farm business. With the erection of the new buildings, as outlined in Section 1.2.2 above, electricity use at Ingliston Farm is expected to double.

7.3.2. Economic and social benefits for the local community

Farmers are considered to be particularly good at recycling extra income back to the farm and wider local economy. Results from the Scottish Income-Output Tables[13] demonstrate that agriculture in general displays a high multiplier effect on the wider economy. Within this assessment agriculture is seen to be within the top 10% of industries for generating additional income in other industries, and within the top 25% for generating additional employment in other industries. Previous studies have also demonstrated that agricultural activity is particularly effective in supporting local economic activity and employment.

The local ownership of this project by a farmer is therefore considered to maximise the real economic benefit available to Angus from renewable energy development. This is the main reason that the Scottish Government have set a target for 500MW of locally owned renewable energy projects by 2020.

As outlined above, Mr Shaw's farming business also currently employs 4 full time staff and a number of seasonal staff. Diversifying the farming activities will bring an additional sustainable income stream into the farming business, helping to safeguard these jobs and create new jobs as the business continues to expand through investing the project income into the wider farming business.

7.3.3. Economic Benefits from Construction and Operation

The capital cost of the proposed wind turbine development at Ingliston Farm has been estimated at approximately £1.5m. In 2006 Scottish Enterprise published a report discussing the economic impact of wind farm construction. Based on this report, it is estimated that 29%, or at least £435,000, of the capital cost of the installation and operation of the development would be spent locally in Scotland. This would involve:

- Services (consultancy, planning advice);
- Construction (roads, access, fences etc.);
- Cabling (throughout site and to grid access point); and
- Operation and maintenance.

The use of suitably experienced local contractors and sub-contractors will be encouraged for construction, operation and maintenance works associated with the development, as long as they meet the financial and technical requirements for the build.

The increased likelihood to be able to utilise local companies is an additional benefit of smaller commercial wind energy proposals. In this respect, the significant scale of works associated with larger commercial wind farms often dictates that national or multinational companies are used.

The 2010 SAC study into the benefits of locally owned wind energy developments demonstrated what the above factors may mean in terms of local job creation. It was

[13] http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/IOAllFiles2007

concluded that through development and construction a total of over 5 jobs would be created for a 1 year period, while during operation 2.5 long-term jobs would be created.

7.3.4. Potential Adverse Impacts on the Wider Community

There are a number of potential impacts on the wider community from the proposed development and these include:

- Landscape and visual amenity;
- Noise;
- Shadow flicker; and
- Telecommunications and television reception.

These potential impacts are considered and quantified (where possible) individually in their respective chapters of this Document.

7.3.5. Potential Impact on Wider Tourism and Recreational Assets

From the baseline assessment a number of attractions have been highlighted as having particular importance for tourist activity within the area. The potential impact at each of these attractions is discussed in Table 23 below.

Attraction	Distance from turbine	Potential impact
Angus Core Paths Network	1.4km	Parts of the Core Paths Network within 5km of the site are predicted to experience some theoretical visibility. In practice, users of the Network would experience mostly oblique views of the turbine, where the turbine is visible above the skyline and forms a small element within a wide, open upland agricultural and moorland landscape. Where there are potential views, they are short in duration, oblique and intermittent. Taking into account the distance to the site, the impact of the turbines on the Network is not deemed to be significant.
Kinpurney Hill	3.3km	As illustrated by the ZTV (see Drawing ING010), there is a small area on the summit of Kinpurney Hill (which includes the fort), which will have full theoretical visibility of the proposed wind turbine. The main route members of the public would take to the summit of Kinpurney Hill is understood to be from the south west, on part of the Angus Core Paths Network. This approach to Kinpurney Hill has no theoretical visibility to the turbine. As highlighted by Drawing ING056, the view of the proposed turbine from the summit of Kinpurney Hill does not break the distant ridgeline. Given this, and the scale and distance to the proposed turbine, it is considered that the impact on this tourist feature is not significant, especially when considered in combination with the existing impact of the more visually imposing Ark Hill wind farm, which lies within the same field of view and breaks the ridgeline. The assessment in Chapter 5 of this Supporting Environmental Document also considers that there will be no significant landscape and visual impact, either as a standalone development or cumulatively.

