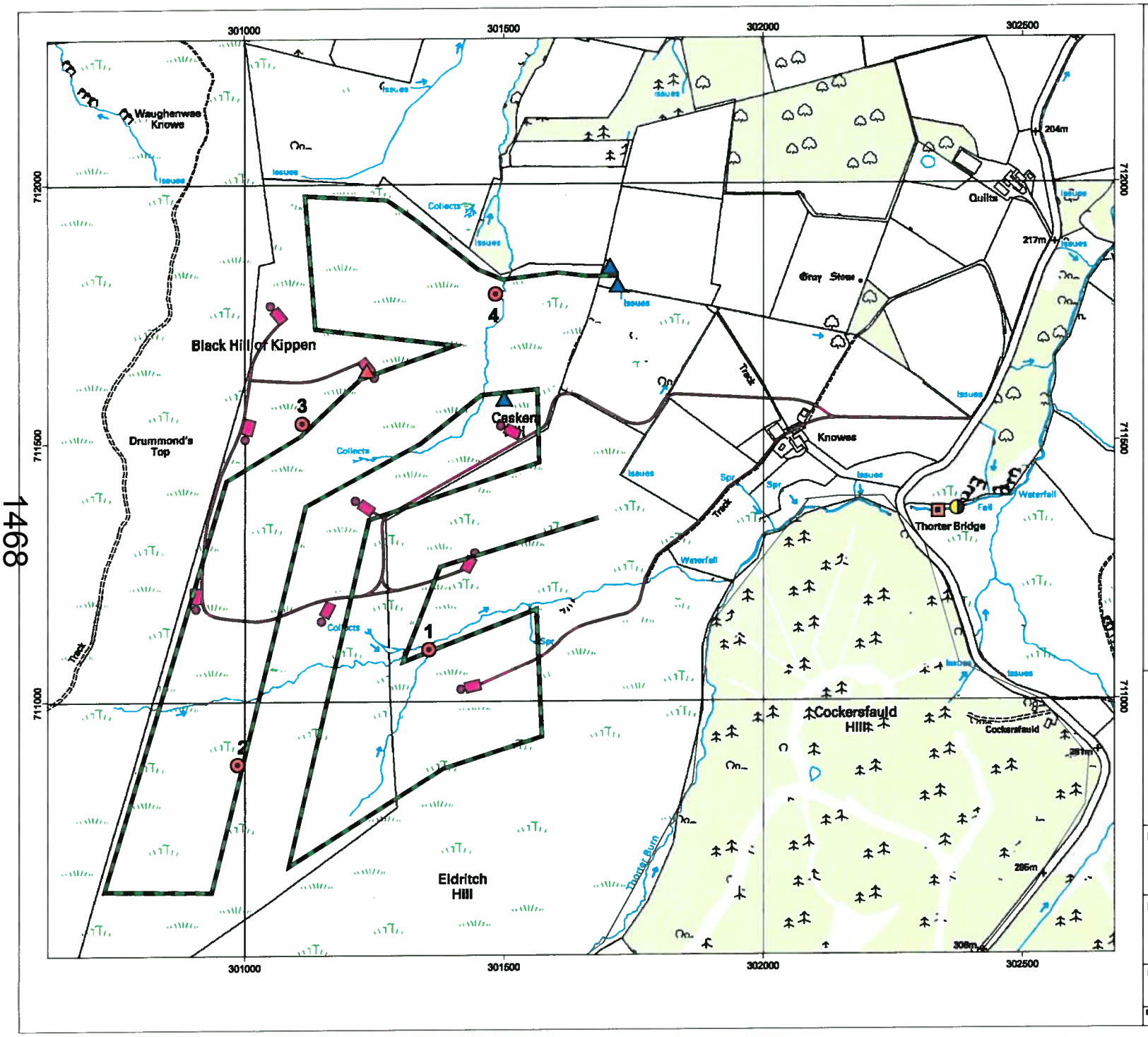

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Knowes Wind Farm

FIGURE

Figure 6: Protected Mammal Survey

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HERITAGE ENVIRONMENTAL LIMITED

Knowes Wind Farm: Ecological Impact Assessment (Ornithology)

February 2014

A Report to: Muirden Energy

	DATE	PREPARED	REVIEWED	REMARKS
ISSUE 1	05/02/14	JD/SK	MB	
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REVISION 2				
REVISION 3				

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1 SUMMARY AND CONCLUSIONS

1.1 Introduction

1.1.1 This independent report by Heritage Environmental Ltd. (HEL) presents an Ecological Impact Assessment (EcIA) with regards to ornithology in relation to the proposed Knowes wind farm near Dunning, Perth and Kinross. A further EcIA has been prepared for the wind farm in relation to ecology. The EcIA has been prepared on behalf of Muirden Energy.

1.2 Summary of Site Proposals

1.2.1 The proposed wind farm would be centred on Ordnance Survey National Grid Reference: NO 012 115. Access would be taken from the B934 via Knowes Farm. Nine turbines, 80 m to blade tip height, are proposed. Figure 1 in Appendix A.4 shows the location and layout of the proposed wind farm.

1.3 Scope of Assessment

1.3.1 The scope of the ornithological assessment includes consideration of effects on the following:

- Statutory designated sites for conservation, including, Special Protected Areas (SPAs) and Biological Sites of Special Scientific Interest (SSSIs);
- Breeding passerines;
- Breeding waders;
- Black grouse *Tetrao tetrix*;
- Diurnal raptors; and,
- Wildfowl.

1.4 Impact and Mitigation Summary

1.4.1 No significant pre-mitigated effects are predicted with regards to the breeding bird assemblage and the wintering/migrating SPA wildfowl populations.

1.4.2 Collision risk modelling considered peregrine falcon *Falco peregrinus* only, with the operational phase of the proposed wind farm assessed to have a non-significant effect on the local population. A cumulative assessment was attempted. A lack of available data meant that the assessment was not progressed with the non-significant effect at the proposed wind farm thought unlikely to impact the local or district population significantly in addition to other wind farm developments

1.4.3 No mitigation measures have been assessed as being required for the proposed wind farm. However, it is expected that the contractor will follow best construction site practices at all times and during all stages of the project construction and that the contractor is made aware of the regulations provided in Appendix A.1. of this document (e.g. Wildlife and Countryside Act 1981).

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2 INTRODUCTION

2.1 Ecological Impact Assessment (EcIA)

2.1.1 This independent report by Heritage Environmental Ltd. (HEL) presents an Ecological Impact Assessment (EcIA) for ornithology in relation to the proposed Knowes Wind Farm near Dunning, Perth and Kinross. The EcIA been prepared on behalf of Muirden Energy.

2.2 Project Description

2.2.1 The proposed wind farm would be centred on Ordnance Survey National Grid Reference: NO 012 115. Access would be taken from the B934 via Knowes farm. The access track would extend to approximately 0.75 km. Nine turbines, 80 m to blade tip height, are proposed.

2.3 Policy and Guidance

2.3.1 This ecological assessment has been undertaken with specific regard to recommendation and legislative requirements given in the following:

- The Environmental Impact Assessment (Scotland) Regulations 1999;
- The Conservation (Natural Habitats &c.) Regulations 1994 (as amended in Scotland);
- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (The Birds Directive);
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention);
- Nature Conservation (Scotland) Act 2000 (NCSA);
- Wildlife and Countryside Act 1981 (WCA);
- Scottish Executive interim Guidance of European Protected Species, Development Sites and the Planning System, 2001;
- Scottish Planning Policy;
- The UK Biodiversity Action Plan (UK BAP);
- The Scottish Biodiversity List (SBL);
- Tayside Local Biodiversity Action Plan (LBAP);
- Institute of Ecology and Environmental Management; Guidelines for Ecological Impact Assessment, 2006; and
- A Handbook on Environmental Impact Assessment, SNH 2005.

2.3.2 Appendix A.1 Policy & Guidance provides further details of the relevant legislation used to inform this report.

2.4 Scope of Ecological Assessment

2.4.1 The scope of the ecological assessment includes consideration of effects on the following (refer Appendix A.1. Policy & Guidance for further details):

Statutory Designated Sites

- Wetlands of International Importance (Ramsar Sites);
- European Sites (Natura 2000 Sites);

- Biological Sites of Special Scientific Interest (SSSIs);
- National Parks (NPs);
- National Nature Reserves (NNRs); and
- Local Nature Reserves (LNRs).

Non-statutory Designated Sites

- Royal Society for the Protection of Birds (RSPB) sites;
- Scottish Wildlife Trust (SWT) sites;
- National Trust for Scotland (NTS) sites.

Protected Species

- European Protected Species; and
- Nationally Protected Species

Species of Importance

- Species recognised through the Scottish Biodiversity List and LBAP; and
- Various listings of birds of conservation concern (e.g. Eaton *et al.* 2009).

3 ECOLOGICAL ASSESSMENT METHODOLOGY

3.1 Introduction

3.1.1 The following details the approach used in this EcIA.

3.2 Initial Site Walkover Survey

3.2.1 A walkover of the proposed wind farm site, and up to 2 km beyond, was undertaken in August 2012 in order to identify any key constraints and also to establish/confirm the requirements for detailed ornithology surveys. This included determining the locations of vantage points for flight activity surveys and surveying the extent of habitat suitable for black grouse and raptor species. The results of the walkover survey were used to help define the scope of assessment.

3.3 Consultation

3.3.1 Following completion of walk over surveys (refer 3.2.1, above), the following organisations were asked for opinion on the proposed scope of assessment.

Perth and Kinross Council, as Planning Authority

3.3.2 A method statement, detailing proposed methodologies was sent, via e-mail to Mr G. Dimeck of Perth and Kinross Council on 16 October 2012. A further request was made on 3 February 2014. No formal response has been received to date.

Scottish Natural Heritage

3.3.3 A method statement, detailing proposed methodologies was sent, via e-mail to the Scottish Natural Heritage (SNH) Tayside and Grampian office on 16 October 2012. Following initial discussions with Jonathan Agnew of SNH, further justification for the proposed use of a single vantage point (VP) was provided, via e-mail on 26 October 2012. Mr Agnew responded, via e-mail, on 29 October 2012, stating that the methodologies proposed following walkover assessment (including the use of a single VP) appeared to be adequate for the site.

3.4 Desk Study

3.4.1 A desk study was carried out and included a review of:

- SNH database of designated sites for nature conservation;
- National Biodiversity Network (NBN) Gateway which collates and maintains a database of protected species and ecological features of conservation importance. It should be noted that this source was used to provide a background context (and thus help define the scope of assessment) and was not used in any way as a primary data source;
- RSPB records of Schedule1/Annex I Birds, plus any other bird species not afforded enhanced statutory protection but considered to be of conservation importance (for example black grouse *Tetrao tetrix*) that it may hold for the site and the surrounding area (up to 2 km outwith wind farm area); and
- The Tayside Raptor Study Group for any records it may hold of breeding/roosting raptors in the wind farm area and up to 2 km out with.

3.4.2 Results from the desk study are included in Section 4 Description and Evaluation of Baseline, where appropriate.

3.5 Target and Secondary Species

3.5.1 SNH has identified a list of priority species which are potentially at risk from onshore wind farms (*Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas,* Table 1a and Table 1b, SNH 2006).

3.5.2 Following the walkover survey a list of likely target species for which flight activity surveys and breeding surveys to be completed was defined, based on the species priorities identified by SNH (refer Table 1).

Table 1: Target and Secondary Species

Target Species		Secondary Species
Northern goshawk *Accipiter gentilis*		Common buzzard *Buteo buteo*
Osprey *Pandion haliaetus*		Common kestrel *Falco tinnunculus*
Peregrine falcon *Falco peregrinus*		Eurasian sparrowhawk *Accipiter nisus*
Short-eared owl *Asio flammeus*		Northern lapwing *Vanellus vanellus*
Black grouse *Tetrao tetrix*		Common snipe *Gallinago gallinago*
Eurasian curlew *Numenius arquata*		Gull species
Hen harrier *Circus cyaneus*		
Merlin *Falco columbarius*		
Wintering wildfowl		

3.5.3 In addition to the likely target species, all species listed within Table 1a and Table 1b of the SNH guidance were recorded and mapped as appropriate and where encountered. In addition, given that the South Tayside Goose Roosts SPA is within 10 km of the proposed wind farm site, consideration was given to an assessment of wintering wildfowl in terms of winter flight activity surveys. However, feeding/loafing habitat for wintering wildfowl within and around the site is limited. Such habitat comprises mainly steep and/or enclosed (by forestry) ground that is generally not favoured by the SPA's qualifying wildfowl species and winter field surveys were therefore scoped out of the assessment.

3.5.4 A list of secondary species for the site has also been defined (see Table 1 above) for which activity summaries were recorded during flight activity surveys (see Table 13 in Appendix A.3.). In addition, these species were also included as a focus of effort along with any target species encountered during breeding bird surveys.

3.5.5 All species encountered were recorded as part of the breeding bird surveys.

3.6 Study Areas

3.6.1 The following study areas have been considered:

- Desk study: up to 5 km beyond the proposed wind farm site[1] (NBN, RSPB, etc.) or to 20 km beyond proposed site with regard to SPAs and SSSIs, etc.;
- Particular consideration of the qualifying features of the South Tayside Goose Roosts SPA which lies approximately 10 km to the proposed wind farm site, the Loch Leven SPA (ca. 15 km distant) and Firth of Tay and Eden Estuary SPA (c. 20 km to the east);

[1] For the purposes of this assessment, the site is taken to be the outermost extents of all proposed wind farm infrastructure, including access tracks.

- Breeding birds: proposed wind farm site and 250 m beyond where potentially suitable habitat is present and access was available (private grounds/buildings were not accessed);
- Breeding waders: proposed wind farm site and 750 m[2] beyond where potentially suitable habitat is present and access was available;
- Breeding diurnal raptors listed on Schedule 1/Annex I: turbine envelope and 2 km beyond and infrastructure (i.e. access tracks, etc.) and 750 m beyond where potentially suitable habitat is present and access was available;
- Black grouse *Tetrao tetrix*: turbine envelope and 1.5 km beyond and infrastructure (i.e. access tracks etc.) and 750 m beyond where potentially suitable habitat is present and access was available.

3.7 Flight Activity Surveys

3.7.1 As per guidance given in *Survey methods for use in assessing the impacts of onshore windfarms on bird communities* (SNH 2005), flight activity levels of target were assessed to inform on potential bird collisions with turbines and other interactions such as displacement effects.

3.7.2 Summer and winter VP surveys were undertaken due to the potential presence of breeding and wintering target species. This provided a full 12 months' data, beginning mid-September 2012 to mid-March 2013 for the winter period and from end March 2013 to end August 2013 for the summer period.

3.7.3 A single VP (refer Figure 1 in Appendix A.2) was selected to provide the best coverage of the study area so that all areas of the turbine envelope were covered for flight activity, and extending to **more than** 200 m beyond the turbine envelope.

3.7.4 VP watches were of 3 hours in duration, as this period is more likely to ensure recording of bird activity where target species are present (e.g. adult food passes, display flights, food carrying, etc.). As per SNH guidance, the survey effort for the summer and winter periods, respectively, was 36 hours per VP. VP survey effort was targeted to provide a good spread of coverage across the diurnal range during both the summer and winter periods. Table 9 in Appendix A.3. provides the hours watched per VP across the summer and winter periods.

3.7.5 During each VP watch the area in view was scanned constantly by eye and using binoculars and telescope until a target species is detected in flight. Once detected, the bird/flock was visually followed until it ceased flying or was lost from view. The duration of the flight and the flight height was recorded on standardised forms and the route followed by the bird(s) mapped on a suitably scaled map. In order to characterise the flights the following flight height bands were recorded to assess collision risk with turbines measuring 80 m to tip, with a hub of 56 m:

- <25 m;
- 25 - 85 m; and
- >85 m above ground.

3.7.6 VPs were undertaken during all weather conditions, except when conditions prevented recording of target species' flights. Table 9 in Appendix A.3. provides a breakdown of weather conditions during flight activity surveys.

[2] 750 m is recommended as this is in line with recent evidence identifying the zone of potential impact on some wader species. This is in excess of the 500 m recommended in SNH Guidance.

3.7.7 In addition to recording flight lines of target species, the number and activity of secondary species was recorded at the end of each 5 minute period throughout the 3 hour watch. Data collected under this method were used to calculate an index of flight activity for those species concerned.

3.8 Species Specific Surveys

3.8.1 Due to the potential presence of species that are not adequately surveyed using the British Trust for Ornithology (BTO) Common Birds Census (CBC) method, there is a requirement for species specific surveys for certain groups of species. The following species-specific surveys, therefore, were undertaken

3.9 Black Grouse

3.9.1 The presence of any potential black grouse lek sites was determined according to methods outlined in *Survey methods for use in assessing the impacts of onshore windfarms on bird communities* (SNH 2005).

3.9.2 A systematic walkover of all suitable lekking areas within the study area was carried out at dawn on the 22/24 April and 7/8 May 2013 during suitable weather conditions (i.e. wind less than Beaufort 3, and no precipitation) in order to confirm the presence and exact location of any leks. Each visit comprised a systematic walk through suitable habitat within the study area at dawn and no more than two hours after in order to confirm the presence and exact location of any leks.

3.10 Diurnal Raptors

3.10.1 Based on guidance given in *Raptors: a field guide to survey and monitoring* (Hardey *et al.* 2005) and *Bird monitoring methods* (Gilbert *et al.* 1998), the approach followed for identifying the presence and location of species of breeding diurnal raptors that may be present within the study area was based on a combination of VP watches and walkover surveys. Based on SNH guidance for those species that may be present, the distance beyond the wind farm for which surveys for breeding nest site locations were completed was 2 km[3].

3.10.2 The diurnal raptor surveys was undertaken over a period of one breeding season and involved three survey visits to each area from March to July 2013.

3.10.3 It is acknowledged that short-eared owl *Asio flammeus* are active during the night and also during the dawn and dusk periods, as well as during the day. The degree to which short-eared owls are detectable during daylight hours varies dependent on the stage in the breeding cycle (Calladine *et al.* 2010). Guidance given in Hardey *et al.* (2005) recommends the period of the day over which surveys for short-eared owl should ideally be carried out. Broadly speaking this is the 4 hours after dawn or before dusk during the incubation period (mid-April to May) extending to the first 8 hours after first light (or 4 hours before dark) during June and July (main chick rearing period). Given this known variation in activity and detectability, surveys were targeted during suitable times of the day at appropriate times of year in order to maximise the efficiency of the surveys.

3.10.4 It is considered that targeting the moorland element of the diurnal raptor surveys during the dawn and dusk periods, particularly in the early part of the season, did not detract from identifying other target species, namely hen harrier *Circus cyaneus* and merlin *Falco columbarius*. Hardey *et al.* (2005) recommend watches for hen harrier are undertaken in the morning from 6:00 am or earlier or in the evening up to 8:00 pm. Similarly for merlin, Hardey *et al.* (2005) recommend watches are undertaken in the

[3] 2 km was taken as the survey distance for merlin, peregrine, hen harrier red kite, osprey etc. with 1 km for northern goshawk.

morning before 10:00 or in the evening after 16:00. As such, it is considered that a three visit survey schedule targeted at the appropriate times of day is a robust methodology for identifying moorland raptors, including short-eared owl.

3.10.5 For areas in intensive agricultural landscapes supporting only scattered trees (e.g. boundary trees along field margins), a single walkover survey was completed over the period May to July 2013 to identify the presence of any nest sites.

3.10.6 The 3 survey visits of the study site were undertaken across 12 dates from 12 March 2013 to 12 July 2013 inclusive, in the following periods: the first visit during the period mid-March to end of April 2013; the second visit during the period mid-May to mid-June 2013; and the third visit during mid-June to mid-July 2013.

3.11 Breeding Bird Survey

3.11.1 A breeding bird survey (BBS) was undertaken within the study areas (see Section 3.6.1) based on the methods outlined in *Survey methods for use in assessing the impacts of onshore windfarms on bird communities* (SNH 2005), to inform on potential breeding bird impacts such as habitat loss and other interactions such as displacement effects.

3.11.2 A territory mapping method, involving a scaled-down 3 visit version of the BTO CBC methodology was used. A systematic search of the study area was completed. All evidence of habitat utilisation by birds was recorded and marked on a suitably scaled map. Recording methodology used standard BTO registration codes and standard CBC behaviour codes. The 3 survey visits of the study site were undertaken across 4 dates from 22 April 2013 to 24 June 2013 inclusive, in the following periods: the first visit during April 2013; the second visit in May 2013; and the third visit in June 2013.

3.11.3 Analysis of the field maps was undertaken together with maximum count data in order to produce final distribution maps of all birds throughout the study area. The following criteria were used to establish whether birds were breeding:

3.11.4 For all birds:

- Presence of nest, eggs and/or chicks;
- Alarm calling indicative of nest, young or territory;
- Displaying or in song-flight;
- Performing a distraction display;
- Birds aggressively defending territories; and
- Birds seen carrying food to nest or young.

3.11.5 For all raptors:

- If a pair was attached to a territory.

3.11.6 For all grouse:

- If a pair was recorded; and
- Males in territorial behaviour (lekking).

3.11.7 For all passerines:

- Birds singing or alarm calling.

3.11.8 All other behaviour was considered as being indicative of non-breeding activities.

3.12 Assessment of Effects

3.12.1 The process of ecological impact assessment has been undertaken by consideration of best practice guidance (*e.g.* Institute of Ecology and Environmental Management guidelines [IEEM 2006]) and professional judgement, in order to provide a methodology that is robust and fit for purpose for this project. The following provides an outline of the methodology used to provide a structured approach to determining potential adverse effects of the project. The assessment involves the following process:

- Evaluation of nature conservation value;
- Impact assessment of project; and
- Provision of mitigation measures.

Evaluation of Nature Conservation Value

3.12.2 The first stage of ecological impact assessment involves applying a nature conservation value to each ecological feature or receptor (*i.e.* species or group) present within the defined study areas. Ecological receptors are assigned a nature conservation value based on evaluation criteria adapted from existing guidelines and professional judgement. Table 2 shows the level of values and examples that are used as a guide in the evaluation process. Thus, ecological receptors are assigned a value according to a scale of *Negative* to *International Value*.

Impact Assessment of Project

3.12.3 In order to define the implications of the proposed development on ecology and nature conservation an impact assessment of the project is completed. Methods of impact prediction used in this assessment include direct measurements and expert opinion. Published information is also used to determine impacts. Impacts are considered in relation to the probability of the impact occurring, whether they are predicted to be direct, indirect, temporary, permanent, reversible or irreversible.

3.12.4 For each potential impact of the project, an assessment of impact magnitude and effect significance is provided based on the guidelines given in Table 2: Guidelines for Assessing Impact Magnitudes and Table 4: Matrix for Assessing Significance of Effects.

3.12.5 The magnitude of an impact is assessed in conjunction with the nature conservation value of the receptor (see Table 2) to provide an indication of effect significance (see Table 3). Impact magnitude is ranked according to a scale of *None* to *High*, based on increasing magnitude. In recognising a continuum of effect significance, these are ranked according to a scale of *None* to *Major*, based on increasing adverse impact. A *Positive* category is also provided to indicate where there is a predicted increase in conservation status compared to the base-line.

3.12.6 For the purpose of this assessment a *significant effect* on ecology or nature conservation is defined here as any impact of moderate or major significance. Definitions of these terms are provided in Table 4: Matrix for Assessing Significance of Effects.

Mitigation Measures

3.12.7 Mitigation measures have been recommended where it is anticipated that a significant impact may result without measures being implemented or in accordance with Best Practice guidelines, or to fulfil legal obligations. An assessment of post-mitigation effects is provided to show the overall effect of the proposed development.

Table 2: Guideline Nature Conservation Evaluation Criteria

Level of Value	Examples
International **(European or Global)**	• Habitats and/or species that meet published criteria for international designation such as World Heritage Sites, Biosphere Reserves, Biogenetic Reserves, Ramsar Sites or sites of EU importance i.e. SPA's. • Outstanding examples of ecological features in a European context (*i.e.* high quality, good extent, viable areas of habitats and high density, core part of species population, etc.) of habitat types and species listed in Annex I and Annex II of the Habitats Directive.
National **(UK or Scotland)**	• Habitats and/or species that meet published criteria for national designation such as SSSI's, NNR's or MNR's. • Outstanding examples of ecological features in a national context (i.e. high quality, good extent, viable areas of habitats and high density, core part of species population, etc.) of species listed in Schedules 1, of the WCA and Scottish Biodiversity List Priority Species.
Regional (SNH Natural Heriatge Zone No. 16: Eastern Lowlands)	• Habitats and/or species not satisfying international (*e.g.* SPA, *etc.*) or national (*e.g.* SSSI *etc.*) designation criteria, but are good examples of the following: ▪ sites containing regionally important numbers of a single species (*e.g.* >1% of SNH Natural Heritage Zone population for birds); and ▪ species outlined in a Local BAP to be of regional rarity or localisation.
District (Perth and Kinross Local Plan: Perth Area)	• Good population sizes and/or assemblages of Red/Amber List birds. • Sites meeting the criteria for Local District Authority area designation (*e.g.* SINC's or LNR's). • Viable populations of species as identified in an LBAP
Local (Proposed wind farm site and 5 km beyond)	• Common breeding, wintering or migrant bird species • Non-critical populations or non-critical use of resource (*e.g.* a non-natal/temporary place of shelter or limited area of foraging resource) of certain widespread and/or abundant bird species of conservation concern.
Negligible	• Very common and abundant species.
Negative	• Alien fauna which have a deleterious ecological effect *e.g.* those species scheduled under Section 14, Schedule 9 to the WCA.

Table 3: Guidelines for Assessing Impact Magnitudes

Impact Magnitude	Guidelines
High Negative	A negative, fundamental change to the ecological baseline . Impact(s) that have a substantial effect on ecological feature(s) with regard to magnitude, extent and duration. For example complete or substantial, • loss of an ecological feature; • reduction in population viability.
Medium Negative	A negative, material change to the ecological baseline. Impact(s) that have a moderate effect on ecological feature(s) with regard to magnitude, extent and duration. For example moderate, • deterioration in habitat quality; • reduction in population distribution.
Low Negative	A negative change of limited scale to the ecological baseline. Impact(s) that have a limited effect on ecological feature(s) with regard to magnitude, extent and duration. For example limited, • short term reduction in species diversity; • habitat loss of temporary duration.
Negligible Negative	A very slight, detectable negative change to the ecological baseline. Impact(s) that have a very limited effect on ecological feature(s) with regard to magnitude, extent and duration. For example very limited, • disturbance of a temporary nature to species/habitats; • impacts that would not affect the viability or carrying capacity of the site.
None	No detectable impact(s) on the ecological baseline.
Positive	Impact(s) resulting in positive effect(s) on the ecological baseline.

Table 4: Matrix for Assessing Significance of Effects

		Magnitude of Impact			
		High Negative	**Medium Negative**	**Low Negative**	**Negligible Negative**
Value of Ecological Feature	**International**	Major	Major	Moderate	Minor
	National	Major	Major	Moderate	Minor
	Regional	Major	Moderate	Minor	Minor
	District	Moderate	Moderate	Minor	Negligible
	Local	Minor	Minor	Negligible	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

Significance: Significant Impact | Non-significant

4 DESCRIPTION AND EVALUATION OF BASELINE

4.1 Introduction

4.1.1 The following details the results of ornithological surveys undertaken within the respective study areas, and relevant desk study records.

4.2 Designated Sites

Designated Ornithological Sites

4.2.1 The following designated ornithological sites are present within 20 km of the proposed wind farm:

SPAs

4.2.2 **Loch Leven SPA** in central Scotland comprises the largest natural eutrophic waterbody in Britain, Loch Leven itself. It is a relatively shallow loch, surrounded by farmland, with a diverse aquatic flora and shoreline vegetation. The boundary of the Loch Leven SPA follows that of the Loch Leven SSSI except for the exclusion of 4 ha of SSSI towards the northern end of the loch. Loch Leven SPA qualifies under Article 4.1 by supporting a population of European importance of:

- Wintering Icelandic whooper swan *Cygnus cygnus* (1993/94-97/98 winter peak mean of 97, 2% of British population).

4.2.3 Loch Leven SPA qualifies under Article 4.2 by regularly supporting populations of European importance of:

- Wintering Icelandic/Greenlandic pink-footed goose *Anser brachyrhynchus* (1993/94-97/98 winter peak mean of 17,163, 8% of total population, all of which winters in Britain); and
- Northern shoveler *Anas clypeata* (509, 1% of NW European & 5% of British).

4.2.4 Loch Leven SPA further qualifies under Article 4.2 by regularly supporting a wintering waterfowl assemblage of European importance (1993/94-1997/98 winter peak mean of 34,280) which includes large populations of:

- Cormorant *Phalacorax carbo* (391, 3% of GB);
- Gadwall *Anas strepera* (245, 3% of GB),
- Eurasian teal *Anas crecca* (2,771, 2% of GB),
- Common pochard *Aythya ferina* (1,095, 2% of GB),
- Tufted duck *Aythya fuligula* (3,636, 6% of GB); and
- Common goldeneye *Bucephala clangula* (339, 2% of GB).

4.2.5 **South Tayside Goose Roosts SPA** comprises seven lochs, a number of smaller water bodies and other wetland habitats in Strathearn and Strathallan to the west of Perth. The site overlaps with three SSSIs: Carsebreck and Rhynd Lochs, Drummond Lochs, and Dupplin Lakes (see below).

4.2.6 The site qualifies under Article 4.2 by supporting, in summer, a nationally important breeding population of:

- Eurasian wigeon *Anas penelope* (In the four year period 1988-91 between 14 and 16 pairs were recorded, representing 4% of the British breeding population)

4.2.7 The site also qualifies under Article 4.2 by regularly supporting internationally important wintering numbers of two species of geese:

- Pink-footed goose (in the five-winter period 1985/86 to 1989/90 an average peak count of 31,800 was recorded i.e. 29% of the Iceland/Greenland population, all of which winters in Britain); and
- 9,700 greylag goose *Anser anser* (10% of the total Icelandic population, all of which winters in Britain).

4.2.8 The South Tayside Goose Roosts SPA also support important assemblages of breeding and wintering birds typical of open water and associated wetlands. Breeding species include Eurasian wigeon, gadwall, northern shoveler, ruddy duck *Oxyjura jamaicensis*, common snipe *Gallinago gallinago*, Eurasian curlew *Numenius arquata* and redshank *Tringa totanus*. Besides the geese, other wintering species include: mute swan *Cygnus olor*, whooper swan, Eurasian wigeon, Northern shoveler, tufted duck, common goldeneye, goosander *Mergus merganser*, and twite *Carduelis flavirostris*.

4.2.9 The **Firth of Tay & Eden Estuary SPA** lies approximately 19.5 km (at its closest) to the east of the proposed wind farm. It is a complex of estuarine and coastal habitats in eastern Scotland stretching from the mouth of the River Earn in the inner Firth of Tay east to Barry Sands on the Angus Coast and St Andrews on the Fife Coast. The SPA is contained within the following SSSIs: Inner Tay Estuary, Monifieth Bay, Barry Links, Tayport-Tentsmuir Coast and Eden Estuary.

4.2.10 Qualifying interest of the SPA is from Article 4.1 of the Birds Directive by regularly supporting nationally important breeding populations of the following Annex I species:

- Marsh harrier *Circus aeruginosus* (average of 4 females in 1992-96, 3% of GB); and
- Little tern *Sterna albifrons* (average of 25 pairs between 1993 and 1997, 1% of GB);.

4.2.11 Internationally important wintering population of the following Annex I species also occur: namely,

- Bar-tailed godwit *Limosa lapponica* (2,400, 5% of GB and 2% of Western European).

4.2.12 The SPA also qualifies under Article 4.2 by regularly supporting an internationally important wintering population of the following species:

- Redshank (1,800 individuals; 2% of GB and 1% of northwest European populations).

4.2.13 The SPA also qualifies under Article 4.2 by regularly supporting in winter over 20,000 waterfowl with a 1990/91-94/95 winter peak mean of 48,000 waterfowl, comprising 28,000 wildfowl and 20,000 waders.

4.2.14 Internationally important wintering populations (1990/91-94/95 winter peak means) of the following species are included:

- Pink-footed goose (2,800; 1% of GB and Icelandic/Greenlandic populations); and
- Greylag goose (1,200; 1% of GB and Icelandic populations);

4.2.15 In addition, nationally (UK) important wintering populations of the following species are also present (assemblage qualifiers only): cormorant (230, 2% of GB), shelduck *Tadorna tadorna* (1,200, 2% of GB), eider *Somateria mollissima* (13,800, 18% of GB), long-tailed duck *Clangula hyemalis* (560, 2% of GB), common scoter *Melanitta nigra* (3,100; 9% of GB), velvet scoter *Melanitta fusca* (730, 24% of GB), common goldeneye (230, 1% of GB), red-breasted merganser *Mergus serrator* (470, 5% of GB), goosander (220, 2% of GB), oystercatcher *Haematopus ostralegus* (5,100, 1% of GB), grey plover *Pluvialis*

squatarola (920, 2% of GB), sanderling *Calidris alba* (220, 1% of GB), dunlin *Calidris alpina* (5,200, 1% of GB) and black-tailed godwit *Limosa limosa* (150, 2% of GB).

4.2.16 The conservation objectives for the Firth of Tay & Eden Estuary SPA are as follows:

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

4.2.17 The Firth of Tay and Eden Estuary is also designated as a Ramsar site, recognising the complex of coastal habitats, which include extensive invertebrate-rich intertidal mudflats and sandflats created by the sediment load deposited by the River Tay. Also present are large areas of reedbed and sand-dune and a small amount of saltmarsh. This site is recognised as being of International conservation value. The site qualifies for designation under criteria 5 and 6 of the Ramsar Convention. Under criterion 5, it qualifies for the internationally important assemblage of wintering waterfowl, where it supports more than 27,000 waterfowl. Under Criterion 6, species or populations of birds occur at levels of international importance, where the qualifying species with peak counts in spring and autumn are:

- Common redshank, 1.8% of the population.

4.2.18 Species with peak counts in winter are:

- Pink-footed goose, 2% of the population;
- Greylag goose, 2.1% of the population; and
- Bar-tailed godwit, 1.5% of the population.

4.2.19 Subsequent to designation, a number of species/populations have been identified for possible future consideration under criterion 6. These include:

- Species with peak counts in spring/autumn: Goosander, 1.6% of the population.

SSSIs

4.2.20 The following SSSIs that qualify due to their ornithological resource are present within 10 km of the proposed wind farm:

- Inner Tay Estuary;
- Dupplin lakes;
- Carsebreck and Rhynd lochs

4.2.21 The Tay Estuary is one of the largest estuaries in Scotland. It stretches for approximately 20 km from the confluence of the Rivers Earn and Tay in the west to the Tay rail bridge in the east. **The SSSI Inner Tay Estuary** consists primarily of inter-tidal sand and mud flats that extend seawards out to the main channel, the majority of which lie on the

northern side of the estuary. With regards to birds, the site is important for its wintering populations of roosting grey geese and its breeding birds, including several nationally important populations of estuarine/fenland species.

4.2.22 The Inner Tay Estuary is part of the Firth of Tay and Eden SPA, and as such it is designated for the same suite of bird species as reported above in Section 4.2.9.

4.2.23 **The Carsebreck and Rhynd Lochs SSSI** lies north of the A9 between Dunblane and Auchterarder in lowland Perthshire. The site contains a range of habitats including the raised bog of Shelforkie Moss, together with base-rich flush and fen communities surrounding a group of three artificial lochs. The lochs are important as a roost for wintering greylag and pink-footed geese. The southern boundary of the site runs, in part, along the Allan Water.

4.2.24 The raised bog is one of the largest in the Tayside region. The flush and fen communities support a relatively high number of plant species, including several of restricted distribution.

4.2.25 The Carsebreck and Rhynd Lochs SSSI is part of the South Tayside Goose Roosts SPA, and as such it is designated for the same suite of bird species as reported above in Section 4.2.9

4.2.26 **The Dupplin Lakes SSSI** lies on the eastern end of the Gask ridge above Strathearn, 6 km south west of Perth. The site consists of mixed woodland surrounding the lowland lochs of Dupplin Loch and Pitcairnie Loch with a small pool between them. This site is important for pink-footed geese, and breeding birds.

4.2.27 The site is of international importance as a roost for pink-footed geese in the winter, being one of only seven open water roosts for grey geese in the district. It is nationally important for its population of scarce breeding waterfowl, and one of only six sites notified in Perth & Kinross for breeding birds associated with open water.

4.2.28 Although not notified for these natural features, the site also holds large populations of wintering duck, and has rich botanical interest particularly around Blairbell Wood.

4.2.29 The Dupplin Lakes SSSI is part of the South Tayside Goose Roosts SPA, and as such it is designated for the same suite of bird species as reported above in Section 4.2.9.

4.3 Desk Study

Tayside Raptor Study Group

4.3.1 No response has been received from the Tayside Raptor Study Group following a data request in April 2013 and February 2014.

RSPB

4.3.2 No response from has been received from the RSPB following a request in April 2013 and February 2014.

NBN

4.3.3 Desk study data from the NBN Gateway dataset of 10km squares NN 90, NN 91, NO 00 and NO 01 (in which the wind farm out to 2 km is contained) confirmed the presence of the following target and secondary species:

Greylag goose in:

- NO 00 1 km square in tetrad Q.

Black grouse in:

- NN 90 (listed as breeding in 10 km tetrad only; from Bird Conservation Targeting Project in the UK 2006-2011); and

- NN 91 (as above).

Barn owl *Tyto alba* in:

- NN 90 tetrads J & X;
- NN 91 tetrads A, B & S;
- NO 00 tetrads F & L; and
- NO 01 tetrad Y.

Northern lapwing *Vanellus vanellus* in:

- NN 90 tetrads C, E, J, R & V;
- NN 91 tetrads G, K & Y;
- NO 00 tetrads A, C, F, G, Q, R, S, U, V, W, X & Z; and
- NO 01 tetrads A, I, R, S, T, V, Y & Z.

European golden plover *Pluvialis apricaria* in:

- NO 00 1 km square in tetrad Q.

Eurasian curlew in:

- NN 90 tetrads B, C, E, H, I, J, N, P, R, S, V, W &X;
- NN 91 tetrads G & I;
- NO 00 tetrads A, B, E, F, G, H, K, L, M, N, Q, R, S, T, U, V, W & Z; and
- NO 01 tetrads A, I, L. R, T, V & Y.

Common snipe in:

- NN 90 in tetrads A, B, C, L, R & V; and
- NO 00 tetrads B, Q, S, T, U & Z.

4.4 Breeding Birds (Passerines)

4.4.1 The study area supports an assemblage of species that would be expected from a site on upland habitat in the Scottish central belt, with both moorland and lowland farmed habitats. Table 5 provides a summary of the bird resource recorded in the study area (Also see Table 11 in Appendix A.4. for complete data set). The maximum count, i.e. the most number of registrations of breeding activity on any single visit across the season together with professional judgement was used to assess the number of breeding pairs of each species on site (Figure 2 in Appendix A.2 shows the breeding birds across the study area taking the visit of maximum number for each species to show the distribution for that species).

Table 5: Number of breeding birds recorded on survey visits

Species	Status	Breeding pairs	Evaluation as a receptor
Carrion crow	-	2	Negligible value
Chaffinch	-	1	Negligible value
Common linnet	SBL, Red List & Tayside LBAP Priority	1	Negligible value

	species		
Common raven		2	Local value
Eurasian curlew	SBL, Amber List & Tayside LBAP species of conservation concern	2	Local value
Lesser redpoll	SBL, Red List & Tayside LBAP Priority species	2	Local value
Meadow pipit	Tayside LBAP species of conservation concern	22	Local value
Northern lapwing	SBL, Red List & Tayside LBAP Priority species	1	Local value
Sky lark	SBL, Red List & Tayside LBAP Priority species	16	Local value
Northern Wheatear	Amber list & Tayside LBAP species of conservation concern	1	Local value
Whinchat	Amber list & Tayside LBAP species of conservation concern	2	Local value
Willow warbler	Amber list & Tayside LBAP species of conservation concern	1	Negligible value

4.4.2 Appendix A4. provides a description of numbers recorded and species accounts for breeding and non-breeding birds listed in Table 5 above, that are listed on Schedule 1 to the WCA, Annex 1 of the Birds Directive, Birds of Conservation concern (specifically Red List species) and/or are Priority Species on the SBL and UK BAP and/or the Tayside Local BAP. A justification for the species evaluations is also provided.

4.4.3 In view of the proportion of respective Scottish populations to those recorded, the study area is considered to be of *Local Value* for breeding Eurasian curlew, northern lapwing, sky lark *Alauda arvensis,* lesser redpoll *Carduelis cabaret,* meadow pipit *Anthus pratensis,* northern wheatear *Oenanthe oenanthe,* whinchat *Saxicola rubetra* and common raven *Corvus corax.* Given the potential adverse impacts on wader species of the proposed wind farm, this group is discussed below.

4.4.4 The remainder of breeding birds listed in Table 5 above are common and widespread species which have been recorded in relatively low numbers. The study area is considered to be of *Negligible Value* for these species.

4.5 Waders

4.5.1 Eurasian curlew and northern lapwing were recorded as breeding on the wind farm site (see Figure 3 in Appendix A.2 for distribution of breeding waders).

Eurasian Curlew

4.5.2 The wader surveys recorded the presence of a single pair of Eurasian curlew within the study area. A single flight of curlew was recorded across the summer flight activity surveys (a flight of 35 seconds) but this was outwith the turbine envelope.

4.5.3 Eurasian curlew is a widespread breeding resident in Scotland with a breeding population of approximately 58,800 pairs (Forrester *et al.*, 2007; 16-27% of the European breeding population). The winter population, which also includes immigrants from Fennoscandia, is approximately 85,700 birds. This figure also includes 20% of the East Atlantic Flyway non-breeding population therefore Eurasian curlew is included in the UK Amber List of Birds of Conservation Concern. It is also a species with unfavourable conservation status in Europe (SPEC 2 or 3) and is listed on the SBL List under the categories 'Conservation action needed' and 'Avoid negative impacts'.

4.5.4 Eurasian curlew is a 'target' species in that it is considered to be at risk from onshore wind farms during the breeding season (Table 1a. in SNH, 2006). Local numbers of curlew are not available with the 2nd Bird Atlas (Gibbons *et al.*, 1993) pointing to the local area as being of relatively high 'abundance', with breeding levels in the 3rd or 4th decile. The most recent BTO Bird Atlas (Balmer *et al.*, 2013) does not point to any significant change in the population. Thus, given the presence of 1 pair of curlew within the study area (i.e. less than 0.002% of the Scottish population), the study area is considered as being of *Local Value* for Eurasian curlew.

Northern Lapwing

4.5.5 A single pair of Northern lapwing was recorded in the study area (see Figure 3 in Appendix A.2). No flights were noted during VP watches. In addition, the species is a non-target species (i.e. not listed in Table 1a or Table 1b of SNH guidance SNH, 2006).

4.5.6 Northern Lapwing is a common and widespread resident in Scotland. The Scottish breeding population of 71,500-105,600 pairs represents 52-66% of the UK breeding population (from Forrester *et al.*, 2007). There is evidence of contraction in the breeding range away from the uplands in western mainland Scotland. An estimated 65,000-69,000 birds winter in Scotland. It is included in the UK Amber List of Birds of Conservation Concern due to a moderate (25-49%) decline in the UK breeding population over the last 25 years. Also the UK holds at least 20% of the East Atlantic Flyway non-breeding population. It is also listed on the SBL under the categories 'Conservation action needed' and 'Avoid negative impacts'.

4.5.7 The only data available for 'local' lapwing population are that from the Strathallan Survey Area where 98 pairs were recorded as breeding in 2006 (Perth and Kinross Bird Report 2006). Bird atlas abundance data (Gibbons *et al.*, 1993 & Balmer *et al.*, 2013) point to the local area in the vicinity of the study area as being in the first or second decile i.e. an area of high relative abundance for this species. The presence of a single pair in the study area therefore means the study area is considered as being of *Local Value* for lapwing.

Black Grouse

4.5.8 Forest grouse surveys revealed no black grouse present within the study area (i.e. to 1.5 km of the turbine layout and 750 m of the access track).

4.5.9 There are no known leks reported for the study area and as such the study area is considered to be of *Negligible Value* for black grouse. No effects are predicted and they are not considered further in this assessment.

4.6 Schedule 1/Annex 1 Raptors

Hen harrier

4.6.1 Hen Harrier were not recorded breeding in the study area (i.e.to 2 km of the turbine layout). Three hen harrier flights were recorded on 24 October 2012, almost certainly involving the same adult female bird. The bird was seen for a total of 105 seconds within

the turbine envelope all of which was below potential collision height. No other sightings were recorded.

4.6.2 This is a widespread but scarce breeding species in Scotland. The breeding population is an estimated 505 pairs (Etheridge *et al.*, 2013) with the wintering population in Scotland estimated at 1,050-1,540 birds representing 79% of the UK population, 5-9% of the European population and 2-3% of the species total numbers in the Western Palearctic. It is listed in Annex 1 of the Birds Directive and Schedule 1 of the WCA. It is included in the UK Red List of Birds of Conservation Concern due to the historical decline in the UK during 1800-1995 and it is a species with unfavourable conservation status in Europe (SPEC 2 or 3).

4.6.3 The low level of flight activity over the survey area and the fact that only a single bird was seen flying through in the winter period (no roosting or feeding activities were recorded) suggests that the study site is considered to be of *Local Value* for hen harrier.

Peregrine Falcon

4.6.4 Peregrine falcon were not recorded breeding in the study area (i.e. to 2 km of the turbine layout). Across the course of the 12 months of flight activity survey, five flights of peregrine falcon were recorded over the study area, four of which were below potential collision height:

- 24 October 2012 - two flights for a total of 20 seconds
- 27 August 2013 – two flights (one of 5 seconds, one of 10 seconds).

4.6.5 A single flight at potential collision height was also recorded on:

- 24 July 2013 – single flight at potential collision height for 135 seconds.

4.6.6 In addition, peregrine was recorded over the survey area during the raptor surveys of 2 April, 23 April and 31 May 2013. This species is known to breed in the Ochil Hills.

4.6.7 Peregrine falcon is a scarce but widespread breeding resident in Scotland. The Scottish breeding population is approximately 600 pairs (from Forrester *et al.*, 2007) with 2,000-2,500 individuals present in winter. These figures represent 42% of the UK population and approximately 6% of the European population. It is listed in Annex 1 of the Birds Directive and Schedule 1 of WCA. It is a species with unfavourable conservation status in Europe (SPEC 2 or 3), therefore is included in the UK Amber List of Birds of Conservation Concern.

4.6.8 With regard to the regional level, Knowes Wind Farm would lie within Natural Heritage Zone (NHZ) 16: Eastern lowlands, which has an estimated population of some 65 pairs of peregrine falcon. The latest published Scottish Raptor Study Group figures for 2012 indicate 58 pairs of peregrine breeding in Tayside and Fife region (Etheridge *et al.*, 2013). This would suggest over 180 birds present across the year at the Regional level (120 adult birds and at least a further 60 non-breeding and younger birds)

4.6.9 The level of flight activity for peregrine falcon is considered to be low across the study area with the recorded activity confirming the study area is likely to be within the foraging range of a breeding pair. As such the study site is considered as being of *District Value* for peregrine falcon.

Merlin

4.6.10 Merlin were not recorded breeding in the study area (i.e. to 2 km of the turbine layout). Two merlin flights were recorded during the survey seasons. A single bird (sex unknown) was noted on 27 October 2012 for 30 seconds with a male bird seen for c. 60 seconds

across the survey area on 9 April 2013. Both flights were below potential collision height.

4.6.11 Merlin is included on Schedule 1 of the WCA, Annex I of the Birds Directive and are also included on the Amber List of BoCC (Eaton *at al.* 2009). The wintering population of merlin in Scotland is ca. 3,000 birds (Forrester *et al.* 2007).

4.6.12 The level of flight activity for merlin is considered to be very low and as such the study area is considered as being of *Local Value* for merlin.

Short-eared owl

4.6.13 Short-eared owl were not recorded breeding in the study area (i.e. to 2 km of the turbine layout). Four flights of short-eared owl were recorded during the flight activity surveys: on 9 January 2013 a single bird was seen hunting for c. 150 seconds within the turbine envelope with 3 flights recorded on 13 March 2013, all the latter out with the turbine envelope. In addition, a dead short-eared owl was found within the study area during a BBS survey on the 25 April 2013; the bird had apparently having died of starvation following the late snows of Spring 2013.

4.6.14 Short-eared owl is a resident breeder in Scotland although many move from the breeding areas to separate wintering sites. The Scottish breeding population is estimated at 125-1,250 pairs, which is 77% of the UK breeding population. Continental immigrants augment the winter population, which is given as 300-3,000 individuals. As it is a species with unfavourable conservation status in Europe (SPEC 2 or 3) it is included in the UK Amber List of Birds of Conservation Concern. It is listed on Annex I of the Birds Directive.

4.6.15 The fact that no breeding birds were found during survey work and a maximum of a single bird only was seen in the winter period suggests that the study area is used as a temporary, non-breeding foraging area only. As such the study site is considered as being of *Local Value* for short-eared owl.

4.6.16 No further Schedule 1 or Annex I species of raptor was identified as breeding within the study area or recorded during the flight activity surveys.

4.7 Wintering Wildfowl

4.7.1 Pink-footed geese were recorded as flying over the study area. A total of 4 flights were recorded involving 66 birds. Flights were in the direction north to south (and vice-a-versa). Of these, only one flight, involving a total of 6 birds was recorded as crossing the turbine envelope (see Figure 4 in Appendix A.2) and this flight was above potential collision height.

4.7.2 Pink-footed goose is an abundant passage and winter visitor to Scotland with 100,000-150,000 birds (50% of the world population) wintering with over 200,000 birds present in October. It is included on the UK Amber List of Birds of Conservation Concern due to 50% of the UK non-breeding population being found on ten or less sites. The South Tayside Goose Roosts SPA population is estimated to be above 10,000 birds (a maximum count of 31,800 pink-footed geese is attributed to this SPA) and is taken as the local population most likely to be affected by the proposed wind farm due to its location some 10 km distant. According to Mitchell (2012) "*Dupplin Loch was an important roost from the 1960s and this continued well into the 1990s with 62,000 birds being counted in October 1994, however numbers have declined since that time. Numbers at Carsebreck/Rhynd Loch were generally fewer than 7,000 birds up to 1987/88, after which numbers increased, with a peak of 18,500 in October 1998. Pink-footed Geese were first noted at Drummond Pond in December 1988. Numbers increased to a peak of 7,000 birds in 1996/97, but have subsequently declined.*"

4.7.3 Mitchell (2012) describes the feeding locales as follows: "*The main feeding areas for the Dupplin flocks are in the Earn Valley to the south, Pow Water valley to the north. At times the geese flight south towards Glenfarg, north into Glenalmond. From Carsebreck/Rhynd Loch, birds flight to Strathallan, from Gleneagles to Dunblane, north east into Strathearn and south west into the Forth valley. Birds from Drummond Pond tended to feed on farmland a few kilometres to the south and east. Very few Pink-footed Geese now roost at Drummond Pond (although 630 were counted there in November 2009). The decline in numbers of Pink-footed Geese at Dupplin Loch has been dramatic with very few (often nil) roosting there between 2003 and 2009. However, in the most recent winters, numbers have been variable with 18,500 counted there in November 2009. However, numbers at Carsebreck/Rhynd Loch have remained high, often over 10,000 birds. Counts of between 2,000 and 9,000 birds have been regular at the site in the most recent period. Although large numbers still use Strathearn, there are very few feeding records from the most recent period*". Mitchell does stress however, that "*This area is another example of the feeding distribution of geese in recent years being under represented by a lack of records.*"

4.7.4 Pink-footed goose is a species of International conservation importance as a qualifying interest of the Firth of Tay and Eden Estuary SPA, the Loch Leven SPA and the South Tayside Goose Roosts SPA. However, the proposed wind farm essentially lies out with any major flight lines associated with feeding and roosting geese in the area and this is backed up by there having been only a single flight recorded over the turbine envelope during the flight activity surveys. As such, it is considered that the airspace above the study area should be considered as being of *Local Value* for pink-footed goose given the low number of flights recorded over the study area and the few numbers of birds involved.

4.7.5 Greylag goose is listed as a species of qualifying interest for the Firth of Tay and Eden Estuary SPA and the South Tayside Goose Roost SPA, however, no greylag geese were recorded overflying the site during the flight activity surveys. As such, the study site is considered to be of *Negligible Value* for greylag goose. No effects are predicted and greylag goose is not considered further in this assessment.

Information Gaps

4.7.6 Access for purposes of survey was not restricted across the survey area. As such, it is not considered that there were any information gaps within the study areas that were initially described. However, following an update to the application in September 2013 and the requirement for an access track to the east of the site (from the B934 Dunning-Yetts O'Muckhart road to Knowes Farm) the BBS survey carried out in 2013 did not fully cover the extent of the final application boundary. This area has been covered during the raptor surveys and we believe that there were no species of conservation concern additional to those encountered during the BBS.

5 ASSESSMENT OF PRE-MITIGATED EFFECTS

5.1 Introduction

5.1.1 The following provides an assessment of pre-mitigated effects on ecology and nature conservation, in relation to key project activities.

5.1.2 The main aim of presenting pre-mitigation effects is in order to:

- Define potential significant effects associated with the proposed project; and
- Provide a rational basis for requirement and scale of mitigation measures proposed to minimise residual effects (refer to Section 8).

5.2 Wind farms and their effects on bird life

5.2.1 There is broad agreement that there are three main threats that onshore wind farms pose to populations of breeding and/or wintering birds:

- Direct habitat loss through construction of wind farm infrastructure;
- Displacement through indirect habitat loss and disturbance; and
- Death through collision or interaction with turbine blades.

5.2.2 In addition, there may also be a so-called barrier effect, in which the operational wind farm presents itself as a physical barrier to directional bird flights (e.g. the 'predictable' flights of geese moving from roosts to their feeding grounds) which has to be circumvented.

5.2.3 Direct habitat loss is associated with the construction phase of the wind farm. Displacement and disturbance impacts relate primarily to increased human activities during the construction phase, though displacement effects are also a consideration during the operational lifetime of the wind farm. Collision with turbines is associated with the operational phase of the wind farm as is any possible barrier effect.

5.2.4 An assessment of the effects of wind farms on birds identified species groups were which are at particular risk from the potential risks listed above (see Langston & Pullan 2003). The following sections provide an assessment of pre-mitigated effects on the bird resource of the study area in relation to the potential risk highlighted in Langston & Pullan (2003) together with professional judgement.

5.2.5 The potential threats of displacement from the wind farm and collision risk are mutually exclusive, i.e. birds displaced from the wind farm air space will no longer be at risk of collision. However, for many species the degree of risk of either impact is not fully understood. As such, where both potential risks have been identified in Langston & Pullan (2003) for particular species or species groups both risk have been considered below. The likelihood or significance of risk is discussed in relation to individual species where relevant information is available.

5.3 Construction Phase

5.3.1 Construction effects would largely be restricted to habitat loss and/or change and increased disturbance due to the presence of construction activities and associated traffic and workers. The upgrading and use of access tracks to and from the proposed wind farm as well as the construction of turbine compounds will lead to both habitat loss (of some 3 ha.) and disturbance issues.

Designated Ornithological Sites

Firth of Tay and Eden Estuary SPA

5.3.2 With regards to the effect of construction work on the qualifying features of the Firth of Tay and Eden Estuary SPA, the vantage point surveys and species specific surveys have not confirmed use by any qualifying species within the study area. Therefore it is predicted that there will be no likely significant effect on the SPA, or its qualifying features during the construction phase of the proposed wind farm.

Loch Leven SPA

5.3.3 With regards to the effect of construction work on the qualifying features of the Loch Leven SPA, the vantage point surveys and species specific surveys have not confirmed use by any qualifying species within the study area. Therefore it is predicted that there will be no likely significant effect on the SPA, or its qualifying features during the construction phase of the proposed wind farm.

South Tayside Goose Roost SPA

5.3.4 With regards to the effect of construction work on the qualifying features of the South Tayside Goose Roost SPA, the species specific surveys have not confirmed use by any qualifying species within the study area. Although Eurasian curlew were recorded within the study area, given the separation distance to the SPA, these are not likely to form part of the SPA's breeding population.. No likely significant effect on the SPA, or its qualifying features during the construction phase of the proposed wind farm are predicted..

Inner Tay Estuary SSSI

5.3.5 The Inner Tay SSSI has been fully considered with regards to the impact of construction on its designated bird species as part of the Firth of Tay and Eden Estuary SPA. It is considered that no qualifying species from the SPA were recorded during the surveys. No likely significant effect on the SSSI, or its qualifying features are expected during the construction phase of the proposed wind farm.

Carsebreck and Rhynds Lochs SSSI

5.3.6 The Carsebreck and Rhynds Lochs SSSI has been fully considered with regards to the impact of construction on its designated bird species as part of the South Tayside Goose Roosts SPA. No likely significant effect on the SSSI, or its qualifying features are expected during the construction phase of the proposed wind farm.

Dupplin Lochs SSSI

5.3.7 The Dupplin Lochs SSSI has been fully considered with regards to the impact of construction on its designated bird species as part of the South Tayside Goose Roosts SPA. No likely significant effect on the SSSI, or its qualifying features are expected during the construction phase of the proposed wind farm.

Breeding Birds (Passerines)

5.3.8 It is likely that some breeding bird territories will be lost during the construction phase of the proposed wind farm due to habitat loss. In addition, increased levels of human activity would also be expected to lead to disturbance of species using the study area.

5.3.9 Potential positive effects of wind farm developments have been suggested with regard to species such as sky lark and meadow pipit due to construction producing more openness in the sward structure allowing increased feeding and breeding opportunities (Pearce-

Higgins *et al.*, 2012) – although this effect may have been an anomaly in the data set and should be regarded with caution.

5.3.10 All breeding passerines have been assigned as being of *Local* or *Negligible Value* and none of these species has been identified as being particularly sensitive to wind development impacts, and it is unlikely that disturbance impacts would affect the conservation status of these species in the longer-term. As such, the impact of construction is likely to be *Negligible Negative*, with the significance being at a non-significant *Negligible* level. However, given the general level of protection afforded to wild birds, (see Appendix A.1 for The WCA), timing of works may be constrained.

Value: Local or Negligible Value

Magnitude: Negligible Negative

Significance: Negligible

Waders

Eurasian curlew

5.3.11 It is considered that the foremost threat to Eurasian curlew associated with wind farm developments is that of displacement (see Langston & Pullan, 2003). A study by Pearce-Higgins *et al.* (2009), pointed to effects on breeding Eurasian curlew up to 800 m distant from the edge of wind farms. This study found that there was a reduced breeding density associated with the presence of a wind farm with an increased avoidance up to 800 m away from the turbines. Indeed, it was estimated that there would be a reduction in density of breeding Eurasian curlew of 42.4% within 500 m of the turbine array. Also, more recent work from Pearce-Higgins *et al.* (2012) showed a significant reduction in the numbers of breeding Eurasian curlew following construction of the wind farm site; disturbance through construction activities was thought to be the main factor. In contrast to several other species monitored in the study, Eurasian curlew did not show re-colonisation of the wind farm sites for at least three years following post-construction (Pearce-Higgins *et al.*, 2012).

5.3.12 With regards to the impact of the proposed wind farm, and assuming the effects found by Pearce-Higgins *et al.*, (2009) are applicable, and of a similar order of magnitude, to a generic wind farm development, it is likely that approximately 45% of curlew will be lost at the proposed Development at Knowes due to displacement during construction. This would mean that there would be an estimated reduction from 1 to c. 0.55 pairs breeding on site during construction (equating the "real" loss of 1 pair).

5.3.13 The district and local populations of Eurasian curlew are not known but the loss of 0.45 breeding pairs (equating the "real" loss of 1 pair) would equate to c. 0.001% of the Scottish breeding population. At the *Local Value* population evaluation it is considered that displacement effects due to construction would be of a *Low Negative* impact on the receptor, with the effects of construction producing a *Negligible*, non-significant impact.

Value: Local Value

Magnitude: Low Negative

Significance: Negligible

Northern Lapwing

5.3.14 Northern lapwing is a wader species thought to be least detrimentally affected by wind farms (Pearce-Higgins *et al.*, 2012) and is classed in the same group as other waders associated with short vegetation.

5.3.15 It is unclear as to whether the single pair of Northern lapwing within the study area will be affected by the construction phase of the proposed wind farm but the c. 400 m separation distance from any wind farm construction is considered sufficient to buffer ny potential impacts. It is likely that sufficient suitable breeding habitat will remain during the construction phase across the study area and its immediate environs that would largely negate any potential impact. Construction will have no significant effect on the local population and as such should be regarded as being of *Negligible* significance (*Local Value* population with *Negligible Negative* impact).

Value: Local Value

Magnitude: Negligible

Significance: Negligible

Schedule 1/Annex 1 Raptors

Hen harrier

5.3.16 Madders and Whitfield (2006) identified hen harrier as having a low to medium sensitivity to displacement from wind farms. Construction and human activities can cause abandonment of hen harrier nests and roosts; wind farm construction displacement has been suggested to occur up to 500 m around construction sites (Bright et al., 2006).

5.3.17 Given that there was only a single sighting in the winter period and none in the summer period it is considered that the magnitude of impact of the construction on hen harrier will be *Negligible Negative* with the significance of these effects at a *Negligible*, non-significant level.

Value: Local Value

Magnitude: Negligible Negative

Significance: Negligible

Peregrine Falcon

5.3.18 Madders and Whitfield (2006) identified foraging peregrine falcon as having a low sensitivity to displacement from wind farms, i.e. there was no reported evidence of any displacement effects caused by disturbance. However, it is acknowledged that this is based on a low number of studies.

5.3.19 Notwithstanding the uncertainty regarding displacement of foraging peregrine falcon, in general most research tends to show that displacement of foraging raptors from wind farms due to disturbance is not significant (Ruddock & Whitfield, 2007). Given the lack of evidence to support displacement of foraging raptors and also the generally low level of flights recorded from the area (5 flights in total) it is considered that the construction phase of the proposed wind farm would be unlikely to represent a significant impact on the local population.

5.3.20 As such the construction phase is considered to represent an impact with a *Negligible* value and therefore a *Negligible* non-significant impact.

Value: District Value

Magnitude: Negligible

Significance: Negligible

Merlin

5.3.21 Merlin have been assessed as being low to moderately sensitive to disturbance, with considerable inter-individual variation. A recommended disturbance distance of 200-400 m has been proposed by Currie and Elliott (1997) for forestry workers.

5.3.22 As for peregrine falcon, the lack of evidence to support displacement of foraging raptors and low level of flights recorded in the study area (2 flights in total) it is considered that the construction phase of the proposed wind farm would be unlikely to represent a significant impact on the local population.

5.3.23 The construction phase threat to the *Local Value* receptor population of merlin during the construction phase is considered to be *Negligible* given the low level of activity and as such the significance of impact of the proposed wind farm is also *Negligible* for the species

Value: Local Value

Magnitude: Negligible

Significance: Negligible

Short-eared owl

5.3.24 Recommended safe working distances for short-eared owl have been suggested of from 100 m to 600 m for forestry workers (in Ruddock and Whitfield, 2007).

5.3.25 With a maximum of 1 bird present in the study area during the early winter and late winter/spring periods, the study area is considered as being of *Local Value.* Since short-eared owl is a non-breeding species with regard to the proposed wind farm, it is considered that although foraging birds may be displaced by construction works, suitable alternative foraging habitat exists across the study area and immediate environs that would largely negate this impact. As such, any impacts are considered as having a *Low Negative* impact with a non-significant *Negligible* significance of effect.

Value: Local Value

Magnitude: Low Negative

Significance: Negligible

Wintering Wildfowl

Pink-footed goose

5.3.26 Pink-footed goose is the only species of SPA-qualifying wildfowl (for all SPAs identified in the wind farm study area) to have been recorded within the study site during the surveys, although these were only of flying geese – see Operational Phase impacts assessed below.

5.3.27 Langston & Pullan (2003) identified several studies that have shown that pink-footed goose is sensitive to impacts caused by anthrogenic disturbance, including construction activities.

5.3.28 However, since no pink-footed geese were recorded as feeding and/or roosting within the study area during survey the impact of construction would be at a *Negligible Negative*

level and as such the magnitude of the impact on the *District Value* population would be of a *Negligible* level, i.e. there will be a non-significant impact only.

Value: Local Value

Magnitude: Negligible Negative

Significance: Negligible

5.4 Operational Phase

5.4.1 An assessment of collision risk with turbines for those species recorded as being present in the study area and also having been identified as being at risk from collision with onshore wind farms (Langston & Pullan, 2003) is presented in the following sections.

5.4.2 The collision analysis followed the methods given in Band *et al.* (2007). Technical Appendix 5 provides details of the collision analysis methods and the results of the analyses.

5.4.3 Following SNH guidelines (SNH, 2005), collision assessment for residency periods were analysed for all species recorded within the study area that are listed in Tables 1a and 1b of SNH guidance as being species at risk of impacts from onshore wind farms (SNH, 2006).

5.4.4 Consideration of barrier effects due to the presence of the operational wind farm are also considered for all species.

Designated Sites

Firth of Tay and Eden Estuary SPA

5.4.5 The only SPA qualifying species recorded during the surveys completed for this assessment were overflying pink-footed geese – see below for an assessment of operational effects on this species.

5.4.6 In summary, with regards to potential effects of the operation of the wind farm on the Firth of Tay and Eden Estuary SPA full consideration has been given to both collision and the presence of the wind farm as a barrier. Potential effects of impacts are predicted to be non-significant in both cases. Therefore, it is considered that the proposed wind farm would not have an adverse effect on site integrity with regards to its qualifying features.

Loch Leven SPA

5.4.7 The only SPA qualifying species recorded during the surveys completed for this assessment were overflying pink-footed geese – see below for an assessment of operational effects on this species.

5.4.8 In summary, with regards to potential effects of the operation of the wind farm on the Loch Leven SPA full consideration has been given to both collision and the presence of the wind farm as a barrier. Potential effects of impacts are predicted to be non-significant in both cases. Therefore, it is considered that the proposed wind farm would not have an adverse effect on site integrity with regards to its qualifying features.

South Tayside Goose Roost SPA

5.4.9 With regards to potential effects of the operation of the wind farm on the South Tayside Goose Roost SPA full consideration has been given to both collision and the presence of the wind farm as a barrier. Potential effects of impacts are predicted to be non-significant. Therefore, it is considered that the proposed wind farm would not have an adverse effect on site integrity with regards to its qualifying features.

Inner Tay Estuary SSSI

5.4.10 The Inner Tay SSSI has been fully considered with regards to the impact of wind farm operation on its designated bird species as part of the Firth of Tay and Eden Estuary SPA. No likely significant effects on the SSSI, or species for which it is designated are expected during the operational phase of the proposed wind farm.

Carsebreck and Rhynds Lochs SSSI

5.4.11 The Carsebreck and Rhynds Lochs SSSI has been fully considered with regards to the impact of wind farm operation on its designated bird species as part of the South Tayside Goose Roosts SPA. No likely significant effects on the SSSI, or species for which it is designated are expected during the operational phase of the proposed wind farm.

Dupplin Lochs SSSI

5.4.12 The Dupplin Lochs SSSI has been fully considered with regards to the impact of wind farm operation on its designated bird species as part of the South Tayside Goose Roosts SPA. No likely significant effects on the SSSI, or species for which it is designated are expected during the operational phase of the proposed wind farm.

Breeding Birds (Passerines)

5.4.13 Although collisions of passerines and non-target non-passerine species almost certainly do occur these are unlikely to be associated with significant effects, and no modelling has been carried out in accordance with SNH guidance.

5.4.14 As stated above, the operational phase of the wind farm may have positive effects on ground nesting species such as sky lark and meadow pipit (Pearce-Higgins *et al.*, 2012). Coupled with the fact that all breeding passerines have been assigned as being of *Local* or *Negligible Value* and none of these species has been identified as being particularly sensitive to wind development impacts, the impact of the operational phase is considered to be *Negligible Negative*, with the significance being at a non-significant, *Negligible* level.

Value: Local to Negligible Value

Magnitude: Negligible

Significance: Negligible

Waders

5.4.15 No wader flights were recorded during the flight activity surveys. As such, any impacts on wader species (notably Northern lapwing and Eurasian curlew) during the operational phase are considered to be *Negligible Negative*, with the significance being at a non-significant, *Negligible* level.

Value: Local Value

Magnitude: Negligible Negative

Significance: Negligible

Schedule 1/Annex 1 Raptors

Hen Harrier

5.4.16 Two hen harrier flights were recorded on 24 October 2012, almost certainly involving the same adult female bird. The bird was seen for a total of 105 seconds all of which was

below potential collision height. From the recorded flights it is predicted that there will be no collisions during the residency period(s).

5.4.17 Foraging hen harriers have a low sensitivity to disturbance at operational wind farms and if displacement of foraging does occur then it will likely be limited to within 100 m of wind turbines (Whitfield & Madders, 2006).

5.4.18 Given that the recorded hen harrier flight activity involved only two flights by the presumed same bird, it is considered that there would be no barrier impacts on this species as a result of the wind farm.

5.4.19 It is considered that there is *Negligible risk* of impact on the *Local Value* of the study area to the local and district populations given that no collisions are predicted from the observed flight activity and that harriers show low sensitivity to disturbance at wind farms.

Value: Local Value

Magnitude: Negligible

Significance: Negligible

Peregrine Falcon

5.4.20 Across the course of the 12 months of flight activity survey, five flights of peregrine falcon were recorded over the study area, four of which were below potential collision height:

- 24 October 2012 - two flights for a total of 20 seconds
- 27 August 2013 – two flights (one of 5 seconds, one of 10 seconds).

5.4.21 A single flight at potential collision height was also recorded on:

- 24 July 2013 – single flight at potential collision height for 135 seconds.

5.4.22 Given that there are no regular flights of peregrine falcon within the survey area, it is considered that there would be no barrier impacts on this species as a result of the wind farm.

5.4.23 A collision risk analysis was carried out for peregrine falcon using the year round observation period (birds being assessed as resident during both the summer and winter seasons). From this it is estimated that between 0.087 and 0.105 peregrines will collide with the turbines each year, i.e. approximately 1 peregrine falcon collision every 10 to 12 years (see Table 18 in Appendix A.6). This number equates to, at most, 0.00875% of the Scottish population of over 1200 peregrine falcon (i.e. over 600 pairs, Forrester *et al.*, 2007).

5.4.24 The most reliable estimate of a regional or local population of breeding peregrine within Tayside comes from the Scottish Raptor Study Group (e.g. RSG report 2011). This gives a total of 59 pairs of peregrine within the Region of Tayside and Fife (i.e. at least 118 adult birds augmented by more than 60 fledglings per year – there were 75 fledged young in 2011). The predicted maximum mortality rate of 0.105 birds per year would lead to an impact in the order of 0.058% on the Regional population (of ca. 180 birds) and is unlikely to have a significant impact on the *District Value* population when compared to annual natural mortality rates within the population of between 70% (in 1st year birds) and 25% in subsequent years (Cramp and Simmons *eds.*, 1980) and as such the impact is considered to be a non-significant *Minor* effect.

Value: District Value

Magnitude: Low Negative

Significance: Minor

Merlin

5.4.25 Two merlin flights were recorded during the survey seasons. A single bird was noted on 27 October 2012 for 30 seconds with a male bird seen for ca. 60 seconds across the survey area on 9 April 2013. Neither flight was estimated to be at potential collision height and therefore no collisions are predicted during the residency period(s).

5.4.26 Given the low numbers of flights recorded, it is considered that there would be no barrier impacts on this species as a result of the wind farm.

5.4.27 The threat to the *Local Value* receptor population of merlin from collision is considered to be *Negligible* given that no collisions are predicted from the observed flight activity and as such the significance of impact of the proposed wind farm is also *Negligible* for the species.

Value: Local Value

Magnitude: Negligible

Significance: Negligible

Short-eared owl

5.4.28 A single short-eared owl flight was recorded during the VP surveys: on 9 January 2013 a single bird was seen hunting for ca. 150 seconds within the turbine envelope. All the flight was below potential collision height, and therefore there would be a predicted no collisions of short-eared owl during their residency period.

5.4.29 The recording of a single flight only, would suggest that there would be no barrier impacts on this species as a result of the wind farm.

5.4.30 The threat to the *Local Value* receptor population of short-eared owls from collision is considered to be *Negligible* given that no collisions are predicted from the observed flight activity and as such the significance of impact of the proposed wind farm is also *Negligible* for the species.

Value: Local Value

Magnitude: Negligible

Significance: Negligible

Wintering Wildfowl

Pink-footed Goose

5.4.31 A single flight of pink-footed geese was recorded on 19 September 2012 that intersected the turbine envelope. Six geese flew above potential collision height, with the flight lasting a total of 70 seconds. From these observations, it is predicted that there will not be any collisions during the residency period.

5.4.32 Langston & Pullan (2003) identified several studies that have shown that pink-footed goose is sensitive to impacts of disturbance and/or displacement so that there is a reduction in use or absence of birds up to 600 m from turbines.

5.4.33 An additional effect during the operational phase of the wind farm is a possible barrier effect. The presence of a wind farm may act as an obstacle to the movement of species

such as geese commuting from roosting to foraging sites or at least increase the energetic costs involved in such movements. Simms *et al.*, (2013) showed that geese tend to avoid offshore wind farms, performing height and horizontal avoidance behaviour to circumvent having to pass over the turbine area. Since only a single flight of 6 pink-footed geese was recorded over the turbine envelope (and above potential collision height), it is unlikely, therefore, that the use of commuting or migrating geese will be affected to any detrimental level with regards to the wind farm as a barrier.

5.4.34 The impact of the operational phase would be of a *Negligible* level to pink-footed goose given that no collisions are predicted from the observed flight activity and no birds were seen using the study area. As such the magnitude of the impact on the *District Value* population would be at a *Negligible* level, i.e. there will be a non-significant impact only.

Value: District Value

Magnitude: Negligible

Significance: Negligible

5.5 Decommissioning Phase

5.5.1 Decommissioning impacts are not comprehensively considered at this stage. There is an anticipated time lag of at least 25 years before decommissioning occurs and the use of the proposed wind farm site and surrounding area by birds could change substantially over time, due for example to climate change or other factors. Therefore, survey in order to inform on assessment of decommissioning effects will be undertaken at an appropriate stage and involving an appropriate suite of ornithological receptors.

5.5.2 In summary, it is likely that similar levels of disturbance will be present during the decommissioning phase as reported for the construction phase of the project and could therefore lead to the displacement of foraging and breeding birds at the time of works. However, habitat re-instatement will take place which may reverse some of the habitat losses during construction.

5.5.3 Positive effects of decommissioning are predictable for collision and barrier effects once the turbines have been removed. The effect of decommissioning works on designated ornithological sites is expected to be non-significant, based on the continuation of base-line use of the study site by qualifying species.

5.5.4 However, further surveys will be completed to ensure any predicted decommissioning effects are mitigated (where possible) to ensure no significant effects on birds.

6 CUMULATIVE EFFECTS

6.1.1 Cumulative impacts are defined as the 'additional changes caused by a proposed development in conjunction with other similar developments or as the combined effect of a set of developments, taken together' (SNH, 2012). There may be cumulative impacts of wind farms on flora and fauna, with the greatest theoretical risk being of significant impacts arising on species and habitats of national or international importance resulting from a number of wind farms being present in a relatively small area. Current guidance suggests that the highest priority for cumulative impact assessment is for species and habitats that are declining and/or not in favourable conservation status and that species and habitats of very high conservation importance or those vulnerable to wind farms may be targeted for cumulative assessments (SNH, 2005).

6.1.2 Given the evaluation of peregrine falcon (District Value) and its presence across the study area during survey work, a cumulative impact assessment is considered appropriate. No population data could be found for peregrine falcon at the District Value

level, therefore the potential impact was assessed at the Regional level (for which population data are available) across Tayside and Fife, and thus, wind farms within this region have been used in the assessment.

6.1.3 Table 6 presents the data for peregrine falcon collision rates accrued from the environmental statements obtained for Tayside and Fife. The online planning portals of the relevant planning authorities was the key source used to obtain the data.

6.1.4 Due to the paucity of sightings and a lack of collision modelling carried out on available data (as assessed following the evaluation of Environmental Statements obtained via local council portals e.g. Perth & Kinross renewable energy proposals) no cumulative assessment was made.

6.1.5 It is deemed that the non-significant effect that was found for the proposed Knowes Wind Farm on peregrine falcon (a maximum of 1 bird colliding with the turbines per 10 years of operation) would not add significantly to any survival impact on the district population of this species.

Table 6: Wind Farm Schemes in Tayside and Fife (i.e. at Regional level)

Wind Farm Name	County	Planning Status	Number of turbines	Hub height (m)	Total height (m)	Predicted peregrine falcon collisions
Arkhill	Angus	Operational	8	Unknown	81	Peregrine not recorded
Davidston Farm, Newtyle	Angus	Pending consideration	1		62	Peregrine not recorded
Frawney	Angus	Application	5	Unknown	80	2 flights recorded above PCH
Henderston Quarry, Newtyle	Angus	Application	1	Unknown	66	Unknown
New Downie Farm, Carnoustie	Angus	Application	1	Unknown	54	Peregrine not recorded
Tealing – Airfield	Angus	Approved/Installed	1	Unknown	93.5	Unknown
West Mains Farm	Angus	Approved	1	Unknown	61	Unknown
Michelin Tyres Plc.	Dundee City	Operational	2	Unknown	120.5	Unknown
Devon Wood	Fife	Application	7	80	121	Peregrine analysed for collision risk modelling (CRM) but no assessment available
Dundee Port	Dundee City	Scoping	2	Unknown	127	Unknown
Drums Farm	Fife	Application	3	39	48	Peregrine not recorded
Earlseat Farm	Fife	Approved	8	Unknown	120	Not recorded
Kedlock Farm, Cupar	Fife	Approved	3	Unknown	20	Unknown
Kenly Wind Farm	Fife	Under appeal	6	Unknown	100	Unknown
Lingo Farm	Fife	Application	5	Unknown	100	3 flights recorded No CRM carried out
Lumbennie Hill	Fife	Approved	1	Unknown	84	Not recorded
Pitillock House	Fife	Approved	3	Unknown	15	Unknown
Scotscraig Mains	Fife	Approved	3	Unknown	20	Unknown
Troywood	Fife	Application	1	Unknown	100	Unknown

West Friarton	Fife	Approved	3	Unknown	20	Unknown
Westfield Wind Farm	Fife	Operational	5	Unknown	110	Unknown
Bonerbo wind farm	Fife	Application	3	Unknown	67	Unknown
Wester Kilmany	Fife	Approved	1	Unknown	87	Peregrine not recorded
Burnfoot	Perth & Kinross	Operational	13	Unknown	102	1 peregrine recorded No CRM carried out
East Blair Farm, Glenfarg	Perth & Kinross	Under consideration	2	Unknown	64	Unknown
Greenknowes	Perth & Kinross	Operational	18	Unknown	93	Unknown
Griffin	Perth & Kinross	Operational	68	Unknown	124	Peregrine recorded No CRM recorded as being carried out
Calliacher	Perth & Kinross	Approved	14	Unknown	109.8	12 sightings of over-flying birds; no CRM carried out
Drumderg	Perth & Kinross	Operational	16	Unknown	108	Unknown
East Camno, Meigle	Perth & Kinross	Approved	1	Unknown	67	Unknown
Easter Fordell Farm, Glenfarg	Perth & Kinross	Screening	1	Unknown	99	Unknown
Ferns Cloquhat	Perth & Kinross	Approved	3	Unknown	84	Unknown
Lochelbank	Perth & Kinross	Operational	12	60	91	Unknown
Newmiln Wind Farm	Perth & Kinross	Scoping	4	Unknown	Unknown	Unknown
Temple Hill, Glenfarg	Perth & Kinross	Under consideration	1	Unknown	84	Peregrine not recorded
Welton of Creuchies	Perth & Kinross	Approved	4	Unknown	99.5	1 observation of 30 sec. No CRM carried out

6.2 Summary

6.2.1 Table 7 provides a summary of the pre-mitigated assessment of impacts on ornithology.

Table 7: Summary of pre-mitigated effects.

Receptor	Value	Impact Magnitude	Impact Significance
Construction impacts			
Eurasian curlew	Local	Negligible	Negligible
Peregrine falcon	District	Negligible	Negligible
Hen harrier	Local	Negligible	Negligible
Short-eared owl	Local	Negligible	Negligible
Pink-footed goose	Local	Negligible	Negligible
Operational impacts			
Eurasian curlew	Local	Negligible	Negligible
Peregrine falcon	District	Low Negative	Minor
Hen harrier	Local	Negligible	Negligible
Short-eared owl	Local	Negligible	Negligible
Pink-footed goose	Local	Negligible	Negligible

7 MITIGATION

7.1.1 There are no significant impacts predicted with respect to the bird assemblage present across the study areas.

7.1.2 The proposed proposed wind farm would see a short-term increase in human presence, machinery and the introduction of construction activities to the area which may cause disturbance to breeding waders and a suite of common passerines. These works, if undertaken during the breeding season (from March to July inclusive), may result in the disturbance to breeding birds causing abandonment of nests and/or potential killing/injury to wild birds.

7.1.3 All wild birds are protected by law under the WCA: It is an offence to:

- Kill or injure any wild bird;
- Capture or keep (dead or alive) any wild bird;
- Destroy or take the eggs of any wild bird;
- Sell or advertise for sale any wild bird or its eggs; and
- Destroy, damage, interfere with, take or obstruct the use of the nest of any wild birds while it is in use or being built.

7.1.4 This legislation means that birds are fully protected in Scotland, and that any planned activity, which may affect them, requires careful consideration to ensure both compliance and that no significant impact is produced on sites with important breeding assemblages.

7.1.5 In order to ensure legal compliance with breeding birds, construction activity on site should be confined to the non-breeding season (from end July to early March) where possible. Any construction activity undertaken during the breeding bird season should be

subject to a bird survey completed by an experienced ecologist, in order to confirm presence/absence of nesting birds. Should active nest sites be present suitable stand-off zones will be required to allow birds access to nest sites. Construction stand-offs from nest sites vary depending on the species present and their stage in the breeding cycle, and should be agreed with SNH.

8 ASSESSMENT OF POST-MITIGATED EFFECTS

8.1.1 Table 8 below provides a summary of post-mitigated effects for the proposed wind farm, confirming that there will be no significant impacts on birds.

Table 8: Summary of post-mitigated effects

Receptor	Value	Impact Magnitude	Impact Significance
Construction impacts			
Eurasian curlew	Local	Negligible	Negligible
Peregrine falcon	District	Negligible	Negligible
Hen harrier	Local	Negligible	Negligible
Short-eared owl	Local	Negligible	Negligible
Pink-footed goose	Local	Negligible	Negligible
Operational impacts			
Eurasian curlew	Local	Negligible	Negligible
Peregrine falcon	District	Low Negative	Minor
Hen harrier	Local	Negligible	Negligible
Short-eared owl	Local	Negligible	Negligible
Pink-footed goose	Local	Negligible	Negligible

9 STATEMENT OF SIGNIFICANCE

9.1.1 The proposed wind farm supports a range of bird species that would be expected from a site on the upland fringes of the Scottish Highlands, with both moorland and lowland farmed habitats.

9.1.2 A single Eurasian curlew pair was assessed as breeding within the study area and as such the proposed wind farm was assessed as being of Local value for the species. No significant effect of the proposed wind farm was expected on the population, however.

9.1.3 The study area was assessed as being of District Value for peregrine falcon, with five flights being recorded across the year's survey. No significant impact was expected of the proposed wind farm on this species.

9.1.4 Pink-footed goose, a qualifying species for the Firth of Tay and Eden Estuary, Loch Leven and South Tayside Goose Roost SPAs, has been recorded overflying the proposed proposed wind farm. Only a single flight was recorded over the wind farm study area and this was above collision height with the study area unlikely to provide potential feeding areas. No significant impacts during the operation of the wind farm are predicted for the SPA populations of birds. Therefore, it is considered that the proposed wind farm would not have an adverse effect on site integrity with regards to its qualifying features.

9.1.5 Flight data were also recorded for short-eared owl, hen harrier, and merlin within the study area. No significant impacts as a consequence of the proposed wind farm are predicted for any of these species – all flights being recorded at below potential collision height.

9.1.6 Cumulative assessment was undertaken for peregrine falcon, which also pointed to non-significant impacts for this species, although data deficiency from other wind farm sites was identified as being an important factor in the assessment.

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APPENDICES

A.1 Policy & Guidance

The Environmental Impact Assessment (Scotland) Regulations 1999

A.1.1 The Regulations implement Council Directive No. 85/337/EEC (now amended by Directive 97/11/EC 14 March 1999) on the assessment of the effects of certain public and private projects on the environment.

A.1.2 The Directive's main aim is to ensure that the authority giving the primary consent for a particular project makes its decision in the knowledge of any likely significant effects on the environment. The Directive therefore sets out a procedure that must be followed for certain types of project before they can be given 'development consent'. This procedure - known as Environmental Impact Assessment (EIA) - is a means of drawing together, in a systematic way, an assessment of a project's likely significant environmental effects. This helps to ensure that the importance of the predicted effects, and the scope for reducing them, are properly understood by the public and the relevant competent authority before it makes its decision.

Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (The Birds Directive)

A.1.3 The Birds Directive was originally adopted by the EC in 1979 in response to the Bern Convention. The European Union now meets its obligations for bird species under the Bern Convention and Bonn Convention and more generally by means of Directive 2009/147/EC (Birds Directive)on the conservation of wild birds (the codified version of Council Directive 79/409/EEC as amended).

A.1.4 The birds Directive provides for the protection, management and control of all species of naturally occurring wild birds in the European territory of Member States. In particular it requires Member States to identify areas to be given special protection for the rare or vulnerable species listed in Annex I (Article 4.1) and for regularly occurring migratory species (Article 4.2) and for the protection of wetlands, especially wetlands of international importance. These areas are known as Special Protection Areas (SPAs).

A.1.5 The Birds Directive is implemented in the UK through the Wildlife and Countryside Act 1981 (as amended) and The Habitats Regulations.

The Conservation (Natural Habitats & c) Regulations 1994 (The Habitats Regulations)

A.1.6 The Conservation (Natural Habitats, &c.) Regulations 1994 as amended apply to European Sites. Where reserved matters (within the meaning of Schedule 5 of the Scotland Act 1998) are concerned, certain provisions of the Conservation of Habitats and Species Regulations 2010 as amended apply instead. Both sets of regulations require an equivalent process in relation to the assessment of plans and projects with the potential to affect European sites, including SPAs.

A.1.7 The requirements are summarised in Circular 6/1995 as amended June 2000 and include, at paragraph 12, "The Regulations require that, where an authority concludes that a development proposal unconnected with the nature conservation management of a Natura 2000 site (which includes SPAs) is likely to have a significant effect on that site, it must undertake an appropriate assessment of the implications for the conservation interests for which the area has been designated."

A.1.8 The need for appropriate assessment extends to plans or projects outwith the boundary of the site in order to determine their implications for the interest protected within the site.

A.1.9 Under regulation 48 of the 1994 Habitats Regulations (or regulation 61 of the 2010 Regulations in respect of reserved matters), this means that the competent authority has a duty to:

- determine whether the proposal is directly connected with or necessary to site management for conservation; and, if not,
- determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects; and, if so, then
- make an appropriate assessment of the implications (of the proposal) for the site in view of that site's conservation objectives.

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)

A.1.10 The Convention's Contracting Parties (including the UK) have assumed a wide range of related obligations covering all aspects of wetland conservation, the implementation of which is facilitated under three main branches of activity: the designation of wetlands of international importance as Ramsar sites; the promotion of the wise-use of all wetlands in the territory of each country; and international co-operation with other countries to further the wise-use of wetlands and their resources.

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

A.1.11 The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS) came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix 1 of the Convention) and concluding multilateral agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix 2 of the Convention).

Wildlife and Countryside Act 1981 / The Nature Conservation (Scotland) Act 2004

A.1.12 The Act provides enhanced statutory protection to rare breeding birds listed under Schedule 1. It is an offence to disturb a Schedule 1 species while it is building a nest or is in, on or near a nest containing eggs or young. In addition, this Act also provides general protection to any wild bird and their nest and eggs. It should be noted that this may affect the timing of works that can be carried out on site.

A.1.13 The Act also provides for the notification of Sites of Special Scientific Interest (SSSIs) – areas of special scientific interest by reason of their flora, fauna, or geological or physiographical features – by the country agencies. The Act also contains measures for the protection and management of SSSIs. The undertaking of agricultural or forestry operations on land within National Parks which has been either moor or heath for 20 years, without consent from the relevant planning authority is also prohibited by the Act.

The UK Biodiversity Action Plan 2007

A.1.14 The following account is taken from the Joint Nature Conservation Committee webpage: http://jncc.defra.gov.uk/page-5155

A.1.15 The UK Biodiversity Action Plan (UK BAP) was published back in 1994, and was the UK Government's response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro.

A.1.16 Following the creation of the UK BAP, devolution, in 1998, led the four countries of the UK (England, Northern Ireland, Scotland and Wales) to develop their own country strategies for biodiversity and the environment, allowing conservation approaches to differ according to the different environments and priorities within the countries. In 2007, however, a shared vision for UK biodiversity conservation was adopted by the devolved administrations and the UK government, and is described in 'Conserving Biodiversity – the UK Approach'.

A.1.17 The 'UK Post-2010 Biodiversity Framework' now (July 2012) succeeds the UK BAP and 'Conserving Biodiversity – the UK Approach', and is the result of a change in strategic thinking following the publication of the CBD's 'Strategic Plan for Biodiversity 2011–2020' and its 20 'Aichi targets', at Nagoya, Japan in October 2010, and the launch of the new EU Biodiversity Strategy (EUBS) in May 2011. The framework demonstrates how the work of the four countries and the UK contributes to achieving the 'Aichi targets', and identifies the activities required to complement the country biodiversity strategies in achieving the targets.

The Scottish Biodiversity List

A.1.18 The following account is taken from the Scottish Biodiversity Forum webpage: www.biodiversityscotland.gov.uk/advice-and-resources/scottish-biodiversity-list/

A.1.19 The Scottish Biodiversity List is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland.

A.1.20 The purpose of the list is to help public bodies carry out their Biodiversity Duty by identifying the species and habitats which are the highest priority for biodiversity conservation in Scotland. It is also a useful source of information for anyone interested in nature conservation in Scotland.

A.1.21 Four categories of action have been defined

- Conservation action needed
- Avoid negative impacts
- Watching brief only; and
- Communicating with the public

A.1.22 In terms of resource, only the first three categories have been considered. Definitions of these categories and their implications are as follows:

Conservation action needed

A.1.23 These include species in Scotland in most urgent need of conservation action. These species fall into two categories:

- Significant decline in Scotland; and
- Rare or restricted distribution and under threat

A.1.24 As recommendations, it is suggested that '*managers of public land, buildings and transport infrastructure should look for opportunities to enhance these habitats and species on their land*'. Also, '*planners and developers should look for opportunities to make space for biodiversity in development through specific species targeted work or by creating open space habitats that link to local habitat networks*'.

Avoid negative impacts

A.1.25 Regulatory authorities need to give particular consideration to avoiding significant negative impacts to these habitats and species. These habitats and species fall into three categories:

- International obligations - protected species or habitats
- Rare or restricted distribution, and/or
- Significant decline in Scotland

A.1.26 Species and habitats protected by law. These are European Protected Species and European habitats and species covered by the Environmental Liability Directive. Statutory requirements and procedures are in place to protect these habitats and species from adverse impacts of development.

A.1.27 Rare or restricted distribution. Particular consideration should be given to avoiding significant negative impacts at locations where species occurs. Often these species will be well known about and protected by Sites of Special Scientific Interest or given specific protection under the Wildlife and Countryside Act. Occasionally rare species occur without specific protection and consideration should be given to raising their profile within the local planning process by giving their sites Local Nature Conservation Site (LNCS) status.

A.1.28 Significant decline in Scotland. Consideration should be given to avoiding significant negative impacts at locations where these species and habitats occur. Many of these habitats and are widespread in Scotland and their decline is linked to land use change and habitat fragmentation over the last 60 years. Planners and developers can help to reverse this trend by looking for opportunities to make space for biodiversity in development and help to enhance habitat networks and green networks where ever possible

Watching brief only

A.1.29 There is less concern for these habitats and species, which only require monitoring for now. These habitats and species fall into two categories:

- On the UK BAP list but not considered to be at particular risk in Scotland; and
- Species with international obligations not picked up in the other two categories for action.

A.1.30 On the UK BAP list. Not all of the habitats and species that are on the UKBAP list are under threat in Scotland. Some are on the list because they are declining, rare or threatened in other parts of the UK. Where widespread species are increasing or stable or habitats are thought to be in generally good condition in Scotland, they have been included in this category.

A.2 Figures

A.3 Survey Results

Vantage point watch data

A.3.1 Table 9 describes the number of hours watched per VP during both summer and winter periods.

A.3.2 Table 10 describes the weather conditions during VP watches in the summer and winter periods respectively.

Table 9. Hours watched per VP during summer and winter periods at Knowes Wind Farm.

	Summer period (h)	Winter period (h)
VP 1	39	36

Table 10. Weather data for Vantage Point (VP) watches at Knowes Wind Farm

VP	Day	Month	Year	Watch Period	Watch Start	Watch Hour	Wind Speed	Wind direction	Precipitation	Cloud Cover (%)	Cloud Base (m)	Temp (°C)	Snow cover (%)	Visibility km
1	19	9	2012	Dawn	0658	1	1-3	W	Nil	50	>500	5	0	>2
1	19	9	2012	Dawn	0758	2	1-2	W	Nil	10	>500	8	0	>2
1	19	9	2012	Dawn	0858	3	1-2	W	Nil	10	>500	9	0	>2
1	19	9	2012	Day	1028	1	1-2	WSW	Nil	20	>500	12	0	>2
1	19	9	2012	Day	1128	2	1-2	WSW	Nil	75	>500	13	0	>2
1	19	9	2012	Day	1228	3	1-2	W	Nil	50	>500	14	0	>2
1	26	9	2012	Dusk	1600	1	1-2	ENE	Nil	75	>500	12	0	>2
1	26	9	2012	Dusk	1700	2	1-0	ENE	Nil	50	>500	11	0	>2
1	26	9	2012	Dusk	1800	3	0	-	Nil	90	>500	7	0	>2
1	24	10	2012	Day	1128	1	0	-	Nil	95	400	11	0	1 - 2
1	24	10	2012	Day	1228	2	0-1	NE	Nil	95	500	11	0	2
1	24	10	2012	Day	1328	3	0-1	E	Nil	40	>750	10	0	2
1	7	11	2012	Dawn	0735	1	3-4	W	Nil	100	>500	6	0	2
1	7	11	2012	Dawn	0835	2	3-4	W	Nil	100	>500	9	0	2
1	7	11	2012	Dawn	0935	3	3-4	W	Nil	100	>500	9	0	2
1	27	11	2012	Dawn	0818	1	1-2	N	Nil	40	>1000	2	0	>2
1	27	11	2012	Dawn	0918	2	1-3	N	Nil	50	>1000	3	0	>2
1	27	11	2012	Dawn	1018	3	1-3	N	Nil	80	>1000	4	0	>2
1	29	11	2012	Dusk	1245	1	1-2	W	Nil	30	>1000	3	0	>2
1	29	11	2012	Dusk	1345	2	0-1	W	Nil	75	>1000	3	0	>2
1	29	11	2012	Dusk	1445	3	0-1	W	Nil	90	>1000	2	0	>2
1	12	12	2012	Day	1030	1	0-1	SW	Nil	20-30	>600	0	0	>3

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VP	Day	Month	Year	Watch Period	Watch Start	Watch Hour	Wind Speed	Wind direction	Precipitation	Cloud Cover (%)	Cloud Base (m)	Temp (°C)	Snow cover (%)	Visibility km
1	12	12	2012	Day	1130	2	0-1	SW	Nil	40	>600	0-1	0	>3
1	12	12	2012	Day	1230	3	0-1	SW	Nil	40	>600	0-1	0	>3
1	9	1	2013	Dusk	1256	1	1-3	W	Nil	100	>500	5	0	>2
1	9	1	2013	Dusk	1356	2	1-2	W	Nil	100	>500	5	0	>2
1	9	1	2013	Dusk	1456	3	1-4	W	Nil	95	>500	4	0	>2
1	17	1	2013	Dawn	0835	1	0	-	Nil	100	>1000	-1	0	>2
1	17	1	2013	Dawn	0935	2	0-1	E	Nil	90	>1000	-1	0	>2
1	17	1	2013	Dawn	1035	3	0-1	E	Nil	90	>1000	-1	0	>2
1	5	2	2013	Day	1245	1	2-4	WNW	Nil	90	>500	2	0	>2
1	5	2	2013	Day	1345	2	2-4	WNW	Nil	80	>500	2	0	>2
1	5	2	2013	Day	1445	3	2-5(6)	N	Nil	50	>500	3	0	>2
1	20	2	2013	Day	1050	1	1-2(3)	SE	Nil	100	400	3-4	0	1-1.5
1	20	2	2013	Day	1150	2	1-2	SE	Nil	100	350-500	3	0	1
1	20	2	2013	Day	1250	3	1-2	SE	Nil	100	500	3-2	0	1
1	13	3	2013	Dusk	1513	1	2-3	N	Nil	80	1000	2	0	>2
1	13	3	2013	Dusk	1613	2	2-4	N	Very light snow	80	>500	1	0	>2
1	13	3	2013	Dusk	1713	3	2-4	N	Nil	100	>500	1	0	>2
1	5	4	2013	Day	1400	1	0-2	ENE	Nil	60	>1000	4	50	>2
1	5	4	2013	Day	1500	2	0-2	ENE	Nil	40	>1000	4	50	>2
1	5	4	2013	Day	1600	3	0	-	Nil	30	2000	4	50	>2
1	9	4	2013	Day	1300	1	3-4	SE	Nil	50	1000	NA	45	>2
1	9	4	2013	Day	1400	2	4	SE	Nil	55	1000	NA	45	>2

VP	Day	Month	Year	Watch Period	Watch Start	Watch Hour	Wind Speed	Wind direction	Precipitation	Cloud Cover (%)	Cloud Base (m)	Temp (°C)	Snow cover (%)	Visibility km
1	9	4	2013	Day	1500	3	4	SE	Nil	60	1000	NA	45	>2
1	16	4	2013	Dusk	1720	1	3-6	WSW	Rain	100	>1000	10	0	>2
1	16	4	2013	Dusk	1820	2	3-7	WSW	Heavy rain	100	>500	6	0	>2
1	16	4	2013	Dusk	1920	3	3-6	WSW	Nil	90	>500	4	0	>2
1	1	5	2013	Day	1215	1	4-5	W	Showers	50	>1000	10	0	>2
1	1	5	2013	Day	1315	2	4-5	W	Showers	50	>1000	11	0	>2
1	1	5	2013	Day	1415	3	4-5	W	Nil	50	>1000	12	0	>2
1	17	5	2013	Dawn	0454	1	0	N	Nil	80	>1000	NA	0	>2
1	17	5	2013	Dawn	0554	2	0	NNW	Nil	90	>1000	NA	0	>2
1	17	5	2013	Dawn	0654	3	0	NNE	Nil	75	>1000	NA	0	>2
1	28	5	2013	Dusk	1845	1	1-3	E	Nil	95	>500	11	0	>2
1	28	5	2013	Dusk	1945	2	0-2	E	Nil	90	>500	10	0	>2
1	28	5	2013	Dusk	2045	3	0-3	E	Nil	80	>1000	7	0	>2
1	13	6	2013	Dawn	0430	1	2-3	SW	Nil	5	>500	7	0	>2
1	13	6	2013	Dawn	0530	2	2-3	SW	Nil	20	>500	10	0	>2
1	13	6	2013	Dawn	0530	3	2	SW	Nil	20	>500	10	0	>2
1	25	6	2013	Day	1135	1	1-2	SW	Nil	100	>600	15	0	>3
1	25	6	2013	Day	1235	2	1-2	SW	Nil	100	>600	16-17	0	>3
1	25	6	2013	Day	1335	3	1-2	SW	Nil	100	>600	18-19	0	>3
1	19	7	2013	Dawn	0501	1	0-1	S	Light shower	5	>2000	14	0	>3
1	19	7	2013	Dawn	0601	2	0-1	S	Nil	5	>2000	16	0	>3
1	19	7	2013	Dawn	0701	3	0		Nil	5-10	>2000	18	0	>3
1	24	7	2013	Dusk	1838	1	0-1	SSE	Nil	90	1000	23	0	>3

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VP	Day	Month	Year	Watch Period	Watch Start	Watch Hour	Wind Speed	Wind direction	Precipitation	Cloud Cover (%)	Cloud Base (m)	Temp (°C)	Snow cover (%)	Visibility km
1	24	7	2013	Dusk	1938	2	0-1	SSE	Nil	90	>500	19	0	>3
1	24	7	2013	Dusk	2038	3	0	SSE	Nil	85	>500	18	0	>3
1	23	8	2013	Dusk	1730	1	2-3(4)	SSW	Light shower	100	750-1000	18	0	>3
1	23	8	2013	Dusk	1830	2	3-4	SSW	Light shower	100	750	16	0	>3
1	23	8	2013	Dusk	1930	3	2-4	SSW	Light shower	100	750	15	0	>3
1	27	8	2013	Day	1130	1	1-2	NW	Nil	20-30	>1000	17-19	0	>3
1	27	8	2013	Day	1230	2	1-2(3)	NW	Nil	40-100	>1000	19-20	0	>3
1	27	8	2013	Day	1330	3	1-2(3)	NW	Nil	100	>1000	18	0	>3

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A.4 Breeding Bird Accounts

A.4.1 The following provides summary species accounts and evaluations of breeding birds with enhanced statutory protection (Schedule I to the WCA and/or Annex I of the Birds Directive); and/or Priority Species on the Scottish Biodiversity List and UK Biodiversity Action Plan; and/or Red or Amber listed species included under the Birds of Conservation Concern (Eaton *et al.* 2009).

Breeding Bird Resource

A.4.2 The following provides a description of the breeding bird resource within the study area following methodology outlined in Section 3.11.

A.4.3 Table 11 presents the number of breeding registrations (see Section 3.11 for definitions) of all birds recorded during breeding bird surveys. The bird survey was carried out to include the proposed wind farm and to a distance out with the proposed wind farm as defined in Section 3.6.

Table 11. Breeding Bird Survey Results (number of registrations per visit and maximum count across all visits)

Species	Species Code	Visit 1	Visit 2	Visit 3	Max Count
Common buzzard	BZ	0	0	1	1
Carrion crow	C.	0	0	2	2
Chaffinch	CH	0	1	1	1
Eurasian curlew	CU	0	1	1	1
Northern lapwing	L.	0	0	1	1
Common linnet	LI	0	1	1	1
Lesser redpoll	LR	1	2	0	2
Meadow pipit	MP	17	22	10	22
Mute swan	MS	1	0	1	1
Common raven	RN	2	0	0	2
Sky lark	S.	14	10	16	16
Northern wheatear	W.	1	0	0	1
Whinchat	WC	0	2	2	2
Willow warbler	WW	0	0	1	1

A.4.4 The following provides summary species accounts and evaluations of breeding birds (not including waders) with enhanced statutory protection (Schedule I to the Wildlife and Countryside Act 1981 and/or Annex I of the Birds Directive); and/or Priority Species on the SBL and UK Biodiversity Action Plan; and/or Red or Amber listed species included under the Birds of Conservation Concern (Eaton *et al.* 2009).

Common Linnet

A.4.5 A maximum count of 1 breeding unit (i.e. pair) of common linnet *Carduelis cannabina* was made on the first, second and third BBS visit to the study area.

A.4.6 In lowland Scotland this is a widespread and fairly common resident. It is scarce in upland areas and absent from the north and west of the country. The breeding population of 70,000-90,000 pairs consists of the Scottish endemic subspecies *autochona*. The winter population is estimated at 150,000-200,000 birds. Common linnet is listed on the SBL (Category – avoid negative impacts); as a Priority Species on the UK BAP; and as a Red Listed Species under the Birds of Conservation Concern due to a 50% decline in its population between the 1970's and 2000.

A.4.7 Due to the relatively low number of breeding linnet in the study area, the study area is considered of *Negligible Value* for linnet.

Lesser redpoll

A.4.8 A maximum count of 2 registrations of breeding lesser redpoll *Carduelis cabaret* was recorded on the second BBS visit to the study area at Knowes.

A.4.9 The study area does not support prime breeding habitat for lesser redpoll (i.e. birch trees etc.) and should be considered to be of *Negligible Value* only due to the population representing only a small proportion of the 7,500 – 15,000 pairs of lesser redpoll in Scotland (Forrester *et al.* 2007). Lesser redpoll is listed on the SBL (Category – avoid negative impacts); as a Priority Species on the UK BAP; and as a Red Listed Species under the Birds of Conservation Concern

A.4.10 The study area thus represents a small proportion of this number and as such is regarded as being of *Local Value* for lesser redpoll.

Sky Lark

A.4.11 A maximum count of 16 registrations of breeding sky lark *Alauda arvensis* was made on the third BBS visit to the study area.

A.4.12 Sky lark is a common and widespread bird in Scotland although many move south during the winter. The Scottish breeding population is estimated to be between 290,000-557,000 pairs with a much reduced winter population of 13,000-40,000 birds. Sky lark is listed on the SBL (Category – avoid negative impacts); as a Priority Species on the UK BAP; and as a Red Listed Species under the Birds of Conservation Concern.

A.4.13 The study area thus represents a small proportion of this number and as such is regarded as being of *Local Value* for sky lark.

A.5 Vantage point flight summary

A.5.1 Vantage point (VP) flight data of all target species (see Table 1) recorded during the VP watches outlined in Table 11 are described in Table 12 for summer flights in the turbine envelope and Table 13 for flights recorded in the winter period in the turbine envelope.

A.5.2 Secondary species recorded during winter and summer VP watches are described in Table 14. The number of occurrences in each 5-minute watch period are tabulated and expressed as a proportion of total watched period recorded.

Table 12. Summer Flights in Turbine envelope 2013

Day	Month	Year	VP	Watch	Time	Species	BTO Code	Flight No.	No. birds	Flight Duration (sec.)	Time at Height Bands (sec.)		
											0-25m	25-85m	>85m
9	4	2013	1	Day	1340	Merlin	ML	16	1	60	60	0	0
24	7	2013	1	Dusk	1903	Peregrine falcon	PE	18	1	135	0	135	0
27	8	2013	1	Day	1334	Peregrine falcon	PE	19	1	5	5	0	0
27	8	2013	1	Day	1336	Peregrine falcon	PE	20	1	10	10	0	0

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Table 13. Winter Flights in Turbine envelope 2012-2013

Day	Month	Year	VP	Watch	Time	Species	BTO Code	Flight No.	No. birds	Flight Duration (sec.)	Time at Height Bands (sec.)		
											0-25m	25-85m	>85m
19	9	2012	1	DAWN	831	Pink-footed goose	PG	1	6	70	0	0	70
24	10	2012	1	DAY	1254	Peregrine falcon	PE	4	1	10	10	0	0
24	10	2012	1	DAY	1349	Peregrine falcon	PE	5	1	10	10	0	0
24	10	2012	1	DAY	1350	Hen harrier	HH	6	1	70	45	0	0
24	10	2012	1	DAY	1402	Hen harrier	HH	7	1	90	60	0	0
27	10	2012	1	DAWN	858	Merlin	ML	11	1	30	30	0	0
9	1	2013	1	DUSK	1556	Short-eared owl	SE	12	1	150	150	0	0

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Table 14. Occurrences of Secondary species during winter and summer vantage point watches

Species	Winter period (39h: 468 periods)		Summer period (36h: 432 periods)	
	No. Occurrences	Max. Count	No. Occurrences	Max. Count
Common buzzard	1 (0.21%)	1	11 (2.55%)	3
Common kestrel	13 (2.78%)	2	3 (0.69%)	1
Common raven	14 (2.99%)	4	15 (3.47%)	3
Eurasian sparrowhawk	0	0	1 (0.23%)	1
Lesser black-backed gull	0	0	2 (0.46%)	24

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A.6 Collision Risk Analysis Methods

A.6.1 The collision risk analysis modelling was carried out according to the methodology presented in Band *et al.* (2007). Since only peregrine falcon was recorded as flying through the turbine envelope at potential collision height, collision assessment was made using analyses for less predictable (foraging) flights following Band *et al.* (2007).

Stage 1: Methodology for non-predictive flights

A.6.2 The following model was used to predict bird strikes for species that were seen to 'use' the airspace of the wind farm for e.g. foraging etc. The following species was analysed following this method:

- Peregrine falcon.

A.6.3 The proportion of observation time individual species were recorded flying at between 25 and 85 m height was calculated for each vantage point.

A.6.4 The size of the flight risk area was taken as the flight activity per hectare of visible area - *F* in Table 18.

A.6.5 Bird occupancy was assessed within the flight risk volume for the period examined, given in Table 17. This sum was then used to determine the number of transits (bird occupancy) over the season. Season was defined according to SNH guidance – thus, for peregrine a full year's data was assessed (i.e. 75 hours per VP) as being applicable for the species due to the potential residency period.

A.6.6 The mean number of hours between sunrise and sunset were calculated for each month (averaged for the 5th and 25th day of each month). It was assumed that diurnal raptors would be using an available flying period from sunrise to sunset. For each separate period the available flying time was summed. This total was then used as a multiplication factor to estimate the total predicted flight activity over the course of the season based on the birds/h noted during the VP counts (see Table 18).

A.6.7 The time taken (**t**) for a bird to make a transit through the rotors was taken as $\mathbf{t = (d+l)/v}$ with **v** estimated as the flight speed of the birds through the wind farm in m/sec.

A.6.8 The number of bird transits through the rotors was determined as the total occupancy of the volume swept by the rotors divided by the transit time; $\mathbf{n \times (Vr/Vw)/t}$.

Stage 2: Probability of a bird flying through a rotor and being hit

A.6.9 Band *et al.*, 2007 was followed to determine the chance that a bird would be hit (and assumed killed) by a rotor whilst making its way through the rotor-swept area. An Excel file provided by Scottish Natural Heritage (SNH) was used which allowed for rapid calculation of the collision probability subject to turbine characteristics (width, pitch, speed of rotation and maximum chord of the turbine blades as defined in Table 15) and parameters associated with the bird species being estimated (wing-span. Length and flight speed; see Table 16).

A.6.10 A percentage value is obtained which, when multiplied by the number of bird transits through the rotors, gives rise to the number of bird collisions (**c**) per year (based on the numbers obtained during Stage 1 of the calculations). Since the turbines were estimated to be operational for 80% of available time only (Angus Elder pers. comm.), the number of collisions was corrected by that figure ($\mathbf{c \times 0.8}$). In addition, for the non-predictive flights of raptors, the proportion of time birds were flying at rotor height was modified as a proportion (48/60) of the 25-85m recording band since rotor height extended from 32m to 80m above ground.

A.6.11 The value obtained from Stage 1 and Stage 2 of the collision analysis described above is based on the assumption that birds do not take any avoiding action when flying through the turbine area. Data exist that show that avoidance rates are significant – often 98% or more, depending on bird species. Therefore in order to provide a reasonable estimate of potential collision, avoidance rates for different species were taken into consideration. Avoidance rates for use in the collision analysis have been taken from guidance published by SNH (SNH 2010 & SNH 2013).

A.6.12 Collision risk data are shown below across the range of rotor pitch and speeds (rotation period). All data and the conclusions from them are discussed in Section 5.13 for peregrine falcon.

Table 15: Parameters of wind farm and of turbines used in collision modelling

Hub height	**56 m**
Rotor radius (R)	24 m
Turbine height	80 m
Area of Wind farm	810000 m2
No. turbines (N)	9
Max. Rotor depth (d)	5.75 m
Max. chord	2.382 m
Pitch	Variable (from 0 to 30 degrees)
Rotation period	3.75 – 1.875 sec. (i.e.16-32 rpm)
Turbine operation time	Est. 80%

Table 16: Parameters of birds used in collision modelling

	Peregrine
Length of bird m (l)	0.42[a]
Wing span m	1.02[a]
Assumed flight speed ms^{-1}	20[c]

[a]. taken from BTO website http://blx1.bto.org/birdfacts/results

[b]. Band *et al.*, 2007

[c]. Cochran & Applegate, 1986

Table 17. Occupancy periods used in Stage 1 calculations

	Flying time available (h)
Raptors	**Sunrise to Sunset**
Year period	4454

Table 18. Collision analysis for peregrine, residency considered as year round (a non-predictive flight species, following Band *et al.*, 2007)

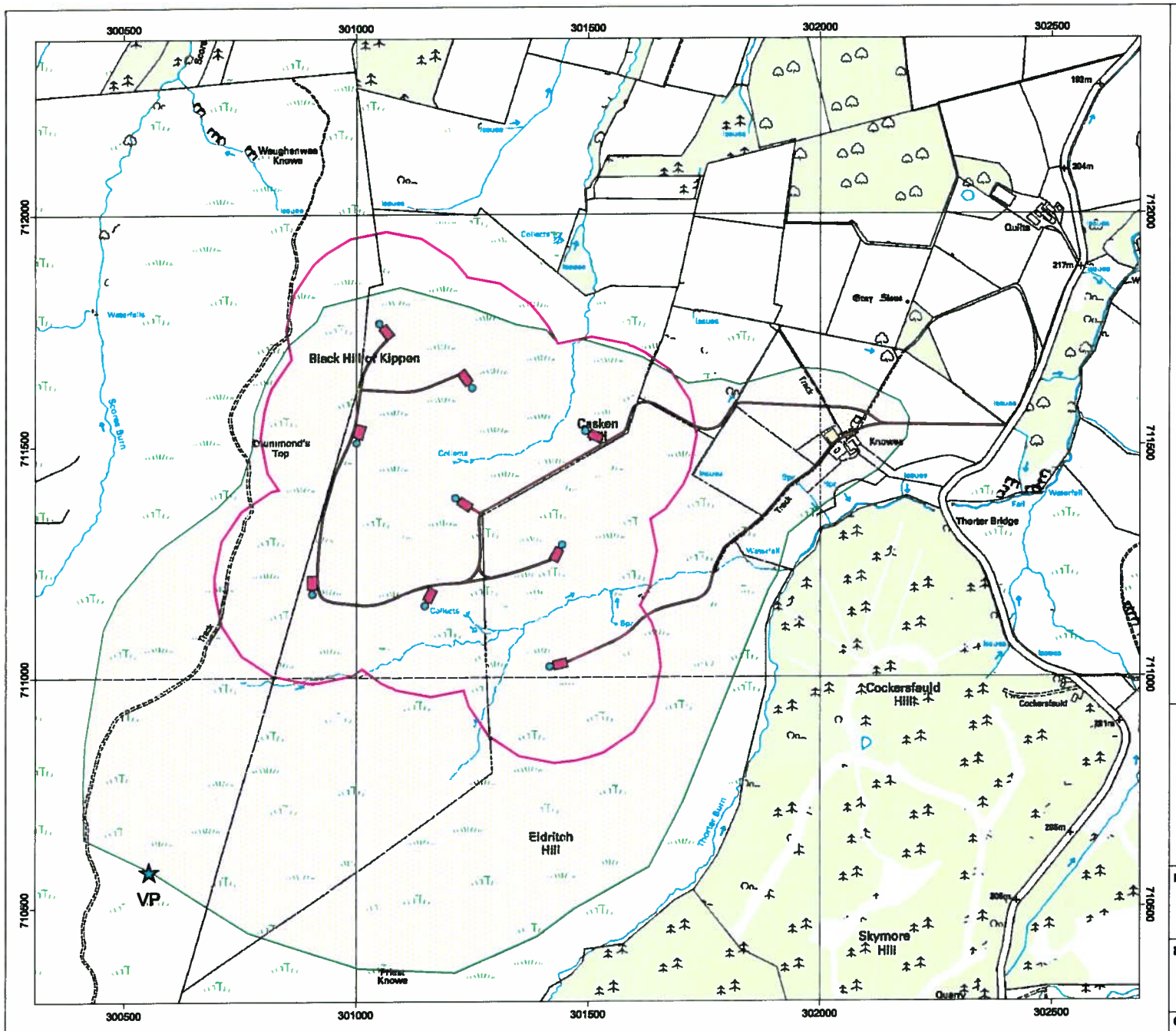
Peregrine					
Vantage Point	Area watched ha	Time watched h	Flight at pch sec.	Flight Rate	Flight rate per hectare
VP 1	75	75	135	0.000520833	6.94444E-06
				F =	6.94444E-06

	Occupancy period (h)	Wind Farm Area (ha)	*F*	*n (h*ha*F)*
Occupancy (n)	4454	81	6.944×10^{-6}	2.505

Peregrine					
	No. turbines	Rotor radius	Depth of rotor	Length of bird	Vr
Flight Risk Volume (Vr)	9	52 m	5.75 m	0.42 m	$100484m^3$
	n	Vr	Vw	Bird hours (b)	
Bird occupancy of swept area (b)	2.505	$100484m^3$	3880000	0.0064751	
	Depth of rotor	Length of bird	Bird speed m/s	t	Number of transits (b/t)
Time taken for bird to make a transit (t)	5.75 m	0.42 m	20	0.3085	58.769

Peregrine				
	Pitch 0° Rotation period 1.875 sec	Pitch 0° Rotation period 3.75 sec	Pitch 30° Rotation period 1.875 sec	Pitch 30° Rotation period 3.75 sec
Collision rate	10.3%	9.8%	10.9%	9.1%

Collision rate (no avoidance; b/t*collision risk)	7.7827	7.4049	8.2361	6.8004
Collision rate (98% avoidance)	0.1557	0.1481	0.1647	0.1360
Collision rate – avoidance & turbine 80% use	0.1245	0.1185	0.1318	0.1088
Collision rate as a function of rotor diameter (104m) & assessed height (120m)	**0.0996**	**0.0948**	**0.1054**	**0.08705**



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PROJECT

Knowes Wind Farm

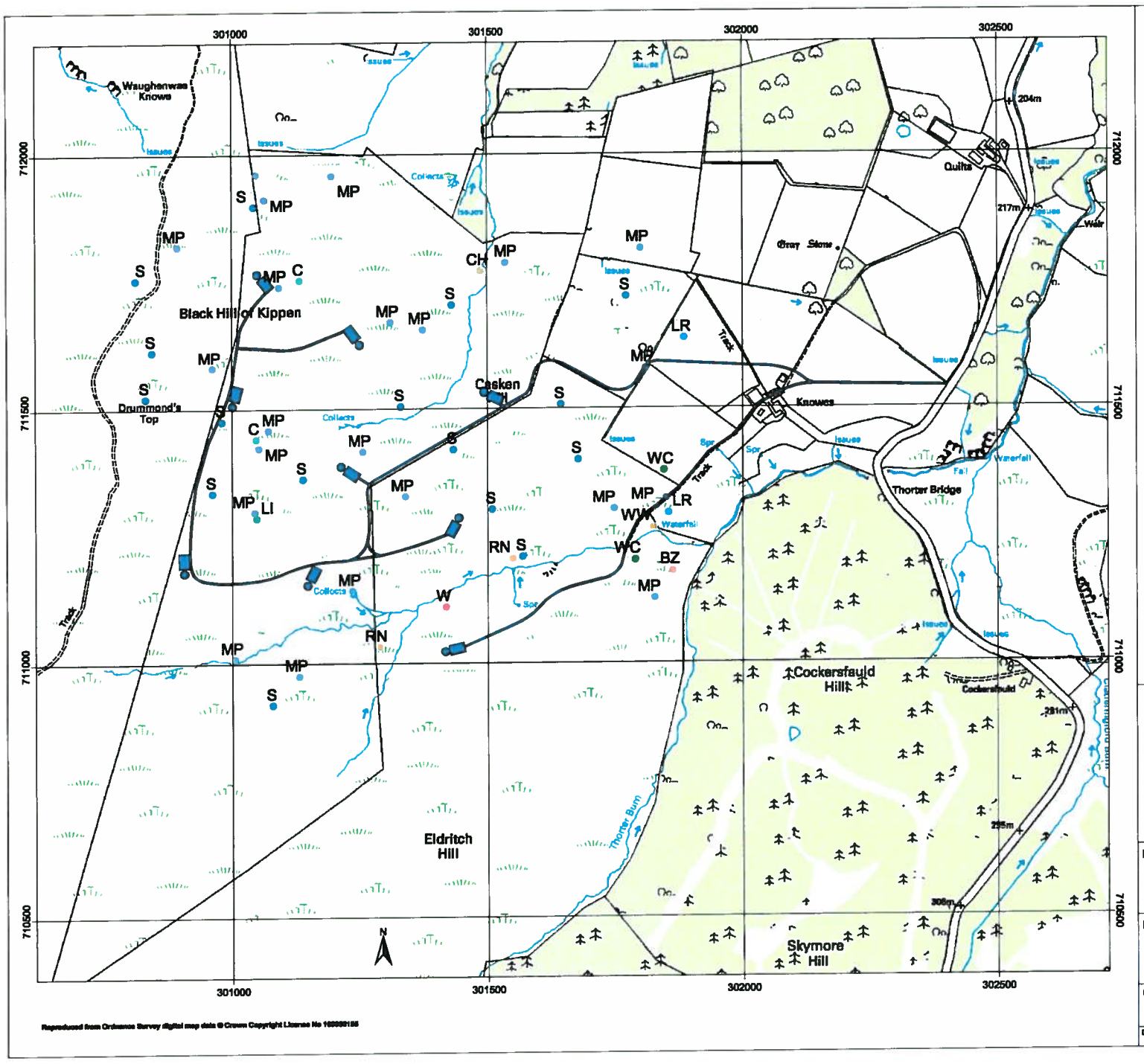
FIGURE

Figure 1: Vantage point and viewshed in relation to development

CLIENT

Muirden Energy

DRAWN: SK	APPROVED: MB	DATE: 04 February 2014



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Breeding bird species codes

- BZ - Common buzzard
- C - Carrion crow
- CH - Chaffinch
- LI - Common linnet
- LR - Lesser redpoll
- MP - Meadow pipit
- RN - Common raven
- S - Sky lark
- W - Northern wheatear
- WC - Whinchat
- WW - Willow warbler
- Combined infrastructure

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FIGURE

Figure 2: Breeding Bird Survey

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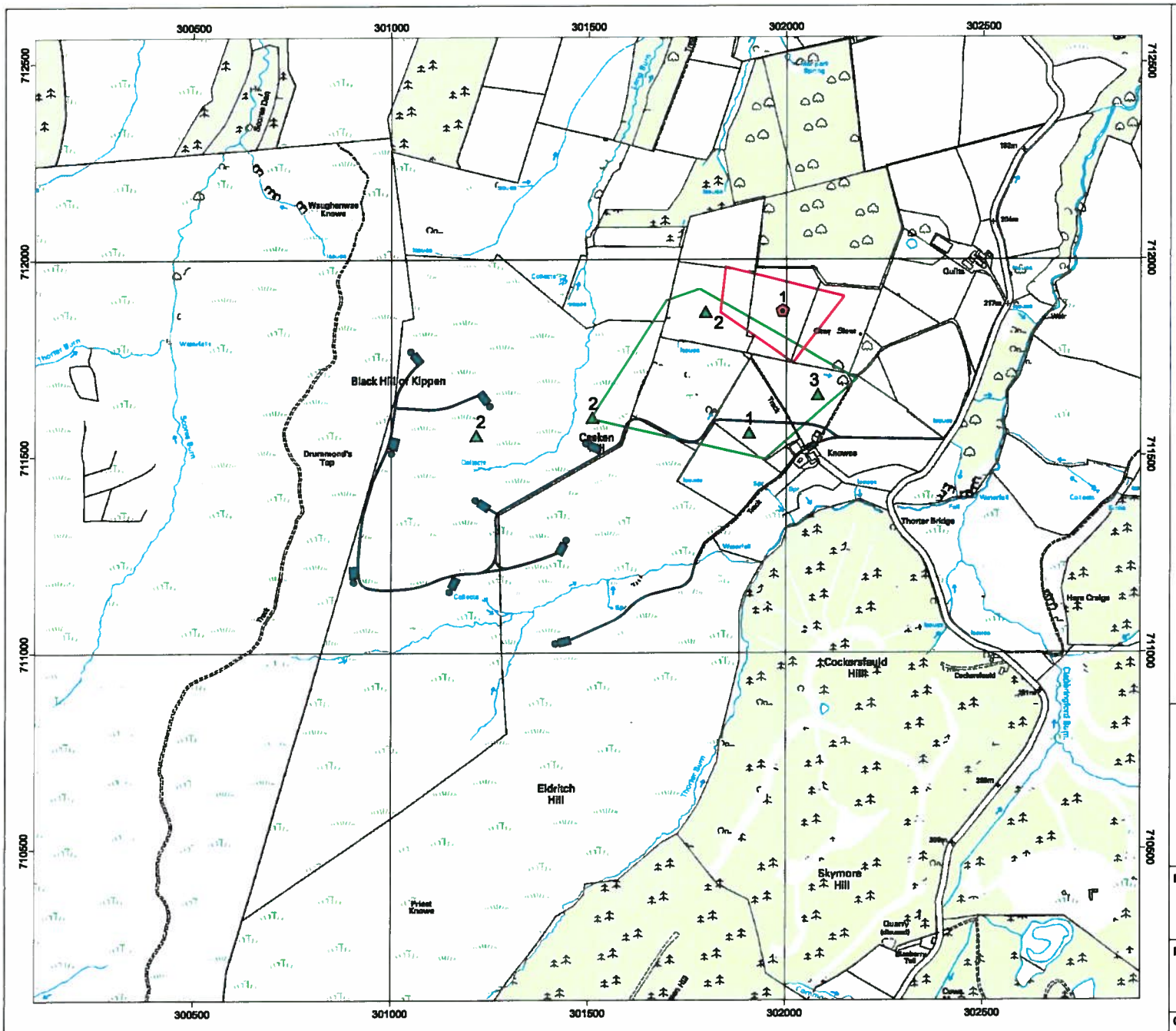

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FIGURE

Figure 3: Breeding waders

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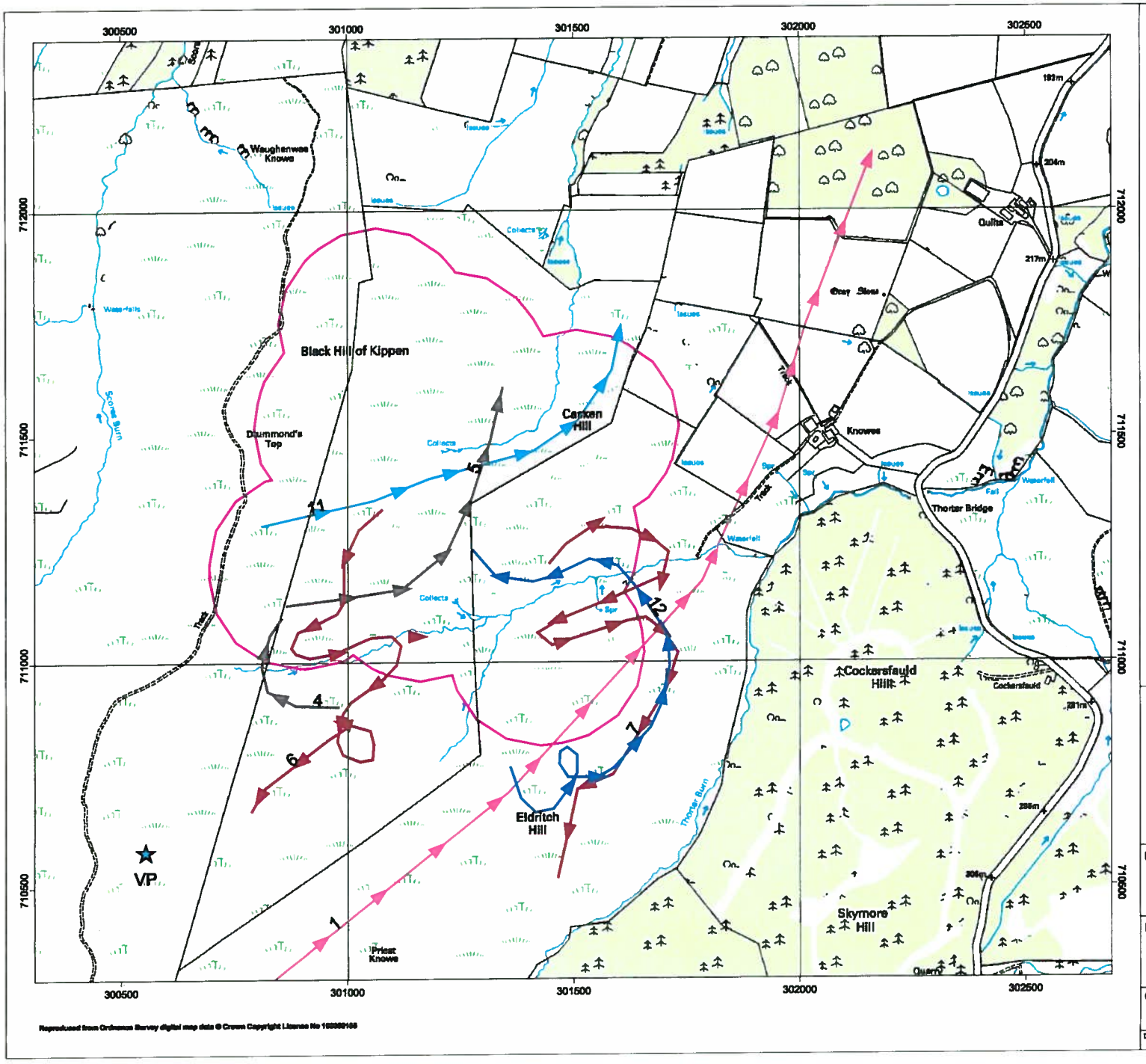

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FIGURE
Figure 4: Winter Flight Activity

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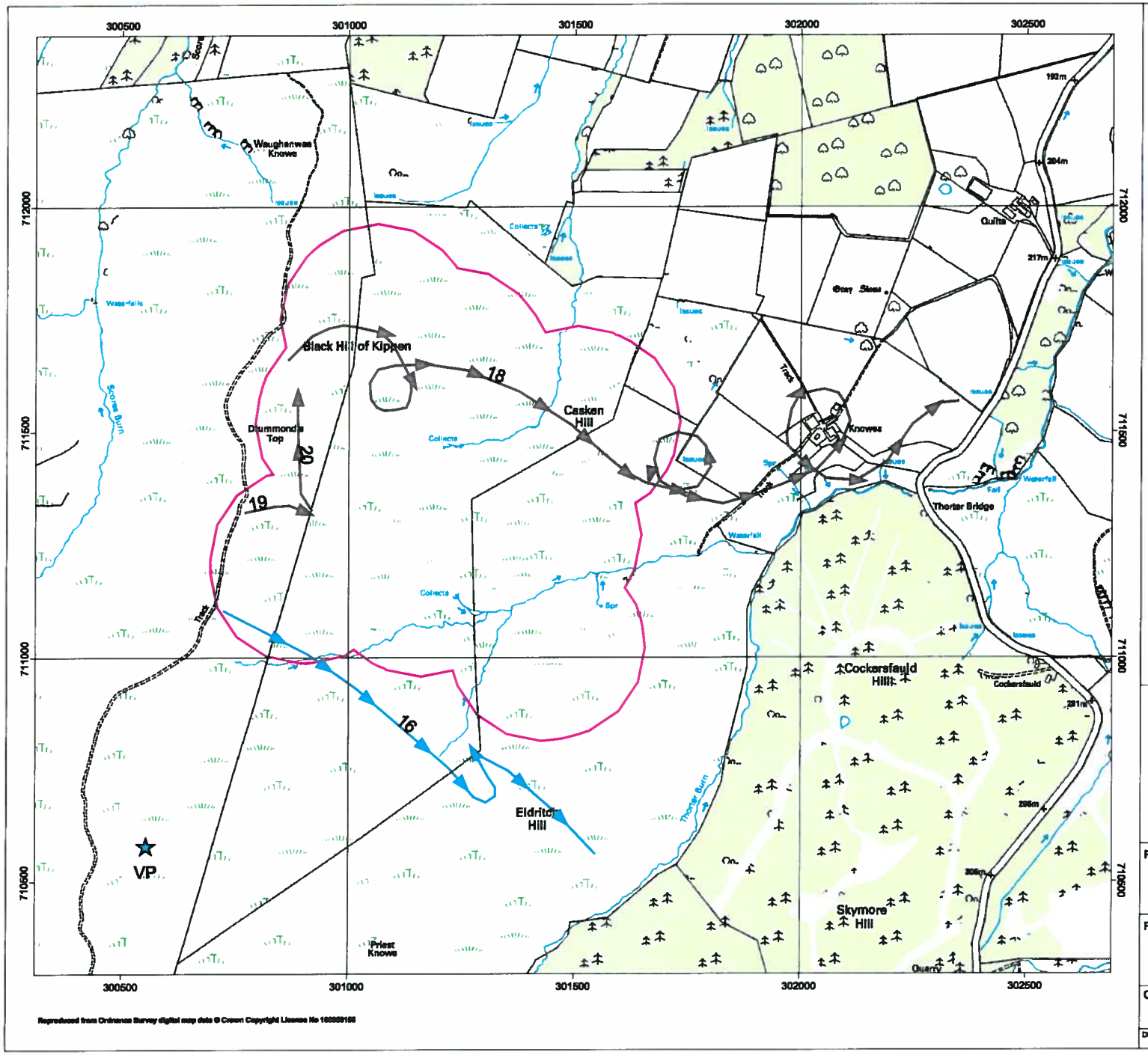

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FIGURE
Figure 5: Summer Flight Activity

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CHAPTER 7

HYDROLOGY, HYDROGEOLOGY AND SOILS

7 HYDROLOGY, HYDROGEOLOGY AND SOILS

7.1 EXECUTIVE SUMMARY

7.1.1 An assessment of the potential effects associated with the construction and operation of the development on hydrology, hydrogeology and soil features in terms of both quality and quantity has been undertaken.

7.1.2 A detailed review of the baseline conditions was used as the basis to determine the potential impacts of the proposed development if no mitigation measures were in place. This concluded that the significance of the potential adverse impacts on hydrology, hydrogeology and soil features is expected to range from moderate to negligible. Adverse impacts of moderate significance are expected for surface waters and private water supplies without mitigation.

7.1.3 Best practice measures to mitigate against all potential adverse impacts during the construction, operation and decommissioning phases have been outlined.

7.1.4 In order to ensure that these measures are carried out, a development site Construction Environmental Management Plan (herein referred to as CEMP) will be drawn up and adhered to by all development site contractors.

7.1.5 With adoption of the proposed mitigation measures, the development has been assessed as having the potential to give rise to adverse impacts of minor significance or lower on hydrology, hydrogeology and soils.

7.2 INTRODUCTION

7.2.1 This chapter presents an assessment of the potential effects associated with the proposed development on hydrology, hydrogeology and soils.

Objectives

7.2.2 Key objectives of this report were:

- to identify the key baseline hydrological, hydrogeological and soil catchment conditions of the development site; and
- to identify sensitive receptors.

7.2.3 Effects on hydrology, hydrogeology and soils may result in secondary ecological effects on habitats, or species. Effects on ecological receptors are considered in Chapter 6: Ecology and Ornithology.

Development area

7.2.4 The development area is predominantly used for farming. The development covers a total area of approximately 1km^2. Land cover at the site is mainly comprised of upland heath.

7.2.5 The site is located on the north-east facing slope of a ridge which runs from Corb Law (475m Above Ordnance Datum (AOD)) 1.5km south of the development, over the Black Hill of Kippen (360m AOD) which is located within the development boundary, to Kippen Hill (165m AOD) 1km north of the development area. The turbines are located in three parallel lines which run in a north-south orientation. The development area is located within the catchment of the River Earn which discharges into the Tay Estuary. Minimum elevations are 260m AOD at the north-eastern corner of the development area and maximum elevations are 400m AOD at the south-western corner of the development area.

7.3 LEGISLATIVE AND PLANNING CONTEXT

7.3.1 The development has been assessed in accordance with the EIA Regulations (1999) and under the legislative framework of the Control of Pollution Act 1974 (as amended) Part II: Pollution of Water, and the Water Framework Directive (WFD) (2000/60/EC).

7.3.2 The WFD was transposed into Scottish Legislation through the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act) and implemented through The Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended) (CAR). The overall objective of the WFD is to protect, maintain and in some cases improve the water environment.

7.3.3 The CAR regulations have upgraded existing statute and introduced new regimes to ensure Scottish law is compliant with the WFD. The new CAR regulations address point source pollution, abstraction and impoundments, building and engineering works in, or adjacent to, the fresh water environment. Under the regulations it is now necessary to gain a CAR authorisation, through 'General Binding Rules', Registration, or Licence (depending on the potential risk associated with the activity) to carry out the above activities.

7.3.4 Additional legislation and guidance relevant to the assessment is outlined in Table 5.1.

Table 5.1 Assessment and mitigation guidance

Topic	Sources of information
Additional Legislation	Water Environment (Oil Storage) (Scotland) Regulations 2006 Water Environment and Water (Scotland) Act (WEWS Act) 2003 Pollution Prevention and Control (Scotland) Regulations 2000 EC Freshwater Fish Directive (78/659/EEC), and the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 Habitats Directive (92/43/EEC)
SEPA Policies	No. 19: Groundwater Protection Policy for Scotland, Dec 2003 No. 26: Policy on the Culverting of Watercourses No. 54: Land Protection Policy
SEPA Pollution Prevention Guidelines (PPGs)	PPG1: General guide to the prevention of water pollution PPG2: Above ground oil storage tanks PPG4: The disposal of sewage where no mains drainage is available PPG5: Works in, near or liable to affect watercourses PPG6: Working at construction and demolition sites PPG8: Safe storage and disposal of used oil PPG21: Pollution incident response planning
CAR Guidance	SEPA: Water Environment (Controlled Activities) (Scotland) Regulations 2011 WAT-PS-06-02: Culverting of Watercourses (2006)
National Planning Policy	Scottish Planning Policy (SPP), (Flooding and Drainage Chapter) Scottish Executive (2010)
Scottish Executive Planning Advice Notes (PANs)	PAN 50 Controlling the Environmental Effects of Surface Mineral Workings (surface and groundwater) (2006) PAN 58 Environmental Impact Assessment PAN 61 Planning and Sustainable Urban Drainage Systems PAN 69 Planning and Building Standards Advice on Flooding

Other Guidelines	CIRIA C502: Environmental Good Practice on Site CIRIA C515 Groundwater Control - Design and Practice CIRIA C532: Control of water pollution from construction sites CIRIA C648: Control of water pollution from linear construction projects CIRIA C697: Sustainable Urban Drainage Systems Design Manual for Scotland and Northern Ireland CIRIA C689: Culvert Design and Operation Guide Forestry Commission, Forests and Water Guidelines Edition 4 (2003) Private Water Supplies: Technical Manual, Scottish Executive (2006) Scottish Executive: River Crossings and Migratory Fish: Design Guidance, April 2000 Scottish Government (2006) Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments WAT-SG-25: Good Practice Guide - River Crossings (2010) WAT-SG-26: Good Practice Guide - Sediment Management (2010) WAT-SG-29: Good Practice Guide – Construction Methods (2009) WAT-SG-31: SEPA Special Requirements for Civil Engineering Contracts for the Prevention of Pollution V2 June 2006. WAT-SG-32: SEPA Guidance on the Special Requirement for Civil Engineering Contracts V2 June 2006 SNH: Scottish Wildlife Series (2008). Otters and Development. (www.snh.org.uk/publications/on-line/wildlife/otters/default.asp). SNH: Constructed tracks in the Scottish Uplands' (2006) SNIFFER: Development of a groundwater vulnerability screening methodology for the Water Framework Directive, September 2004

7.4 METHODOLOGY

Baseline

7.4.1 A baseline study and description of the local hydrological environment was formed through:

- consultation with relevant statutory bodies and key stakeholders;
- review of legislative framework and assessment guidance;
- desk study of published information and a field visit to establish the baseline conditions; and
- estimation of catchment characteristics using Flood Estimation Handbook (FEH) software and the Institute of Hydrology Report No. 124 (1994).

Data sources

7.4.2 A desktop study was carried out in order to gather baseline data on the development site; the sources consulted are outlined in Table 5.2.

Table 5.2 Baseline data and collated published information

Topic	Sources of information
Geology	BGS Geological Survey of Scotland Kinross (sheet 40) 1:63,360 Drift Edition (1973) BGS Geological Survey of Scotland Kinross (sheet 40) 1:63,360 Solid Edition (1973) BGS Hydrogeological Map of Fife and Kinross 1:100000 (1986) BGS Digital 1:625000 and 1:50000 UK Geological Datasets SEPA River Basin Management Plan (interactive map): http://www.sepa.org.uk/water/river_basin_planning.aspx
Climate	The National River Flow Archive: http://www.ceh.ac.uk/data/nrfa/index.html. British Geological Survey, Hydrogeological Map of Scotland, 1:625,000, 1988. MetOffice Rainfall data for gauging station from 1971 – 2000. Flood Estimation Handbook (FEH) CD-ROM
Topography	Ordnance Survey 1:50,000 map sheet 58.
Surface Water	SEPA River Basin Management Plan (interactive map). http://www.sepa.org.uk/water/river_basin_planning.aspx. SEPA Indicative River and Coastal Flood map on-line http://www.sepa.org.uk/flooding/flood_map/view_the_map.aspx. National River Flow Archive: http://www.ceh.ac.uk/data/nrfa/index.html Institute of Hydrology (IH), 1999-2006. Flood Estimation Handbook and CD ROM. Institute of Hydrology (1994). Flood estimation for small catchments. Report No IH124, Wallingford. Institute of Hydrology (1992). Low flow estimation in the UK. Report No IH108, Wallingford. Hydrological Data UK: Hydrometric Register and Statistics 1996-2000, CEH & BGS.
Groundwater	British Geological Survey Groundwater Vulnerability Map of Scotland 1: 625,000, 1995. Hydrogeological map of Scotland, British Geological Survey, 1: 625,000, 1988. SEPA Digital Groundwater Vulnerability Maps, SNIFFER (2004). Institute of Hydrology (IH), 1999. Flood Estimation Handbook and CD ROM. SEPA River Basin Management Plan (interactive map). http://www.sepa.org.uk/water/river_basin_planning.aspx.

Site visit

7.4.3 A survey visit was undertaken in January 2013 by a suitably qualified hydrologist to help determine the hydrological characteristics of the proposed development. The survey allowed a visual assessment of crossing points, surface water features, land use, hydrological regime and to gain an understanding of the site topography, geology and soils.

7.4.4 Peat depth and private water supply surveys were undertaken in April 2013 to assess the extent of peat deposits and characterise private water supplies that may be at risk from the development.

7.4.5 Further survey work was also undertaken in January 2014 to assess peat depths and watercourses crossings under a modified design layout.

Assessment of effects

7.4.6 The assessment methodology is based on SNH guidance; a Handbook on Environmental Impact Assessment (2006), the methodology also draws on guidance from the Water Environment Sub-Objective from Transport Analysis Guidance (TAG) published by the Department of Transport (2003) and the paper by Mustow *et al* (2005).

7.4.7 On completion of the baseline review the sensitivity of the receiving environment, as defined in Table 5.3, has been assessed and the sensitive receptors identified.

Table 5.3 Definitions of receptor sensitivity

Sensitivity of receptor	Characteristics of defining receptor sensitivity
Very High	High quality and rarity, regional or national scale and limited potential for substitution/ replacement. This includes the following: • Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC); • EC Identified Bathing Waters (76/160/EEC); • SEPA Water Quality defined as High; • Surface Water - large scale industrial abstractions >1000 m^3/day within 2 km downstream; • Abstractions for public drinking water supply; • Private Water Supplies – Surface water abstractions within 0 – 200 m and groundwater spring abstractions from 0-100 m from construction activities; • Designated salmonid fishery and/or salmonid spawning grounds present; • Watercourse widely used for recreation, directly related to watercourse quality (e.g., salmon fishery) within 2 km downstream; • Conveyance of flow and material, main river >10 m wide; • Active floodplain area (important in relation to flood defence); • Groundwater abstractions >1000 m^3/day (within zone of influence from development); • Groundwater - public drinking water supply; • Groundwater aquifer vulnerability classed between 4d, 4c, 4b, 4a and 5 in the SEPA vulnerability classification scheme; and • Geology rare or of national importance as defined by SSSI or Regional Important Geological Site (RIGS).
High	Receptor with a high quality and rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution/replacement. This includes the following: • SEPA Water Quality defined as Good; • Large scale industrial agricultural abstractions 500-1000 m^3/day within 2 km downstream; • Surface water abstractions for private water supply for more than 15 people; • Private Water Supplies – Surface water abstractions within 200 m – 600 m, groundwater spring abstractions from 100 m – 400 m, and groundwater borehole abstractions from 0 – 200 m from construction activities; • Designated salmonid fishery and/or cyprinid fishery (coarse fish, including roach, carp, chub, bream etc); • Watercourse used for recreation, directly related to watercourse quality (e.g. swimming, salmon fishery etc); • Conveyance of flow and material, main river >10 m wide; • Active floodplain area (important in relation to flood defence); • Watercourse/floodplain/hydrological feature that provides critical flood alleviation benefits; • Flooding of property or high value land; • Groundwater abstractions 500-1000 m^3/day (within zone of influence from development); • Groundwater abstraction for private water supply >10 m^3/day or serves >50 people; • Groundwater aquifer vulnerability classed as 3 in the SEPA vulnerability classification scheme; and • Peat typically greater than 1m deep on slopes in excess of 6 degrees with evidence of

	peat instability.
Medium	Receptor with a medium quality and rarity, local scale and limited potential for substitution/replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution/replacement. This includes the following: • SEPA Water Quality defined as Moderate; • Industrial/agricultural abstractions 50-499 m^3/day within 2 km downstream; • Occasional or local recreation (e.g. local angling clubs); • Conveyance of flow and material, main river <10 m wide or ordinary watercourse >5 m wide; • Existing flood defences; • Flooding of low value land; • Groundwater abstractions 50-499 m^3/day; • Private Water Supplies – Surface water abstractions from 600m – >800 m, groundwater spring abstractions from 400 m – 800 m and groundwater borehole abstractions from 200 m – 600 m from construction; • May be subject to improvement plans by SEPA; • Designated cyprinid fishery, salmonid species may be present and catchment locally important for fisheries; • Watercourse not widely used for recreation, or recreation use not directly related to watercourse quality; • Groundwater aquifer vulnerability classed as 2 in the SEPA vulnerability classification scheme; and • Peat typically greater than 1m deep on slopes of 4-6 degrees.
Low	Receptor with a low quality and rarity, local scale and limited potential for substitution/replacement. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character. This includes the following: • SEPA water quality defined as Poor or Bad; • Industrial/agricultural abstractions <50 m^3/day within 2 km downstream; • Fish sporadically present or restricted, no designated features; • Receptors not used for recreation e.g. no clubs or access route associated with watercourse; • Watercourse <5m wide – flow conveyance capacity of watercourse low – very limited floodplain as defined by topography, historical information and SEPA flood map; • No flooding of property or land; • Groundwater abstractions <50 m^3/day; • Private Water Supplies – groundwater spring abstraction >800 m and • groundwater borehole abstractions from 600 - >800m from construction activities; • No public drinking water supplies; • Groundwater aquifer vulnerability classed as 1 in the SEPA vulnerability classification scheme; • Receptor heavily engineered or artificially modified and may dry up during summer months; • Geology not designated under a SSSI or RIGS or protected by specific guidance; • Peat depths typically less than 1m deep with slopes less than 4 degrees; and • Not subject to water quality improvement plans by SEPA.

7.4.8 The potential effects of the development on the sensitive receptors were assessed through:

- identification of construction, operation and decommissioning phase activities and their potential effects;
- assessment of the significance of impacts of the development, taking into account the sensitivity of the receiving environment and the potential magnitude (scale of duration) of the effect;
- identification of the appropriate applied mitigation measures, and
- assessment of the significance of residual impacts of the development, taking into account the sensitivity of the receiving environment and the potential magnitude (scale of duration) of the effect after applied mitigation.

7.4.9 Assessment of the magnitude of effect includes the timing, scale, size and duration of the potential effect. For the purposes of this assessment the magnitude criteria are defined as follows in Table 5.4.

Table 5.4 Magnitude of effect

Magnitude	Criteria	Description
High	Results in loss of attribute	Fundamental (long term or permanent) changes to the hydrology, hydrogeology or soils; Extent of 'high risk' areas (1 in 200 year - SPP) will be significantly increased; Loss of EC designated Salmonid Fishery; Loss of national level designated species/habitats; Changes in WFD water quality status of river reach; Loss of flood storage; and Pollution of potable source of abstraction compared to predevelopment conditions.
Medium	Results in effect on integrity of attribute or loss of part of attribute	Material but non-fundamental (medium term) changes to the hydrology, hydrogeology or soils; Extent of 'high risk' areas (1 in 200 year - SPP) will be moderately increased; Loss in productivity of a fishery; and Discharges to the receiving water, but insignificant enough to change its water quality status.
Minor	Results in minor effect on attribute	Detectable but non-material (temporary) changes to the hydrology, hydrogeology or soils; and No increase in flood risk.
Negligible	Results in an effect on the attribute but of insufficient magnitude to affect the use or integrity	No perceptible changes to the hydrology, hydrogeology or soils; Discharges to watercourse but no loss in quality, fishery productivity or biodiversity; No significant effect on the economic value of the receptor; and No increase in flood risk.

7.4.10 The significance of the potential effects of the proposed development has been defined by taking into account the sensitivity of the receiving environment and the potential magnitude of the effect. Table 5.5 outlines how the sensitivity of the receptor and the magnitude of the impact define the significance of an effect.

Table 5.5 Significance criteria

Magnitude	Sensitivity			
	Very High	**High**	**Medium**	**Low**
High	Major	Major	Moderate	Minor
Medium	Moderate	Moderate	Moderate	Minor
Minor	Minor	Minor	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

7.4.11 Potential effects are, therefore, concluded to be of major, moderate, minor or negligible effect. Major and moderate effects are considered to be significant in terms of the EIA Regulations (1999).

7.5 CONSULTATION

7.5.1 SEPA provided comments relating to construction activities, the release of sediment from exposed surfaces and pollution prevention in the original scoping response (dated 02/08/2012). SEPA requested that the following points relating to hydrology be considered in the EIA:

- Disruption to wetlands including peat lands;
- Disturbance and re-use of excavated peat;
- Existing groundwater abstractions;

- Engineering activities in the water environment;
- Water abstraction; and
- Pollution prevention and environmental management.

7.5.2 SNH provided comments relating to soil and water in their scoping response (dated 20.08.12). SNH requested that the following points relating to soil and water be considered in the EIA:

- Avoid impacts on watercourses; and
- Pollution prevention and control measures should be fully described.

7.5.3 Perth and Kinross Council were consulted (by e-mail dated 06.02.13) to provide information on private water supplies within 2 km of the proposed wind farm site. The information provided included supply names, supply source locations (grid references), the number of properties using each supply and whether the supplies were treated or untreated.

7.6 BASELINE CONDITIONS

Hydrology (existing surface water drainage patterns)

7.6.1 The development area is located on a north-east facing slope of a ridge which runs from Corb Law (475m AOD) to the south of the development area, to Black Hill of Kippen (360m AOD) at the northern extent of the development boundary. Three watercourses (SW1, SW2 and SW3) drain the development site.

7.6.2 The site drains into the Long Burn and Thorter Burn sub-catchments of the Dunning Burn/River Earn catchment. These catchment are discussed below (refer to Figure 5a).

Long Burn sub-catchment

7.6.3 An area of 0.4km^2, of the development area, drains to the north into the Long Burn sub-catchment (2.0km^2) via the Long Burn (SW2) and an unnamed tributary (SW3) of the Long Burn. These tributaries form part of the Dunning Burn catchment (26.7km^2) which forms part of the larger River Earn catchment (863.0km^2). The River Earn discharges into the Tay Estuary approx. 20km east of the development site.

7.6.4 There are several artificial drainage channels and areas of wet flush within this catchment.

7.6.5 There are no proposed crossings within the Long Burn sub-catchment.

Thorter Burn sub-catchment

7.6.6 An area of 0.6km^2, of the development area, drains to the Thorter Burn sub-catchment (4.9km^2), via an unnamed tributary (SW1) of the Thorter Burn (SW4). The Thorter Burn is also an upper tributary of the Dunning Burn and River Earn catchments.

7.6.7 There are several artificial drainage channels and areas of wet flush within this catchment.

7.6.8 There are two proposed watercourse crossings (C1 & C2) within the Thorter Burn sub-catchment. The crossings are located on the headwaters of SW1 near the southern boundary of the development site.

Climate

7.6.9 The FEH catchment descriptors indicate a Standard Average Annual Rainfall (SAAR) of 1201 mm for the Thorter Burn (SW4) sub-catchment and a SAAR of 1092 mm for the Long Burn (SW2) sub-catchment.

7.6.10 The SAAR for the development area is considered to be below average for Scotland (the average Met Office statistics for 1961-1990 for Scotland is approximately 1470 mm).

7.6.11 The UK mapped annual average rainfall amount as presented on the Met office web pages shows that the development area lies within the drier eastern region of Scotland. Annual average rainfall is within the 800 to 1250mm band.

7.6.12 Table 5.6 details the monthly rainfall climate averages for Perth which show that August to January are the highest rainfall months (source: http://www.weather2travel.com/climate-guides/united-kingdom/perth.php).

7.6.13 Differences between the total annual rainfall recorded for Perth in Table 5.6 below and the values given for the wind farm site (see 7.6.9) are considered likely to be due to the development being located at a higher elevation.

Table 5.6 Average monthly rainfall (Perth)

Month	Rainfall (millimetres)
January	75
February	50
March	56
April	42
May	54
June	53
July	59
August	68
September	72
October	76
November	70
December	70
Total	745

Designated sites

7.6.14 The River Earn is designated as 'Salmonid Waters' and is protected for existing freshwater fish.

7.6.15 The River Earn lies within the designated Strathmore/Fife Nitrate Vulnerable zone (UKS916763). These nutrient sensitive areas are designated under the Nitrates Directive (91/676/EEC) as sensitive areas under the Urban Waste Water Treatment Directive (91/271/EEC).

7.6.16 The development area lies within a Drinking Water Protection Area which is associated with the Glenfarg bedrock and localised sand and gravel aquifers.

7.6.17 The Inner Tay Estuary is designated as a Site of Special Scientific Interest (SSSI) for saltmarsh habitats and habitats demonstrating the transition from saltmarsh to freshwater fens and dry land.

7.6.18 The Firth of Tay and Eden Estuary are designated as Special Area of Conservation (SAC) for several estuarine habitats.

7.6.19 There are no other identified designated sites which lie within catchments which could be affected by impacts from the proposed wind development.

Catchment analysis

7.6.20 The closest SEPA operated river gauging station lies on the River Earn at Forteviot Bridge (National Grid Reference (NGR) NO 044 1B3) - Gauging Station 16004. This gauging station monitors flows from a 782.2km^2 catchment and as such is too large and is not applicable for analysis at the site of interest.

7.6.21 The FEH CD-ROM gives a Standard Percentage Runoff (SPRHOST) of about 40.6% and Base Flow Index (BFIHOST) of 0.524 for the catchment of SW1 at the point where the watercourse feeds into the Thorter Burn (SW4). These values indicate the prevalence of low permeability soils across the development site. The Hydrogeological Map of Scotland (1988) indicates that infiltration is less than 100 mm per year.

7.6.22 As watercourses draining the development area are effectively ungauged the design flows for the watercourses have been calculated using the methodologies detailed below.

7.6.23 As the sub-catchment draining the development site is low lying and less than 25 km^2 in area, the Institute of Hydrology Report No. 124 (Marshall & Bayliss, 1994), 'Flood estimation for small catchments' methodology for rural catchments has been used to estimate design flows (refer to original report for methodology). Catchment descriptors required for the regression equation were derived from the Flood Estimation Handbook (FEH) CD Rom. As a comparison,

the FEH CD Rom and the FEH/FSR rainfall runoff method, using ISIS, were also used to provide an alternative estimate of design flows for the sub-catchments.

7.6.24 Low flows (Q95) have been estimated using the methodology recommended in the Institute of Hydrology Report No. 108 (1992), 'Low flow estimation in the UK'.

7.6.25 Design flows have been estimated for the sub-catchments. Estimated flows are summarised in Table 5.7.

Table 5.7 Indicative sub-catchment design flows

Drainage catchments				
Watercourse	Unnamed burn (SW1) at point of convergence with Thorter Burn (SW4)		Long Burn (SW2) at point of convergence with unnamed burn (SW3)	
Area (km^2)	2.4		0.55	
NGR location	NO 02350 11350		NO 01950 12700	
Method	FEH/FSR	IH124	FEH/FSR	IH124
Return Period (Years)	Discharge (m3s-1)		Discharge (m3s-1)	
2	1.7	1.3	0.35	0.15
100	4.9	3.5	1.0	0.42
200	5.7	3.9	1.2	0.46
200 plus 20% for climate change	6.8	4.7	1.4	0.55
Low Flow Q95	0.007		0.001	
Mean Annual Flow (MAF)	0.068		0.013	
N.B. Potential evaporation is taken as ~350mm/yr (Hydrometric Register and Statistics, mean annual loss average for closest stations 016004).				

Flood risk

7.6.26 SEPA's Indicative River and Coastal Flood Map of Scotland was consulted to identify those areas potentially at risk of flooding. Thorter Burn, Dunning Burn and the River Earn exhibit corridors of flood risk (for a 1 in 200 year return period event) outwith the development area. The proposed wind turbines and infrastructure are located outwith the indicative 1 in 200 year event flood plain. A summary of the potential sources of flooding and a review of the potential risk posed by each source at the application site is presented in Table 5.8 below.

Table 5.8 Flood risk

Potential flood source	Potential flood risk	Reasoning for decision
Fluvial/Tidal	No	The indicative flood map (SEPA) shows that the area around the development wind turbines and infrastructure is not at risk from fluvial or tidal flooding.
Groundwater	Localised	The proposed wind turbines and infrastructure are located on elevated sloping ground therefore groundwater is likely to be relatively deep and groundwater flooding is unlikely, however springs (issues) are recorded within and adjacent to the development area and therefore localised flooding may occur, but is not considered a significant risk.
Pluvial (rainwater)	Localised	The development area is located in an area of below average rainfall for Scotland. The ground is peaty. Localised flooding may occur where the ground is already saturated or the groundwater levels are already high, particularly in areas of wet flush.
Artificial drainage and water supply systems	Localised	There are open field drainage systems that may be susceptible to localised blockages and constrictions. These artificial drainage channels are likely to reduce the time to peak flow as a result of a decrease in rainfall infiltration and overland flow. However, these artificial drainage channels individually drain very small areas and are unlikely to cause a flood risk to the wind turbines and infrastructure.

7.6.27 The proposed wind turbines and infrastructure are located in flood zone 1. Flood Zones and acceptable development types, in accordance with SPP (2010), are explained in Table 5.9.

Table 5.9 Flood zones

Flood zone	Flood risk	Predicted annual probability	Characteristics
Zone 1	Low	Less than 0.1% (1000yr flood)	No constraints All development types generally acceptable
Zone 2	Low-Medium	0.1% – 0.5% (1000yr - 200yr flood)	Not usually necessary to consider flood risk unless local conditions indicate otherwise Most development types are generally acceptable
Zone 3a	Medium-High	Greater than 0.5% (200yr flood)	Flood risk assessment required The policy for development on functional flood plains applies Areas already built up may be suitable for development provided flood prevention measures to the appropriate standard already exist, are under construction or are planned as part of a long term development strategy in a structure plan context Land raising may be acceptable
Zone 3b	Medium-High	Greater than 0.5% (200yr flood)	Flood risk assessment required The policy for development on functional flood plains applies Undeveloped and sparsely developed areas are generally not suitable for additional development Exceptions may arise if a location is essential for operational reasons, e.g. for some utilities infrastructure, and an alternative lower risk location is not achievable Land raising may be acceptable

Geology

Superficial

7.6.28 The BGS Geological Survey of Scotland Kinross (sheet 40) 1:63,360 Drift Edition (1973) indicates that bedrock is at or near the surface across the majority of the development area, with boulder clay (labelled as glacial till in newer publications) deposits observed along the northern and eastern perimeters of the development area.

7.6.29 The BGS Hydrogeological Map of Fife and Kinross 1:100000 (1986) and the BGS 1:50000 Digital Geological Datasets confirm the lack of superficial deposits across the majority of the development area and the occurrence of till and undifferentiated drift deposits along the northern and eastern perimeters of the development area.

7.6.30 From peat depth surveys peat deposits were found to be either absent or thin (<0.5m) across the development site. Refer to Figure 5b for the peat depth survey results.

Solid

7.6.31 The BGS Geological Survey of Scotland Kinross (sheet 40) 1:63,360 Solid Edition (1973) and the BGS 1:50,000 Digital Geological Maps indicate that the development is predominantly underlain by igneous extrusives of the Ochil Volcanic formation, which consist of tuff and tufaceous lava pebble and conglomerate andesite and basalt. Sedimentary formations occur across north of the development area in the form of undivided lower Old Red Sandstone and conglomerates. The dip direction of sedimentary bedrock formations in the area is to the north-west.

7.6.32 Bedrock exposures identified within the development area during the site walkover confirmed the presence of intrusive igneous formations. The solid geology is representative of the region and no features of geological note have been identified.

Hydrogeology (superficial and solid)

Groundwater bodies

7.6.33 A search of the SEPA River Basement Management Plan (RBMP) GIS Database was undertaken to provide information on the groundwater bodies in the region of the site. This database indicates that the site is underlain by Glenfarg bedrock and localised sand and gravel aquifers

(ID150250). Sand and gravel superficial deposits may be present within the development area where glacial till deposits occur. The overall status of the groundwater body has been classified by SEPA as 'Poor' with a high degree of confidence in 2008, this is due to the quality of groundwater being classified as 'Poor' with a high degree of confidence. This groundwater body has shown an upward trend in pollutants due to diffuse source pollution from mixed farming.

7.6.34 The Glenfarg bedrock and localised sand and gravel aquifers are classified as being within a Drinking Water Protection Zone (protected area identifier code: 150250), referring to a body of water which may be used for the abstraction of groundwater. The status has been classified by SEPA as 'Pass'. It is noted that most of Scotland is classified as a protection area.

Aquifer characteristics

7.6.35 Superficial till deposits, where present, consist of silty sandy clays with clasts up to boulder size. The BGS Hydrogeological Map of Fife and Kinross indicates that till deposits in the region of the development do not yield groundwater. However, groundwater may occur within patches of permeable sandy till.

7.6.36 The BGS Digital Hydrogeological Map of Scotland indicates that the igneous rocks which predominantly underlay the development area feature no intergranular permeability, and contain only small amounts of groundwater in the near surface weathered zone and secondary fractures. The sedimentary sandstones with subordinate conglomerates, siltstone and mudstone to the north of the development feature greater intergranular permeability, dominantly fracture flow characteristics and locally yield moderate amounts of groundwater.

7.6.37 The SEPA Bedrock Aquifers Map (2004) classifies underlying aquifers according to the predominant groundwater flow mechanism (fracture and/or intergranular) and the estimated groundwater productivity. Aquifer productivity is divided into five productivity classes ranging from very low productivity (yielding <0.1l/s) to very high productivity (yielding >20l/s). The map shows that the underlying bedrock beneath the development area has been classified as having fracture flow with low productivity (F L) over igneous intrusive and fracture flow with moderate productivity (F M) over sedimentary sandstone.

7.6.38 The SEPA Vulnerability of Groundwater (in the upper most aquifer) Map (2004) assesses the vulnerability of the vertical pathway from a potential hazard at the ground surface to the underlying water table. The following characteristics of the pathway between the ground surface and the water table can affect the degree of attenuation of contaminants and have been used to determine the vulnerability classification presented on the published map:

- the permeability and clay content of the superficial deposits;
- the thickness of the superficial deposits;
- the mode of groundwater flow in bedrock aquifers (fracture or intergranular flow);
- the permeability and clay content of intergranular bedrock aquifers, and;
- the depth to the water table in both superficial and intergranular bedrock aquifers.

7.6.39 Aquifer vulnerability is divided into five classes (1 to 5) with 1 being least vulnerable and 5 being most vulnerable.

7.6.40 The SEPA Groundwater Vulnerability map shows that the groundwater in the underlying units (uppermost aquifer) is classified as being Class 4b - 5 which suggests high vulnerability to those pollutants not readily adsorbed or transformed.

Groundwater levels and flows

7.6.41 In the absence of published information or data held by SEPA, it is inferred that shallow groundwater flow beneath the site will generally follow topography, with the majority of flow

being north and east towards the Dunning Burn. However, the location of permeable sandy beds within superficial till deposits will also be an influential factor on shallow groundwater flow.

7.6.42 It is possible that bedrock groundwater flow beneath the site will follow the dip of the underlying strata (as detailed in 7.6.31), with flow being to the north-west. However fracture flow is highly unpredictable due to the dependency of flow on the location and orientation of faults and other discontinuities.

7.6.43 Shallow groundwater within glacial tills and the weathered bedrock zone is likely to provide groundwater as baseflow to streams, springs and wells in the area which are utilised by private water supplies.

7.6.44 There are no active boreholes within the development area. There are three private water supply boreholes located <1km from the development boundary (PWS3, PWS6 and PWS10, refer to Figure 5a and 5c).

Water resources

Public Water Supplies

7.6.45 No Scottish Water (SW) assets were identified within the development area.

Private Water Supplies

7.6.46 Information was requested from Perth and Kinross Council and local landowners on private water supplies within 2km of the proposed development and site surveys were undertaken to identify and characterise private water supplies. From this information, ten supplies (PWS1-PWS10: refer to Figures 5c) were identified as being potentially located within catchments draining the proposed development site and within 2km of the proposed development site. Refer to Appendix 3 Private Water Supply Risk Assessment for full methodology and results.

7.6.47 Table 5.10 details the private water supplies.

Table 5.10 Private water supplies identified within potentially affected catchments

PWS No.	Properties	Supply location (NGR)	Supply type	Estimated volume abstracted (m3 /day)	Distance of source from infrastructure (m)	Sensitivity of PWS
PWS1	Knowes Farm	NO 01946 11412	Spring	People <10 Livestock <50	7	Very High
PWS2	Kippen House, Kippen Stables, Pebblestone, Marcassies, Lodge House	NO 02439 11991	Spring	People >10	300	High
PWS3	Quilts Farm	NO 02007 12520	Borehole	People <10 Livestock <50	650	Low
PWS4	Dairy Cottage, one other	NO 00721 13054 NO 00720 13051	Spring	People <10	950	High
PWS5	Keltie Castle, Keltie Lodge, Meadowbank (5 properties), Duncrub (2 properties).	NO 02694 12694	Surface Water	People >10	1300	High
PWS6	Tongyfield House	NO 02428 12720	Borehole	People <10	1000	Low
PWS7	Pitmeadow	NO 01126 12019	Surface Water	People <10 Livestock <50	1200	Medium
PWS8	Kippen Home Farm	NO 01951 13998	Spring	People <10 Livestock <50	300	High
PWS9	Findony Farm	NO 02515 10964	Borehole	Industrial 50-499	2300	Medium
PWS10	Cockersfauld	NO 02515 10964	Borehole	People <10	700	Low

Fisheries

7.6.48 The River Earn is classified as a Freshwater Fish Directive Salmonid Water (UKS7865942).

7.6.49 Refer to Ecology Chapter 6.

Water Quality (groundwater and surface water)

7.6.50 SEPA's interactive River Basin Management Plans Map was consulted to identify the ecological status of the waters within and adjacent to the study area.

7.6.51 The SEPA water monitoring and classification system provides the data to support the aim of the WFD (2000/60/EC): 'that all water bodies are of good ecological status, or similar objective, by 2015'.

7.6.52 The classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on an ecological classification system with five quality classes (High, Good, Moderate, Poor and Bad). It has been devised following EU and UK guidance and is underpinned by a range of biological quality elements, supported by measurements of chemistry, hydrology (changes to levels and flows) and morphology (changes to the shape and function of water bodies).

7.6.53 The classification of groundwater bodies describes whether or not they are polluted and whether or not the volume of any water being abstracted from them is sustainable without significant impacts on rivers or wetlands that depend on the groundwater.

7.6.54 Tables 5.11 and 5.12 show the 2008 status results for the watercourses and water bodies within and those outwith but adjacent to the site.

Table 5.11 Watercourse status

Watercourse	Water body ID code	Ecological status	Chemical status	Overall status	Associated protected areas
River Dunning	6804	Moderate	Pass	Moderate	Freshwater Fish protected area (UKS7865942) Strathmore/Fife Nitrate Vulnerable zone (UKS916763)
River Earn	6800	Poor	Pass	Poor	Freshwater Fish protected area (UKS7865942) Strathmore/Fife Nitrate Vulnerable zone (UKS916763) River Earn Drinking Water Protection Zone (6800)

7.6.55 Pressures on the surface water quality of the River Dunning emanate from diffuse source pollution and point source pollution.

7.6.56 Pressures on the surface water quality of the River Earn emanate from morphological alterations and alien species.

Table 5.12 Groundwater Body Status 2008

Groundwater body	Water body ID Code	Quality	Quantity	Overall status	Associated surface waters
Glenfarg bedrock and localised sand and gravel aquifers	150250	Poor	Good	Poor	Dunning Burn

7.6.57 The main issues affecting the groundwater are diffuse source pollution.

Sensitivity of receptors

7.6.58 On the basis of the baseline surveys and available information, Table 5.11 identifies the sensitivity of receptors with justification for their categorisation.

Table 5.11 Sensitivity of receptors

Receptor	Sensitivity	Comment
Surface waters		
Dunning Burn catchment	Very High	Watercourse used for recreation (salmonid fisheries), directly related to watercourse quality Downstream watercourses designated as 'Salmonid Water'
River Earn catchment	Very High	Watercourse used for recreation (salmonid fisheries), directly related to watercourse quality Downstream watercourses designated as 'Salmonid Water'
Flood risk		
Flood Risk	Low	The development area is located in flood zone 1 No areas of development fall within the 1 in 200yr flood inundation envelope.
Geology		
Superficial	Low	There is not expected to be significant superficial deposits and there are no geological designations within the development area.
Solid	Low	Not nationally important and no designations – typical of the wider area.
Hydrogeology		
Glenfarg bedrock and localised sand and gravel aquifers	Very High	Aquifers are classed as being vulnerable to those pollutants not readily adsorbed or transformed (Vulnerability Class 4b-5) in SEPA vulnerability classification scheme. Groundwater is dominated by low productivity fracture flow, offering little protection from pollutants. Strathmore/Fife Nitrate Vulnerable zone (UKS916763) The development area is part of a Drinking Water Protection Area (Glen Esk) – status 'Pass'.
Water resources		
Private Water Supplies	Very High	Ten private water supplies identified within 2km, which supply an approximate total of twenty five properties. The nearest supply (PWS1) utilises shallow groundwater abstractions and is within 100 m from the proposed development infrastructure (refer to Table 5.10 for details).
Public Water Supplies	Low	No public water supplies were identified within the development area

Proposed development

7.6.59 A detailed description of the proposed development and operations is provided in Chapter 1. For the purposes of this section, a review of the development proposals which may impact the baseline hydrology, hydrogeology and soils of the application site is provided below:

- construction of nine wind turbine generators – crane pads and turbine bases;
- development of new access track for turbine delivery;
- widening and realignment of existing track; and
- development of two new watercourse crossings.

7.7 ASSESSMENT OF POTENTIAL EFFECTS

7.7.1 The potential impacts of the construction, operation and decommissioning phases of the proposed development on the sensitive receptors are identified in Tables 5.14 and 5.15. As decommissioning activities will be very similar to construction activities they are included in the discussion on construction effects.

Construction effects on hydrology

Modification to surface runoff

7.7.2 Increases in the rate and volume of runoff can be caused by excavations, exposure of bare ground and compaction of soils and poor design of site drainage. As well as increasing the risk of downstream flooding, it is also possible that increases in the volume of runoff entering watercourses can alter the water quality and hydrological regime of the development area.

7.7.3 Due to the moderately sloping topography and the superficial geology present a low degree of infiltration at the development site is anticipated. Movement of construction traffic may lead to compaction of the soil, reducing soil permeability and rainfall infiltration, which could lead to changes in the runoff rates at the development area. Increases in runoff may lead to changes in the flow pattern within a receiving watercourse, which could potentially lead to a change in watercourse morphology and effects on ecology. Runoff can also arise from track dust suppression during dry periods.

7.7.4 The approximate total permanent land take for site infrastructure including the access track would be approximately 0.02km^2. The permanent infrastructure would occupy approximately 0.0023% of the River Earn catchment.

7.7.5 Potential modifications to surface runoff are considered to be of a minor magnitude.

Impediments to flow

7.7.6 Inappropriately designed watercourse and drain crossings on site could restrict flow in the watercourses and drainage systems and reduce hydraulic capacity. Poorly constructed watercourse and drain crossings can also cause hydraulic jumps at the inlet and outlet of a crossing. The results of poorly constructed watercourse and drain crossings could increase the promotion of erosion and sedimentation within the watercourses and open drains, ultimately having a detrimental effect on water quality.

7.7.7 Access tracks associated with watercourse and drain crossings can also alter drainage to the upper reaches of watercourses if inadequately designed and installed. This can lead to higher water levels upstream leading to increased localised flood risk.

7.7.8 Potential impediments to flow are considered to be of a minor magnitude.

Chemical pollution

7.7.9 Small amounts of chemicals could be stored and used on-site during the construction of the proposed development. These include unset concrete, concrete additives, fuel and oil. These pollutants may adversely affect the water quality of the receiving surface water and groundwater environment, if poorly handled or stored.

7.7.10 Spillages of concrete may occur during concrete pumping operations into turbine bases, which may runoff into surface watercourses. Concrete is highly corrosive and can cause pH changes in watercourses; this can have severe or fatal consequences on freshwater ecology.

7.7.11 Contamination of surface water may also occur as a result of spillages from routine plant maintenance, improper storage and accidental spillages.

7.7.12 Should an unmitigated pollution incident occur, there is a potential for increased surface water runoff with pollutant loads such as oils and fuels from hardstandings and unset concrete from turbine foundations, especially during heavy rainfall.

7.7.13 Due to the distance from construction activities, requiring the anticipated use of these chemicals, to adjacent watercourses on site the potential effects associated with chemical pollution are considered to have a medium magnitude.

Erosion and sedimentation

7.7.14 Changes in natural drainage patterns due to runoff from exposed soil, dewatering, stripping of vegetation and topsoils may lead to the erosion and transport of sediment into watercourses. Increased flow rates due to site drainage can also lead to increased erosion of watercourse bed and banks. Sedimentation of watercourses can have a detrimental effect on flood storage capacity and water quality.

7.7.15 Sediment can settle out in slower moving stretches of a watercourse, with the potential to smother gravels used for salmonid spawning and hatching, whilst deposits of significant quantities of sediment can alter river morphology. Sediment can also have effects on the health of aquatic fauna by interfering with respiration and increasing stress levels.

7.7.16 Excavations have the potential to fill with rain water, surface runoff and passive groundwater seepage from cut faces and in such instances water will have to be pumped out, contributing to runoff from the site. Water pumped from excavations is likely to contain a moderate level of dissolved and suspended solids. If left to drain in a concentrated flow path, it is likely to result in erosion and convey a sediment load to the downstream watercourse.

7.7.17 Changes in erosion and sedimentation rates are considered to be of a medium magnitude.

Construction effects on hydrogeology

Groundwater level and flow

7.7.18 The installation of the foundations may come into contact with shallow groundwater and have localised impacts on the groundwater regime. Deeper excavations such as those needed for the turbine bases are likely to disrupt localised shallow groundwater within the fractured bedrock and glacial till. Physical cut-offs or dewatering of turbine excavations are likely to alter soil interflow patterns. Cut-offs are likely to divert flow away from the excavation, while dewatering temporarily lowers the water table in the vicinity of the excavation.

7.7.19 Changes in groundwater levels and flows are considered to be of a minor magnitude.

Groundwater quality

7.7.20 As the underlying bedrock aquifer is dominated by fracture flow, any spills of hydrocarbons, chemicals, transformer oils and fuel leaks during construction present a potential source of contamination. However the glacial till covering the majority of the development area is expected to provide a level of protection to the groundwater in the bedrock.

7.7.21 Cable trenches can also provide preferential flow pathways for groundwater, especially if cut to the drift and bedrock interface. However, groundwater in the glacial till is expected to be limited.

7.7.22 The impacts on the groundwater environment are considered to be of a minor magnitude.

Private Water Supplies

7.7.23 As with surface water and hydrogeology, a number of chemicals will be stored and used on-site during construction of the proposed wind farm.

7.7.24 Potential effects on private water supplies include the infiltration or runoff of contaminants with the potential to affect the quality of waters from groundwater springs from which the local supplies abstract.

7.7.25 Dewatering from excavations and construction of 'cut' access tracks present a risk to private supplies. Dewatering and 'cut' access tracks can disrupt the flow of groundwater and potentially affect the quality and quantity of water serving the supplies.

7.7.26 The proposed access track to Turbine 10 runs within 7m of PWS1 and cuts through the catchment for this shallow groundwater (spring) supply, with the potential to cut off >90% of the supply catchment. No other supplies are likely to be significantly affected by the development. The impacts of the proposed development on private water supplies is considered to be of a high magnitude.

Construction effects on geology

Compaction and erosion

7.7.27 The movement of construction traffic throughout the development site could cause compaction of the soils. The effects of compaction will be localised to the site tracks and infrastructure locations, but has the potential to result in a reduction in soil permeability and rainfall infiltration, thereby increasing the potential for runoff and erosion.

7.7.28 Increases in compaction and erosion are considered to be of a minor magnitude.

Removal of material

7.7.29 During the construction it is envisaged that the main impact on the geology would be the removal of in-situ geological deposits during excavation for the access tracks and foundations. The stratum as discussed above does not have any particular geological rarity value and does not display any significant features which cannot be observed elsewhere.

7.7.30 Removal of material is considered to be of a negligible magnitude.

Structural

7.7.31 Prior to any construction activities on site detailed intrusive site investigations will be completed to confirm material properties and ground conditions in the vicinity of each turbine. Foundation analysis and Stability Risk Assessments should be undertaken by an appropriately qualified engineer. Due to the limited proposed earthworks and nature of the geology, construction of the turbine foundations is considered to be of a minor magnitude.

Operational effects on hydrology

Modification to surface runoff

7.7.32 Modification of the surface hydrological regime of the site, changes to the volume and to runoff rate, would occur as a result of the presence of the proposed infrastructure. Drainage of site infrastructure would result in reduced time to peak and increased runoff volumes leading to a potential increase in the risk of flooding in downstream catchments. Drainage will be designed to attenuate flow and any discharges will be limited to the predevelopment greenfield runoff rate.

7.7.33 These impacts are considered to be of a minor magnitude.

Impediments to flow

7.7.34 During the operational phase, impediments to flows generally only arise should there be any blockages to ditches and watercourses resulting from natural vegetation and erosion debris. This could cause a localised flood risk to on site operations should it occur.

7.7.35 This impact is considered to be of a minor magnitude.

Chemical Pollution

7.7.36 The potential risk of pollution would be substantially lower during the operational phase because of the decreased levels of activity. The majority of potential pollutants would have been removed when construction is complete, however, lubricants for turbine gearboxes, hydraulic oils and the potential for possible fuel leaks from maintenance vehicles would remain.

7.7.37 These impacts are considered to be of a minor magnitude.

Erosion and sedimentation

7.7.38 Levels of erosion and sedimentation would also be much lower than during construction as there are unlikely to be excavations or bare exposed ground, following post construction

restoration. Some erosion and sedimentation would still be possible on the access tracks, hardstandings and drainage ditches as a result of scouring during extreme rainfall events. Similarly there could be some minor erosion and sedimentation around new and upgraded watercourse crossings, and around drainage crossings as they find a new equilibrium. This could have a detrimental effect on the ecology of aquatic plants, fish, and invertebrates.

7.7.39 These impacts are considered to be of a minor magnitude.

Operational effects on hydrogeology

Groundwater quality

7.7.40 During the operational phase of the proposed development there would be considerably less on-site activity than during construction. As the underlying bedrock aquifer is dominated by fracture flow, the leaching of hydrocarbons, chemicals, transformer oils and fuel leaks from maintenance still present a potential source of contamination to the site. However the glacial till covering the majority of the development area is expected to provide a level of protection to the groundwater in the bedrock and the groundwater table in the bedrock is located at depth so that attenuation of any spills is expected to occur in the unsaturated zone.

7.7.41 Cut tracks and their drainage may impact on pore water and any localised shallow groundwater in the glacial till. Backfilled cable trenches may provide preferential flow pathways for any localised groundwater in the glacial till.

7.7.42 The magnitude of this impact on the groundwater environment is considered to be minor.

Private water supplies

7.7.43 Potential effects on private water supplies include the infiltration or runoff of contaminants with the potential to affect the quality of water from groundwater springs. Access tracks constructed using the 'cut' method may divert shallow groundwater away from a supply catchment with the potential to affect the quantity of water from groundwater springs.

7.7.44 There is potential for >90% of the catchment for PWS1 to be permanently cut off by the new proposed 'cut' access track. These impacts are considered to be of a high magnitude.

Operational Effects on geology

Changes to soil interflow patterns

7.7.45 The interception of diffuse overland flow by the tracks and their drainage will disrupt the natural drainage regime of the site, concentrating flows. This prolonged or permanent alteration to the drainage and soil interflow patterns may lead to the drying out of soils, which can ultimately lead to increased erosion.

7.7.46 These potential impacts on soils during the operational phase are considered to be of negligible magnitude.

7.8 MITIGATION

7.8.1 A number of the potential impacts on hydrology have been addressed through the design process by positioning infrastructure to avoid identified hydrological features, (Figure 5a). However, construction and operation activities still have the potential to cause pollution of the water environment, if appropriate mitigation measures are not incorporated.

General site pollution control

7.8.2 During the contractor tendering process for the construction works, environmental specifications and objectives shall be included in the tender documents so that all contractors can allow for mitigation measures in their tender costs. In addition, the use of the following construction contract conditions WAT-SG-31: SEPA Special Requirements for Civil

Engineering Contracts for the Prevention of Pollution V2 (2006) and WAT-SG-32: SEPA Guidance on the Special Requirement for Civil Engineering Contracts V2 (2006) shall be applied.

7.8.3 The conditions to prevent pollution will be addressed within a CEMP, to be prepared in consultation with SEPA and to be submitted at least one month prior to the commencement of development. This CEMP shall systematically identify the pollution risks associated with each operation, and will include:

- A Drainage Management Plan (DMP), which will detail proposed surface drainage measures to treat and deal with all the surface runoff from the site, to be designed in accordance with Sustainable urban Drainage Systems (SuDS) principals.
- A Pollution Prevention Plan (PPP) which will detail the embedded mitigation measures as identified within this ES and any supplementary statements, to address each of the identified pollution risks and proposals for planning activities in relation to heavy rain (using up to a 3 day forecast).
- An environmental checklist to monitor and plan the timing of works to avoid construction of roads, dewatering of pits and other potentially polluting activities during periods of high rainfall (August to January for the development area, however it should be noted that the annual rainfall for this location is below the average recorded for Scotland).
- Details of how the works will be programmed to avoid any adverse impact on sensitive receptors which takes into consideration and avoids working during high rainfall events.
- An Accident Management Plan (AMP) to detail emergency contingency for PWS's and spillage plans.
- A Water Quality Monitoring Plan (WQMP), to detail regular visual inspections and appropriate monitoring of water quantity and quality, and the recording of required environmental actions. To be implemented six months before, during and six months after construction.
- Details of the arrangements for the appointment of an appropriately qualified and experienced environmental manager to supervise operations on site during the whole construction period, and with the authority to stop work and implement remedial work with immediate effect.
- Identification of all construction elements and their location in relation to sensitive receptors such as watercourses.
- A location map of all areas of disturbance with the potential to generate silt-laden run-off, with details of the proposed mitigation at each point as recommended by CIRIA guidance documents.
- A location map of all potential chemical contamination sources, including all fuel, oil and chemical storage areas, vehicle compounds, refuelling sites, waste depots and on-site sewage systems.
- Procedures for dealing with water contaminated from concrete and the excavations into which the concrete is to be poured.

7.8.4 Site specific mitigation measures to deal with the potential impacts identified above, and to be incorporated into the CEMP, are outlined below.

Chemical pollution

7.8.5 Measures to prevent chemical pollution shall include:

- Tool box talks - contractors working on the site will undertake toolbox talks for all site staff, relating to pollution prevention.
- Storage – all equipment, materials and chemicals will be stored within the site compound area, which is at least 50m from watercourses. The chemical, fuel and oil store, within the compound, will be locked, sited on an impervious base within a secured bund of 110% of the storage capacity, within the site compound as per CIRIA guidelines, SEPA PPGs (7 and 8) and the Water Environment (Oil Storage) (Scotland) Regulations 2006.
- Vehicles and refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution to surface water and groundwater. Where practicable, refuelling of vehicles and machinery will be carried out on an impermeable surface in one designated area (the site compound), well away from any watercourse or drainage systems. Where this is not possible, a lockable mobile refuelling bowser (double skinned), will be used and operated by a designated person. As per CIRIA guidelines, SEPA PPGs (7 and 8) and the Water Environment (Oil Storage) (Scotland) Regulations 2006.
- An Accident Management Plan – will ensure that emergency equipment is available on site i.e. spill kits and absorbent materials, advice is available on action to be taken and who should be informed in the event of a pollution incident, and will also be designed and employed for oil and chemical spills that cannot be dealt with at a local level.
- Maintenance – only emergency maintenance to construction plant will be carried out on site, and will preferably be carried out in one designated area (the site compound) on an impermeable surface well away from any watercourse or drainage, except where vehicles have broken down necessitating maintenance at the point of breakdown.
- Welfare arrangements – on-site toilet facilities will be located within the site compound and be adequately designed and maintained to ensure all sewage is disposed of appropriately, as per PPG4. This will take the form of either chemical toilets with the waste water and soild waste tankered off-site for disposal or an on-site septic tank with soakaway.
- Cement and concrete – use an as neutral a pH concrete as practicable, designed to protect the quality of the local groundwater. Any wash waters will be contained within suitable tanks for off-site disposal.

Runoff, erosion and sedimentation

7.8.6 Measures to prevent runoff and sediment laden water entering watercourses will include:

- Materials employed to construct the access track and hardstandings (crane pad and compound) will be of a sufficient grade/type to ensure that the existing soil infiltration rates are maintained to protect the quantity of local watercourses. The track construction will avoid the use of cements or fine materials as fill.
- Track drainage, shall be designed to prevent the build-up of large volumes of water, the cut tracks shall be cambered towards regular drainage features, be porous and act as

soakaways thereby preventing any concentration of flows, direct discharge to the downstream watercourses preventing any loss of connectivity within the catchments.

- Destabilisation works, excavations, ground disturbance or stripping of vegetation and/or topsoil will be planned to be undertaken, where practicable, to avoid the local higher rainfall periods between August and January (it should be noted that the location receives a lower annual rainfall than the Met Office Scottish annual average). Any works shall be suspended during rainfall events to minimise creation of sediment laden surface runoff and weather forecast information shall be utilised to plan the timing of excavation works.
- Sediment mobilisation – stockpiles of any excavated materials (fines in particular) and imported construction weather sensitive materials shall be minimised in extent. The stockpiles shall be sited outwith 50m from any watercourse and outwith 10 m from any installed/constructed drainage measures. Where practicable these stores will be sited on flat ground, enclosed within keyed in silt fencing and reinstated/covered over at the earliest possible opportunity.
- Buffer zones – suitable buffer zones (as specified by SEPA and the Forests and Water Guidelines, 2003) of at least 50m shall be maintained between the access track, turbine base, new ditches and the downstream local watercourses to allow for entrapment of sediments and protection of riparian zones through the use of silt traps and settlement ponds, and to avoid sediment reaching the downstream watercourse directly. It should be noted that a buffer, to the downstream surface watercourses, was considered in the design process and as a result no infrastructure is proposed within 50m of watercourses with the exception of perpendicular access track crossings. Turbine 1 marginally infringes on the 50m buffer zone, being located at a distance of 47m from the watercourse SW2. This item should be microsited to ensure a buffer zone of 50m between construction activities and watercourses.
- The construction of drainage ditches shall be kept to a minimum, but where necessary for cut track, the length of individual drains shall be minimised to avoid intercepting large volumes of water and concentrating flows.
- The gradient of drainage ditches shall be kept as shallow as possible to avoid high velocities during storm events, gravel check dams and silt fencing shall be installed at regular intervals along drain lengths to reduce velocities and encourage settlement of sediment particles.
- The length of track drainage shall be minimised and tracks shall be cambered to direct runoff to any constructed drainage and avoid any ponding.
- Inspections and cleaning of silt traps and sediment settlement tanks will be undertaken regularly to ensure they remain fully operational and effective.
- Temporary pumping of localised spring/groundwater from turbine bases during construction shall be attenuated in bunded/impermeable settlement ponds and treated before being discharged to areas of ground capable of absorbing the water. Pumped water shall not be discharged directly into any nearby surface watercourses under any circumstances.

- Cables will be laid in trenches alongside the cut access track. All the cables shall be buried within a trench, the trenches shall be back filled and any possible flows within the trenches shall be restricted by the use of regular impermeable bunds.

Change in groundwater levels

7.8.7 The effects of groundwater control during construction are likely to be temporary and reversible. Localised lowering of the groundwater table around drainage ditches shall be reduced by minimising the lengths and depth of the ditches. Permanent physical cut-offs will be avoided where possible, except for shallow groundwater routed around the turbine bases. Drainage design shall be fully detailed in the CEMP.

Private Water Supplies

7.8.8 A 250m buffer around private water supplies should be maintained to minimise risk of disruption to groundwater flow or chemical pollution.

7.8.9 One supply (PWS1) is located within this buffer zone and there is also potential for the catchment to this supply to be permanently cut off by the construction of the new access track to T10 (see Figure 5c). There is also potential for disruption of PWS pipework for PWS1 within the vicinity of Knowes Farm.

7.8.10 A vegetated farm track currently exists along the route of the proposed new access track to T10. The proposed new access track design will maintain the existing hydrological connectivity between the spring source for PWS1 and the indicative supply catchment as shown in Figure 5c. This may entail the use of permeable track materials, culverting and 'floating-track' design. PWS infrastructure (pipework, tanks) will be located prior to works and avoided, protected and/or replaced if damaged. Infiltration and runoff of contaminants will be prevented through a drainage design which will direct runoff from tracked areas away from the PWS catchment and avoidance of refuelling and storage of chemicals within the supply catchment and within 250m of the PWS source.

7.8.11 Access tracks, turbine bases and crane hardstandings related to turbines T3 and T5 in the north of the development area should be constructed in a way to ensure the integrity of PWS2 and PWS8, located at a distance of 307m and 259m from development infrastructure respectively. Water quality monitoring should be carried out at PWS1, PWS2 and PWS8 prior to, during and after the construction works. No refuelling or storage of chemicals should be undertaken within 250m from private water supply sources.

7.8.12 It is noted that as part of the design process the section of access track between T3 and T5 was rerouted to avoid any infrastructure being located within the catchment of PWS2.

7.8.13 The following general mitigation is recommended:

- A detailed investigation of drainage patterns across the site and off site shall be undertaken to fully characterise the PWS;
- A Pollution Prevention Plan (PPP) and a Water Quality Monitoring Plan (WQMP) shall be prepared in advance of the construction works to reduce the likelihood of groundwater and surface water pollution and ensure rapid response in the case of a pollution event; and
- A detailed contingency plan shall be provided to ensure protection to all PWS at risk.

7.8.14 Refer to Appendix 3 Private Water Supply Risk Assessment.

Turbine foundations

7.8.15 During the formation of foundations, the following construction practices are recommended:

- turbine hardstandings will be designed in such a way to direct flow into infiltration trenches, the infiltration trenches will allow the treatment of runoff before gradually discharging back into the natural drainage network;
- if the ground is unsuitable for the use of infiltration measures, grass swales will be used in combination with settlement lagoons/detention basins where required;
- excavations should be sloped to as shallow an angle as possible;
- excavated material should not be placed on marginally stable ground above excavations; and
- the dewatering scheme should minimise the introduction of sediment into downstream watercourses.

Access tracks

7.8.16 During the construction of access tracks, the following practices are recommended:

- where possible, road alignments should avoid slopes of over 6°. Slopes more than 4° should be assessed on a site-by-site basis;
- the tracks will be constructed with sufficient camber or cross fall to minimise ponding of surface water on the track surface;
- road cuttings should be sloped to as shallow an angle as possible to prevent the undercutting of slopes in accordance with the above criteria;
- the drainage design should aim to maintain, attenuate and treat water within each hydrological catchment; the design should avoid creating areas of concentrated flow and high velocities;
- where access tracks are constructed across natural areas of drainage such as flushes and springs, drainage measures, such as pipe culverts will be installed under the access track to allow the run-off to continue to follow its natural course; and
- drainage schemes should minimise the introduction of sediment into natural watercourses.

Crossings

7.8.17 Two new watercourse crossings are proposed to cross SW1 and a small tributary of SW1 (C1 and C2 on Figure 5a). Table 5.12 details the proposed new and upgraded crossing types, as per guidance from SEPA WAT-SG-25, Construction of River Crossings Good Practice Guide and best practice within the water engineering section of the SEPA website for the identified crossing points.

Table 5.12 New and upgraded water crossing assessment

Ref	Location (NGR)	Watercourse description	Proposed crossing type and CAR Authorisation
C1 – SW1	NO 01771 11231	Watercourse to 0.5m – 1.0m wide. Small catchment with low flows, no fish requirements, low gradient. Bedrock substrate.	Closed pipe culvert CAR - Registration

C2 – tributary of SW1	NO 01555 11076	Spring crossing with flowing watercourse to 0.1m - 0.5m wide. Small catchment with low flows, no fish requirements, low gradient. Vegetated substrate.	Closed pipe culvert CAR - Registration

7.8.18 The new closed pipe culverts will be sized by a qualified hydrologist and the design and installation of the closed pipe culverts shall follow appropriate guidance from the following documents:

- CIRIA (1997). Culvert Design Manual - Report 168;
- Scottish Planning Policy (SPP); Flooding and Drainage Section (2010);
- SEPA, Policy No. 26. Policy on the culverting of watercourses v1 (1998);
- SEPA PS-06-02, V1.2 (2006). Culverting of watercourses: SEPA Position Statement to support the implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2005, and;

- SEPA, WAT-SG-25, Engineering in the Water Environment Good Practice Guide – Construction of River Crossings (April 2005).

7.8.19 The culvert designs shall be detailed in the DMP as part of the CEMP and supplied as supporting information for registration under the CARs (SEPA The Water Environment (Controlled Activities) (Scotland) Regulations 2005 A Practical Guide).

Impediments to flow

7.8.20 Drainage ditches and culverts constructed alongside and under access tracks shall be regularly maintained and inspected for blockages.

Compaction

7.8.21 Traffic access will be restricted to tracked areas to minimise the scheme footprint. Land surrounding the immediate construction area will be fenced off, or otherwise demarcated, to prevent inadvertent intrusion from construction plant.

Increase in runoff

7.8.22 Increased surface runoff from increased hardstanding areas is considered unlikely due to the relatively small increase in area and the existing ground conditions being characterised by low permeability drift deposits. However surface runoff shall be attenuated on-site, as detailed in the DMP, to prevent any increased flood risk downstream from the development area.

Impact on the downstream watercourses

7.8.23 To protect the water quality interests of the downstream catchments, construction works will not be undertaken within 50 m of the watercourses draining the site. T1 is currently located at a distance of 47m from the watercourse SW2 and should be microsited to ensure a buffer zone of 50m between construction activities and watercourses. In addition monitoring comprising of regular visual inspections of the downstream watercourses is recommended, as part of the WQMP, before, during and after construction to ensure no adverse impact on surface water quality.

7.9 RESIDUAL EFFECTS

7.9.1 Tables 5.14 and 5.15 summarise the residual significance of the identified effects following the implementation of mitigation measures, as discussed above. The mitigation measures will substantially reduce the magnitude and likelihood of potential effects. The significance of residual effects, assessed in accordance with Table 5.5, is considered to range from 'Minor' to 'Negligible'.

7.10 CUMULATIVE EFFECTS

7.10.1 Twenty eight cumulative commercial wind turbine sites were identified within 60 km of the development site. Seven of the developments have the potential to cause a cumulative effect on the hydrological and hydrogeological regime.

7.10.2 These sites are detailed in Table 5.13 below.

Table 0.13 Cumulative Wind Farm Sites

Wind Farm Site	Number of Turbines	Approximate Distance and Direction from Site	Status	Shared Hydrological Catchment
Greenknowes	18	6 km; SW	Operational	River Earn
Lochelbank	12	9 km; E	Consented	River Earn
Tillyrie or Milnathort	Unknown	10 km SE	Scoping	River Earn
Standingfauld	9	14km, W	Current Application	River Earn
Tochie Burn	Unknown	23 km; E	Scoping	River Earn
Braes Of Doune	36	28 km, W	Operational	River Earn
Mull Hill	9	32 km N	Current Application	River Earn

7.10.3 Based on the Entec 'Review of Guidance on the Assessment of Cumulative Impacts of Onshore Windfarms' document, the following points are made:

- Combined runoff impacts to water quality can arise from developments located within the same hydrological catchment.
- Impacts to water quality are most likely to occur during the construction phase, although they can also occur from high rainfall events during the operational phase.
- Impacts should be mitigated through control mechanisms and particular methods of construction on both sites.
- Residual impacts are only likely to be significant in the scenario of accidental or unpredictable failure of mitigation measures.

7.10.4 The cumulative impacts on the hydrological and hydrogeological environment are therefore considered to be minor, based on the assumption that appropriate mitigation measures and site pollution control measures will be adopted on all sites.

Table 5.14 Potential construction effects

Sensitive receptor	Sensitivity	Potential effects	Pre-mitigation		Post-mitigation	
			Magnitude	Significance	Magnitude	Significance
Surface water						
Dunning Burn/River Earn catchment	Very High	Contamination from oils/fuels/concrete pouring	Medium	Moderate	Minor	Minor
		Contamination from suspended solids/erosion and sedimentation	Medium	Moderate	Minor	Minor
Flood Risk	Low	Increased runoff rates from hard standing areas, soil compaction and construction drainage resulting in potential increased flood risk to downstream catchments	Minor	Negligible	Negligible	Negligible
		Impediments to flow resulting in increased flood risk and disturbance of on-site hydrology	Minor	Negligible	Negligible	Negligible
Geology						
Superficial	Low	Disturbance of soil during construction	Minor	Negligible	Negligible	Negligible
		Compaction and erosion of soils	Negligible	Negligible	Negligible	Negligible
Solid	Low	Disruption to local geological features from turbine excavations and other excavations required for construction	Minor	Negligible	Minor	Negligible
Hydrogeology						
Glenfarg Localised Sand and Gravel aquifers	Very High	Modification of groundwater levels in bedrock through dewatering	Minor	Minor	Negligible	Negligible
		Potential spills and leaks from oils/fuels/concrete pouring	Minor	Minor	Negligible	Negligible
Water resources						
Private water supplies	Very High	Infiltration or run off of contaminants from the development area	High	Major	Minor	Minor
		Site infrastructure causing a reduction in the quantity of water available	High	Major	Minor	Minor

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Table 5.15 Potential operational effects

Sensitive receptor	Sensitivity	Potential effects	Pre-mitigation		Post-mitigation	
			Magnitude	Significance	Magnitude	Significance
Surface water						
Dunning Burn/River Earn catchment	Very High	Contamination from oils/fuels/concrete pouring	Minor	Moderate	Minor	Minor
		Contamination from suspended solids/erosion and sedimentation	Minor	Moderate	Minor	Minor
Flood Risk	Low	Increased runoff rates from hard standing areas, soil compaction and construction drainage resulting in potential increased flood risk to downstream catchments	Minor	Negligible	Negligible	Negligible
		Impediments to flow resulting in increased flood risk and disturbance of on-site hydrology	Minor	Negligible	Negligible	Negligible
Geology						
Superficial	Low	Changes in soil drainage	Negligible	Negligible	Negligible	Negligible
Hydrogeology						
Glenfarg Localised Sand and Gravel aquifers	Very High	Modification of groundwater levels in bedrock through dewatering	Minor	Minor	Negligible	Negligible
		Potential spills and leaks from oils/fuels/concrete pouring	Minor	Minor	Negligible	Negligible
Water resources						
Private water supplies	Very High	Infiltration or run off of contaminants from the development area	Minor	Minor	Minor	Minor
		Site infrastructure causing a reduction in the quantity of water available	High	Major	Minor	Minor

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7.11 CONCLUSIONS

7.11.1 Construction of the nine turbines involves several phases and activities which may potentially affect the hydrology, hydrogeology and soils of the receiving environments. These activities have been identified and an assessment of their potential effects made.

7.11.2 The main potential effects of the proposed development will be impacts on water quality within downstream catchments through chemical pollution and erosion and sedimentation, with the potential for impacts on designated fisheries, and impacts on water quality and quantity of private water supplies through chemical pollution and sedimentation, loss of supply catchment and disruption of supply infrastructure.

7.11.3 Mitigation measures have been proposed which will reduce the likelihood and magnitude of the potential effects on all of the sensitive receptors, such that any adverse residual effects are assessed as being of minor significance or lower.

7.11.4 Overall, the effects of the proposed wind development on the sites hydrological, hydrogeological and soil regime are not significant under the terms of the EIA Regulations.

7.11.5 In order to ensure that the mitigation measures are carried out, environmental specifications and objectives shall be included in the tender documents so that all contractors can allow for the mitigation measures in their tender costs. A CEMP shall be drawn up and onsite supervision put in place to ensure that the mitigation measures are adhered to by all site contractors. Continued consultation with SEPA and the Perth and Kinross Council will be carried out in order to ensure on-going agreement regarding the proposed mitigation measures.

7.12 REFERENCES

Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10 (HA 216/06) 'Road Drainage and the Water Environment'

HMSO (1995). Preparation of Environmental Statement for Projects that Require Environmental Assessment A Good Practice Guide, 1995.

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Mustow, S.E, Burgess, P.F, Walker, N (2005). Practical Methodology for Determining the Significance of Effects on the Water Environment, WEJ, Journal of the Chartered Institution of Water and Environmental Management, Volume June 2005 No.2, 100-108.

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CHAPTER 8

CULTURAL HERITAGE

8 Cultural Heritage

8.1 Introduction

This chapter considers the potential effects of the proposal on the cultural heritage and archaeological interests of the application site and surrounding area. The aim of the cultural heritage assessment is to describe and analyse the impact of the proposed turbines on cultural heritage and identify any mitigation requirements if necessary.

8.2 Guidance and Legislation

8.2.1 National Policy

Information relating to the historic environment is available through a number of statutory and non-statutory documents and guidance. The most notable of which are:

- Scottish Planning Policy (SPP);
- Scottish Historic Environmental Policy (SHEP, 2011);
- Managing Change in the Historic Environment Guidance Notes; and
- Planning Advice Note 2/2011: Planning and Archaeology.

Scottish Planning Policy states that '*the historic environment is a key part of Scotland's national heritage and it enhances national, regional and local distinctiveness, contributing to sustainable economic growth and regeneration.*'

The Scottish Historic Environmental Policy defines the historic environment as '*the historic dimension that contributes to its quality and character... most obvious in our built heritage: ancient monuments; archaeological sites and landscapes; historic buildings; townscapes; parks; gardens and designed landscapes; and our marine heritage*'. The fundamental principle of SHEP '*is not about preventing change*' but that the historic environment '*should be managed intelligently and with understanding*'. It goes on to identify that, '*there should be a presumption in favour of protection of individual historic assets and also the pattern of the wider historic environment; no historic asset should be lost or radically changed without adequate consideration of its significance and of all the means available to manage and conserve it*'.

The Acts listed below identify the relevant legislation which must be adhered to in regards to cultural heritage within areas sensitive to development:

- Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997;
- The Ancient Monuments and Archaeological Areas Act 1979;
- The Town and Country Planning (Scotland) Act 1997;
- The Planning etc. (Scotland) Act 2006;
- The Protection of Wrecks Act 1973; and
- The Protection of Military Remains Act 1986.

These Acts provide protection for historic features in the landscape through the following statutory designations:

- **Scheduled Ancient Monuments**

The Ancient Monuments and Archaeological Areas Act 1979 gives protection to archaeological sites and ancient monuments of national importance from any development which would adversely affect them. Protection is provided to Scheduled Monuments through the requirement of statutory consent of the Scottish Ministers before works which would result in the demolition, destruction, damage, removal, repair, alteration, flooding or tipping of a Scheduled monument.

- **Listed Buildings**

The Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 gives protection to buildings which are of special architectural or historic interest against detrimental works. Listed buildings are classified into Categories A, B and C(S) of decreasing levels of importance; category 'A' being considered of national or international importance. Protection is provided to listed buildings through the requirement for consent of the Scottish Ministers before the undertaking of any works with a detrimental effect.

There are a number of non-statutory designations which have an importance in decision making. These include archaeological sites, buildings, monuments and areas of historic interest which are taken into consideration by the local planning authority. In regards to cultural heritage, the following sites are considered important on a national level:

- **Gardens and Designed Landscapes**

Gardens and designed landscapes can be defined as grounds that are consciously laid out for artistic effect. They are often the setting of important buildings and, in addition to parkland, woodland, water and formal garden elements, can often have significant archaeological and scientific interest. The historical, cultural and ecological importance of these sites has resulted in the Inventory of Gardens and Designed Landscapes in Scotland which provides the sites with a degree of protection through the planning system; adhering to national policy found in SPP and SHEP which provide further guidance.

8.2.2 Regional and Local Planning Policy

The following sections set out the relevant planning policies covering the Local Authority area. Current regional and local planning guidance is provided by the *Perth and Kinross Council Local Development Plan* adopted in February 2014.

The local development plan identifies a vision for the future development of Perth and Kinross which seeks to promote sustainable economic growth while recognising and protecting the area's valuable heritage and assets. The development plan sets out a new of key policies which address the need for historic heritage protection:

- **Policy HE1: Scheduled Monuments and Non-Designated Archaeology**

HE1A: Scheduled Monuments

"There is a presumption against development which would have an adverse effect on the integrity of a Scheduled Monument and its setting, unless there are exceptional circumstances."

HE1B: Non-Designated Archaeology

"The Council will seek to protect areas or sites of known archaeological interest and their settings. Where development is proposed in such areas, there will be a strong presumption in favour of preservation in situ. Where, in exceptional circumstances, preservation of the archaeological features is not feasible, the developer, if necessary through appropriate conditions attached to the granting of planning permission, will be required to make provision for the survey, excavation, recording and analysis of threatened features prior to development commencing. If discoveries are made during any

development, work should be suspended, the local Planning Authority should be informed immediately and mitigation measures should be agreed."

- **HE2: Listed Buildings**

  " There is a presumption in favour of the retention and sympathetic restoration, correct maintenance and sensitive management of listed buildings to enable them to remain in active use, and any proposed alterations or adaptations to help sustain or enhance a building's beneficial use should not adversely affect its special interest. Encouragement will be given to proposals to improve the energy efficiency of listed buildings within Perth and Kinross, providing such improvements do not impact detrimentally on the special interest of the building. Enabling development may be acceptable where it can be shown to be the only means of retaining a listed building. The layout, design, materials, scale, siting and use of any development which will affect a listed building or its setting should be appropriate to the building's character, appearance and setting."

- **HE3: Conservation Areas**

  HE3A: New Development

  "Development within a Conservation Area must preserve or enhance its character or appearance. The design, materials, scale and siting of new development within a conservation area, and development outwith an area that will impact upon its special qualities should be appropriate to its appearance, character and setting. Where a Conservation Area Appraisal has been undertaken for the area, the details contained in that appraisal should be used to guide the form and design of new development proposals. Applications for Planning Permission in Principle in Conservation Areas will not be considered acceptable without detailed plans, including elevations, which show the development in its setting."

  HE3B: Demolition within Conservation Areas

  "When assessing applications for the demolition of unlisted buildings in Conservation Areas, the Council will give careful consideration to the merits of the building and its contribution to the character and appearance of the Conservation Area. Where a building is considered to be of value, either in itself or as part of a group, there will be a presumption in favour of its retention, restoration for the current or another appropriate use. In those exceptional circumstances where demolition is considered acceptable and is to be followed by the redevelopment of the site, the application for proposed demolition should be accompanied by a detailed application for the replacement development. This is to allow for their consideration in parallel, and to ensure that the replacement scheme will enhance or preserve the character of the area and avoid the formation of gap sites."

- **HE4: Gardens and Designed Landscapes**

  "Gardens and designed landscapes make a significant contribution to the character and quality of the landscape in Perth and Kinross. The Council will seek to manage change in order to protect and enhance the integrity of those sites included on the current Inventory of Gardens and Designed Landscapes. The Council may require the submission of a management plan with any application for development within areas included in the current Inventory."

- **HE5: Protection, Promotion and Interpretation of Historic Battlefields**

  "The Council will seek to protect those battlefields listed on the Inventory of Historic Battlefields. The Council encourages the creation of a Conservation Plan for historic battlefield sites as a means of developing an overall vision and strategy for protecting, conserving and enhancing public awareness of battlefields through a partnership approach."

8.3 Assessment Methodology

8.3.1 Information Sources

In order to examine the wide range of features included within the scope of cultural heritage the following sources were consulted with supplementary sources utilised if necessary:

- Historic Scotland GIS Data
- The Royal Commission for Ancient and Historic Monuments of Scotland Pastmap Database;
- Sites and Monuments Records (SMR);
- The Inventory of Gardens and Designed Landscapes in Scotland; and
- Statutory List of Buildings of Special Architectural or Historic Interest.

8.3.2 Scope of Assessment

The following stages must be undertaken in assessing the impact of change on the setting of a historic asset or place:

- Stage 1: Identify the historic assets that might be affected by the proposed change;
- Stage 2: Define the setting by establishing how surroundings contribute to the ways in which the historic asset or place is understood, appreciated and experienced;
- Stage 3: Assess how any change would impact upon that setting[1].

In order to identify the historic assets that might be affected by the proposed change all assets are recorded within 10km of the wind farm development. In order to place the site within its local context three distinct study areas have been identified (Figure 8.1):

- **A**- 500m from each turbine;
- **B**- 500m-5km from each turbine; and
- **C**- 5km-10km from each turbine.

As stated in the Scottish Government's 'PAN 2011/2: Archaeology' not all archaeological sites and monuments are of equal importance. Within Area A, there is greater potential for direct impacts to occur within the site therefore archaeological and cultural assets of national, regional and local importance are identified and evaluated:

- Scottish Sites and Monument Records (SMR);
- Scheduled Ancient Monuments (SAM);
- Listed Buildings (LB);
- National Monuments Record of Scotland (NMR);
- Historic Gardens and Designed Landscapes (HGDL); and
- Conservation Areas (CA).

Within Areas B and C the potential for direct impacts is significantly reduced, therefore the search within these areas will consider, but is not restricted to, the identification of statutory designations of national or 'high' importance that may experience indirect impact on their setting (See Table 8.1).

During preliminary studies it was not considered necessary to increase the search boundary beyond Area C (in excess of 10km). It is considered that beyond 10km the turbines would not be an overbearing feature within the landscape and consequently cause no significant impact to the setting of a cultural or archaeological asset.

[1] Historic Scotland (2010) Managing Change in the Historic Environment: Setting. Available: http://www.historic-scotland.gov.uk/setting-2.pdf [Accessed: 08/03/2013]

The sensitivity (Table 8.1) and magnitude (Table 8.2) of any potential impact within each search area are evaluated to establish the overall impact expected as a result of the development. To assist in the evaluation process, a blade tip zone of theoretical visibility (ZTV) is used to assess the potential predicted view of the proposed development within all search areas (Figure 3.3). For comparative purposes ZTVs have also been created showing predicted views to hub height of the turbines (Figure 3.6).

Where an impact to a cultural asset is identified as major it is discussed further in the context of its setting with wireframes or photomontages produced where relevant.

8.3.4 Assessment Criteria

The following criteria in Tables 8.1 and 8.2 outline the sensitivity and magnitude of change of the built and cultural heritage. Table 8.3 is a matrix used to assess the overall impact of the development on the built and cultural heritage.

Table 8.1 Built and cultural heritage sensitivity.

Sensitivity	Definition
High	Category A listed buildings Scheduled Monuments Historic Gardens and Designed Landscapes Non-statutory sites likely to be of national importance
Medium	Category B and C(S) listed buildings Archaeological sites on Sites and Monument Record Conservation Areas
Low	Archaeological sites of lesser importance Non-inventory Garden and Designed Landscapes

The magnitude of an impact upon built and cultural heritage results from a change to any of its key cultural characteristics regardless of national, regional or local importance (Table 8.2).

The level of magnitude is influenced by a number of factors and as such, may not meet all criteria set out in Table 8.2 due to the subjective nature of the assessment.

The following factors[2] may assist in establishing the magnitude of change upon the setting of an asset:

- Current landscape or townscape context;
- Visual envelope, incorporating views to, from and across the historic asset or place;
- Key vistas, framed by rows of trees, buildings or natural features that give an asset a place or context, whether intentional or not;
- The prominence of the historic asset or place in views throughout the surrounding area;
- Character of the surrounding area;
- General and specific views including foregrounds and backdrops;
- Relationship between both built and natural features;
- Aesthetic qualities;

[2] Historic Scotland (2010) Managing Change in the Historic Environment: Setting. Available: http://www.historic-scotland.gov.uk/setting-2.pdf [Accessed: 08/03/2013]

- Other non-visual factors such as historical, artistic, literary, linguistic, or scenic associations, intellectual relationships (e.g. to a theory, plan or design), or sensory factors;
- A 'Sense of Place': the overall effect formed by the above factors.

Table 8.2 Magnitude of change to built and cultural heritage receptors.

Magnitude	Definition
Substantial	Receptor(s) is within 500m of the development; and/or The removal or partial removal of a key element or feature resulting in a loss of physical integrity of the asset; and/or The introduction of an uncharacteristic element which has a substantial impact on the setting of the asset.
Moderate	Receptor(s) is within 500m-2km of the development; and/or The removal or partial removal of one or more secondary feature resulting in a significant change to the integrity of the site; and/or The introduction of an uncharacteristic element which has a partial impact on the setting of the asset.
Slight	Receptor(s) is within 2-5km of the development; and/or The partial removal or alteration to one or more secondary feature causing a minor but not significant change to the integrity of the site; and/or The introduction of an uncharacteristic element which has a minor impact on the setting of the asset.
Negligible	Receptor(s) is within 5-10km of the development; and/or The alteration to one or more secondary feature causing no significant change to the integrity of the site; and/or The introduction of an uncharacteristic element which has no impact on the setting of the asset.

The magnitude of effect and sensitivity is used to evaluate the overall impact to receptors as a result of the proposed development (Table 8.3). When the overall impact or effect is found to be major, it is considered significant. Where a significant impact is identified, the asset/feature is discussed in detail with specific mitigation measures identified where necessary. When an impact is found not to be significant the effects are considered low enough that mitigation measures are not required.

Table 8.3 Matrix of magnitude of effect and sensitivity used to test the significance of impact to built and cultural heritage receptors.

Magnitude	Sensitivity		
	High	Medium	Low
Substantial	Major	Moderate – Major	Moderate
Moderate	Moderate – Major	Moderate	Minor – moderate
Slight	Moderate	Minor – Moderate	Minor
Negligible	Negligible	Negligible	Negligible

8.4 Baseline Data

Baseline data has been recorded and assessed and is discussed below for the 3 search areas previously identified. A preliminary search of cultural assets within the study areas revealed that the closest Category B listed building is located approximately 1.5km from Knowes wind farm. As Category B listed buildings are considered to be of medium sensitivity they are unlikely to be significantly affected from

this distance. As such it was not considered necessary to include an assessment of properties in this category and therefore only Category A listed buildings are considered in the assessment.

8.4.1 Area A

All known cultural or archaeological assets of national, regional and local importance in Area A are identified in Figure 8.2.

Within search Area A, 3 Canmore and 2 Historic Environment records were identified. These identified cultural or archaeological assets of local importance are listed and evaluated in Appendix 8.1.

8.4.2 Area B

Cultural or archaeological assets of national importance are identified in Figure 8.3. Within this search area 31 Scheduled Ancient Monuments (SM) were identified. There is 1 Historic Garden and Designed Landscape (HGDL) site and 3 Category A listed buildings. The identified cultural or archaeological assets of national importance are listed and evaluated in Appendix 8.2.

8.4.3 Area C

Cultural or archaeological assets of national importance are identified in Figure 8.4. Within this area 57 Scheduled Monuments and 12 Category A listed Buildings were identified, which are detailed in Appendix 8.4 & 8.5 and evaluated where appropriate.

8.5 Assessment of Potential Effects

8.5.1 Direct Effects

The potential for direct effects to impact any archaeological, cultural or historic asset exists during a variety of activities primarily during the construction and decommissioning of the turbines. Details of the construction phase are found in Chapter 1.7 with the greatest potential existing during activities that cause physical disruption to the site, including the creation of the crane hard-standing, turbine foundations, access tracks and cable laying. Construction activities have the potential to cause irreversible loss or damage to a feature of historic or archaeological significance. Therefore care must be taken to identify and evaluate all assets which may experience physical disturbance in order to establish appropriate mitigation measures where necessary.

Cultural or archaeological assets that can be considered to be at greatest risk during the construction phase of the development would be those within Area A: 500m surrounding each turbine. The location of the access tracks, crane hard-standing and turbine is not in close proximity to any identified features of cultural or archaeological value. Therefore there will be no direct impacts on known assets of cultural or archaeological value resulting from the proposed turbine construction.

As with any development, the potential exists for accidental damage to an asset of archaeological or cultural significance as a result of a deviation from the planned construction or the result of an unexpected event. In order to deal with unexpected events, mitigation measures such as fenced exclusion or buffer zones surrounding areas and vulnerable features must be considered during periods of high risk.

The potential exists for previously undiscovered or unrecorded assets to be disrupted or discovered during periods of ground disturbance. Due to the relatively small area of land-take required for the wind farm project, this impact can be considered minimal; however, is evaluated below with mitigation measures proposed if deemed necessary. Outside of Area A, direct effects are not considered due to

the distance from any physical feature of the turbine during construction, operation, maintenance or decommissioning.

During decommissioning of the wind farm, there would be no additional ground disturbance than those experienced during construction.

8.5.2 Indirect Effects

Indirect effects can be defined as those that occur from a simple or complex pathway resulting in a secondary impact. Indirect effects to cultural or archaeological assets as a result of wind turbine development often occur due to a change in the setting of a feature during operation. However, the potential for indirect impacts varies with each asset dependent on a number of aspects (such as its defining features and characteristics).

Figure 3.7 in Volume 3 shows the potential visibility of the wind turbine blade tips within the search areas up to 10km. Screening from vegetation and the built environment is not taken into consideration and hence depicts a 'worst case' scenario, often lower in practice.

8.5.3 Area A

There are no sites of national importance found within study Area A, which includes a 500m radius from each turbine. Within this area there are two sites of local significance which are designated as RCAHMS records, an enclosure called Casken Hill, and a farmstead called Knowes. The siting of the proposed wind farm and access road will have no direct impact on any asset identified in the search following the iterative design process, which took into consideration all the characteristics of the site.

The potential indirect impact to the cultural relics in this area has been evaluated and shown in Appendix 8.1. Indirect impacts that may result from the proposed Knowes development are found to be of **moderate** effect to these assets, and not significant.

8.5.4 Area B

Sites identified as having particular historic or cultural significance and/or are in close proximity to the proposal have been fully evaluated and discussed below as set out in the methodology. An evaluation of all features of national importance within Area B can be found in the Appendix 8.2 & 8.3.

The Gray Stone standing stone Scheduled Monument is located approximately 700 metres from the closest turbine to the east. The monument comprises a standing stone of Neolithic or early Bronze Age date. The stone stands over 2 metres tall and is of national importance due to its potential to contribute to Neolithic and Bronze Age understanding. The ZTV in Figure 3.4 illustrates views of all 9 turbines, with no potential for woodland screening. Figure 8.5 provides a rendering of the appearance of the turbines from the standing stone. Although the proposed turbines would be distanced less than 1km away it is reasoned that the overall impact to this relic would be moderate. The integrity of this monument would not be compromised as its broader landscape setting is not vital for either its appreciation, or its importance as a source of Neolithic and Bronze Age understanding. In addition, the relic is likely to be most appreciated with views to the north. Historic Scotland state ritual deposits may be expected in the immediate locale of the stone and these would not be directly affected by the site's access track, which would be located in excess of 250 metres south. Considering the relic's high sensitivity, a **moderate-major** impact is predicted that would not be significant.

The Rossie Law Fort Scheduled Monument is located approximately 1.3km from the closest turbine to the north west and comprises a fort formed by a single wall enclosing an area 600ft by 500ft. Very small traces of platforms are discernible in the interior and the enclosing wall is in an extremely ruinous state.

Figure 3.3 illustrates full visibility except to the fort's north western slopes. However, Figure 3.4 illustrates the screening effect of local woodland to the extent that no visibility is predicted at or immediately surrounding the relic. As a worst-case scenario the Knowes development would present a new and prominent visual feature on the vista from this relic, although it should not significantly detract from vantage point views which are looking towards the north, northwest and northeast and which provide the setting and context for the relic. Although the extent of woodland cannot be guaranteed it is reasoned woodland screening will provide at least some degree of mitigation for the life of the project, while current cover will provide total screening of the development. Overall, as a worst case scenario a **moderate-major** impact is predicted.

The Blaeberry Hill Scheduled Monument lies in an open space within a forested area approximately 1.2km from the closest turbine. The scheduled area consists of a deserted settlement with numerous remains and is of national importance due to its potential to contribute to an understanding of pre-improvement upland settlement and economy. The perceived isolation of this relic helps to provide context for its appreciation and it is therefore important that turbine visibility is considered on the approach to the relic, as well as within its bounds. Figure 3.3 illustrates theoretical visibility of up to 6 turbines in the eastern half of the scheduled area. However, woodland screening is predicted to fully screen views of the proposed turbines, as illustrated in Figure 3.4. This screening extends to almost all of the wooded area east of the B934 including the hills of Cock Law and Balquhandy, except for a very minor section of partial visibility >150m north east of the relic's bounds. Due to the extent of screening predicted it is reasoned there will be only a **negligible** impact at this relic.

The Ben Effray Scheduled Monument is located approximately 2.8km to the west of the development and consists of an Iron Age fort on the summit of Ben Effray. The fort is protected by steep cliffs on the south west side and by three lines of defence on the other three sides. Figure 3.3 shows there will be no visibility at or around this relic and the impact of the Knowes development would be **negligible.**

The Category A listed building of Keltie Castle is located approximately 1.5km north from the closest turbine and comprises a fortified Laird's home and dates to about 1600. Figure 3.3 illustrates that theoretical visibility of up to 3 turbines is predicted to the Castle's grounds. Local woodland is expected to fully screen the turbines in areas at least 250m distant from the house in all directions. Figure 8.6 illustrates the screening at the house. Overall, a **negligible** impact is predicted.

The Garden and Designed Landscape (GDL) of Invermay is located approximately 3.8km from the proposed development at its closest point and extends east to approximately 7.4km distant. The gardens are a fine example of the picturesque landscape movement and of high scenic and historical value. Theoretical visibility is predicted across approximately the north western half of the GDL and this is typically of all 9 turbines. Due to the wooded nature of this designed landscape, however, it is expected that screening will reduce visibility. It is also likely that the extent of tree cover remains constant for the life of the development. Figure 3.4 illustrates that visibility would be reduced to the westernmost third of the total area, with some small patches of partial visibility elsewhere across the gardens. It is considered there will be a **slight-moderate** impact to Invermay overall. The principle mitigating factor is the distance of the turbines from the grounds; at ~4-5km turbines of the proposed scale will appear as minor features that should not be intrusive to the garden, nor impact on its scenic value.

8.5.5 Area C

The search radius of Area C extends from 5km – 10km from the proposed wind farm and includes features of national importance, namely Scheduled Ancient Monuments and Historic Gardens and Designed Landscapes. In many cases where the ZTV illustrates theoretical visibility, their introduction

would not be an intrusive addition to the setting. The principle mitigating factor is the considerable distance of the Knowes wind farm from relics in this search area – in all cases it is reasoned that a separation of 5-10km sufficiently reduces the scale and extent of visibility. Each feature has been evaluated individually and can be seen in Appendix 8.4; however, the overall effect was found to be no higher than **moderate** in any case. In the case of the 12 Category A listed buildings all are expected to be screened from the wind farm by woodland. Appendix 8.5 and 8.6 provide a worst case assessment which does not consider woodland screening.

Dupplin Castle is located approximately 8km from the closest turbine and comprises substantial remains of a formal 18th century landscape with an outstanding combination of varied tree species, distribution and scenic views. Figure 3.3 illustrates widespread visibility of the turbines, although woodland screening is predicted to reduce this visibility to approximately a quarter of the area that falls within this study area. It is reasoned that turbines of the proposed scale from a distance of at least 8km would not present an unacceptable impact at this designation. A **moderate** impact is predicted.

8.5.6 Cumulative Impacts

Within a 10km radius of the proposed Knowes Wind Farm there are 2 operational and consented turbine sites. These are located 6-9km from the site. Visualisations of these are available in Volume 3.

There are no impacts to cultural heritage or archaeological assets predicted during construction or decommissioning resulting from the total wind farm activity proposed or operational in the area due to the confined and identified location of physical ground disturbance.

Given that the predicted overall effect of any asset of cultural heritage or archaeological importance is not found to be significant as a result of a change in setting resulting from the Knowes Wind Farm, the overall cumulative impact results in only a **negligible** impact upon the original evaluation.

The cumulative impact predicted at Category A listed buildings within the search radius is also predicted to be no worse than **negligible** in all cases.

8.6 Mitigation

Historic Scotland states that *'for developments such as wind farms...the only potential mitigation is likely to be good design and responsive site layout which avoids or minimises impacts to an acceptable degree.'* The iterative design process detailed in section 1.4 shows the evolution of the proposed wind farm and the considerations taken in their siting. Through this site design in relation to the archaeological or cultural heritage assets there is expected to be no need for mitigation measures in relation to the majority of cultural and archaeological features identified.

8.6.1 Direct Effects

The effects resulting from the proposed turbines are found to be non-significant to all assets within the search area. Despite the minimal land take required for such a development, Area A is at greatest risk from direct impacts in and around the location of ground breaking activity during construction of the turbine and associated infrastructure with the potential to cause disturbance and/or loss to buried archaeological remains. The risk is highest within these areas closest to the access track and turbines (SMR 1) which provide evidence of potentially unknown assets through previous finds. Mitigation measures for these predicted effects could be proposed through the implementation of a watching brief in sensitive areas in agreement with Perth and Kinross Council prior to any construction activities. The outcome of such mitigation will ensure no residual impacts.

8.6.2 Indirect Effects

There are no cultural or archaeological assets identified in the study that are predicted to experience significant effects as a result of the proposed wind farm.

8.7 Residual Effects

Residual effects are a result of impacts caused by a development which cannot be fully addressed through mitigation measures.

8.7.1 Direct Residual Effects

There are no residual direct effects expected on any known cultural heritage assets.

Following mitigation measures identified above there will be no residual impacts on any previously unknown or unrecorded cultural heritage assets.

8.7.2 Indirect Residual Effects

Residual indirect effects may occur as a result of change within the setting of a feature during turbine operation. The magnitude and significance of indirect effects resulting from the proposed wind farm is found to be no greater than **slight-moderate** in range upon any cultural heritage or archaeological asset as discussed above. Consequently, these impacts will not significantly alter the setting of any feature and the residual indirect effect will be negligible beyond impacts previously discussed.

8.8 Summary of Potential Effects

Following evaluation of all known cultural heritage or archaeological features within a 10km radius of the proposed wind farm, it is predicted that there will be no significant impact on any identified assets during construction, operation or decommissioning.

Mitigation measures have been proposed to ensure the protection of any previously unknown or unrecorded assets and are to be confirmed with the Perth and Kinross Council Archaeologist.

There are no residual impacts resulting from the proposed wind farm at Knowes.

9 Communications Infrastructure and Electromagnetic Interference

9.1 Overview

This chapter assesses the possible effects of the proposed wind farm on existing communications infrastructure and aviation air safeguarding facilities. Wind turbines have the potential to be a physical obstruction that could affect communication networks and aviation activities. Therefore these issue need to be addressed and any impacts which require mitigation are detailed in this section.

9.2 Consultation

Guidance outlined by the BWEA has been followed and a wind turbine proforma has been issued to the MOD and BAA.

Consultation requests were also submitted to the main communication and utilities providers identified as potentially affected by the proposed wind turbine development. A table with the consultees repsonses has been included.

9.3 Assessment Methodology

A list of consultees regarding aviation, MoD, telecommunications and television interests in the area were identified based on advice given in the Scottish Governments web based guidance 'Renewables Advice - Onshore Wind Turbines' (2011). The consultees contacted regarding this application are listed in Table 9.1.

Table 9.1 List of aviation, telecommunications and television stakeholders and their responses (if received)

Consultee	Response Received	Comments
Aviation		
MoD	No	-
BAA	No	-
NATS	Yes	A pre-planning assessment was undertaken. In response to consultation with NATS the size of the wind farm was reduced by two turbines. The tip height of two turbines was also reduced. NATS confirmed in September 2013 that this configuration is acceptable to their standards.
Telecommunication		
Ofcom	Yes	No objection
Joint Radio Company (JRC)	Yes	No objection
Atkins Ltd	Yes	No objection
Cable and Wireless	Yes	No objection following assessment.
Television		
BBC	n/a	Due to the digital switchover no impact is anticipated. However, any impacts will be addressed if later identified.

9.4 Assessment of Potential Effects

9.4.1 Aviation

The MoD and BAA have not yet responded. NATS have confirmed that they have no objection to the proposal following changes to the wind farm design and the turbine heights.

9.4.2 Telecommunication

Cable and Wireless have been consulted and they have no objections to the proposal.

9.4.3 Television

The BBC Windfarms Assessment Tool is currently unavailable and likely to remain so until further notice.

9.5 Summary of Potential Effects

The wind farm is located on a site where no unacceptable interference should affect any existing infrastructure, telecommunication services or aviation.

9.6 Mitigation

Issues requiring mitigation are discussed below.

9.6.1 Telecommunications

Future Fixed Link Telecommunications Traffic

In relation to the potential impacts on future fixed links for the telecommunications industry, the proposed wind cluster, given permission, will become an established element within the area. It will not be possible to establish a new fixed link through the site with the wind cluster in situ.

9.6.2 Television

Most television reception problems can be dealt with by improving the receiving aerials or providing the affected household with an alternative signal source. Where these workarounds are not possible, an investigation may have to be made to implement and provide customised distribution systems to the affected households.

In the event that television reception at local residences is impacted upon, the applicant will commit to appropriate mitigation measures. These measures can be assured in the form of a planning condition if required.

9.7 Residual Effects

There are no residual effects expected from proposed wind farm at Knowes.

APPENDIX 1

Abnormal Indivisible Load Investigations and Route Inspection.

Transportation of Wind Turbine Components to Proposed Knowes Windfarm, Perth and Kinross, Scotland.

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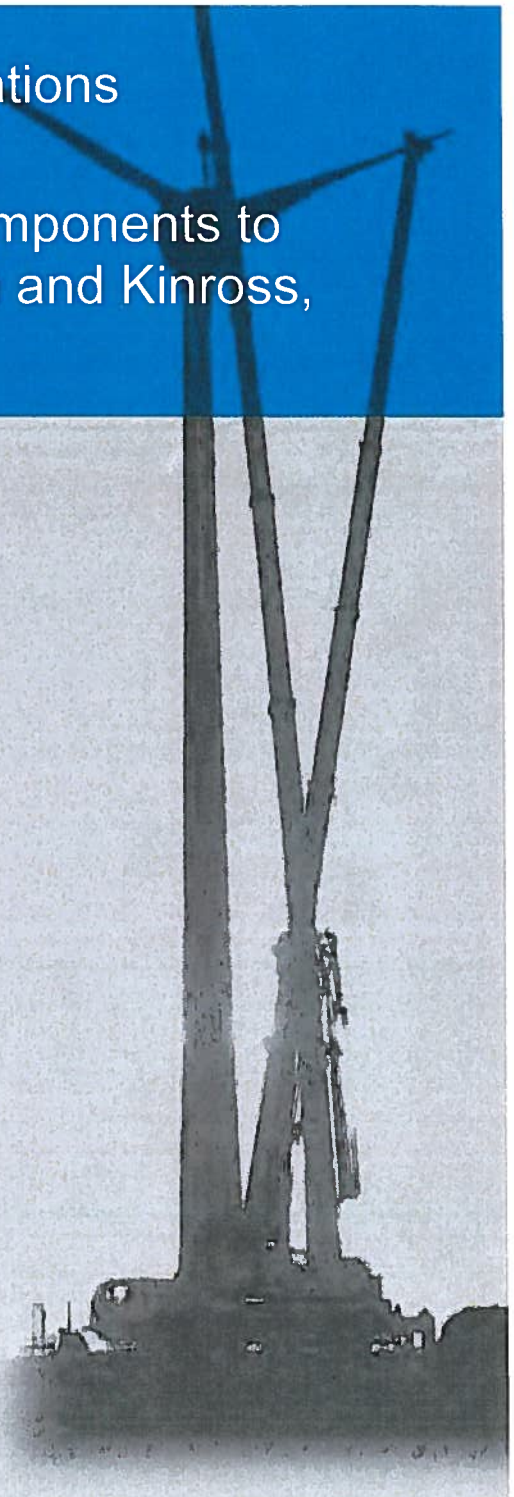

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Document Revisions

No.	Date	Details
0	28.06.13	First Issue
1		
2		

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Executive Summary

Muirden Energy has identified a site for wind farm development proposal at Knowes Farm, south of Dunning, Scotland.

Despite Knowes Farm being closer to Dunning, we have found that it will not be possible to deliver wind turbine blades from the A9 north. Four possible routes were considered but negotiability issues on all four compounded with the geography of Dunning itself means that access is not achievable from the north. Therefore, access must be considered from the south and using the B934 from Yetts of Muckhart.

The route from the M90 at junction 6 via the A977, A823 & A91 is acceptable with caution in particular on the A823 Rumbling Bridge where full highway occupation will be necessary and the generator packed at the appropriate height on the trailer.

All loads, including the mobile crane, should approach Knowes Farm from the South.

The B934 averages some 4 meters in width and is generally good with however several pinch points that require confirmatory surveys. The worst three bends have been checked by swept path OS survey and found to be negotiable with any improvements being able to be made within what appears to be the highway boundary.

Several surveys in addition to the three that have been carried out are recommended to ensure the surveyors preliminary opinion that facilitation works will be within the highway boundaries.

No consideration has been given in these studies for government policy requirements in terms of the delivery of wind turbine components at Special Order category, where Highways Agency policy is to deliver via the nearest suitable and advisable port. It should be noted that the Highways Agency may require that access for Special Order category loads considers access via the nearest available port of delivery. This has not been specifically considered within this report.

No work has been undertaken in terms of the structural suitability of the proposed routes to the site and the status of the proposed routes should be confirmed by additional studies if the project proceeds.

The design to the entrance into the site will need to be considerate of wind turbine delivery vehicles as detailed in the provisional drawings provided with this report.

Nothing in this report shall be construed in any way as confirming that the route has the capacity to accommodate the proposals without the legal notification procedures being followed or that agreement with governing authorities has been provided.

This report is intended to be a summary of the Abnormal Indivisible Load (AIL) route access at the current time and is not a guarantee that the route will be cleared in the future.

1. Introduction

1.1. Muirden Energy has contracted Wynns Ltd to carry out the visual route inspection report for the assessment of possible access for wind turbine equipment, to the proposed Knowes Farm in Perth and Kinross, south of Dunning. Access is considered in terms of Abnormal Indivisible Load (AIL) requirements.

1.2. It is the intention to install Enercon E-70 wind turbines to the proposed development site with a blade length of 33.3m. It should be noted that we are aware that the Enercon E-70 class turbine has a generator width of 4.99m. These dimensions are based on file information available to Wynns Ltd and the transport configurations are discussed further in Section 3. No other turbine components have been considered within this report.

1.3. We are aware of projects where turbine dimensions can vary, specifically with regard to the tower sections and generators. Therefore caution should be applied and clarification given as to the current manufacturing specifications of wind turbine components to allow AIL access issues to be confirmed as part of the planning process.

1.4. Three swept path assessment drawings have been produced which detail the negotiability of the 33.3m blade through the worst case pinch points on the route. It should be noted that there may be a requirement for further swept path assessments as part of the planning process but the worst case locations have been highlighted.

1.5. We have included in this report a location plan showing where swept path assessments have been carried out and also where we recommend additional drawings and instrument surveys. Please see drawing no. ME-KWF-SPLP01 appended to this report.

1.6. It has been assumed for the purpose of these investigations that a route from a potential suitable port of delivery to the general study area will be accessible and this has not been explored in detail within these works.

1.7. Section 5 discusses the potential routes identified to the development site in terms of physical negotiability on the public road network. This report does not include information on the structural status of the proposed routes to the development site and it will be necessary to undertake a review of this aspect of AIL access in the future should the project progress.

1.8. This report is intended to be a summary of the AIL route access at the current time and is not a guarantee that the route will be cleared in the future. Specific movements will need to be assessed at the time on an individual basis and discussions will need to be entered into with all structural authorities on the proposed routes to the development site. If any further information is required, it is available on request.

2. Legislation

2.1. *Definition of Abnormal Indivisible Load (AIL)*

2.1.1. The Department for Transport state that the strict definition of an AIL refers to a load which cannot, without undue expense or risk of damage, be divided into two or more loads for the purpose of carriage on roads and which, owing to its dimensions or weight, cannot be carried on a vehicle which complies in all respects with the 'standard vehicle regulations' these are:

- The Road Vehicles (Construction and Use) Regulations 1986 (as amended)
- The Road Vehicles (Authorised Weight) Regulations 1998 (as amended)
- The Road Vehicles Lighting Regulations 1989 (as amended).

2.1.2. All equipment should be stripped of any ancillaries before they are transported. The requirement for further dismantling is only likely to be acceptable to the HA where it cannot be economically achieved due to the requirement to construct to extremely high tolerances within specific factory environments.

2.1.3. Conventional heavy goods vehicles have an operating weight limit of 44 tonnes. The category known as abnormal indivisible loads (AIL) covers those vehicles where the gross weight exceeds 44 tonnes. An Abnormal Load is defined as that which cannot be carried under Construction and Use (C&U) Regulations. Items which, when loaded on the load carrying vehicle exceed the weights encompassed by the C&U Regulations, but do not exceed Special Order Permission Limits, are governed by Special Types General Order (STGO) categories 1 to 3 depending on size. Where dimensions exceed 6100mm in width, 30000mm in rigid length or 150 tonnes gross weight, Special Order from the Highway Agency (HA), is required.

2.1.4. Special Order category AIL movements are authorised by the Highways Agency (HA) Abnormal Loads team, an executive agency of the Department for Transport (DfT), based in Birmingham. For movements commencing and ending in Scotland Special Order loads are administered on behalf of the HA by Transport Scotland.

2.2. *DfT Policy on the movement of Special Order Category Loads*

2.2.1. The Department for Transport has adopted a 'water-preferred' policy for the transport of AILs. This means that, where an application is sought for the movement of a Special Order or VR1 category load (more than 5.0m width) by road, the Department, via its executive agency, the HA (and Transport Scotland), will turn down the application where it is feasible for a coastal or inland waterway route to be used instead of road. The HA advise that this decision is based on a number of factors including whether the load is divisible, the availability of a suitable route, the amount of traffic congestion that is likely to be caused and the justification for the load to be moved. The Highway Agency Abnormal Loads Team is the department responsible for the authorisation of Special Order AIL's and government policy is that the closest available port of access should be used for the delivery of such oversize items.

2.2.2. No specific approach has been made to the Highways Agency Abnormal Loads Team in terms of government policy requirements regarding the delivery of wind turbine components at

Special Order category, and it is assumed for the current study purposes that turbine components will be delivered via a suitable Scottish port.

2.2.3. Muirden Energy should be aware that it will be necessary to get Agreement in Principle (AiP) from the Highways Agency in terms of the port of delivery for Special Order items prior to delivery.

2.3. *Temporary Traffic Orders and Section 96 of the Roads (Scotland) Act 1984*

2.3.1. Temporary Traffic Orders are used where the local highway authority considers that works on the highway, or some large deliveries, require a road to be closed temporarily to general through traffic. Such closures require a temporary traffic regulation order issued by the Highway Authority under the Road Traffic Regulation Act 1984. In terms of the wind farm component deliveries it is possible that the council will require such an order for the travel of the loads to site from the more major roads as the whole road width will be taken up by the loads for much of the final approaches to site.

2.3.2. In addition to any Temporary Traffic Orders the County Council may wish to ensure that Section 96 of the Roads (Scotland) Act 1984 has been entered into in order to enable AIL access to be agreed. Such agreements are not always, in our experience, asked for as the matter of damage to the carriageway is usually covered by the appointed haulage contractors' indemnity. Section 96 of the Roads (Scotland) Act 1984 allows for the recovery of extraordinary expenses in repairing roads damaged by heavy vehicles, having regard to the average expense of maintaining the road. It allows the Council to pursue costs, through the sheriff court, from the person or body that has caused the damage. Section 96 also allows the Council to reach agreement with the person or body beforehand on a contribution towards the costs of maintaining the road. Section 48 of the Act allows for the Roads Authority to enter into an agreement with any person willing to contribute to the construction or improvement of a road.

3. Transport Configurations

3.1. Due to the size of the components it is not possible to transport them under the regulations governing Construction and Use (C&U) vehicles (44 tonne gross, 18.65m long and 2.9m wide). It will therefore be necessary to comply with legislation regarding Special Types General Order (STGO).

3.2. As stated, the movement of abnormal indivisible loads is controlled by the requirements of the Department for Transport (DfT) that stipulate varying notice procedures and notice period's dependent upon overall dimensions.

3.3. The following drawing has been constructed to provide guidance with regard to the probable transport arrangements necessary to deliver the turbine blade under consideration. These should be treated with caution and are based on the best available information at this time, and also on the turbines that we understand may be selected for development. All loads are subject to change and clarifications from the appointed turbine manufacturer but the loads shown seek to determine the worst case length, width, height and weight that may be expected to require delivery.

- Drawing Ref No. ME-KWF-BO1 shows a typical transport arrangement for the movement of a 33.3m blade (Enercon E70 Blade) carried on a 3 axle extendible beam trailer showing an overhang of 5m. (It should be noted that the overhang shown is subject to manufacturers agreement)

3.4. We are aware from our experience that blades may be supported on their load carrying trailers in alternative ways. It is most important that the manufacturers are consulted to confirm that their blades may be carried with varying rear overhang. Generally, some 4 meters of rear overhang is commonly deployed, since increased rear overhang creates the need for a much larger amount of room, free of obstruction, to the rear of where the vehicle makes turnings on a route although where there is a desire to minimise overrun areas and there is ample over-sail area, deployment of an increased rear overhang sometimes has its advantages.

4. Road Route Structural Information

4.1. This report does not include information on the structural status of the proposed routes to the development. Wynns Ltd. strongly recommends that a review of this aspect of AIL access is undertaken in the future should the project progress.

4.2. The assessment of structural constraints would identify weight restrictions that may apply in regard to turbine parts for delivery and would involve a desk top study on routes from the motorway and trunk road network to the proposed wind turbine location. These works would typically consider the most onerous tower section, nacelle and crane expected to be required for delivery to the site and would include a review of historical AIL route information in the area.

4.3. It would also be necessary to liaise with the local and highway authorities. In addition to Perth & Kinross County Council, it should be noted that there are other statutory approving authorities who need to be consulted with regard to approval of AIL movements. These include Transport Scotland and their Trunk Road Agency Managing Agents, Scottish Canals (formally British Waterways), BR Property Board and Network Rail. It can on occasions also be necessary to liaise with private structure owners in terms of structures that are not managed by any standard-statutory authority.

4.4. It will also be a requirement to liaise with the police authorities on the proposed routes to the development site to agree any specific escorting requirements, movement timings and traffic management arrangements.

5. Assessment of Route Negotiability

5.1. A route survey was undertaken on 07.06.13 and the potential access routes to the proposed site access location have been considered in terms of negotiability requirements. The routes inspected are shown on Map 1 which is appended to this report.

5.2. *Route 1 – Preferred Route.*

5.2.1. Proposed Route 1 is shown below:

- Assume M90 northbound routing from Rosyth
- Exit M90, junction 6 onto A977
- Turn right onto A823
- Turn right, continuing A823
- Turn right onto B934
- Continue to proposed site entrance at OS Grid Reference NO 0237 1163

5.2.2. A summary of the negotiability issues on Route 1 is now provided in the photographs and accompanying notes below.

5.2.3. Swept path drawings have been undertaken at the locations considered the worst case pinch point identified on route as well as possible site access. It may be necessary to undertake further swept path assessments to satisfy Perth & Kinross County Council in line with their planning requirements but the following sections detail where items of street furniture may reasonably be expected to be removed.

5.2.4. For the purposes of the survey, the distance was measured from the junction of the B9342 & A824 (OS Grid Reference NO 0050 0191) and all photographs on the B934 shown below up to the site entrance note the distance from that point in order to place them with some degree of accuracy.

Photograph 1
Junction A977 & A823.
Vehicle moves away from camera. Turning right at junction onto A823.

Photograph 2

Junction A977 & A823. Vehicle enters from the right of the camera and turns right, exiting in the middle distance. Give way sign will need removal for blade transport.

Photograph 3

Rumbling Bridge (above) would need a structural check before commencing with the move. Vehicle enters from behind the camera and exits in the middle distance.

Photograph 4

Junction of the A823 & A91. Vehicle enters from behind the camera and we recommend exits in contraflow where the 'No Entry' signs can be seen.

Photograph 5
Junction A91 & A823. Vehicle comes from behind the camera and exits in middle distance.

Photograph 6
Vehicle moves toward camera.

Photograph 7
Vehicle moves away from camera.

Photograph 8
Vehicle moves toward camera.

5.2.5. The above three bends, the first being a slow right, were measured at a distance of 0.5 miles from B934 & A823 Junction and will require surveying as it is expected that blade over sail will fall outside the highway boundary. A swept path drawing has been carried out for this bend to assess the extent of over sail outside forestry track. Please see Drawing No. ME-KWF-SPO1 (Sheet 1 of 1), this drawing achieved by OS MasterMap® should be treated with extreme caution until a detailed instrument survey is carried out to accurately plot the relationship between the road and environs.

5.2.6. Following instrument survey, it may be found that road widening within the highway boundary may be sufficient to contain over sail within the highway.

Photograph 9
Vehicle moves away from camera.

Photograph 10
Vehicle moves towards camera.

5.2.7. Photographs 9 & 10 show the bridge over the River Devon located 0.9 miles onto the A934 at approximate OS Grid Reference NO 0062 0294. The surveyor believes that in order to facilitate blade transport, blades will need to be set up to go over bridge parapets (height measured at 1.2m max) or parapets removed on right-hand run in and left-hand run out.

5.2.8. A swept path drawing has been carried out for the negotiation of this bridge, shown in above photos, to assess the extent of over sail outside highway. Please see Drawing No. ME-KWF-SP02 (Sheet 1 of 1), this drawing achieved by OS MasterMap® should be treated with caution until a detailed instrument survey is carried out to determine exact positions and heights of parapets and extent of road edge.

Photograph 11
Vehicle moves away from camera.

Photograph 12
Vehicle moves towards camera.

5.2.9. 1.1 miles from B934 & A823 junction, photographs 11 & 12 show a rocky outcrop. Blades will not negotiate without increasing road width to nearside – approximately 1m – to 2m to fence line (decreasing). A survey is recommended to confirm any remedial works required.

Photograph 13
Vehicle moves towards camera.

5.2.10. Slow right hand bend 1.8 miles from junction. Blade will over sail fence on inside bend, (seen to the left of photograph 13). This could be avoided by increasing the width on the outside verge by 1.5m, subject to confirmatory survey.

Photograph 14
Vehicle moves away from camera.

5.2.11. Photograph 14, taken at Earnieside Farm, approx. 2.5 miles from junction. Road width measured at 4.8m.

Photograph 15
Vehicle moves away from camera.

Photograph 16
Vehicle moves towards camera.

5.2.12. The left-hand bend seen in photographs 15 & 16 was measured at a distance of some 2.9 miles from junction. Blades will over sail inside bend, requiring telegraph pole removal. It appears

the verges are part of the highway as the fence line is set well back. Confirmatory survey recommended.

Photograph 17
Vehicle moves towards camera.

5.2.13. Photograph 17 shows right-hand bend, 3.2 miles from junction. Over sail outside of the highway boundary will occur but appears to be open land.

5.2.14. A swept path drawing has been carried out for these bends to assess the extent of over sail outside of the highway boundary. Please see Drawing No. ME-KWF-SPO3 (Sheet 1 of 1), this drawing achieved by OS MasterMap® should be treated with extreme caution until a detailed instrument survey is carried out to accurately plot the relationship between the road and environs.

Photograph 18
Vehicle moves towards camera.

5.2.15. 3.3 miles from junction, left-hand bend with inside embankment steep with foliage. The fence line is set well back from highway, located on an embankment and the land appears open. A survey is required to confirm access.

Photograph 19
Vehicle moves away from camera.

Photograph 20
Vehicle moves towards camera.

5.2.16. The left-hand bend where vehicle will approach the camera (seen in photographs 19 & 20) is taken some 3.7 miles from the junction. Blades will over sail outside carriageway to the right (left of photograph), where the embankment can be seen. Foliage will need to be cut back and there is also space on right of bend to increase road width. A survey is required to confirm access.

Photograph 21

Vehicle moves away from camera.

Photograph 22
Vehicle moves towards camera.

5.2.17. Left then right bend at 4.4 miles. Over sail of blades will occur outside road surface but land is open so would assume still within the highway.

Photograph 23
Vehicle moves towards camera.

Photograph 24
Vehicle moves away from camera.

5.2.18. Bad right hand bend located 5.1 miles from junction. Over sail to the right of bend will occur, exceeding fence line. Left hand verge offers approximately 1-2 meters to fence line so possibly increasing the width of road to the left will avoid 3rd party land take. A survey is required to confirm access.

Photograph 25
Vehicle moves towards camera.

5.2.19. Blades will over sail left hand verge toward hedge line, shown to the right in photograph 25 located 5.2 miles after B934 & A823 junction. There is however an additional 1.5 meters to the right of bend which could be used to correct this issue. An instrument survey is required to verify access.

Photograph 26
Vehicle moves away from camera.

Photograph 27
Vehicle moves away from camera.

5.2.20. Photographs 26 & 27 are of the right hand bend, located approx. 5.8 miles north of junction. Blades will over sail inside bend over fence line – approximately 3.0m from edge of road. Surveyor also believes that a small tree located on this inside bend may also require removal. The ditch within the left hand verge seen in photograph 27 could possibly be used for additional room to keep off over sail mentioned above, but there are likely to be issues with this alternative. A survey is required to verify access.

Photograph 28
Vehicle moves towards camera.

5.2.21. 6.1 miles from junction, photograph 28 is taken of right hand bend by Greenhill Farm. Possible over sail of right hand fence, however, the verge to the left (seen in right of photograph) should give enough room to allow blade to keep off the fence.

Photograph 29
Vehicle moves towards camera.

5.2.22. Right hand bend located 6.3/6.5 miles north of junction. Over sail on the inside of the bend is probable. Fir trees seen to the left of photograph would need to be cut back if blades travel over fence line. There is also a good verge to the left of the bend if needed.

Photograph 30
Vehicle moves towards camera.

5.2.23. Photograph 30 is taken outside Blayberry Toll Cottage, and is situated 6.8 miles from B934 & A823. There should be just sufficient room to negotiate this left hand bend with use of the forestry track on right hand side (left of photo) to keep the blade off the cottage fence line. A survey is required to verify access.

Photograph 31
Vehicle moves towards camera.

5.2.24. Slow right hand bend, 7.0 miles from junction. Use verge to keep within fenced road boundary.

5.2.25. 7.3 miles from junction a slow left hand bend is situated. Plenty of over sail room to the left, with the fence line set back several meters from the road.

Photograph 32
Vehicle moves towards camera.

5.2.26. A slow right hand bend is located 7.7 miles from junction. Over sail will occur on right inside of bend. Only narrow verge on left of bend. Left hand bend just after. Embankment just where over sail will occur. Possibly enough verge on right to avoid contact with embankment. It is recommended that this is confirmed by survey with the bend immediately prior.

Photograph 33
Knowes Farm existing access seen to the left of the photograph

5.2.27. 7.85 miles from junction, Knowes farm access on left.

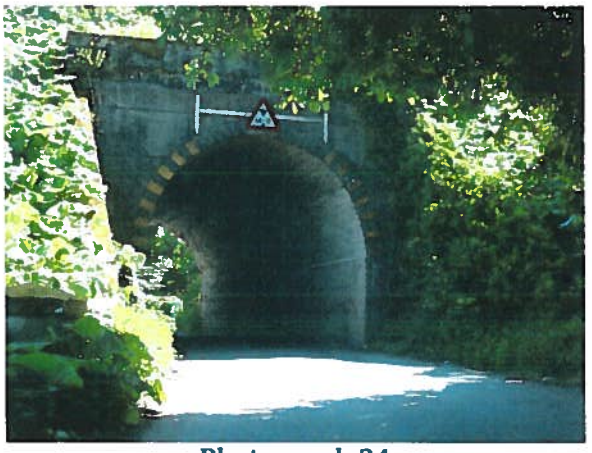
5.3. *Alternative Routes Considered*

5.3.1. Described below in the following notes and photographs are the other four alternative access routes to the proposed site. All utilising the M9/A9 northbound.

5.4. *Route 2*

5.4.1. Proposed Route 2 is shown below:

- M9/A9 Northbound
- Turn right onto B8062
- Turn right onto B934
- Continue to proposed site access at OS Grid Reference NO 0237 1163



Photograph 34
Vehicle moves away from camera.

Photograph 35
Vehicle moves towards camera.

5.4.2. Rail over road bridge shown in photographs 34 and 35 is not suitable for negotiation by blade transport.

5.5. *Route 3*

5.5.1. Proposed Route 3 is shown below:

- M9/A9 Northbound
- Turn right onto unclassified road, heading towards Whitemoss.
- Turn left B8062
- Turn right onto B934
- Continue to proposed site access

Photograph 36
Vehicle moves away from camera.

Photograph 37
Vehicle moves towards camera.

5.5.2. Photographs 36 and 37 show the unclassified road used when utilising route 3. The road geometry on this unclassified road would mean blades would over sail third party land in several places.

5.6. *Route 4*

5.6.1. Proposed Route 4 is shown below:

- M9/A9 Northbound
- Turn right onto B9141 to Dunning
- Turn left, then right onto B934
- Continue to proposed site access

Photograph 38
Vehicle moves away from camera.

Photograph 39
Vehicle moves away from camera.

5.6.2. Rail over Road Bridge seen in above photographs is not suitable for negotiation by blade transport.

5.7. *Route 5*

5.7.1. Proposed Route 5 is shown below:

- A9 Northbound,
- Turn right B934, onto B935
- Turn right onto B934, continue to Dunning
- Turn right, Kirkstyle Square
- Turn left Thorntree Square/B934
- Continue South to proposed site access.

Photograph 40
Vehicle moves away from camera turning right to cross the bridge over the River Earn.

Photograph 41
Reverse angle. Vehicle moves towards camera.

Photograph 42
Reverse angle. Vehicle moves towards camera.

5.7.2. Of the four routes which could be used to access Dunning and the B934 from the north, this route (Route 5) offers the best possibilities. However, surveys would be required at the right turn onto the River Earn Bridge shown in photograph 40 and also of the right hand bend immediately after the level crossing, shown in photograph 42.

5.7.3. Notwithstanding the above, negotiation of Dunning from the north to gain access onto the B934 is not possible, the reasons of which can be seen in the following photographs.

Photograph 43

Vehicle moves away from camera, travelling south east on B9141. Slight left turn onto the B8062 then right down the B934, (seen between the two buildings).

Photograph 44

Reverse angle of photograph 43. Vehicle moves towards camera.

Photograph 45

Vehicle moves away from camera, travelling south south east on B934.

5.7.4. All the above photographs are of Dunning and as can be seen, negotiation of this town is not possible with building and road alignments as they are. Therefore Route 1 avoiding Dunning entirely is the route recommended by the surveyor.

6. The Width of Highways, Fences and Verges, Overrun and Over Sail

6.1. As is evident in the notes detailed within Section 5 there is a significant amount of over sail required on the B934. The following information is provided as generic information only to highlight some of the issues that should be considered.

6.2. M Orlick (1993) states that in general there will not be documentary evidence of the width of a highway and, if there is, it may well not be conclusive. *"What matters more is what exists on the ground."* If the Highway Authority has maintained land at the side of the road, as well as the metalled road itself, that is strong evidence that the land is part of the highway.

6.3. The rights of public passage and the consequential restrictions on the powers of owners to deal with their land as they see fit have meant that there have been plenty of disputes as to the width of particular highways. As well maintenance by Highway Authorities, the existence of statutory undertakers' apparatus such as telephone cables, electric cables and gas mains can indicate extent of highway.

6.4. If the undertakers have obtained way leave consents from adjoining owners to place their apparatus in, say, a verge at the side of the road. That suggests that the verge is not part of the highway. If, on the other hand, they have not obtained any way leaves, then this suggests that they are using their statutory powers and the Public Utilities Streetworks Code to lay services in the highway without the need to obtain consents of any private.

6.5. *Fences and verges*

6.5.1. The existence of a metalled road may be a good indication of the extent of the highway when such a road crosses unenclosed land such as a heath or common. It is no indication of the extent of the highway in other cases for example where there are fences or ditches on both sides of the highway the public right of passage will be taken to be the extent of the whole space between the fences or ditches even through the width of the highway may be varying and unequal and even though there may be a substantial amount of land lying between the metalled road and the fence. However it should be noted that the presumption that the fences mark the highway boundary can often be rebutted and confirmation of the highway boundary, where there exists ambiguity should be confirmed with the relevant highway authority.

6.6. *Over-sail*

6.6.1. Over-sail is a common occurrence when moving large wind turbine components and therefore it is important to understand the law. The law that needs to be considered is the law of trespass which is defined as the unauthorised interference with the possession of someone's home, garden or other land interests. It is useful to note that trespass is not a criminal offence and trespassers cannot usually be prosecuted. They can, however, be sued, as trespass is a civil offence.

6.6.2. The boundary of a property may be indicated by a physical marker such as a river, a wall, or a fence. The actual boundary may fall on either side of the boundary feature or fall along the median line through the boundary feature itself or bear no resemblance to the physical boundary feature. The starting point for establishing a boundary is the title deeds. Theoretically speaking, it is an established legal principle that a vertical boundary also extends

from the subsoil beneath the boundary to the centre of the earth and also extends to the sky above. This means that ownership of property includes the airspace above it and also the ground beneath it.

6.6.3. There is established protocol for over-sail in the construction sector where an over-sail licence is issued as this is often an issue if, for example, a large crane is being used. An over-sail licence is an agreement which provides a land owner (and its developer) with the legal right to pass through another's air space. If a crane is used in a construction project the jib of the crane may well swing in and out of neighbouring airspace. Without an over-sail licence this could constitute a trespass and the land owner could be faced with an injunction.

6.6.4. Guidance states that the licence should cover issues such as time of day (and night) that the item of plant may over-sail neighbouring land, the heights of the over-sail and the duration of the licence. An indemnity for any damage caused by the crane may also be included.

6.6.5. With specific reference to the transportation of wind farm components it is essential to try and negotiate an agreement for any financial compensation payable for the use of land which is either owned by another party or subject to rights in favour a third party. As with any dispute, a reasonable approach can produce savings in terms of costs awards should the matter reach court even if the other party to the dispute refuses to negotiate with you.

7. Site Access off Highway

7.1. The site entrance off the highway at the proposed access point will require consideration during design to provide adequate opportunity to leave the principle highway with expediency. The turning circles identified within the transport configuration drawings discussed in Paragraph 3.3 should be applied within the design phase.

7.2. Much of the access design criteria on which the planning authorities relies upon is contained in "*Places Streets and Movement*", a national document published in 1998. In particular this sets out the visibility standards at access onto the road network. The sight line information, shown in Table 1 below, should be considered in conjunction with the turning radii information detailed within the transport configuration drawings.

7.3. To enable drivers emerging from the access to see and be seen by drivers proceeding along the carriageway unobstructed visibility is needed within the proximity of the junction. The distance along the centre line of the new access from the carriageway edge to the point where the emerging driver should be able to see a specified distance in each direction of the principal carriageway can be derived from the aforementioned documentation.

Table 1 Junction Visibility Splays

Measured Major Road Speed - **Mph**/kph	**70/** 120	**60/** 100	**50/** 85	**40/** 70	**30/** 50
Major Road Distances (m)	295	215	160	120	70

8. Site Access Roads

8.1. *Recommended on-site roadway geometry*

a) Access road minimum width - 5.00 metres

(Width at turns to be considerate of transport configuration drawings)

	-	6.00m
b) Access road minimum bend radius	-	30.00m
c) Access road maximum longitudinal slope	-	1 in 8, 12%
d) Access road maximum lateral slope	-	1 in 30, 3.3%
e) Access road minimum specification axle loads	-	15 te per axle
f) Minimum convex/concave radii	-	Convex – 200m
	-	Concave – 150m

8.1.1. The above are based upon drained roads consisting of crushed rock or similar with a top layer of non-slippery gravel. Gradients in excess of 7 degrees (1:8, 12%) are subject to acceptance by haulier and crane hire companies.

8.2. *Road criteria and construction recommendations.*

a) All road preparations to be similar to type 1 road base.

b) Large loose stones on the surface are to be removed.

c) Adequate facility to be included in the road design to facilitate surface water drainage, particularly in the hilly terrain.

d) All roads will be put under frequent heavy haul conditions throughout the period of the erection phase. Consideration should be given to the servicing of the road infrastructure during the life of the wind farm and these should be over laid with construction requirements and wherever possible the two should be combined.

e) Potholing will occur, even in the best prepared roads and facilities should be made available to repair these areas within the scheme of things.

f) Severe bends greater than 90 degrees should be avoided wherever possible. If they have to be used then this section should be covered in Tarmac or concrete.

g) At the base of severe gradients consideration should be given to install sand traps or run-out areas to accommodate possible emergency situation with the heavy transport equipment during delivery or removal operations.

h) Roads between wind turbines should be type 1 road base construction. The level and cross fall of these roads will determine the type of cranes to be used and the methodology of relocating them between lifting locations finalised.

8.3. *Traction problems with delivery vehicles.*

8.3.1. We are aware that a number of projects, in similar terrain as that proposed have encountered difficulties with the delivery vehicles gaining adequate traction on the temporary haul roads as follows:-

a) Lack of weight on the 5th. Wheel of articulated units will most probably resulted in lack of grip on the tractor unit resulting in excess damage to road preparation from spinning drive wheels.

b) Grounding out on underside of low loader trailer beds due hogging in the road preparation.

c) Trailers, with heavy equipment, sliding off the side of the road due to adverse camber or slopes, especially during excessive wet conditions.

d) Self-drive modular trailers unable to get enough traction due to the lack of weight of the item being transported.

e) On certain sites it has been necessary to revert to the use of ballasted tractor units as a means of hauling equipment up or down the haul roads.

f) Regular maintenance of road surfaces is vital throughout the duration of the heavy hauling operations.

8.4. *Crossing of water- courses*

8.4.1. By the very nature of developing in mountainous regions there are often many streams and tributaries that have to be crossed. Theses crossing points will have to be designed so as not to cause a disruption to flow rates and be able to accommodate the axle loads, the gross ground loadings over the contact area and be considerate of the vehicle track widths that have to cross the structure built to facilitate site development. Where these are to be of a temporary nature then sophistication can be minimal. Commonly temporary watercourse crossing on development sites often take the form of a fascine which is constructed by pipes of either concrete or PVC placed within the channel and then overlain with compacted road-stone making removal reasonably simple. An alternative to a permanent bridge structure that would require maintenance could be to develop a shallow ford armoured with setts to provide a running surface.

Photograph 46

Typical Fascine arrangements used for temporary, on site crossing of burns and streams (the track-way shown in the above photograph could be replaced with a road-stone).

9. Summary and Conclusions

9.1. Dependent upon the final transport dimensions, wind turbine components of the magnitude being considered would necessitate application for movement orders at Special Types General Order and Special Order Categories. Special Order movements will need to be considerate of the Department for Transport[s] "water preferred" policy.

9.2. Special Types General Order transport configurations can generally be delivered from any port within the United Kingdom, as they are unlikely to attract central government scrutiny.

9.3. A number of possible routes were inspected in terms of negotiability requirements. The route from the South via M90 and Rumbling Bridge is the preferred route to the general development area. This would lend itself to blades being landed on the north side of the Firth of Forth possibly Rosyth, although port investigations are not part of the scope of this report.

9.4. Three swept path assessments have been included to show remedial works that will be necessary at three of the most significant locations on the proposed access routes. The swept paths have been produced from Ordnance Survey MasterMap® data, and as such should be treated with caution until the recommended instrument surveys are carried out.

9.5. All routes via Dunning have been surveyed and found not to be negotiable for the size of blade considered in the study.

9.6. Street furniture will need removing as described in the photographic report. Of particular note is the restricted carriageway width on the A823 at Rumbling Bridge. We would recommend that prior to any deliveries, traffic management issues are addressed as part of the Special Order process.

9.7. The B934 has been considered and swept path drawings using OS data have been produced based on what we consider the worst three areas that require negotiation.

9.8. From the OS data, and in line with the opinion of the surveyor whist inspecting the route, it is believed that the necessary improvements for the most difficult bends can be carried out within the highway boundary. This should be confirmed with more accurate instrument surveys once the project is confirmed.

9.9. The carriageway width on the B934 is sufficiently wide for the mobile crane, assuming 3.0m max outside track. We recommend that all AIL's plus the mobile crane are routed from the south.

9.10. We would strongly recommend that a structural route check is now undertaken to ensure that the structures on route, of which there are several, are acceptable for the loadings that will be generated by the AIL's and mobile crane.

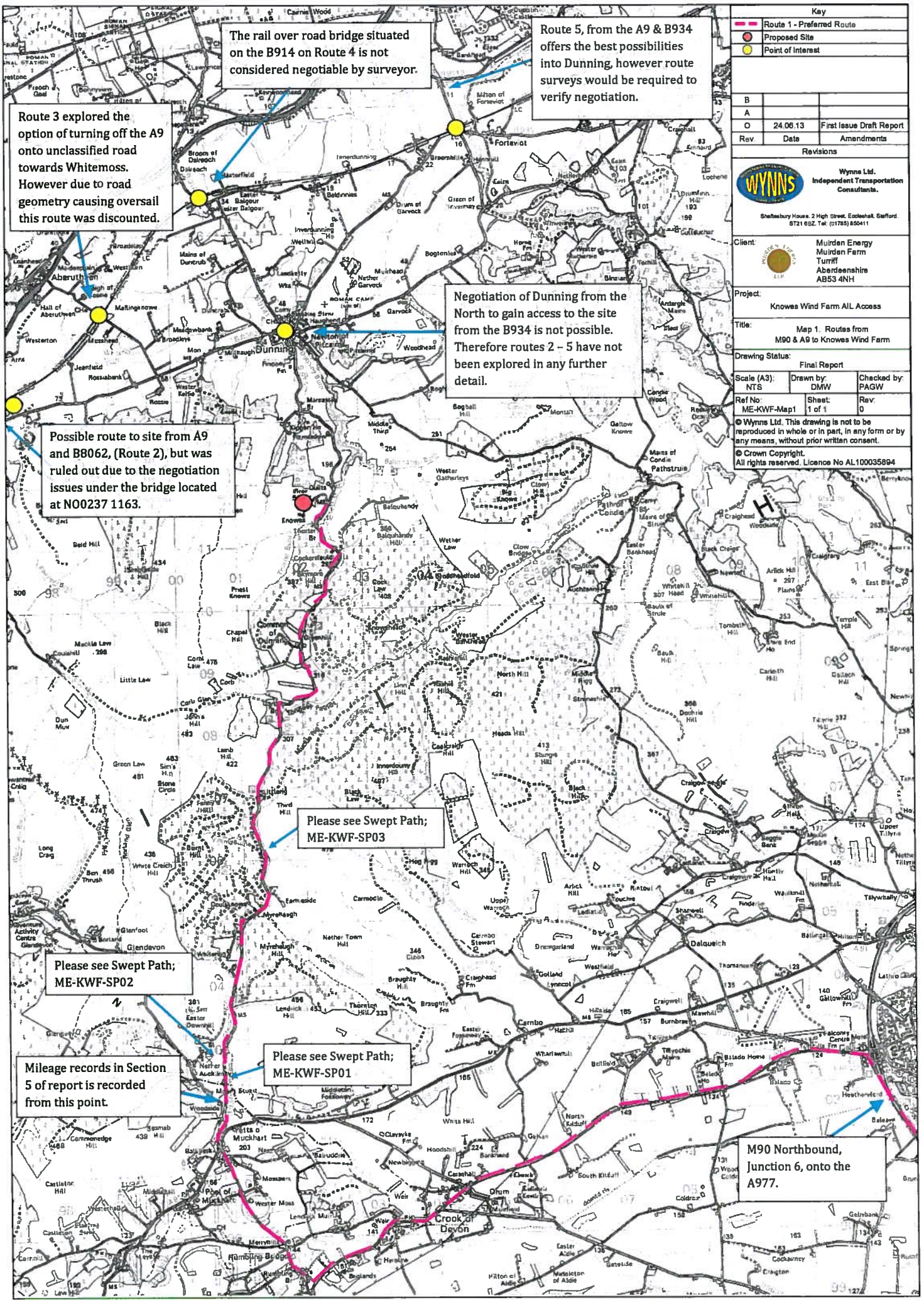
9.11. No work has been undertaken in terms of the structural suitability of the proposed routes to site and the status of the structures on the proposed routes should be confirmed by additional studies if the project proceeds.

9.12. The design of the turn into the site will need to be considerate of wind turbine delivery vehicles and the ground loadings they impart. Of particular concern would be the heavy lift crane needed during the construction phase of the turbine build which have an outside track width of 3.0m and minimum wheel loads of 6 tonnes.

9.13. This report does not constitute a full street furniture survey and this should be carried out by the appointed contractor prior to mobilisation and agreed with the appropriate authorities.

9.14. Nothing in this report shall be construed in any way as confirming that the route has the capacity to accommodate the proposals without the legal notification procedures being followed or that agreement with governing authorities has been provided.

Maps


The rail over road bridge situated on the B914 on Route 4 is not considered negotiable by surveyor.
Route 5, from the A9 & B934 offers the best possibilities into Dunning, however route surveys would be required to verify negotiation.
Route 3 explored the option of turning off the A9 onto unclassified road towards Whitemoss. However due to road geometry causing oversail this route was discounted.
Negotiation of Dunning from the North to gain access to the site from the B934 is not possible. Therefore routes 2 – 5 have not been explored in any further detail.
Possible route to site from A9 and B8062, (Route 2), but was ruled out due to the negotiation issues under the bridge located at NO0237 1163.
Please see Swept Path; ME-KWF-SP03
Please see Swept Path; ME-KWF-SP02
Please see Swept Path; ME-KWF-SP01
Mileage records in Section 5 of report is recorded from this point.
M90 Northbound, Junction 6, onto the A977.
Key
Route 1 - Preferred Route
Proposed Site
Point of Interest
B
A
O 24.06.13 First issue Draft Report
Rev Date Amendments
Revisions
Wynns Ltd.
Independent Transportation Consultants.
Shaftesbury House, 2 High Street, Eccleshall, Stafford. ST21 6BZ. Tel: (01785) 850411
Client:
Muirden Energy
Muirden Farm
Turriff
Aberdeenshire
AB53 4NH
Project:
Knowes Wind Farm AIL Access
Title:
Map 1. Routes from M90 & A9 to Knowes Wind Farm
Drawing Status:
Final Report
Scale (A3): NTS
Drawn by: DMW
Checked by: PAGW
Ref No: ME-KWF-Map1
Sheet: 1 of 1
Rev: 0
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Drawings

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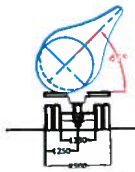
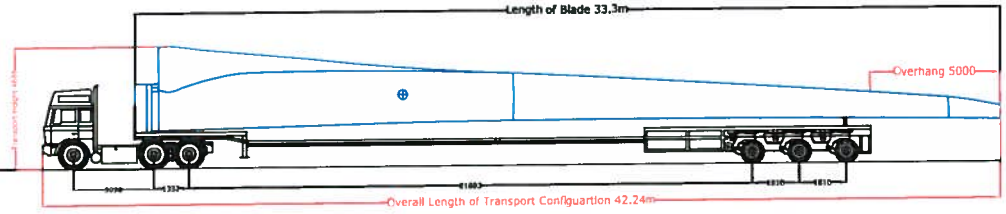
Fax: +44 (0)1785 851866
www.wynnslimited.com

1627

*
Blade would preferably be rotated 45° on transporter to ensure transport height was no greater than 4.95m.

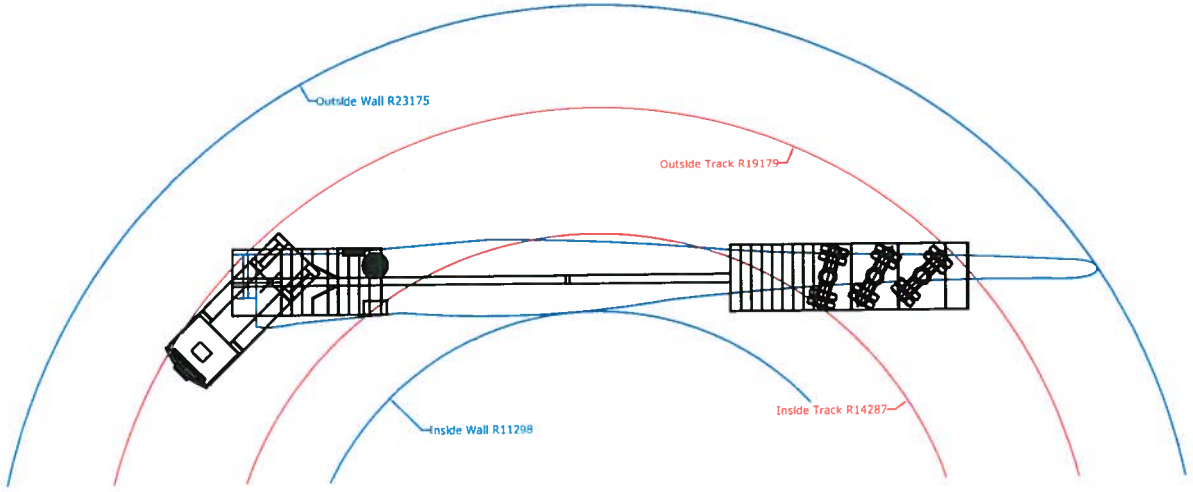


End Elevation



3 axle modular extendable beam trailer - Concept Model Only - Side Elevation
33.3 metre Enercon Turbine Blade, showing 5m overhang
Scale 1/200

3 axle modular extendable beam trailer - Concept Model Only - Plan View
33.3 metre Enercon Turbine Blade, showing 5m overhang
Scale 1/200



3 axle modular extendable beam trailer - Concept Model Only
Minimum turning Radii
33.3 metre Enercon Turbine Blade, showing 5m overhang
Scale 1/200

3 Axle Extendable Trailer	
Self Weight of Blade	6.0 Te
Self Weight of Trailer	22.0 Te
Total Combined Load	28.0 Te
Load Per Axle	5.60 Te
Load Per Wheel	1.40 Te
Ground Bearing Pressure	1.86 Te/m2
Tyre Contact Patch	150mm x 155mm
Tyre Pressure	140psi / 9bar

Tractor (12Te)	
Front Axle	6.0 Te
Rear Axle	8.6 Te
Rear Axle	8.6 Te

Actual dimensions, including axle spacing and mean running height, may vary slightly depending on manufacturer of trailer deployed.

All linear measures in millimetres unless stated otherwise.

Drawing of Wind Turbine Components are indicative only.

Overhang shown is subject to manufacturers agreement relating to positioning of support frame.

Rev.	Date	Ammendments
B		
A		
0	04/06/13	Issued for comment

Revisions

Wynns ltd
Independant Transportation Consultants

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Client:
Muirden Energy
Muirden Farm
Turriff
Aberdeenshire
AB53 4NH

Project:
Knowes Wind Farm

Title:
33.3m Turbine Blade
Transported on Extendable Beam Trailer
Showing Minimum Turning Radii
Assume manual steering.

Drawing status:		
	Draft Report	
Scale (A3): 1/200	Drawn by: DJT	Checked by: PAGW
Dwg. No: ME-KWF-B01	Sheet: 1 of 1	Rev: 0

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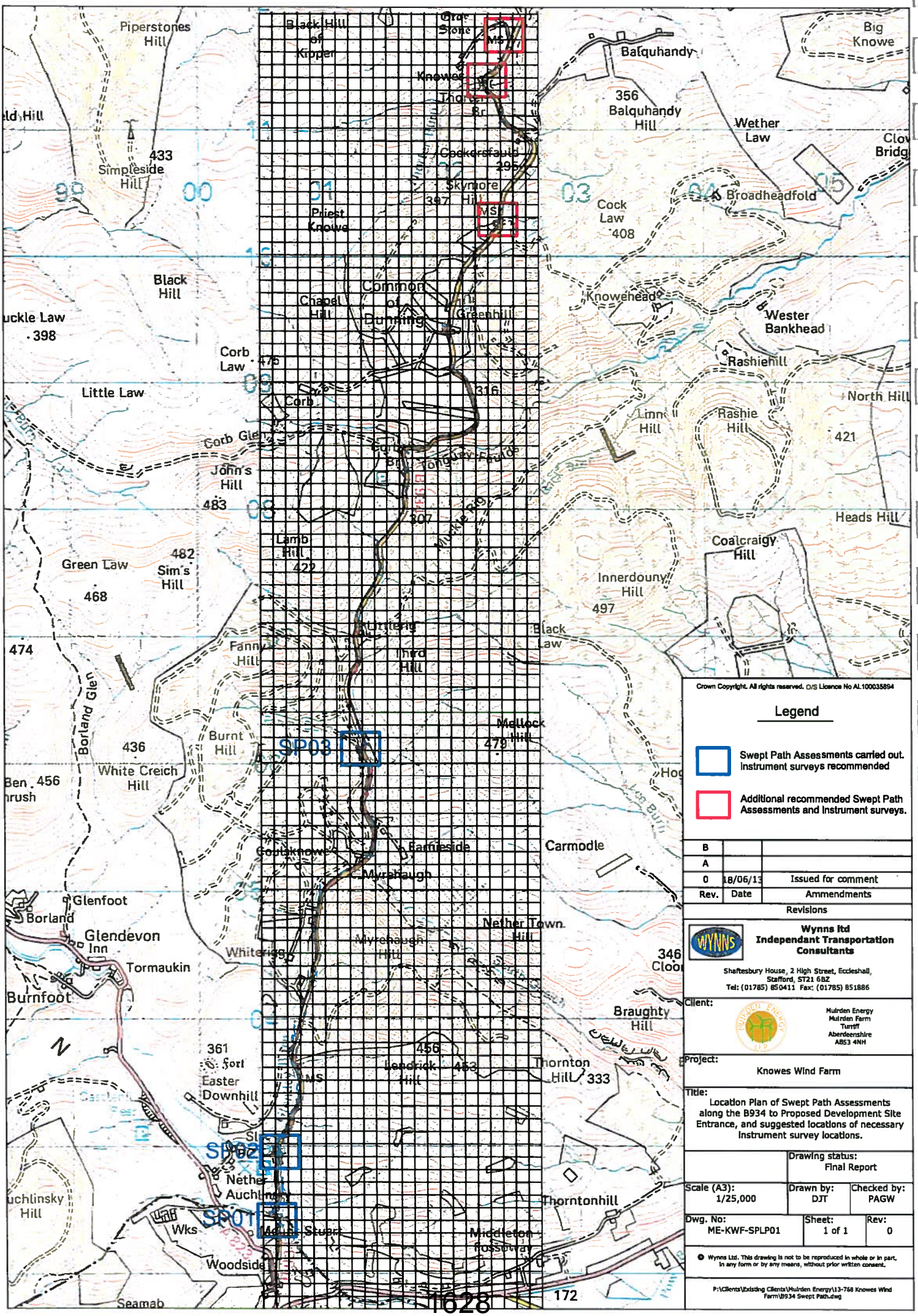
P:\Clients\Existing Clients\Muirden Energy\13-768 Knowes Wind Farm\B01.dwg



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Legend

Swept Path Assessments carried out. Instrument surveys recommended

Additional recommended Swept Path Assessments and Instrument surveys.

Rev.	Date	Ammendments
B		
A		
0	18/06/13	Issued for comment

Revisions

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Client: Muirden Energy
Muirden Farm
Turriff
Aberdeenshire
AB53 4NH

Project: Knowes Wind Farm

Title: Location Plan of Swept Path Assessments along the B934 to Proposed Development Site Entrance, and suggested locations of necessary Instrument survey locations.

Drawing status:		
Final Report		
Scale (A3): 1/25,000	Drawn by: DJT	Checked by: PAGW
Dwg. No: ME-KWF-SPLP01	Sheet: 1 of 1	Rev: 0

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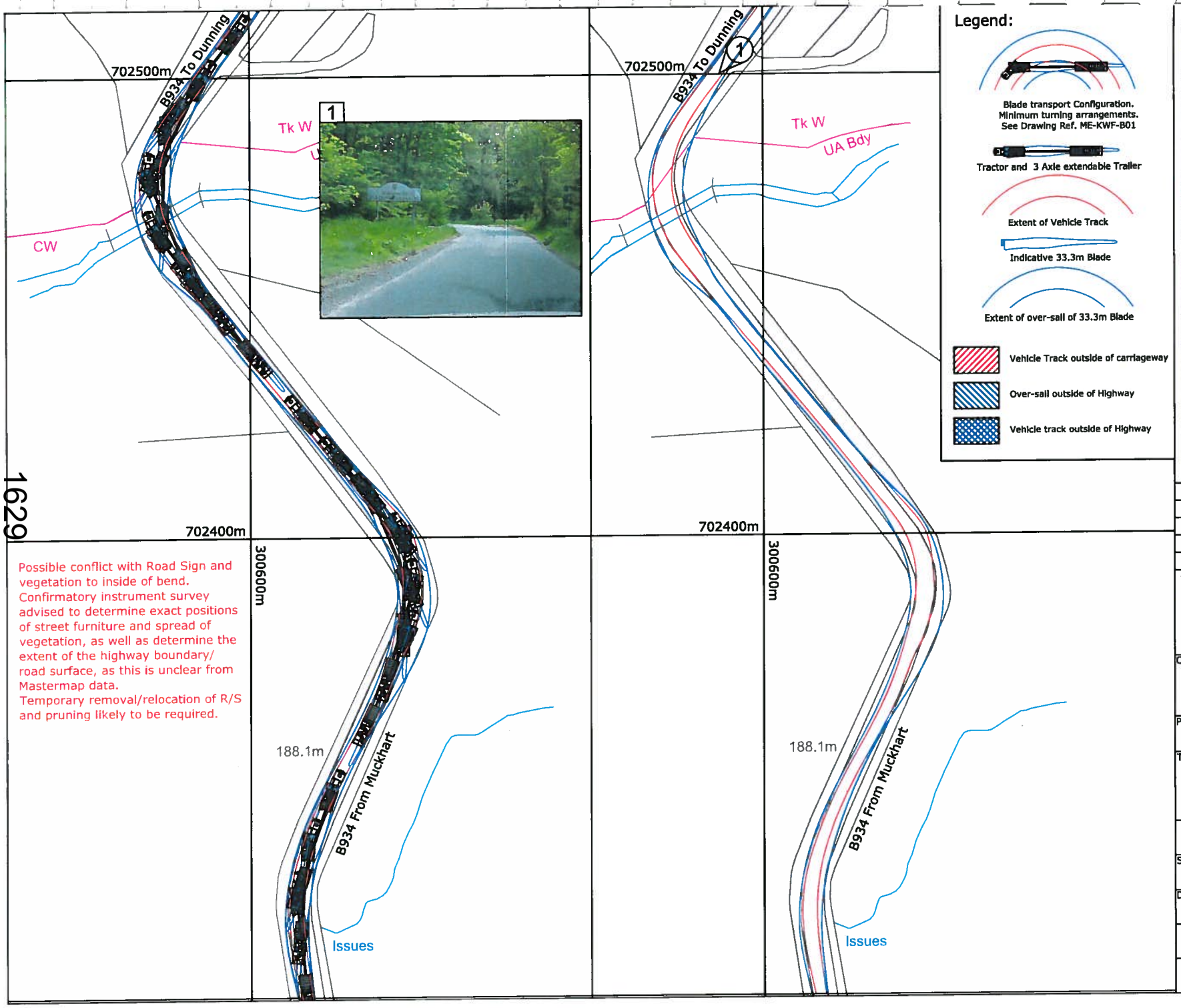

1629

Possible conflict with Road Sign and vegetation to inside of bend. Confirmatory instrument survey advised to determine exact positions of street furniture and spread of vegetation, as well as determine the extent of the highway boundary/ road surface, as this is unclear from Mastermap data.
Temporary removal/relocation of R/S and pruning likely to be required.

Legend:

- Blade transport Configuration. Minimum turning arrangements. See Drawing Ref. ME-KWF-B01
- Tractor and 3 Axle extendable Trailer
- Extent of Vehicle Track
- Indicative 33.3m Blade
- Extent of over-sail of 33.3m Blade
- Vehicle Track outside of carriageway
- Over-sail outside of Highway
- Vehicle track outside of Highway

Location Plan

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A		
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Client:
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Muirden Farm
Turriff
Aberdeenshire
AB53 4NH

Project: Knowes Wind Farm

Title: Swept Path Assessment of B934 To Proposed Development Site Entrance. Wind Turbine component - 33.3m Blade Transported on Extendable Beam Trailer. Approximate OS Grid Reference: NO 0060 0240.

Drawing status: Draft Report		
Scale (A3): 1/750	Drawn by: DJT	Checked by: PAGW
Dwg. No: ME-KWF-SP01	Sheet: 1 of 1	Rev: 0

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703000m

B934 To Dunning

B934

Glendey Burn

Negotiability of the bridge appears feasible due to the nature of the transport arrangement shown, and height which the blade is carried. Oversail of the bridge parapets would be required.
Confirmatory instrument survey required to determine exact positions/heights of parapets and extent of road edge. This is unclear from mastermap data.

1630

702900m

300600m

B934 From Muckhart

703000m

B934 To Dunning

B934

Glendey Burn

2

B934 From Muckhart

702900m

300600m

Legend:

Blade transport Configuration. Minimum turning arrangements. See Drawing Ref. ME-KWF-B01

Tractor and 3 Axle extendable Trailer

Extent of Vehicle Track

Indicative 33.3m Blade

Extent of over-sail of 33.3m Blade

Vehicle Track outside of carriageway

Over-sail outside of Highway

Vehicle track outside of Highway

Location Plan

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Rev.	Date	Ammendments
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A		
0	18/06/13	Issued for comment

Revisions

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Client:

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Muirden Farm
Turriff
Aberdeenshire
AB53 4NH

Project: Knowes Wind Farm

Title: Swept Path Assessment of B934 To Proposed Development Site Entrance. Wind Turbine component - 33.3m Blade Transported on Extendable Beam Trailer. Approximate OS Grid Reference: NO 0062 0294.

	Drawing status: Draft Report	
Scale (A3): 1/500	Drawn by: DJT	Checked by: PAGW
Dwg. No: ME-KWF-SP02	Sheet: 1 of 1	Rev: 0

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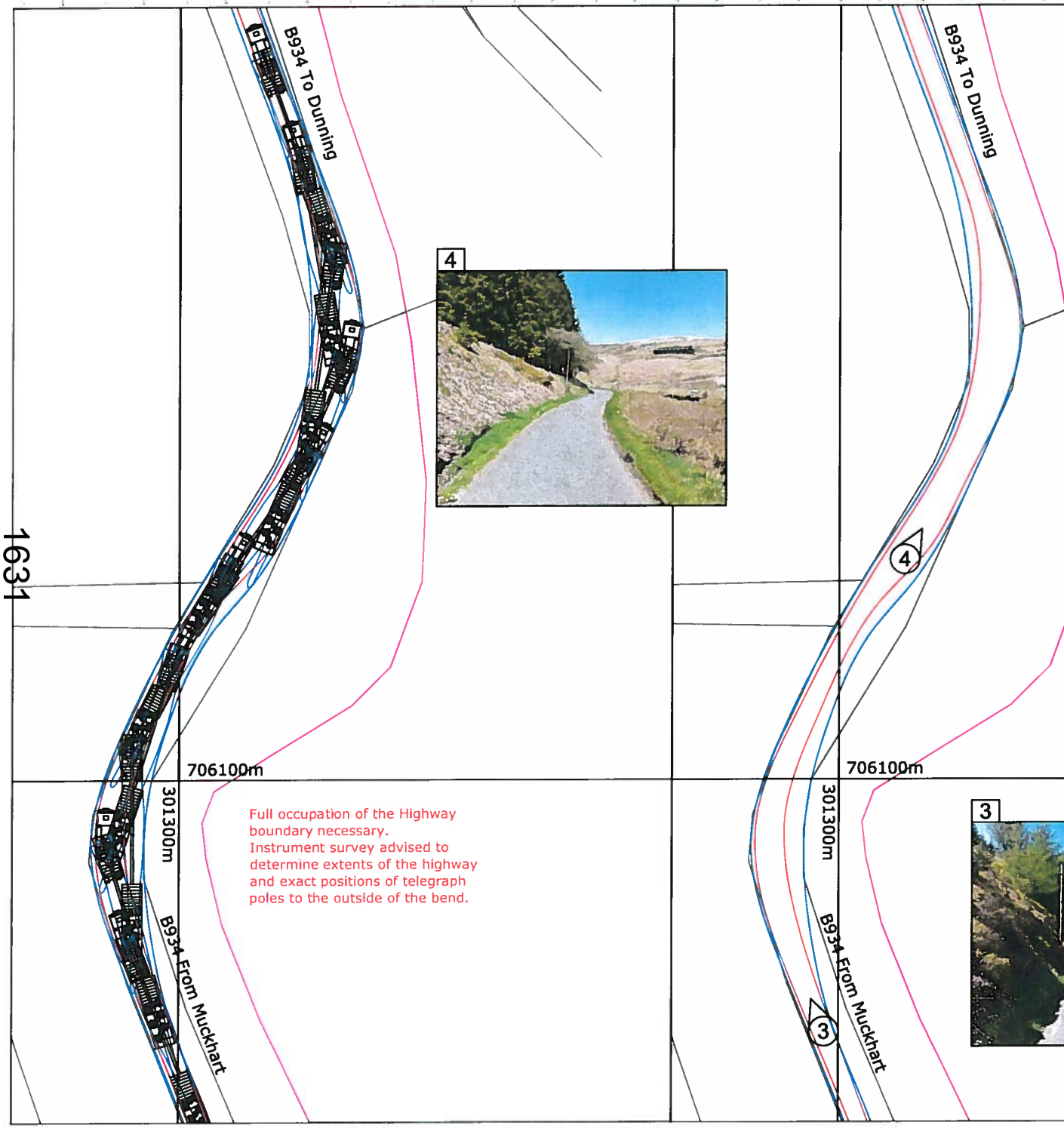
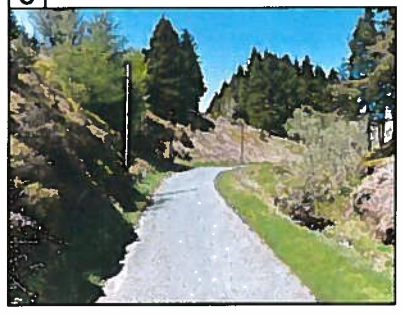


1631



Legend:

Blade transport Configuration. Minimum turning arrangements. See Drawing Ref. ME-KWF-B01

Tractor and 3 Axle extendable Trailer

Extent of Vehicle Track

Indicative 33.3m Blade

Extent of over-sail of 33.3m Blade

Vehicle Track outside of carriageway

Over-sail outside of Highway

Vehicle track outside of Highway

Location Plan

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Rev.	Date	Ammendments
B		
A		
0	18/06/13	Issued for comment

Revisions

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Muirden Farm
Turriff
Aberdeenshire
AB53 4NH

Project: Knowes Wind Farm

Title: Swept Path Assessment of B934 To Proposed Development Site Entrance. Wind Turbine component - 33.3m Blade Transported on Extendable Beam Trailer. Approximate OS Grid Reference: NO 0131 0612.

Drawing status: Draft Report		
Scale (A3): 1/500	Drawn by: DJT	Checked by: PAGW
Dwg. No: ME-KWF-SP03	Sheet: 1 of 1	Rev: 0

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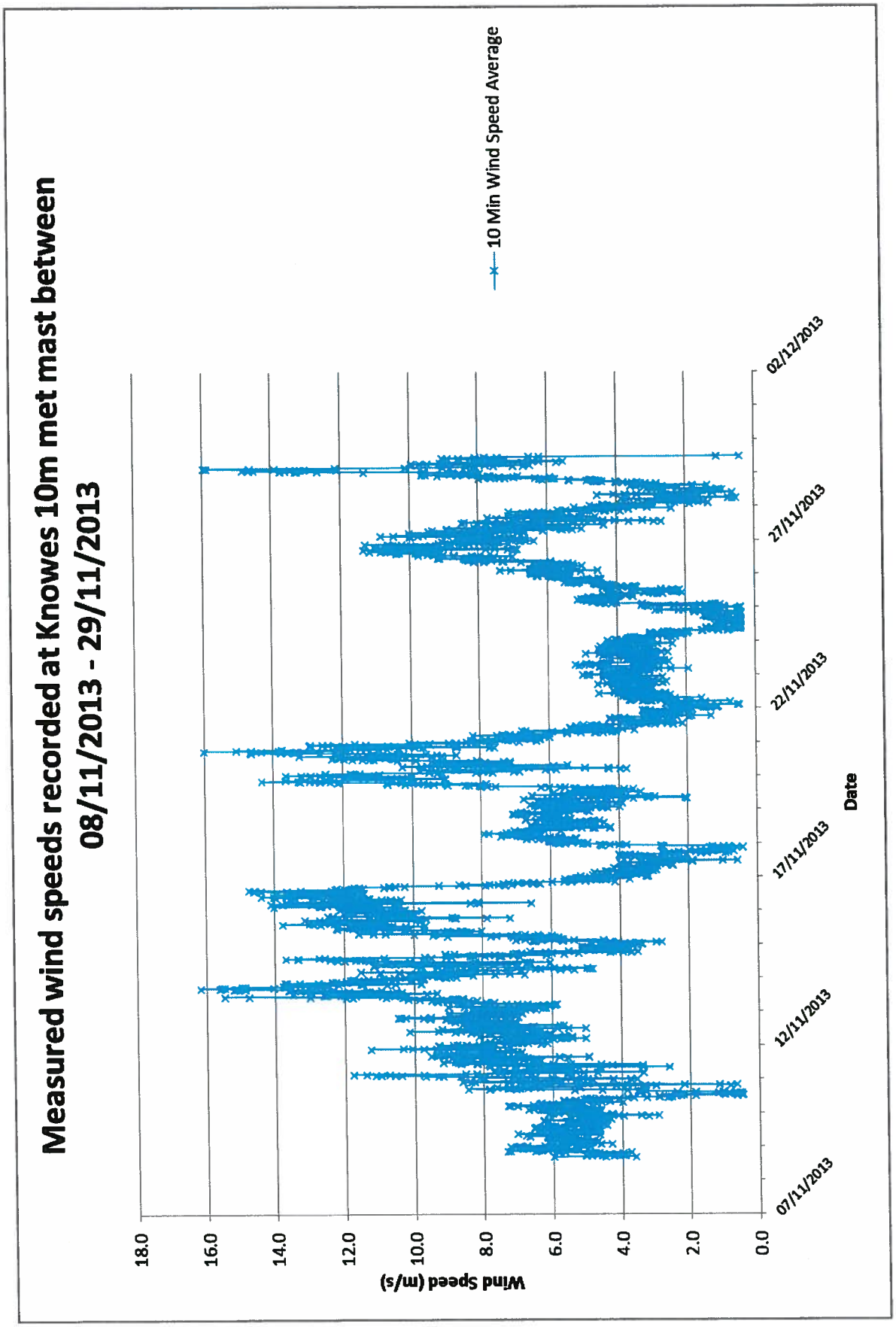
APPENDIX 2

Appendix 2 Noise

Met mast wind data

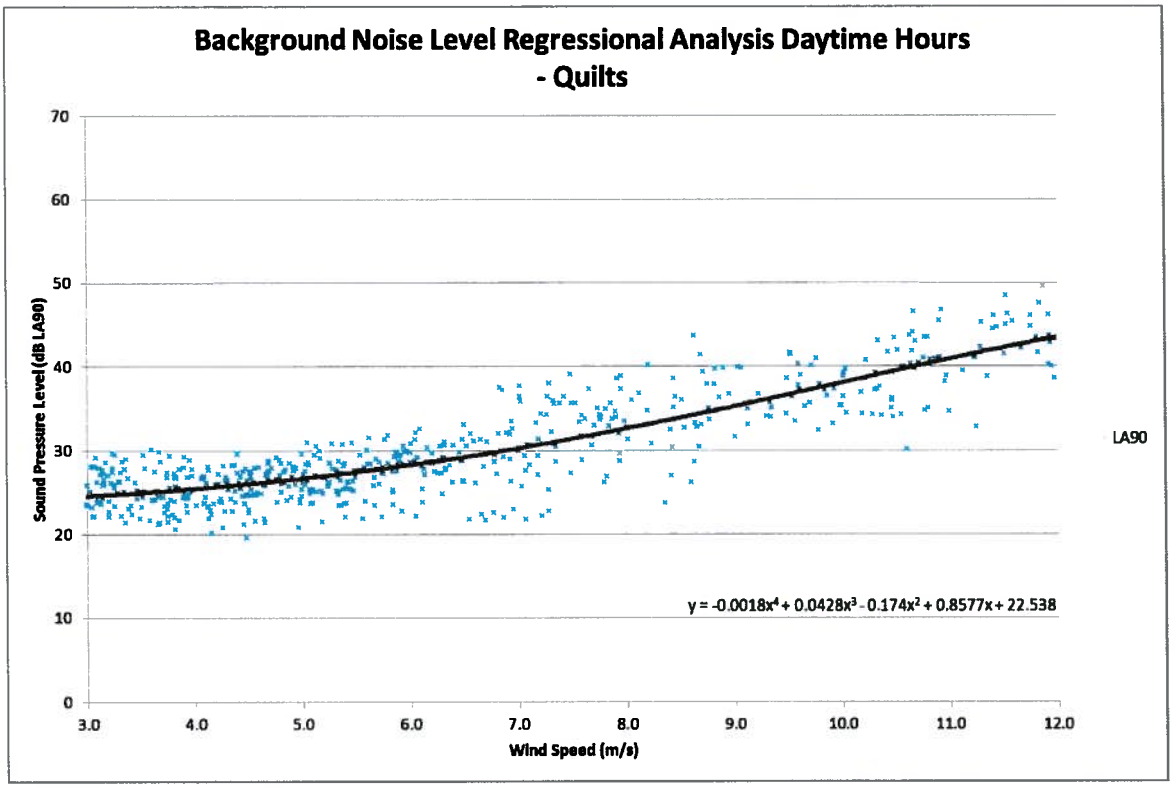

Measured wind speeds recorded at Knowes 10m met mast between
08/11/2013 - 29/11/2013
10 Min Wind Speed Average
Wind Speed (m/s)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
07/11/2013
12/11/2013
17/11/2013
22/11/2013
27/11/2013
02/12/2013
Date

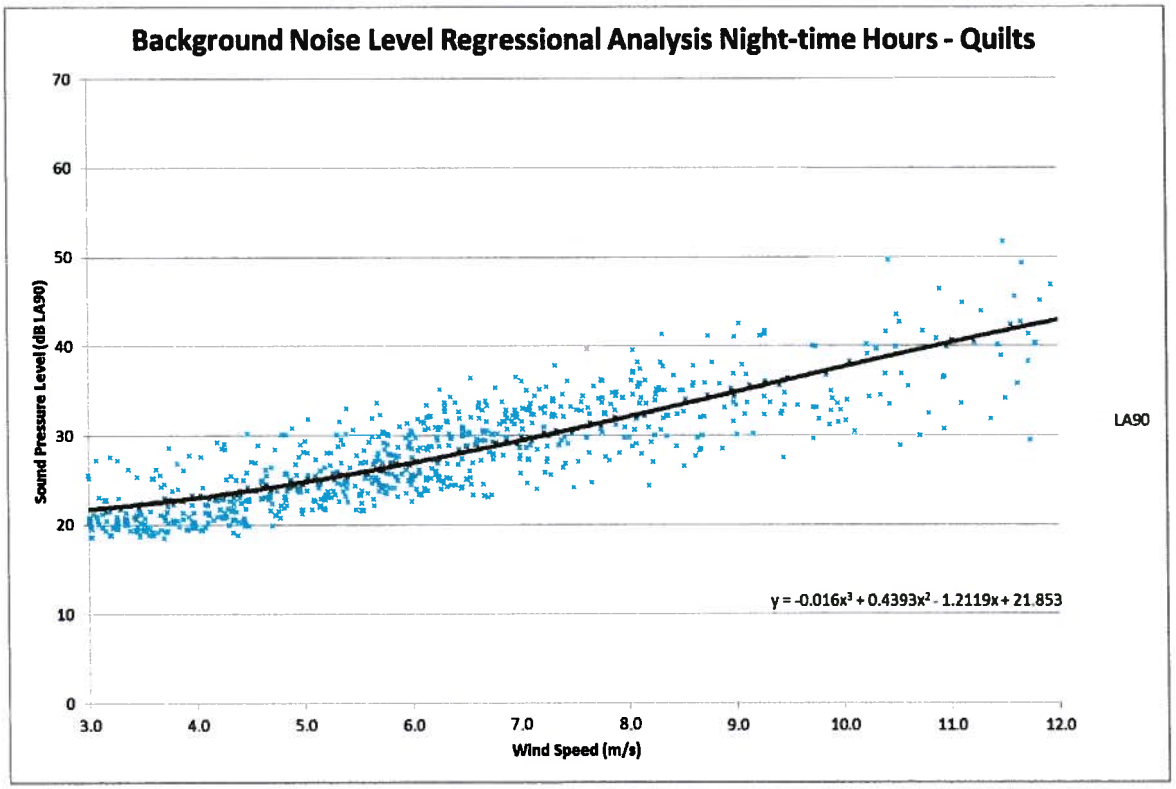
Backgroiund Noise Locations

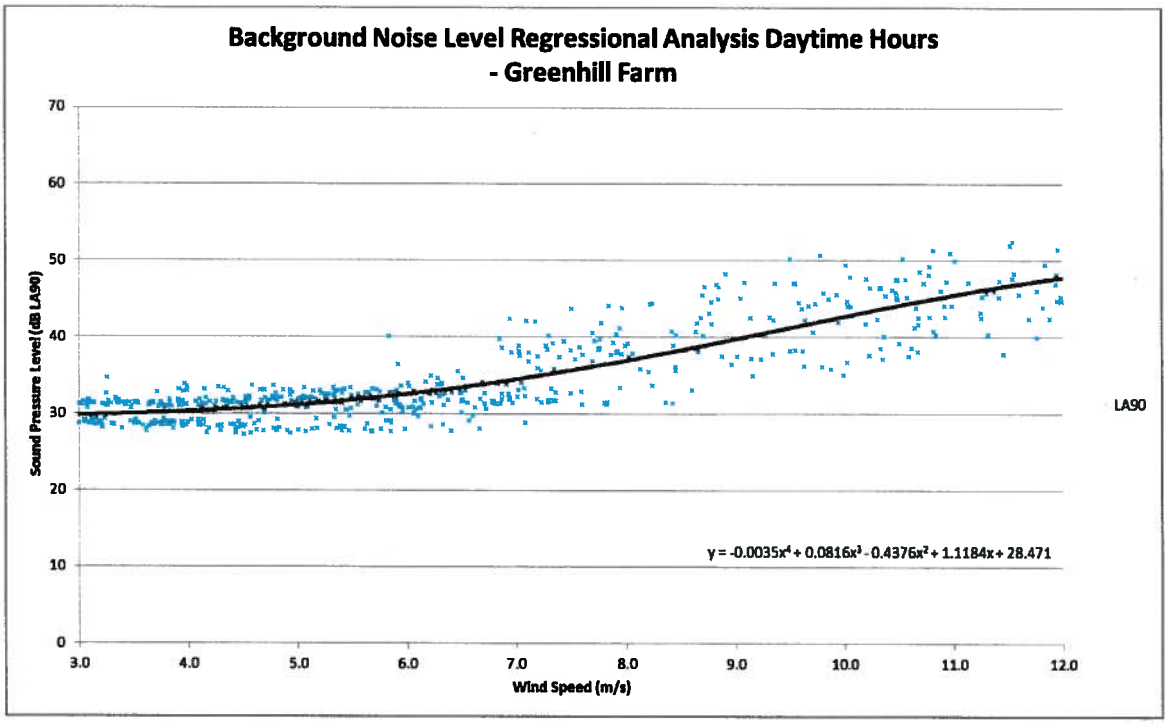
Quilts

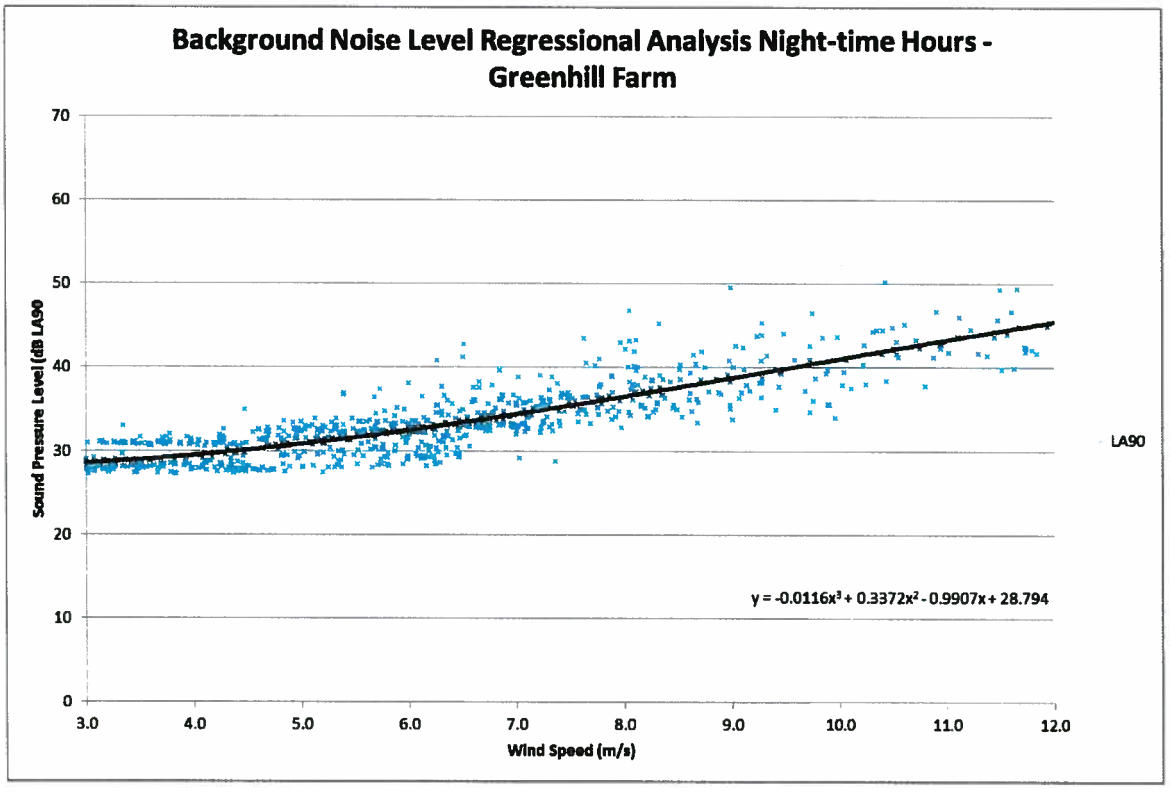
Greenhill

Background Noise Level Regression Analysis






Background Noise Level Regressional Analysis Daytime Hours - Greenhill Farm
Sound Pressure Level (dB LA90)
Wind Speed (m/s)
LA90
y = -0.0035x⁴ + 0.0816x³ - 0.4376x² + 1.1184x + 28.471
0
10
20
30
40
50
60
70
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0


Background Noise Level Regressional Analysis Night-time Hours - Greenhill Farm
Sound Pressure Level (dB LA90)
Wind Speed (m/s)
LA90
y = -0.0116x³ + 0.3372x² - 0.9907x + 28.794
0
10
20
30
40
50
60
70
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0

Calibration Certificates

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 10 April 2013 Certificate N° 1304145

AV Calibration
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Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
Tel: +44 (0)1462 638600
Fax: +44 (0)1462 638601
Email: lab@avcalib.co.uk
www.avcalibration.co.uk

Page 1 of 2 pages

Signed
G.Parry

CLIENT	Muirden Energy LLP Muirden Farm Turriff Aberdeenshire AB53 4NH
F.A.O.	Margaret Burns
REF.	Order N° M0056 Job N° TRAC13/04065/01
DATE OF RECEIPT	5 April 2013
PROCEDURE	AV Calibration Engineer's Handbook, Section 2
IDENTIFICATION	Sound calibrator Rion type NC-74 serial number 34625620, with one-inch housing and adapter type NC-74-002 for half-inch microphone.
CALIBRATED ON	8 April 2013

The measurements detailed herein are traceable to units of measurement realised at the National Physical Laboratory.
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Page 2 of 2 pages

MEASUREMENTS

The sound pressure level generated by the sound calibrator in its half-inch configuration was measured three times using a B&K type 4134 microphone with its protective grid in position. The microphone sensitivity was traceable to National Standards.

RESULTS

The mean level of the calibrator output, corrected to the standard atmospheric pressure of 101.3 kPa using manufacturers' data, was

94.00 ± 0.13 dB rel 20 µPa

The fundamental frequency of the sound output was 1002 Hz ± 0.06%, and its total distortion was (1.50 ± 0.11) %.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor *k*=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the *Guide to the Expression of Uncertainty in Measurement* published by the International Organisation for Standardisation (ISO).

During the measurements the laboratory environmental conditions were:

temperature: 22 to 23 °C
barometric pressure: 99.9 to 100.0 kPa
relative humidity 33 to 43 %.

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Page 1 of 7 pages

Signed
G.Parry

CLIENT	Muirden Energy LLP Muirden Farm Turriff Aberdeenshire AB53 4NH
F.A.O.	Margaret Burns
REF.	Order N° M0056 Job N° TRAC13/04065/02
DATE OF RECEIPT	5 April 2013
PROCEDURE	AV Calibration Engineer's Handbook, Section 25
IDENTIFICATION	Sound level meter Rion type NL-52 [serial no. 00320632] connected via a preamplifier type NH-25 [serial no. 10640] to a half-inch microphone type UC-59 [serial no. 03381] fitted with a foam windshield type WS-10. Associated calibrator Rion type NC-74 [serial no. 34625620] with one-inch housing and adapter type NC-74-002 for half-inch microphone.
CALIBRATED ON	10 April 2013

The measurements detailed herein are traceable to units of measurement realised at the National Physical Laboratory.
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CERTIFICATE OF CALIBRATION ISSUED BY AV CALIBRATION	Certificate Number 1304149 Page 2 of 7 pages

The sound level meter was set up using the type NC-74 sound calibrator supplied; it was set to frequency weighting A, and initially read 93.9 dB which was correct. This reading was derived from Calibration Certificate no. 1304145 supplied by this laboratory and manufacturers' information on the free-field response of the sound level meter when fitted with the windshield. The calibration check frequency was 1 kHz.

Procedures based on IEC 61672-3:2006 (BS EN 61672-3:2006) were used to perform the periodic tests.

RESULTS

The sound level meter submitted for testing has successfully completed the class 1 periodic tests carried out, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1 : 2002 (BS EN 61672-1 : 2003) because evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1 : 2002 (BS EN 61672-1 : 2003) and because the periodic tests carried out cover only a limited subset of the specifications in IEC 61672-1 : 2002 (BS EN 61672-1 : 2003).

The self-generated noise recorded with the microphone replaced by the electrical input device was:

12.4 dB (A) ; 17.1 dB (C) ; 22.4 dB(Z)

The environmental conditions recorded at the start and end of testing were:

Start: 22 to 23 °C, 35 to 45 %RH and 99.9 to 100.0 kPa
End: 22 to 23 °C, 33 to 43 %RH and 99.9 to 100.0 kPa

All measurement data are held at AV Calibration for a period of at least six years.

CERTIFICATE OF CALIBRATION ISSUED BY AV CALIBRATION	Certificate Number 1304149 Page 3 of 7 pages

Technical information including adjustment data specified in the *Technical Notes* 55750 (11-03), *Instruction Manual* 55530 (11-03), *Description for IEC 61672-1* 56030 (11-04) and additional data supplied by Rion has been used to carry out this verification. No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006 (BS EN 61672-3:2006), of some of the adjustment data given in the technical notes was made available by the manufacturer. The uncertainty of measurement of these adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002 (BS EN 61672-1:2003).

No publicly-available evidence has been found that the Rion NL-52 sound level meter design has successfully undergone pattern evaluation in accordance with IEC 61672-2:2002 (BS EN 61672-2:2003) by an independent testing organisation responsible for pattern approvals. It has therefore been tested as a Class 1 instrument in accordance with the manufacturer's claims.

LABORATORY MEASUREMENT UNCERTAINTIES

The measured errors obtained during testing have been extended by the laboratory's expanded measurement uncertainty before assessing conformance to the standard, and it is these extended errors which are quoted in the following pages. In accordance with convention, positive measured errors have been extended by the positive value of expanded uncertainty, and negative measured errors by the negative value. Where a bilateral extended error (± n.n dB) is given, this implies that the measured error was numerically zero.

The laboratory's expanded measurement uncertainties, including contributions from manufacturer-specified corrections where appropriate, are as follows:

Test ①: ± 0.33 dB @ 125 Hz; ± 0.47 dB @ 8 kHz
Test ②: (± dB) 0.33 @ 63 Hz; 0.33 @ 125 Hz; 0.33 @ 250 Hz; 0.33 @ 500 Hz; 0.33 @ 1kHz; 0.33 @ 2 kHz; 0.36 @ 4 kHz; 0.47 @ 8kHz; 0.61 @ 16kHz
Test ③: ± 0.13 dB
Tests ④⑤: ± 0.20 dB
Test ⑥: ± 0.27 dB
Test ⑦: ± 0.23 dB
Sound calibrator: ± 0.23 dB

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor *k*=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the *Guide to the Expression of Uncertainty in Measurement* published by the International Organisation for Standardisation (ISO).

CERTIFICATE OF CALIBRATION ISSUED BY AV CALIBRATION	Certificate Number 1304149 Page 4 of 7 pages

Measurement data - Test ① : Acoustical signal test of frequency weighting C (electrostatic actuator method)

Frequency, Hz	Extended error, dB	Tolerance, dB
125	0.41	± 1.5
8000	-0.52	+2.1, -3.1

The above data include manufacturer-specified corrections for case reflections

Measurement data - Test ② : Electrical signal tests of frequency weightings

Frequency, Hz	Extended error in A-weighting, dB		Extended error in C-weighting, dB		Extended error in Z-weighting, dB		Tolerance, dB
	most +ve	most -ve	most +ve	most -ve	most +ve	most -ve	
63	0.23	-0.43	0.33	-0.33	0.33	-0.33	± 1.5
125	0.33	-0.33	0.43	-0.23	0.33	-0.33	± 1.5
250	0.33	-0.33	0.33	-0.33	0.33	-0.33	± 1.4
500	0.43	-0.23	0.53	-0.13	0.53	-0.13	± 1.4
1000	REF	REF	REF	REF	REF	REF	REF
2000	0.43	-0.23	0.43	-0.23	0.43	-0.23	± 1.6
4000	0.46	-0.26	0.46	-0.26	0.46	-0.26	± 1.6
8000	0.97	0.03	0.97	0.03	0.87	-0.07	+2.1, -3.1
16000	-2.59	-3.81	-2.59	-3.81	-1.19	-2.41	+3.5, -17.0

The above data include manufacturer-specified corrections for the measured microphone response, case reflections and windshield

Measurement data - Test ③ : Frequency and time weightings at 1 kHz

Parameter measured	Extended error, dB	Tolerance, dB
LAF	REF	REF
LCF	± 0.13	± 0.4
LZF	± 0.13	± 0.4
LAS	± 0.13	± 0.3
LAeq	± 0.13	± 0.3

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Certificate Number 1304149

Page 5 of 7 pages

Measurement data - Test ④: Level linearity on the reference level range (at 8 kHz, ref 94.0 dB).

Reference (only) range		
Nominal reading, dB	Extended error, dB	Warning flags
24.0	U/R	U/R
25.0	0.30	¤
26.0	0.30	¤
27.0	0.30	¤
28.0	0.30	¤
29.0	0.30	¤
30.0	0.30	¤
34.0	± 0.20	¤
39.0	± 0.20	¤
44.0	± 0.20	¤
49.0	± 0.20	¤
54.0	± 0.20	¤
59.0	± 0.20	¤
64.0	± 0.20	¤
69.0	± 0.20	¤
74.0	± 0.20	¤
79.0	± 0.20	¤
84.0	± 0.20	¤
89.0	± 0.20	¤
94.0	Ref	¤
99.0	± 0.20	¤
104.0	± 0.20	¤
109.0	± 0.20	¤
114.0	± 0.20	¤
119.0	± 0.20	¤
124.0	± 0.20	¤
129.0	± 0.20	¤

Reference (only) range		
Nominal reading, dB	Extended error, dB	Warning flags
131.0	± 0.20	¤
132.0	± 0.20	¤
133.0	± 0.20	¤
134.0	± 0.20	¤
135.0	± 0.20	¤
136.0	± 0.20	¤
137.0	± 0.20	¤
138.0	O/L	O/L
139.0	O/L	O/L

Linearity tolerances, dB	± 1.1

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Measurement data - Test ⑤ Toneburst response

Parameter	Burst length ms	Extended error 1, dB	Extended error 2, dB	Extended error 3, dB	Tolerance, dB
LAFmax	200	± 0.20	± 0.20	± 0.20	± 0.8
	2	± 0.20	± 0.20	± 0.20	+1.3, -1.8
	0.25	-0.30	-0.30	-0.30	+1.3, -3.3
LASmax	200	± 0.20	± 0.20	± 0.20	± 0.8
	2	± 0.20	± 0.20	± 0.20	+1.3, -3.3
LAE	200	± 0.20	± 0.20	± 0.20	± 0.8
	2	± 0.20	± 0.20	± 0.20	+1.3, -1.8
	0.25	-0.30	-0.30	-0.30	+1.3, -3.3

Measurement data - Test ⑥ : Peak C sound level

Frequency, Hz	Burst length cycles	Extended error 1, dB	Extended error 2, dB	Extended error 3, dB	Tolerance, dB
8000	1	-0.47	-0.37	-0.37	± 2.4
500	+ ½	-0.47	-0.47	-0.47	± 1.4
	- ½	-0.47	-0.47	-0.47	± 1.4

Measurement data - Test ⑦ : Overload indication

Extended error in level of negative pulse required to trigger overload, relative to level of positive pulse required: ± 0.23 dB (tolerance ± 1.8 dB)

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NOTES

1 The windscreen correction filter was set to *WS-10* and the diffuse field correction filter to *off* for all tests. It was noted that as received the windscreen correction filter was set to *WS-15*, which does not correspond to the accessories supplied.

2 No suitable microphone frequency response information was supplied with the instrument. It was therefore measured by this laboratory using the electrostatic actuator method.

3 The instrument was running firmware version 1.2

4 All tests were carried out on the main measurement channel, with the exception of that for Peak C sound level which is available only on the sub-channel.

5 The following adjustment data, to be added to the electrostatic actuator response, have been issued by Rion. The uncertainties are for a coverage factor $k = 2$.

Frequency, Hz	Correction, dB	Uncertainty, dB
63	-0.02	± 0.23
125	-0.02	± 0.23
250	-0.02	± 0.23
500	-0.04	± 0.23
1000	0.00	± 0.23

Frequency, Hz	Correction, dB	Uncertainty, dB
2000	0.25	± 0.23
4000	1.04	± 0.28
8000	3.55	± 0.41
16000	9.25	± 0.57

MEASUREMENT SYSTEMS

CERTIFICATE OF CONFORMANCE

Date of Issue	**20 June 2013**
Customer	**Muirden Energy**
Certificate Number	**CONF061303**

	Manufacturer	Type	Serial Number
Sound Level Meter	Rion	NL-52	00231673
Preamplifier	Rion	NH-25	21618
Microphone	Rion	UC-59	04310

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 61672-1:2002 Class 1.

The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

Signed..... Position Calibration Manager. Date 20th Jun 2013.....

BEAUFORT COURT, 17 ROEBUCK WAY, MILTON KEYNES, MK5 8HL
☎ 01908 642846 🖷 01908 642814
✉ info@noise-and-vibration.co.uk 🖳 www.noise-and-vibration.co.uk

ACOUSTICS NOISE AND VIBRATION LIMITED. REGISTERED IN ENGLAND NO. 3549028. REGISTERED OFFICE AS ABOVE

Appendix 4.2 Predicted Construction Noise Levels

Access Tracks

Plant List	Ref	Number	L_{Aeq} db at 10m	Duration of activity as % of 12h	Duration Adjustment dB	$L_{Aeq\ (12h)}$ db
Tracked Excavator (25t)	C2 19	1	77	100	0	77
Tracked Excavator (90t)	C6 5	1	86	100	0	86
Roller (rolling fill)	C2 37	1	79	100	0	79
Dozer (20t)	C2 12	1	81	100	0	81
Dump Truck (29t)	C2 30	1	79	100	0	79
					Total $L_{Aeq\ (12h)}$	89

Noise Sensitive Receptor	L_{Aeq}	Distance	Adjustments			Predicted $L_{Aeq(12h)(db)}$
			Distance	Screening	Reflection	
Quilts	89	460	-39.6	0	0	49.4
Cockersfauld	89	715	-44.4	0	0	44.6
Blaeberry Toll	89	1100	-49.0	0	0	40.0
Unknown	89	1300	-50.9	0	0	38.1
Baadhead	89	1040	-48.4	0	0	40.6

Foundation Excavation

Plant List	Ref	Number	L_{Aeq} db at 10m	Duration of activity as % of 12h	Duration Adjustment dB	$L_{Aeq\ (12h)}$ db
Excavator (25t)	C.2 19	1	77	100	0	77
Dump Truck (29t)	C.2 30	1	79	100	0	79
Water Pump (20kw)	C.2 45	1	65	100	0	65
					Total $L_{Aeq\ (12h)}$	81

Noise Sensitive Receptor	L_{Aeq}	Distance	Adjustments			Activity $L_{Aeq(12h)}$ dB
			Distance	Screening	Reflection	
Quilts	81	1089	-48.9	0	0	32.1
Cockersfauld	81	1121	-49.2	0	0	31.8
Blaeberry Toll	81	1233	-50.3	0	0	30.7
Unknown	81	1319	-51.0	0	0	30.0
Baadhead	81	1057	-48.6	0	0	32.4

Turbine Foundation Build

Plant List	Ref	Number	L_{Aeq} db at 10m	Duration of activity as % of 12h	Duration Adjustment dB	$L_{Aeq(12h)}$ dB
Concrete mixer truck (discharging) and concrete pump (pumping)	C.4 28	1	75	100	0	75
Poker vibrator	C.4 33	1	78	100	0	78
					Total L_{Aeq}	80

Noise Sensitive Receptor	L_{Aeq}	Distance	Adjustments			Activity
			Distance	Screening	Reflection	$L_{Aeq(12h)}$ dB
Quilts	80	1089	-48.9	0	0	31.1
Cockersfauld	80	1121	-49.2	0	0	30.8
Blaeberry Toll	80	1233	-50.3	0	0	29.7
Unknown	80	1319	-51.0	0	0	29.0
Baadhead	80	1057	-48.6	0	0	31.4

Turbine Erection

Plant List	Ref	Number	L_{Aeq} db at 10m	Duration of activity as % of 12h	Duration Adjustment dB	$L_{Aeq(12h)}$ dB
Tracked Mobile Crane (600t)	C.4 50	1	71	100	0	71
Tracked mobile Crane (105t)	C.4 52	1	75	100	0	75
					Total L_{Aeq}	76

Noise Sensitive Receptor	L_{Aeq}	Distance	Adjustments			Activity
			Distance	Screening	Reflection	$L_{Aeq(12h)(db)}$
Quilts	76	1089	-48.9	0	0	27.1
Cockersfauld	76	1121	-49.2	0	0	26.8
Blaeberry Toll	76	1233	-50.3	0	0	25.7
Unknown	76	1319	-51.0	0	0	25.0
Baadhead	76	1057	-48.6	0	0	27.4

Gamesa	**TECHNICAL REPORT**	*Code:* **GD037369-en** *Rev.:* **1**
		Date: **20/01/09** *Page* **1** *of* **22**
		Approval process: **Electronic: PDM Flow + Translation**
Type of Documentation: **Design**	*Title:* **SPECTRAL ANALYSIS OF NOISE EMISSIONS IN G5X WIND TURBINES**	*Author:* **IRS**
Deliverable: **SC007**		*Revised:* **FPL**
		Approved: **RMP**

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RECORD OF CHANGES

Rev.	Date	Author	Description
0	04/02/08	IRS	Initial version
1	11/12/08	IRS	Update of noise absolute values Inclusion of tables to FULL POWER New format update

1. AIM

This document performs a one-third octave band spectral analysis of the noise for G5X turbines. This study shall be performed based on the noise measurement reports prepared by accredited centers, WINDTEST, DEWI, and internal reports available in the Gamesa Innovation and Technology database.

Based on the analysis of the one-third octave-band noise measurements, a model shall be defined for G52, G58 wind turbines that is independent to the measurement parameters.

The noise emissions of the G8X group of wind turbines measured by the accredited centers, were made in line with the IEC61400-11 standard, considering, as indicated, sound pressure levels in the interval of speeds from 6 to 10m/s.

2. SCOPE

This document applies to G5X wind turbines. The spectral noise distribution is the same for all the noise levels, changing only the amplitude or noise level (WLL) for different operating conditions. Therefore, the procedure and the models presented in this report apply to any noise level and wind speed.

Due to the uncertainty in the measurements and the fact that the models proposed here are based on experimental data, it is not possible to guarantee the accuracy of these models. They must be interpreted as an approximation and not as a prediction of the spectral noise distribution produced by the wind turbine.

3. DEFINITIONS AND ACRONYMS

WT: Wind turbine.

4. DESCRIPTION

The procedure proposed in this report consists of reducing the number of variables on which the noise depends (turbine operating state, density, turbulence intensity, rotation speed, etc.) to facilitate the analysis of all the available noise spectra. The method to follow in all the reports for G8X wind turbines is to standardize all the spectra in third octaves at a reference noise level, $L_{Aeq,ref.}$, of **100dB(A)**. For this purpose, the amplitude, or noise level, of each third octave is standardized according to the following expression:

$$\overline{L}_{Aeq,i} = \overline{L}^{0}_{Aeq,i} + (\overline{L}_{Aeq,ref} - \overline{L}_{Aeq,total\ espectro}) \quad \textbf{[1]}$$

Where:

$\overline{L}_{Aeq,i}$ = standardized noise level, where i is the nominal frequency in third octaves [Hz].

$L^{0}_{Aeq,i}$ = noise level of the spectrum at the frequency i

$L_{Aeq,ref}$ = reference noise level 100dB

$L_{Aeq,totalespectro}$ = total noise level of the spectrum

The total noise level of the spectrum once standardized is 100dB(A). This allows us to compare the distribution in frequencies of turbines that produce a different noise level. With this comparison you can establish a trend, and associate a spectral distribution to a type of turbine. Once this is completed, to recover or to calculate the sound power distribution for a turbine or certain noise level, it is only necessary to do the standardization operation in reverse order.

To transfer the standardized noise spectra to 100 dB(A) to the turbine noise levels, it is necessary do the standardization operation in reverse order. For this purpose, you just need to add the difference between the noise level for which you wish to know the spectrum distribution to each value of the standardized spectrum and the 100 dB(A) to the that have been standardized:

$$\overline{L}^{0}_{Aeq,i} = \overline{L}_{Aeq,i} + (\overline{L}_{Aeq,total\ espectro} - \overline{L}_{Aeq,ref}) \quad \textbf{[2]}$$

To calculate the distribution in frequencies of the noise produced by a turbine, you need to know the control law that has been applied to the turbine. The wind speed and the noise produced by the wind turbine are related by these control laws. These laws are shown in **Appendix A** for the G52 and G58 models for different tower heights.

The procedure for calculating the sound spectrum of a turbine in certain conditions consists in obtaining, from the table corresponding to the tower height and to the control law, the noise level for the desired wind speed. Once you have this value, the standardized spectrum of the wind turbine model is displaced using **[2]**.

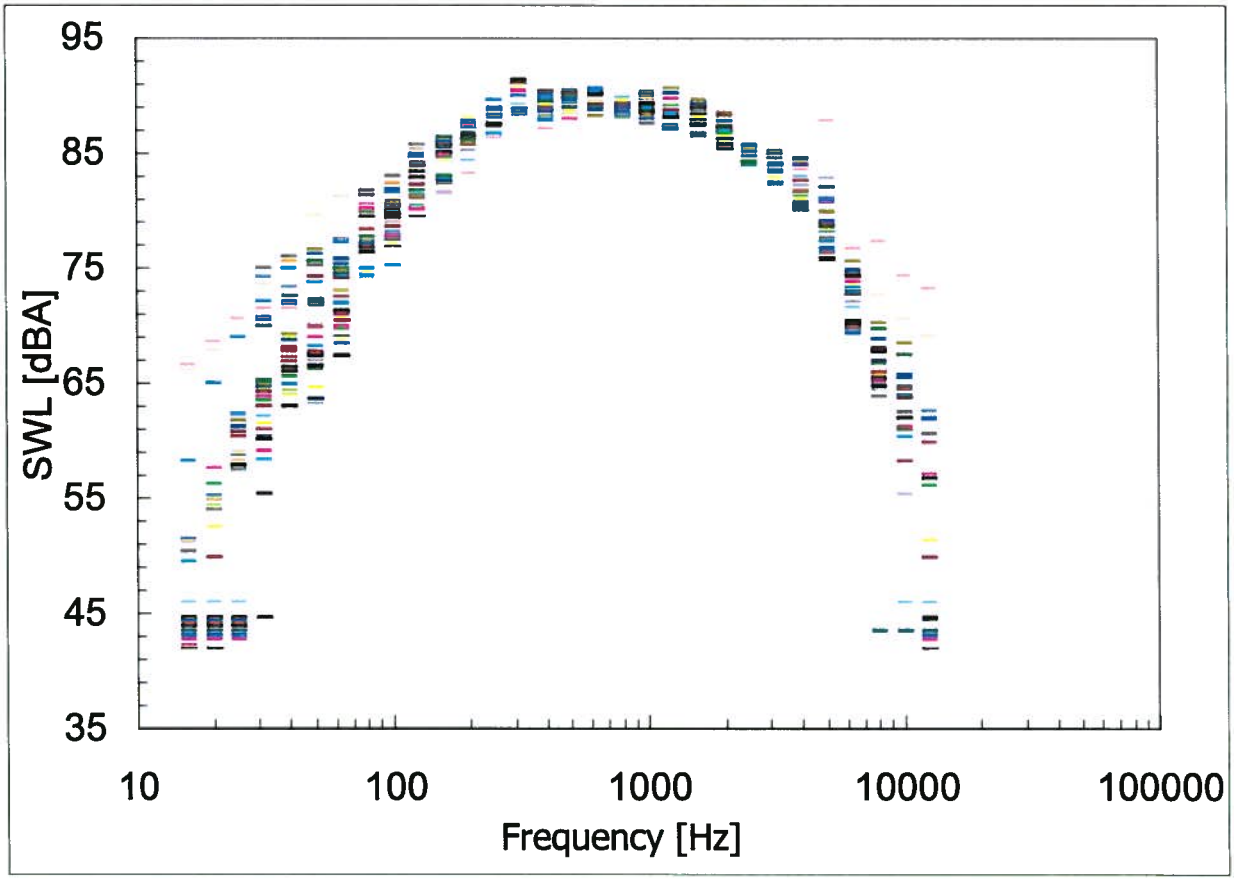
Appendix B includes a demonstrative example.

5. STANDARDIZED OCTAVE SPECTRA AT 100DB FOR G5X WT

Below are the one-third octave-band noise emission spectra measured for G5X turbines. These spectra have been standardized to a noise level of 100dB(A) according to the expression **[1]**.

5.1. NOISE REPORTS FOR WT 52

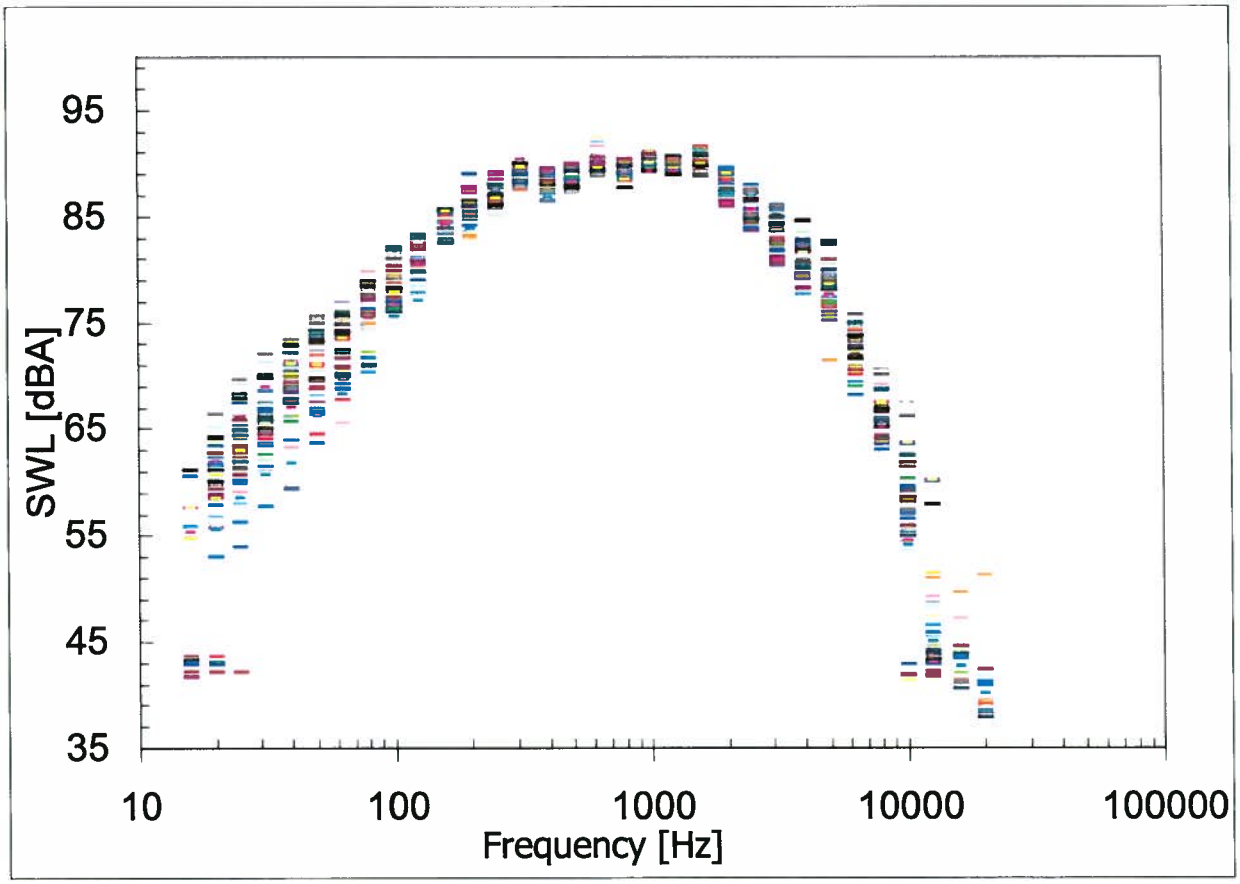
The noise spectra analyzed for the G52 wind turbine in standardized third octaves are included in the reports **[re.3]** and are shown in Graph 1.



Graph 1: Standardized one-third octave-band spectra at 100dB measured by accredited centers.

5.2. NOISE REPORTS FOR WT 58

The standardized one-third octave-band noise spectra analyzed for the G58 wind turbine are included in the reports **[ref.4]** and are shown in Graph 2.



Graph 2: Spectra in standardized third octaves at 100dB measured by accredited centers for the G58.

6. GNOISE MODEL

The semi-empirical model Gnoise is based on establishing four sources of aerodynamic noise

- Noise produced by the turbulence of the incident current.
- Noise due to the thickness of the trailing edge.
- Noise due to the interference of the limit layer with the trailing edge.
- Noise produced by the blade tip vortex.

Below, the aforementioned generation mechanisms are shown schematically.

NOISE PRODUCED BY THE TURBULENCE OF THE INCIDENT CURRENT.

When the blades of the wind turbine rotate they encounter atmospheric turbulence that causes variations in the local angle of attack, which causes fluctuations in the lift and resistance forces. The correlation that provides the Sound Pressure Level is:

$$SPL_{1/3}(f) = 10\log_{10}\left[\frac{B\sin^2\theta\rho^2 c_{0.7}R\sigma^2 V_{0.7}^4}{d^2 a_0^2}\right] + K_a$$

$$V_{0.7} = 0.7R\Omega$$

$$f_{peak} = \frac{S_0 V_{0.7}}{H - 0.7R}$$

Where

$SPL_{1/3}$= sound pressure level in third octave bands (dB)

f = central frequency of the band (Hz)

B = number of blades

θ = angle between the center line of the rotor-receptor and its vertical projection on the rotor drawing (rad)

ρ = air density (kg/m^3)

$c_{0.7}$= rope in the radius 0.7R (m)

σ^2= average quadratic turbulence (m^2/s^2)

$v_{0.7}$= effective speed in 0.7R (m/s)

K_c= scale factor depending on the frequency (dB)

f_{peak}= frequency for K_a maximum (Hz)

S_0= Strouhal constant number = 16.6

H= height of the tower (m)

NOISE DUE TO THE THICKNESS OF THE TRAILING EDGE

Another source of aerodynamic noise to be taken into account is the creation of vortices due to the fact that the trailing edge is blunt. The expression derived from the literature is:

$$SPL_{1/3}(f) = 10\log_{10}\sum_{nstac}\frac{BdrV_r^{5.3}t\sin^2(\theta/2)\sin^2\psi}{(1+M\cos\theta)^3(1+0.2M\cos\theta)^2 d^2}10^{\frac{K_c}{10}}$$

$$f_{peak} = \frac{0.1V_r}{t}$$

$$M = \frac{V_r}{a_0}$$

Where

M= Mach number of each blade station

dr= differential of r belonging to each station (m)

ψ = angle between the center line of the rotor-receptor and its horizontal projection on the rotor drawing (rad)

t= thickness of the trailing edge (m)

K_c= scale factor depending on the frequency (dB)

nstac= number of stations in which the blade is divided

V_r= effective speed for each blade station

d= distance between the emitter and the receptor

a_0= speed of sound (340 m/s)

NOISE DUE TO THE INTERFERENCE OF THE LIMIT LAYER WITH THE TRAILING EDGE

Another source of noise is that generated by the interaction of the turbulent limit layer with the slipstream of the profile. The approximation used in this case is:

$$SPL_{1/3}(f) = 10\log_{10}\sum_{nstac}\frac{V_r^5 BD\delta ldr}{d^2}\left(\frac{S}{S_{\max}}\right)^2\left[\left(\frac{S}{S_{\max}}\right)^{1.5}+0.5\right]^{-4}10^{\frac{K_b}{10}}$$

$$D = \frac{\sin^2(\theta/2)}{(1+M\cos\theta)(1+0.2M\cos\theta)};\ \delta = \frac{0.37c}{N_R^{0.2}};\ N_R = \frac{V_r c}{\nu};\ S = \frac{f\delta}{V_r}$$

Where

D= directivity factor

δ= thickness of the limit layer

c= rope of each of the blade stations

N_r= Reynolds number of each of the stations

ν= cinematic viscosity (m^2/s)

S= Strouhal number of each station

S_{max}=0.1

K_b= constant scale factor = 5.5 dB

NOISE PRODUCED BY THE BLADE TIP VORTEX

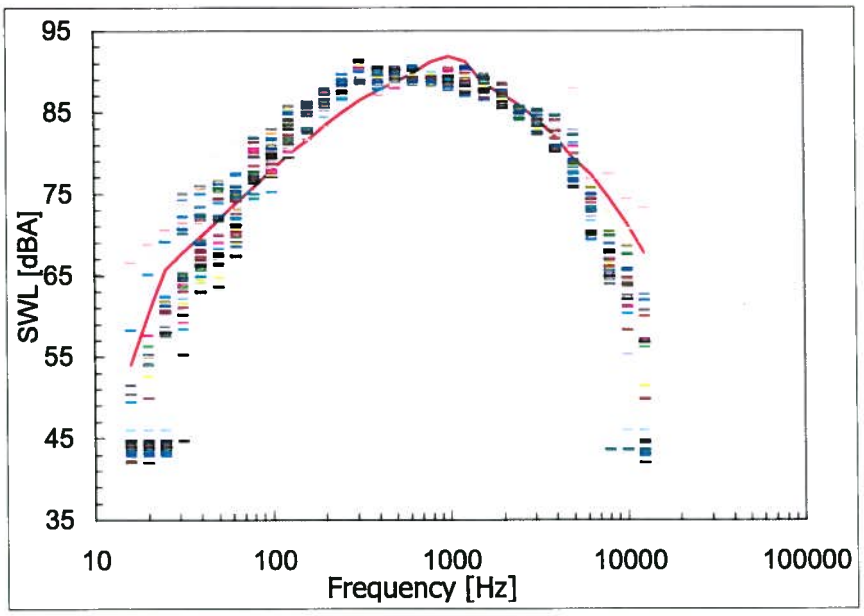
The expression that provides the sound pressure level produced by the blade tip vortex is:

$$SPL_{1/3} = 10\log_{10}\left[\frac{M^2 M_m^3 l^2}{R^2}\right] - 30.5(\log 10\hat{f} + 0.3)^2 + 126$$

$$\hat{f} = \frac{fl}{V_r};\ \frac{l}{c} = 0.008\alpha_{tip};\ \frac{V_m}{V_r} = (1+0.036\alpha_{tip});\ M_m = \frac{V_m}{a_0}$$

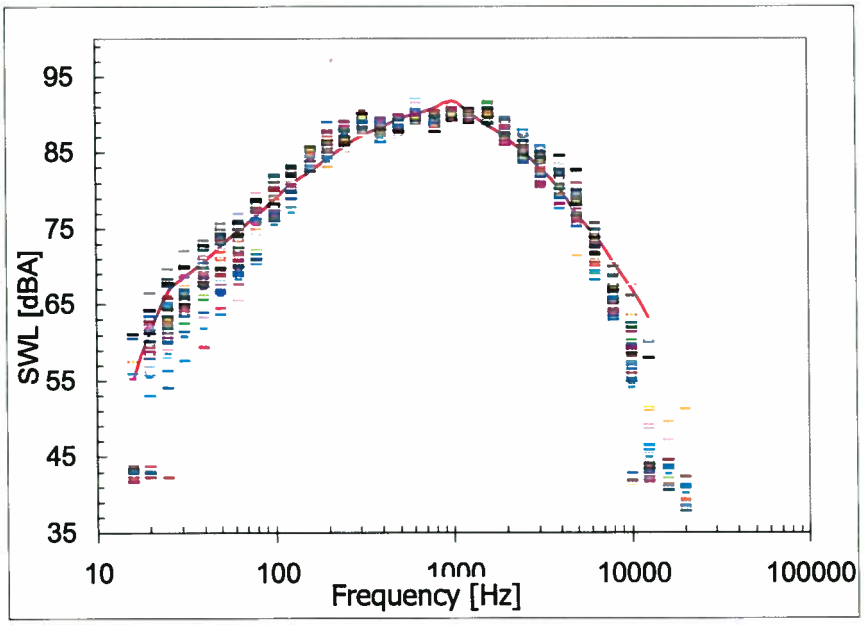
Graphs 3 and 4 compare the semi-empirical Gnoise model standardized according to expression **[1]** with the standardized noise measurements analyzed previously for G5X wind turbines.

- **G52**



Graph 3: Gnoise Model comparison with experimental measurements for G52 wind turbines

- **G58**



Graph 4: Gnoise Model comparison with experimental measurements for G58 wind turbines

Despite the results offering a good approximation, the hypotheses on which calculation for the Gnoise model is based are not thoroughly validated so cannot be generally used.

7. PROPOSED METHOD

Starting with the noise measurements in third octaves made by accredited centers for G58 and G52 wind turbines, there are three standardized models for every turbine:

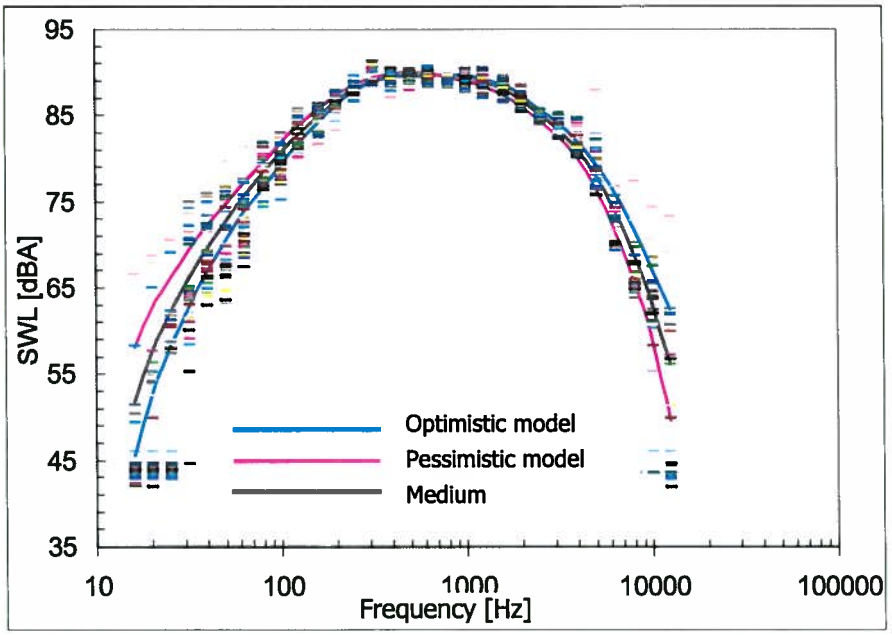
- Optimistic model: This model assigns greater energy content to high frequencies.
- Pessimistic model: This model assigns greater energy content to high frequencies.
- Average: This model contains approximately 50% of the share of the previous models.

1. Proposed models for G52

Table 1 presents three models based on the standardized one-third octave-band noise measurements at 100dB carried out by accredited centers for G52:

Modelo optimista		Modelo pesimista		Media	
f [Hz]	100dB	f [Hz]	100dB	f [Hz]	100dB
16	45,6	16	58,0	16	51,8
20	52,6	20	62,6	20	57,6
25	58,2	25	66,1	25	62,2
31,5	62,9	31,5	69,5	31,5	66,2
40	66,9	40	72,2	40	69,5
50	70,5	50	74,7	50	72,7
63	73,9	63	77,3	63	75,7
80	76,7	80	79,6	80	78,4
100	79,2	100	81,8	100	80,7
125	81,8	125	83,9	125	82,8
160	84,2	160	85,7	160	84,9
200	86,2	200	87,3	200	86,8
250	87,9	250	88,5	250	88,2
315	88,9	315	89,4	315	89,1
400	89,4	400	89,8	400	89,6
500	89,7	500	90,0	500	89,8
630	89,7	630	90,0	630	89,8
800	89,7	800	89,5	800	89,6
1000	89,7	1000	89,1	1000	89,4
1250	89,3	1250	88,4	1250	88,9
1600	88,5	1600	87,4	1600	88,0
2000	87,3	2000	86,1	2000	86,8
2500	85,7	2500	84,4	2500	85,2
3150	84,1	3150	82,6	3150	83,3
4000	81,9	4000	80,2	4000	81,1
5000	79,3	5000	76,5	5000	78,0
6300	76,1	6300	71,6	6300	73,9
8000	71,6	8000	65,6	8000	68,6
10000	67,0	10000	58,8	10000	62,9
12500	62,5	12500	49,6	12500	56,1
$L_{Aeq,ref}$	100		100		100

Table 1: Spectral distribution model for G52 wind turbines



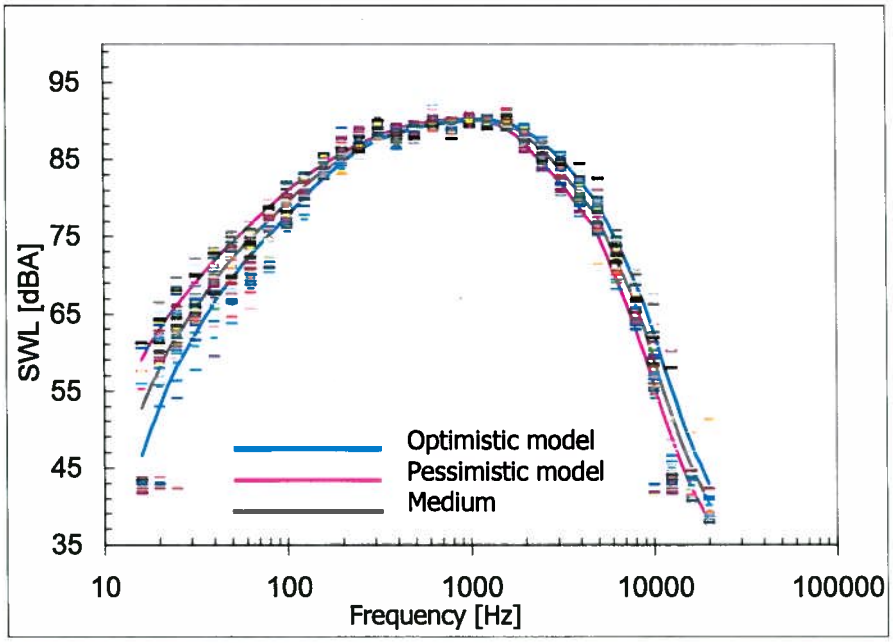
Graph 5: Spectral distribution model for G52 wind turbines

2. Proposed models for G58

Table 2 shows three standardized spectral noise distribution models at 100dB for the G58 wind turbine.

Modelo optimista		Modelo pesimista		Media	
f [Hz]	dBA	f [Hz]	dBA	f [Hz]	dBA
16	46,5	16	59,0	16	52,8
20	53,0	20	62,9	20	57,9
25	58,0	25	66,1	25	62,0
31,5	62,4	31,5	69,0	31,5	65,7
40	66,4	40	71,9	40	69,1
50	69,5	50	74,2	50	72,1
63	72,6	63	76,6	63	74,7
80	75,2	80	78,8	80	77,1
100	77,7	100	80,8	100	79,4
125	80,1	125	82,6	125	81,5
160	82,6	160	84,4	160	83,5
200	84,6	200	85,8	200	85,2
250	86,3	250	87,1	250	86,7
315	87,6	315	88,2	315	87,9
400	88,4	400	89,0	400	88,7
500	89,1	500	89,6	500	89,3
630	89,6	630	90,0	630	89,8
800	89,9	800	90,3	800	90,1
1000	90,2	1000	90,3	1000	90,3
1250	90,3	1250	90,0	1250	90,2
1600	89,8	1600	89,0	1600	89,5
2000	88,7	2000	87,1	2000	88,1
2500	87,2	2500	84,7	2500	86,2
3150	85,0	3150	81,9	3150	83,6
4000	82,3	4000	78,7	4000	80,6
5000	79,1	5000	75,3	5000	77,3
6300	74,4	6300	69,4	6300	71,9
8000	69,0	8000	63,1	8000	66,2
10000	62,7	10000	55,9	10000	59,1
12500	55,3	12500	49,1	12500	52,0
16000	48,3	16000	42,5	16000	45,3
20000	43,0	20000	37,9	20000	40,4
$L_{Aeq\,ref}$	100		100		100

Table 2: Spectral distribution models for G58 wind turbines.



Graph 6: Spectral distribution model for G58 wind turbines

8. REFERENCES

- **[ref.1]:** IEC "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques. Second edition. 2002-12
- **[ref.2]:** "WAGNER, BAREIβ, GUIDATI. "WIND TURBINE NOISE"
- **[ref.3]:** Noise reports drawn up by accredited centers for the G52 wind turbine.
    - *DEWI S AM 106/03*
    - *DEWI S AM 107/03*
    - *DEWI S AM 108/03*
    - *DEWI S AM 110/03*
    - *DEWI S AM 111/03*
    - *DEWI S AM 112/03*
    - *DEWI S AM 113/03*
    - *DEWI S AM 114/03*
    - *DEWI S AM 126/03*
    - *DEWI S AM 127/03*
    - *WT 5540/07*
- **[ref.4]** Noise report drawn up by Windtest for **G58 wind turbines**.
    - *DEWI S AM 119/03*
    - *DEWI S AM 121/03*
    - *DEWI S AM 128 / 03, 2003-11-25*
    - *DEWI S AM 129 / 03, 2003-11-25*
    - *DEWI AM 05 02 05 - 01*
    - *DEWI AM 05 02 05 – 02*
    - *DEWI AM 050205 - 05- 04*
    - *DEWI AM 050205 - 06*
    - *DEWI AM 050304 - 10*

APPENDIX A: Noise versus wind speed for different tower heights.

Below, in table format, you can see the noise level values for the G52 and G58 wind turbines for different tower heights (H). These values are given for different speeds at hub height (W_S). Consult documents GD027763R3, GD027764R3, GD027758R2 and GD027759R2 for further information on this issue.

Wind turbine G52 in FULL POWER mode:

	H = 44m		H = 53.59yd		H = 60.15yd		H = 71.08yd	
W_{10} [m/s]	dB(A)	W_s [m/s]	dB(A)	W_s [m/s]	dB(A)	W_s [m/s]	dB(A)	W_s [m/s]
4	92.9	5.12	93.1	5.20	93.4	5.29	93.8	5.41
5	97.0	6.40	97.4	6.50	97.7	6.61	98.2	6.77
6	101.1	7.68	101.4	7.8	101.7	7.93	102.1	8.12
7	102.8	8.96	102.9	9.1	103.0	9.25	103.1	9.47
8	103.6	10.24	103.7	10.4	103.7	10.57	103.7	10.83
9	103.7	11.52	103.7	11.7	103.7	11.90	103.7	12.18
10	103.7	12.8	103.7	13	103.7	13.21	103.7	13.53
11	103.7	14.08	103.7	14.30	103.7	14.54	103.7	14.89
12	103.7	15.36	103.7	15.60	103.7	15.86	103.7	16.24

Table 3. G52 in FULL POWER.

Wind turbine G52 in LOW NOISE mode:

		H = 44m		
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2	LEVEL 3
4	5.12	92.9	92.9	92.9
5	6.40	97.0	97.0	97.0
6	7.68	100.0	99.1	98.2
7	8.96	100.3	99.5	98.3
8	10.24	101.0	100.0	98.8
9	11.52	101.2	100.2	99.1
10	12.8	101.5	100.6	99.2
11	14.08	102.9	102.5	101.9
12	15.36	103.7	103.7	103.7

Table 4. G52 at 44m

H = 53.59yd				
W10[m/s]	WS[m/s]	LEVEL 1	LEVEL 2	LEVEL 3
4	5.2	93.1	92.9	92.9
5	6.5	97.3	97.0	97.0
6	7.8	100.0	99.1	98.2
7	9.1	100.4	99.6	98.3
8	10.4	101.0	100.0	98.8
9	11.7	101.2	100.3	99.2
10	13.0	101.6	100.7	99.3
11	14.3	103.2	103.0	102.7
12	15.6	103.7	103.7	103.7

Table 5. G52 at 53.59yd

H = 60.15yd				
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2	LEVEL 3
4	5.29	93.4	92.9	92.9
5	6.61	97.7	97.0	97.0
6	7.93	99.5	98.4	98.2
7	9.25	100.5	99.7	98.3
8	10.57	101.1	100.0	98.9
9	11.9	101.3	100.3	99.2
10	13.22	101.7	100.9	99.7
11	14.53	103.7	103.7	103.7
12	15.86	103.7	103.7	103.7

Table 6. G52 at 60.15yd

H = 71.08yd				
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2	LEVEL 3
4	5.42	92.9	92.9	92.9
5	6.77	98.2	98.2	98.2
6	8.12	99.7	98.6	98.2
7	9.47	100.6	99.8	98.4
8	10.83	101.2	100.1	99.0
9	12.18	101.3	100.4	99.2
10	13.53	101.7	100.9	99.7
11	14.89	102.9	102.5	103.7
12	16.25	103.7	103.7	103.7

Table 7. G52 at 71.08yd

Wind turbine G58 in FULL POWER mode:

W_{10} [m/s]	H = 44m dB(A)	W_S [m/s]	H = 60.15yd dB(A)	W_S [m/s]	H = 71.08yd dB(A)	W_S [m/s]	H = 77.65yd dB(A)	W_S [m/s]
4	94.8	5.12	95.0	5.29	95.2	5.42	95.3	5.48
5	98.0	6.4	98.5	6.61	99.0	6.77	99.3	6.85
6	102.1	7.68	102.6	7.93	102.9	8.12	103.0	8.22
7	103.3	8.96	103.3	9.25	103.4	9.47	103.4	9.59
8	103.6	10.24	103.60	10.57	103.6	10.83	103.6	10.96
9	103.6	11.52	103.60	11.9	103.6	12.18	103.6	12.33
10	103.6	12.8	103.60	13.21	103.6	13.53	103.6	13.7
11	103.6	14.08	103.60	14.54	103.6	14.89	103.6	15.07

Table 8. G52 in FULL POWER

Wind turbine G58 in LOW NOISE mode:

H = 44m			
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2
3	3.84	94.6	94.6
4	5.12	94.8	94.8
5	6.4	97.8	97.8
6	7.68	100.8	99.6
7	8.96	101.6	100.5
8	10.24	101.9	101.0
9	11.52	102.0	101.1
10	12.8	102.0	100.9
11	14.08	102.9	102.4
12	15.36	103.6	103.6

Table 9. G58 at 44m

H = 60.15yd			
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2
3	3.96	94.6	94.6
4	5.29	95.0	95.0
5	6.61	98.5	98.5
6	7.93	101.1	99.8
7	9.25	101.7	100.6
8	10.57	101.9	101.1
9	11.9	102.0	101.1
10	13.22	102.0	101.1
11	14.53	103.6	103.6
12	15.86	103.6	103.6

Table 10. G58 at 60.15yd

H = 71.08yd			
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2
3	4.06	94.6	94.6
4	5.42	95.2	95.2
5	6.77	99.1	99.1
6	8.12	101.3	99.9
7	9.47	101.8	100.7
8	10.83	102.0	101.1
9	12.18	102.0	101.1
10	13.53	102.0	101.1
11	14.89	103.6	103.6
12	16.25	103.6	103.6

Table 11. G58 at 71.08yd

H = 77.65yd			
W_{10} [m/s]	W_S [m/s]	LEVEL 1	LEVEL 2
3	4.11	94.6	94.6
4	5.48	95.3	95.3
5	6.85	99.4	99.4
6	8.22	101.4	100.0
7	9.59	101.8	100.8
8	10.96	102.0	101.1
9	12.33	102.0	101.1
10	13.7	102.0	101.1
11	15.07	103.6	103.6
12	16.44	103.6	103.6

Table 12. G58 at 77.65yd

APPENDIX B: EXAMPLE OF FREQUENCY SPECTRUM TRANSFER

Below is a practical example of the noise spectrum calculation for a G52 wind turbine with a LEVEL 1 control law, a tower height of 49 meters and a speed **at the hub** of 9 m/s.

From **Table 1** (or from **Graph 5)** we obtain the standardized spectral distribution of frequencies, which in this case is presumed to correspond to the average model. **Table 4** gives the noise level corresponding to the conditions specified, which in this specific case is **101.2 dB(A)**.

In the first column of **Table B1**, the frequency is divided in third octaves. The second column indicates the values corresponding to each one-third octave for the standardized spectrum (obtained from Table 2), whereas the third column indicates the corrected values for a noise level of 101.2dBA. As you can see, the values in the third column are those of the second plus 1.2dB (101.2dB - 100dB = 1.2dB), as indicated in the equation **[2]**.

	100 dBA	**102.1 dBA**
f [Hz]	[dBA]	[dBA]
16	51,8	53
20	57,6	58.8
25	62,2	63.4
31.5	66,2	67.4
40	69,5	70.7
50	72,7	73.9
63	75,7	76.9
80	78,4	79.6
100	80,7	81.9
125	82,8	84
160	84,9	86.1
200	86,8	88
250	88,2	89.4
315	89,1	90.3
400	89,6	90.8
500	89,8	91
630	89,8	91
800	89,6	90.8
1000	89,4	90.6
1250	88,9	90.1
1600	88,0	89.2
2000	86,8	88
2500	85,2	86.4
3150	83,3	84.5
4000	81,1	82.3
5000	78,0	79.2
6300	73,9	75.1
8000	68,6	69.8
10000	62,9	64.1
12500	56,1	57.3

Table B1. Displacement of the frequency spectrum from 100dBA to 101.2 dBA for a G52 wind turbine.

The result of the process is clearly represented in the graph in **Figure B1.**

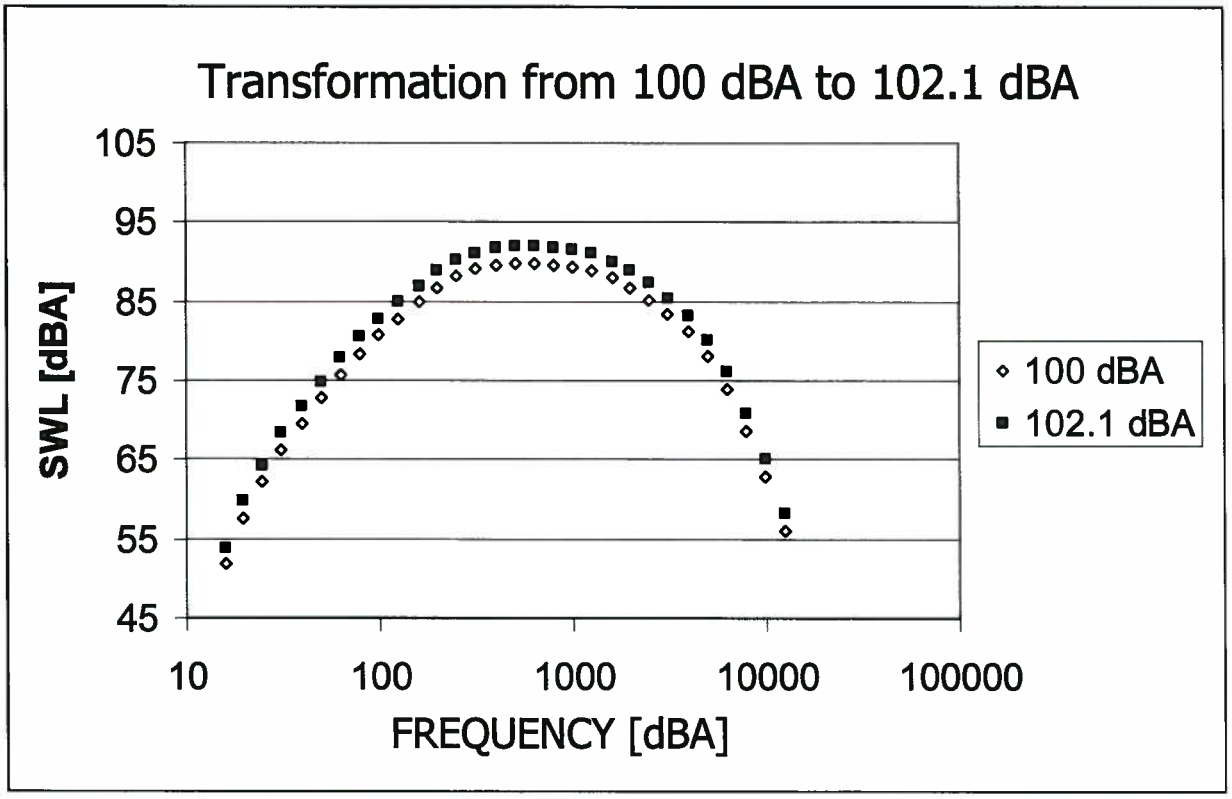


Figure B1. Graphic representation of displacement of the frequency spectrum from 100dB to 102.1dB for a G52 wind turbine.

APPENDIX 3

KNOWES WIND FARM
PWS RISK ASSESSMENT

ISSUE DATE: JANUARY 2014

REPORT STATUS: FINAL

JOB NO: 1248

COPY NO: 00

REV. NO: 01

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1. INTRODUCTION

This report presents a risk assessment of the potential effects of the Knowes Wind Farm on private water supplies (from herein referred as PWS).

1.1 SCOPE OF WORK

Key objectives of the assessment are:

- To identify all PWS sources within 1km of the development and within the zone of influence from the development using information collected during a desk study, consultation and a site visit;
- To undertake a risk assessment of any identified PWS's and produce a risk assessment register; and
- To provide an indicative Contingency Plan in case of disruption to or degradation of a private water supply.

1.2 DEVELOPMENT

The Knowes Wind Farm includes for installation of eleven wind turbines and related access tracks and infrastructure.

1.3 RESPONSES

SEPA mention in their scoping response (dated 2nd August 2012) that existing groundwater abstractions should be identified, and that any abstractions within 100m of roads, tracks and trenches and within 250m from borrow pits and foundations should be avoided unless an appropriate investigation is undertaken to minimise the impacts on abstraction.

1.4 DISCLAIMER

The identification of private water supplies and interpretation of the ground conditions is based on the information obtained during site visits and from the desk study. All reasonable skill, care and diligence has been exercised in carrying out this report, within the timescales available. Notwithstanding the efforts made in carrying out this report, within the timescales available, it is possible that other soil and groundwater conditions and private water supplies, as yet undetected, may exist, and this must be taken into account in any reliance on the findings of this report.

This report has been prepared in relation to the Knowes Wind Farm, and takes into account the client's particular instructions and requirements. It is provided to the client subject to the terms of our appointment. Save to the extent we expressly agree in writing, it is not intended to be relied upon by any third party and no responsibility is undertaken to any third party.

2. DESK STUDY

2.1 GEOLOGY AND HYDROLGEOLOGY

A review of the British Geological Society 1:50,000 Digital Geological Datasets and the 1:625,000 Hydrogeological Map of Scotland was undertaken to characterise the geology and hydrogeology of the region.

Superficial deposits are largely absent across the development area with bedrock at near to the surface. Small areas of glacial till are found across the northern and eastern perimeter of the development site. Glacial till deposits do not typically yield groundwater, however patches of permeable sandy till can yield higher volumes of groundwater and can be important in supporting PWS's and providing baseflow to streams.

The bedrock geology of development area is predominantly underlain by igneous extrusives of the Ochil Volcanic formation, with dominantly conglomerate formations to the north and basaltic andesite formations to the south. Both formations have low productivity with dominantly fracture flow aquifer characteristics. Groundwater is most likely to occur within the shallow weathered zone of such formations. The Scone Sandstone formation, which has a moderate aquifer productivity rating with predominantly intergranular flow, is also present to the north of the development area.

2.2 POTENTIAL PWS PROPERTIES

A desk study was undertaken in order to determine all the properties which had the potential to utilise a PWS. The desk study pulled together information on PWS's from the following sources:

- Perth and Kinross Council registered PWS database;
- Ordnance Survey 1:25,000 maps; and
- Local knowledge from landowners.

From the desk study a total of eight registered PWS's and two additional properties potentially using a PWS were identified within the zone of influence from the proposed development infrastructure.

3. SITE VISIT

3.1 SURVEY OBJECTIVES

A site survey visit to properties with potential PWS's was undertaken by a suitably experienced hydrologist during April 2013.

The objectives of the site survey visit were to:

- Identify properties using a PWS within 1km of the development infrastructure;
- Confirm properties using SW mains supply within 1km of the development infrastructure; and
- Collect information on properties with PWS and characterise PWS supplies within 1km of the development infrastructure.

It should be noted that no intrusive investigations of any structures associated with the PWS were undertaken during the site survey.

Scheduled visit times were arranged at the properties for which contact details were available.

3.2 QUESTIONNAIRE

Questionnaires with self-addressed envelopes were left at properties with no contact details or where homeowners were not at home during visits to answer questions. An example of the questionnaire is provided in Appendix A.

The surveys collected the following information:

- Supply type (spring, well etc);
- Source and infrastructure locations (NGR);
- Hydrological characteristics within supply catchments;
- Treatment;
- Volumes abstracted;
- Historical quantity issues; and
- Supply quality.

3.3 RESULTS

In total, ten PWS's were identified, which supplied an approximate total of twenty five properties including a nursing home (PWS2) and a food factory (PWS9). All supplies were for domestic usage, four were also for livestock usage and one was also for industrial usage.

These results are detailed in Table 4 and the locations are shown on Figure 1. The full results of the desk study and site survey are given in the spreadsheet 'Knowes PWS Assessment v1.1'.

4. RISK ASSESSMENT

4.1 METHODOLOGY

The assessment methodology is based on SNH guidance; a Handbook on Environmental Impact Assessment (2006), the methodology also draws on guidance from the Water Environment Sub-Objective from Transport Analysis Guidance published by the Department of Transport (2003) and the paper by Mustow *et al* (2005).

Sensitivity

On completion of the baseline data review the sensitivity of each private water supply, as defined in Table 1 has been assessed.

Table 1: Definitions of private water supply sensitivity

Sensitivity of PWS	Characteristics of PWS
Very High	Surface water abstractions within 0 – 200 m and groundwater spring abstractions from 0-100 m from construction activities; and Groundwater abstractions >1000 m^3/day (within zone of influence from development).
High	Large scale industrial agricultural abstractions 500-1000 m^3/day within 2 km downstream; Surface water abstractions for more than 15 people; Surface water abstractions within 200 m – 600 m, groundwater spring abstractions from 100 m – 400 m, and groundwater borehole abstractions from 0 – 200 m from construction activities; Groundwater abstractions 500-1000 m^3/day (within zone of influence from development); and Groundwater abstraction for PWS >10 m^3/day or serves >50 people.
Medium	Industrial/agricultural abstractions 50-499 m^3/day within 2 km downstream; Groundwater abstractions 50-499 m^3/day; and Surface water abstractions from 600m – >800 m, groundwater spring abstractions from 400 m – 800 m and groundwater borehole abstractions from 200 m – 600 m from construction.
Low	Industrial/agricultural abstractions <50 m^3/day within 2 km downstream; Groundwater abstractions <50 m^3/day; Private Water Supplies – groundwater spring abstraction >800 m; and Groundwater borehole abstractions from 600 - >800m from construction activities.

Magnitude of Effect

The magnitude of effect on each private water supply, as defined in Table 2, has been assessed.

Table 2: Magnitude of Effect

Magnitude	Criteria	Description
High	Results in loss of attribute	Fundamental (long term or permanent) changes to the quantity of water available for abstraction compared to predevelopment conditions Pollution of (long term or permanent) potable source of abstraction compared to predevelopment conditions
Medium	Results in effect on integrity of attribute or loss of part of attribute	Material but non-fundamental (medium term) changes to the quantity of water available for abstraction compared to predevelopment conditions Discharges to the receiving water, but insignificant enough to change its water quality status compared to predevelopment conditions
Minor	Results in minor effect on attribute	Detectable but non-material (temporary) changes to the water quality and water quantity compared to predevelopment conditions
Negligible	Results in an effect on the attribute but of insufficient magnitude to affect the use or integrity	No perceptible changes to the water quality and water quantity compared to predevelopment conditions No significant effect on the economic value of the receptor

Potential Risk

The potential risk to the PWS has been defined by taking into account the sensitivity of the PWS and the magnitude of the effect. Table 3 outlines how the sensitivity of the PWS and the magnitude of the impact define the potential risk.

Table 3: Potential Risk

Magnitude of Effects	Sensitivity of PWS			
	Very High	High	Medium	Low
High	Major	Major	Moderate	Minor
Medium	Moderate	Moderate	Moderate	Minor
Minor	Minor	Minor	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Potential risks are therefore concluded to be major, moderate, minor or negligible.

4.2 ASSESSMENT

The potential effects of the development on the PWS's were assessed through:

- Identification of construction activities and their potential effects;
- Assessment of the significance of impacts of the development, taking into account the sensitivity of the receiving environment and the potential magnitude (scale of duration) of the effect; and
- Assessment of the significance of risks from the development, taking into account the sensitivity of the receiving environment and the potential magnitude (scale of duration) of the effect.

Assessment of the magnitude of effect includes the timing, scale, size and duration of the potential effect.

Sensitivity

The sensitivity of each PWS is detailed in Table 4 below.

The following conservative daily consumption figures have been assumed:

- Human consumption 250 litres/day/person; and
- Livestock consumption 110 litres/day/head.

Where no information was obtained on numbers of residents or livestock the following conservative estimates have been made:

- Residents – 6 people per house; and
- Livestock – 200 head of cattle per farm.

Table 4: Private water supplies

PWS No.	Properties	Supply location (NGR)	Supply type	Estimated volume abstracted (m^3 /day)	Distance of source from infrastructure (m)	Sensitivity of PWS
PWS1	Knowes Farm	NO 01946 11412	Spring	People <10 Livestock <50	7	Very High
PWS2	Kippen House, Kippen Stables, Pebblestone, Marcassies, Lodge House	NO 01302 11967	Spring	People >10	300	High

PWS3	Quilts Farm	NO 02439 11991	Borehole	People <10 Livestock <50	650	Low
PWS4	Dairy Cottage, one other	NO 02007 12520	Spring	People <10	950	Low
PWS5	Keltie Castle, Keltie Lodge, Meadowbank (5 properties), Duncrub (2 properties).	NO 00721 13054, NO 00720 13051	Surface Water	People >10	1300	High
PWS6	Tongyfield House	NO 02694 12694	Borehole	People <10	1000	Low
PWS7	Pitmeadow	NO 02428 12720	Surface Water	People <10 Livestock <50	1300	Medium
PWS8	Kippen Home Farm	NO 01126 12019	Spring	People <10 Livestock <50	250	High
PWS9	Findony Farm	NO 01951 13998	Borehole	Industrial 50-499	2300	Medium
PWS10	Cockersfauld	NO 02515 10964	Borehole	People <10	700	Low

Identification of Construction Activities and Potential Effects

A number of chemicals will be stored and used on-site during the construction of the proposed wind turbines. Changes in natural drainage patterns due to runoff from exposed soil, dewatering, stripping of vegetation and topsoils may lead to the erosion and transport of sediment into watercourses. Potential effects on PWS's may include the infiltration or runoff of sediments and chemical pollutants with the potential to affect the quality of waters from groundwater springs and surface waters from which the local supplies abstract.

Dewatering from turbine excavations can disrupt the flow of groundwater and potentially affect the quality and quantity of water serving the supplies. Disruption of hydrological connectivity form the construction of 'cut' access tracks and turbine bases can also cause a loss of PWS catchment contribution.

PWS infrastructure (pipework, tanks) may be disrupted by the construction of new or upgrading of existing access tracks.

Magnitude of Effect

The magnitude of effect on the PWS's is detailed in Table 5 below. The locations of the PWS's in relation to the proposed development are shown in Figure 1.

Indicative PWS catchments for surface waters and shallow groundwater springs have been inferred from topography. Catchments were interpolated using contour lines on OS 1:25,000 GIS tiles.

Table 5: Magnitude of Effect

Ref	Reason	Magnitude of Effect
PWS1	Fundamental (long term or permanent) changes to the quantity of water from potential disruption of PWS pipework. Shallow groundwater abstraction down-gradient from development and within 7m of proposed access track. Potential for >90% loss of effective PWS catchment and pollution of potable source of abstraction.	**High**
PWS2	Fundamental (long term or permanent) changes to the quantity of water and material but non-fundamental (medium term) changes to the quality of water available for abstraction compared to predevelopment conditions Shallow groundwater abstraction down-gradient from development. No potential loss of effective PWS catchment but development located <5m from catchment.	**Medium**
PWS3	Detectable but non-material (temporary) changes to the water quality compared to predevelopment conditions Groundwater borehole abstraction down-gradient from development.	Minor
PSW4	No potential risk to quantity or quality.	Negligible

Ref	Reason	Magnitude of Effect
	Shallow groundwater abstraction down-gradient but outwith zone of influence from development. No potential loss of effective PWS catchment	
PWS5	No potential risk to quantity or quality. Surface water abstraction outwith zone of influence from development.	Negligible
PWS6	Detectable but non-material (temporary) changes to the water quality compared to predevelopment conditions Groundwater borehole abstraction down-gradient from development.	Minor
PWS7	No potential risk to quantity or quality. Surface water abstraction down-gradient but outwith zone of influence from development. No potential loss of effective PWS catchment	Negligible
PWS8	Material but non-fundamental (medium term) changes to the quality of water available for abstraction compared to predevelopment conditions Shallow groundwater abstraction down-gradient from development. No potential loss of effective PWS catchment but development located <30m from catchment.	**Medium**
PWS9	No potential risk to quantity or quality. Borehole groundwater abstraction outwith zone of influence from development.	Negligible
PWS10	No potential risk to quantity or quality. Borehole groundwater abstraction outwith zone of influence from development.	Negligible

5. MITIGATION

5.1 GENERAL MITIGATION

The following general mitigation is recommended:

- The design and construction of the wind turbines and access track should maintain hydrological connectivity between the PWS's and their hydrological catchments. This may involve the use of permeable track materials; under-road culverting and 'floating track' design at the location of PWS1;
- Refuelling activities and storage of chemicals will not be undertaken with 250m from the PWS sources;
- A detailed investigation of drainage patterns across the site and off site shall be undertaken to fully characterise the PWS's;
- A Pollution Prevention Plan (PPP) and a Water Quality Monitoring Plan (WQMP) shall be prepared in advance of the construction works to reduce the likelihood of groundwater and surface water pollution and ensure rapid response in the case of a pollution event;
- Where PWS infrastructure (pipework) may potentially be at risk (PWS1), such infrastructure shall be located prior to works and avoided, protected and/or replaced if damaged; and
- A detailed contingency plan shall be provided to ensure protection to all PWS's at risk (an indicative contingency plan is provided below).

5.2 INDICATIVE CONTIGENCY PLAN

In case of emergency (change in quality and/or quantity of supply) an alternate source of water shall be provided.

A detailed Contingency Plan shall be designed following the:

- Undertaking of a baseline data collection to identify quality and quantity of the identified PWS at potential risk; and
- Monitoring of the quantity and quality of PWS at potential risk over time.

Any identified short or long term detrimental changes to the quantity and/or quality of PWS shall trigger the contingency plan which shall include one of the options for quantity and quality issues detailed in Table 6 below.

Table 6: Options for quantity/quality issues

Options for quantity issues:	Options for quality issues:
Identify and assess alternate local PWS and connect	Identify and assess alternate local PWS and connect
Identify and assess additional local PWS and connect	Install appropriate water treatment/filters
Connect to SW mains	Replace and upgrade existing treatment
	Identify an alternate source of PWS and connect
	Connect to SW mains

A rapid response plan will ensure the rapid delivery of tankered water to those users potentially affected and maintain this PWS until problems are remedied. The core elements of the response plan include the following:

- Establish communication lines and protocols for initiating emergency response;

- Create a plan for immediate distribution of potable water (bottled);
- Create a plan for medium to long term alternative supply (bowser /tanker);
- Develop a protocol for assessing the source of contamination. Consider interactions with intermediary landowners and potential for contamination source to be related to these rather than the development;
- Plan for immediate water quality analysis (have sealed inert sample bottles on site along with a sampling protocol and plan for remittance to a suitable lab);
- Develop a risk management strategy incorporating the following:
    - Establish access to suitable specialist advice regarding possible effects if contaminated water is imbibed;
    - Develop a plan for assessment of contamination duration and obtaining specialist advice on mitigation; and
    - Develop a protocol for re-sampling to establish when the PWS is restored to its former state.
- Write to private water supply users detailing the proposed rapid response plan and a hotline number they can call in the event of contamination;
- Produce business card style hotline card that can be carried or kept in a handy location; and
- Consider sending out periodical communications outlining development phases to PWS users so they are aware of what is happening.

The long term contingency, in case of long term deterioration of quality or quantity, would be to arrange for and fund an alternative source, should the stated options be unsatisfactory to the PWS user, SEPA or the Local Council. This would most likely be an alternative PWS as close to the original as possible where quality and quantity were at least as good as the original, as determined from the baseline survey undertaken as part of a Water Quality Monitoring Plan.

With the application of appropriate mitigation measures the likelihood of any PWS being adversely impacted in the short or long term is considered low.

6. RESIDUAL RISK

Two supplies (PWS1 & PWS2) was assessed to be at a **'Major'** risk and one supply (PWS8) was assessed to be at a **'Moderate'**. All risks were reduced to 'Minor' or 'Negligible' after mitigation measures were considered.

Table 7: Residual risk from the proposed development

			Pre-mitigation		Post-mitigation	
Sensitive receptor	**Sensitivity**	**Potential effects**	**Magnitude**	**Risk**	**Magnitude**	**Risk**
PWS1	Very High	Quality - infiltration or run off of contaminants from the development area	High	Major	Minor	Minor
		Quantity - site infrastructure causing a reduction in the quantity of water available (disruption of PWS catchment and pipework)	High	Major	Minor	Minor
PWS2	High	Quality - infiltration or run off of contaminants from the development area	Medium	Moderate	Minor	Minor
		Quantity - site infrastructure causing a reduction in the quantity of water available	Minor	Minor	Minor	Minor
PWS3	Low	Quality - infiltration or run off of contaminants from the development area	Minor	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS4	Low	Quality - infiltration or run off of contaminants from the development area	Negligible	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS5	High	Quality - infiltration or run off of contaminants from the development area	Negligible	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS6	Low	Quality - infiltration or run off of contaminants from the development area	Minor	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS7	Medium	Quality - infiltration or run off of contaminants from the development area	Negligible	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS8	High	Quality - infiltration or run off of contaminants from the development area	Medium	Moderate	Minor	Minor
		Quantity - site infrastructure causing a reduction in the quantity of water available	Minor	Minor	Negligible	Negligible
PWS9	Medium	Quality - infiltration or run off of contaminants from the development area	Negligible	Negligible	Negligible	Negligible
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible
PWS10	Low	Quality - infiltration or run off of	Negligible	Negligible	Negligible	Negligible

Sensitive receptor	Sensitivity	Potential effects	Pre-mitigation		Post-mitigation	
			Magnitude	Risk	Magnitude	Risk
		contaminants from the development area				
		Quantity - site infrastructure causing a reduction in the quantity of water available	Negligible	Negligible	Negligible	Negligible

7. SUMMARY AND RECOMENDATIONS

Ten private water supplies were identified within the zone of influence from Knowes Wind Farm.

One supply (PWS1 – to Knowes Farm) assessed to be at a '**Major**' potential risk.

Two supplies (PWS2 - to Kippen House Nursing Home, Kippen Stables, Pebblestone, Marcassies and Lodge House, and PWS8 – to Kippen Home Farm) were assessed to be at a '**Moderate**' potential risk.

The remaining seven identified PWS's have been assessed as being at 'Negligible' potential risk (PWS3, PWS4, PWS5, PWS6, PWS7, PWS9 and PWS10).

The PWS's identified as being at major and moderate potential risk (PWS1, PWS2 and PWS8) will require appropriate mitigation in order to reduce this level of potential risk. This should involve the designing of tracks and turbine bases to maintain hydrological connectivity and implementation of a contingency plan. The application of Pollution Prevention Plan (PPP) measures will be effective in reducing groundwater pollution.

A site specific PWS Water Quality Monitoring Plan should be implemented and it is recommended that all three PWS's identified as potentially being at risk within a 1km buffer of the proposed development should be monitored for quantity and quality before, during and after construction.

All risks were reduced to 'Minor' or 'Negligible' after mitigation measures were considered.

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APPENDIX A: EXAMPLE OF PWS QUESTIONNAIRE

Private Water Supply (PWS) Questionnaire

As part of a Risk Assessment of PWS within 1km of the proposed Knowes Wind Turbine Development.

Name	
Status (owner/tenant)	
Address	
Postcode	
Phone number	
Email address	

1. What is the source of your water supply (mains, well, spring, burn, loch off-take, other)?

If you are on the mains you do not need to answer any more questions.

2. Please provide a grid reference of the supply if known, gird references can be found: http://www.streetmap.co.uk/

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3. What is the supply used for (e.g. household, livestock etc)?

4. How many people are in the household (maximum)?

5. How many livestock use the supply (maximum)?

6. What is the method of off-take, e.g. weir, sluice, pump, etc.?

7. How is your private water supply off-take protected (buried, in a shed, concrete structure, slab, fenced off from livestock etc.)?

8. What is the national grid reference of your private water supply off-take (if known)?

Please could you mark the position of your off-take on the map provided

9. If you have a well off-take then how deep is the well?

10. Pipe condition (sound or unsound)

11. Do you know if any other properties supplied by the same source

12. What is the treatment method, please tick all the relevant boxes

Treatment (yes or no)?	
Chlorination (tablet etc)	
U-V lamp	
U-V no pre filter	
Filter - Crypto	
Filter - Sediment	
Filter - GAC	
Filter - Water hardness	
Ozone	
Other	

If other please provide details:

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13. Do you have any existing pollution or other issues with your supply?

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14. Do you have a septic tank?

Associated septic tank

Present (Yes or no)?	
NGR Outfall	

	Yes or No
Regular maintenance	
Signs of vermin	
Is livestock excluded (fenced off)	

	Insert details
Other details	

15. Is your supply the subject of regular water quality testing?

	Yes or No
Regular testing	
	Insert details
Detail results of testing (pass/fail etc)	
Testing body details	

Any other comments or observations	

APPENDIX 4

Appendix 4

Appendix 4.1 Cultural Heritage Assets within Area A: Scottish Monument Records and National Monument Records of Scotland.

Index number	Site Type	Name	Distance to turbine	Built and Cultural Sensitivity	Magnitude of Change	Effect on Built and Cultural Heritage	Significant
26704	Historic Environment & Canmore	Caskin Hill	150m	Low	High	Medium	No
314688	Canmore	Waughenwae Knowe	360m	Low	High	Medium	No
116382	Historic Environment & Canmore	Knowes	430m	Low	High	Medium	No

Appendix 4.2 Cultural Heritage and Archaeological Assets of National Importance within Area B: Scheduled Monuments.

Index number	Site Type	Name	Distance to turbines (km)	Built and Cultural Sensitivity	Magnitude of Change	Effect on Built and Cultural Heritage	Significant
6297	SM	Gray Stone Standing Stone	700m	High	Moderate	Moderate-Major	No
9437	SM	Blaeberry Hill Deserted Settlement	1.3	High	Slight	Moderate	No
2976	SM	Rossie Law Fort	1.3	High	Moderate	Moderate-Major	No
5774	SM	Millhaugh Enclosures	2.2	High	Slight	Moderate	No
5775	SM	Millhaugh Burial Mound, Enclosure and Cropmarks	2.1	High	Slight	Moderate	No
5776	SM	Millhaugh Enclosure and Pit Alignment	2.3	High	Slight	Moderate	No
9434	SM	Dun Knock Fort	2.7	High	Slight	Moderate	No
3133	SM	Ben Effray Fort	3	High	Negligible	Negligible	No
3675	SM	Dunning Roman Camp	3	High	Slight	Moderate	No
7629	SM	John's Hill enclosure	3.2	High	Negligible	Negligible	No
7589	SM	Coulshill hut circle	3.3	High	Negligible	Negligible	No
4213	SM	Castle Craig Fort	3.5	High	Negligible	Negligible	No
9373	SM	Easter Coul Cottage	3.7	High	Negligible	Negligible	No
8916	SM	Mains of Duncrub ring Ditch	3.7	High	Slight	Moderate	No
8915	SM	Mains of Duncrub Settlement	3.7	High	Slight	Moderate	No
8921	SM	Leadketty Farm Pit Circle	3.8	High	Slight	Moderate	No

90321	SM	St Serf's Church	3.8	High	Slight	Moderate	No
3073	SM	Ogle Hill Fort	3.9	High	Slight	Moderate	No
9158	SM	Leadketty Enclosures	4	High	Slight	Moderate	No
7945	SM	Laigh of Rossie enclosed settlement	4.1	High	Slight	Moderate	No
8918	SM	Wellhill Pit Alignment	4.2	High	Slight	Moderate	No
8922	SM	Inverdunning House	4.4	High	Slight	Moderate	No
8923	SM	Inverdunning House Ring Ditch	4.4	High	Slight	Moderate	No
9305	SM	Broadfold Cottage Enclosure	4.7	High	Negligible	Negligible	No
9367	SM	Thorn Fort	4.8	High	Negligible	Negligible	No
8773	SM	Nether Garvock Burial Mounds	4.6	High	Slight	Moderate	No
9159	SM	Inverdunning House Settlement	4.4	High	Slight	Moderate	No
7947	SM	South Strathey Unenclosed Settlement	4.8	High	Slight	Moderate	No
9313	SM	Broadfold Cottage Long Barrow	5	High	Negligible	Negligible	No
4088	SM	Lochie Enclosure	5	High	Negligible	Negligible	No
9307	SM	Thorn Ring Ditch	5	High	Negligible	Negligible	No

Appendix 4.3 Cultural and Heritage Assets within Area B: Category A Listed Buildings and Historic Garden and Designed Landscapes.

Index number/Reference	Site Type	Name	Distance to turbines (km)	Built and Cultural Sensitivity	Magnitude of Change	Effect on Built and Cultural Heritage	Significant
5912	Category A listed building	Keltie Castle	1.5	High	Slight	Moderate	No
5915	Category A listed building	Duncrub Dovecot	3.2	High	Slight	Moderate	No
-	Garden and Designed Landscape	Invermay	5	High	Slight-moderate	Moderate	No
-	Garden and Designed Landscape	Dupplin Castle	9.2	High	Slight	Moderate	No

Appendix 4.4 Cultural Heritage and Archaeological Assets within Area C: Scheduled Monuments

Index number/Reference	Site Type	Name	Distance to turbines (km)	Built and Cultural Sensitivity	Magnitude of Change	Effect on Built and Cultural Heritage	Significant
8029		Drumtogle Enclosure	5.1	High	Slight	Moderate	No
8794		Drum of Garvock	5.1	High	Slight	Moderate	No
9326		Drum of Garvock Enclosure, cropmarks and barrlow	5.2	High	Slight	Moderate	No
9327		Drum of Garvock enclosures	5.2	High	Slight	Moderate	No
9540		Ash Keys	5.3	High	Slight	Moderate	No
8869		Bogtonlea	5.3	High	Slight	Moderate	No
8768		Masterfield	5.5	High	Slight	Moderate	No
8767		Masterfield Ring-ditches	5.5	High	Slight	Moderate	No
7948		Haugh of Aberuthven Standing Stone	5.6	High	Slight	Moderate	No
8868		Bogtonlea enclosures and pit circle	5.8	High	Slight	Moderate	No

8868	Bogtonlea enclosures and pit circle	5.8	High	Slight	Moderate	No
8887	Home Farm enclosures	5.9	High	Slight	Moderate	No
8871	Mijas enclosure	5.9	High	Slight	Moderate	No
8887	Home Farm enclosures	5.9	High	Slight	Moderate	No
8871	Mijas enclosure	5.9	High	Slight	Moderate	No
8879	Mijas cairn	6	High	Slight	Moderate	No
7943	Gascon Hill	6	High	Slight	Moderate	No
8879	Mijas cairn	6	High	Slight	Moderate	No
7939	Orchard Enclosure	6.1	High	Slight	Moderate	No
4111	Forteviot enclosures	6.2	High	Slight	Moderate	No
4111	Forteviot enclosures	6.2	High	Slight	Moderate	No
4232	Forteviot enclosures	6.3	High	Slight	Moderate	No
4232	Forteviot enclosures	6.3	High	Slight	Moderate	No
5590	St Mackessog's Church	6.6	High	Slight	Moderate	No
1634	Auchterarder Castle	6.6	High	Negligible	Negligible	No
8875	Invermay enclosures	7	High	Slight	Moderate	No
1599	Ardagie homestead moat	7.2	High	Slight	Moderate	No
1599	Ardagie homestead moat	7.2	High	Slight	Moderate	No
8882	Kildinny enclosure	7.3	High	Slight	Moderate	No
7627	Down Hill Fort	7.3	High	Negligible	Negligible	No
1604	Gask House	7.5	High	Slight	Moderate	No
1597	Jackschairs wood fort	7.7	High	Slight	Moderate	No
5579	Jackschairs wood cairn	7.7	High	Slight	Moderate	No
90332	Kirkhill Roman Signal Station	7.8	High	Slight	Moderate	No
90333	Muir o'Fauld Roman Signal Station	7.8	High	Slight	Moderate	No
1616	Witch Knowe	7.8	High	Slight	Moderate	No

8881	Kildinny enclosure and pits	7.8	High	Slight	Moderate	No
8706	Easthill Standing Stones	7.9	High	Negligible	Negligible	No
7733	Calfward Ring-ditch	8	High	Slight	Moderate	No
7590	Millhill Enclosure	8	High	Slight	Moderate	No
7591	Gleneagles Castle	8.1	High	Negligible	Negligible	No
1610	Moss-side Cottage	8.1	High	Slight	Moderate	No
3532	Roundlaw Roman Signal Station	8.3	High	Slight	Moderate	No
4073	Peterhead Enclosure	8.3	High	Negligible	Negligible	No
7625	Braughty	8.4	High	Negligible	Negligible	No
9319	Woodside Cottage roundhouse	8.4	High	Slight	Moderate	No
4061	Peterhead Standing Stone	8.5	High	Negligible	Negligible	No
7734	Lowbank Souterrain	8.5	High	Slight	Moderate	No
7593	Loaninghead Fort	8.5	High	Negligible	Negligible	No
2252	Loaninghead Symbol Stone	8.5	High	Negligible	Negligible	No
5400	Mayfield Roman signal Station and Enclosure	8.7	High	Slight	Moderate	No
8770	Broombarns	8.8	High	Slight	Moderate	No
8771	Broombarns settlement	8.9	High	Slight	Moderate	No
7729	Bernie Fort	9	High	Negligible	Negligible	No
9320	South Dumbuils enclosure	9.1	High	Negligible	Negligible	No
661	Castle Law fort	9.2	High	Negligible	Negligible	No
7628	Middleton Fossoway	9.3	High	Negligible	Negligible	No
7735	North Mains Strathallan	9.4	High	Slight	Moderate	No
9376	North Mains Strathallan Henge	9.4	High	Slight	Moderate	No
90331	Ardunie Roman Signal Station	9.4	High	Slight	Moderate	No
7626	Claysike enclosures	9.5	High	Negligible	Negligible	No

8023	Turnibole Church and Burial ground	9.6	High	Slight	Moderate	No
8708	West Mains of Tullibardine	10	High	Negligible	Negligible	No

Appendix 4.5 Cultural and Heritage Assets within Area C: Category A Listed Buildings and Historic Garden and Designed Landscapes.

Index number/Reference	Site Type	Name	Distance to turbines (km)	Built and Cultural Sensitivity	Magnitude of Change	Effect on Built and Cultural Heritage	Significant
-	Garden and Designed Landscape	Invermay	5-7.5	High	Slight	Moderate	No
11211	Category A listed building	Dalreoch bridge over River Earn	6.1	High	Slight	Moderate	No
11071	Category A listed building	Invermay House	6.4	High	Slight	Moderate	No
11074	Category A listed building	Old house of Invermay	6.6	High	Slight	Moderate	No
11057	Category A listed building	Forteviot Square U-plan group	7	High	Slight	Moderate	No

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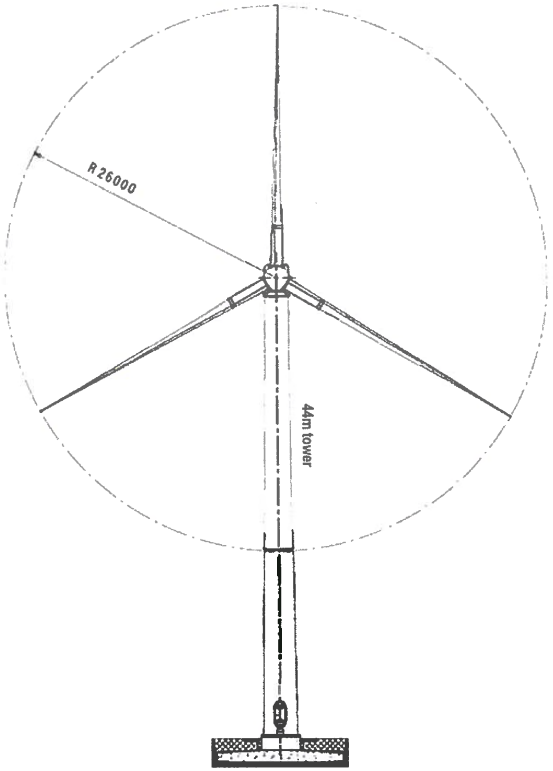

Project Title: Knowes Wind Farm

Client: Knowes Renewables LLP

Figure: Gamesa G52 with 44m Tower Elevation

Scale: 1:500

Drawn by: AE

Checked by: AF

Date: May 2014

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Muirden Energy LLP
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Turriff
Aberdeenshire
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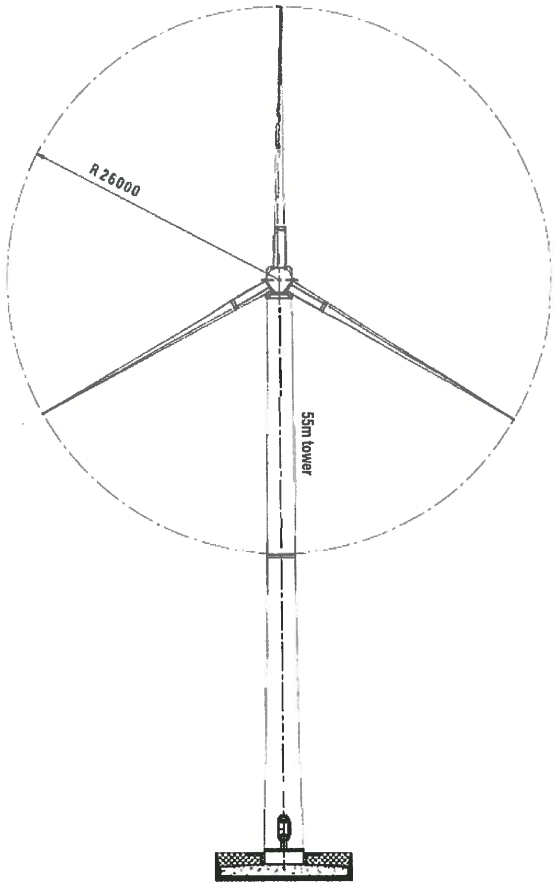

Project Title: Knowes Wind Farm

Client: Knowes Renewables LLP

Figure: Gamesa G52 with 55m Tower Elevation

Scale: 1:500

Drawn by: AE

Checked by: AF

Date: May 2014

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