Auchterhouse Hill	4.7km	As illustrated by the ZTV (see Drawing ING010), only a small area of the Auchterhouse Hill summit has theoretical visibility to the nacelle and blades, with a small area on the northern hillside having only theoretical visibility to the proposed turbine blades. As highlighted by Drawing ING060, there will only be distant views of the proposed development, which are considered insignificant in their impact, especially given the more dominant views to Ark Hill wind farm and the single turbine development at Henderson Quarry. The assessment in Chapter 5 of this Supporting Environmental Document also considers that there will be no significant landscape and visual impact, either as a standalone development or cumulatively.
Glamis Castle	5.0km	Although the majority of Glamis Castle has full theoretical visibility of the turbine, it is considered that existing vegetation cover will shield the majority of the GDL from views of the turbine. This is demonstrated further in Drawing ING063. As such, the visual impact of the proposed development on Glamis Castle is considered to be negligible. The assessment in Chapter 5 of this Supporting Environmental Document also considers that there will be no significant landscape and visual impact, either as a standalone development or cumulatively.
Airlie Castle	7.9km	This GDL is predominantly a river valley with steep sides. The majority of the GDL is entirely shielded from views of the turbine, as indicated by Drawing ING010. For any areas on the edge of the GDL which do have theoretical visibility to the turbine, it is considered that the distance to the turbine, and the existing vegetation cover, will render any visual impact from the turbine as not significant.
Clatto Country Park	9.8km	There is no theoretical visibility to the proposed turbine from Clatto Country Park.

Table 23: Discussion on tourist attractions within the area

In summary, the proposed development is not expected to have a significant adverse impact on tourism and recreation attractions in the surrounding area.

A national study commissioned by the Scottish Government[14] examined the likely economic impact of wind energy development. It should be noted that this report focuses on larger scale commercial wind developments but many points are relevant to smaller wind projects such as the one proposed at Ingliston Farm. The latest Tourism Attitudes Survey states that 'scenery' and 'natural environment' are the main attractions for tourists visiting Scotland. If wind farms were to deter significant numbers of tourists, they could potentially threaten the tourism industry and also the economic sustainability of the local community.

The study assessed the economic impact of four case studies within Scotland where wind farms were likely to be visible. It was carried out in four key stages:

- Identifying the change in likelihood of tourists returning to Scotland;
- Identifying the proportion of tourists in each area where this applies;
- Identifying the proportion of accommodation exposed (drop in 'room with view' sales); and
- Estimating likely proportion of change in expenditure in the affected accommodation.

[14] Scottish Government (2008) Economic Impacts of Wind Farms on Scottish Tourism

From the study, it was concluded that *"overall there does not appear to be any robust evidence to suggest a serious negative economic impact of wind farms on tourism"*. A change in tourism expenditure is predicted if a substantial amount of wind developments is installed in Scotland, however this loss of revenue is expected to be *"offset or reinforced"* by other positive economic or environmental impacts from wind farms. The study also concluded that tourism activity is likely to be displaced to other areas around Scotland rather than reduced entirely.

A survey of tourists was conducted within the four areas used in the case study; it involved information from tourists that were likely to have seen a wind farm during their visit. The survey confirmed that a minority of around 20% - 39% preferred a landscape that contained no wind farms; overseas visitors were found to be more positive than domestic tourists. The vast majority of the tourists surveyed (93% - 99%) that had seen a wind farm during their visit said that it would not affect their decision to return the area or Scotland as a whole.

A more recent document[15], prepared by ClimateXChange on behalf of the Scottish Government, found no evidence to suggest that wind energy development within the four case study areas adversely affected tourism.

7.4. Conclusions

The baseline assessment indicates that the immediate area has a relatively low rural population. It is acknowledged that the turbine could potentially result in adverse impacts on residential amenity. Further studies in relation to visual, noise and shadow flicker impacts have therefore been undertaken to determine whether the development falls within acceptable limits.

The project has been assessed as having an overall positive socio-economic impact on the local area. The turbine represents a strong example of diversification for the farmer and is a significant additional source of revenue. This income stream will not only support the ongoing farming business but will also have direct and indirect benefits on other local businesses and the wider community.

With regard to domestic properties there is no robust evidence to suggest that the wind development will have a substantial negative impact on property values within the area and all effort has been made to maximise the distance from houses and therefore negate any adverse impacts on these properties from impacts such as noise and shadow flicker.

Individual assessment of landscape and visual impacts on tourism sites have shown generally low impacts and these impacts are considered to be insufficient to cause a detrimental effect on the attraction of these sites.

[15] ClimateXChange (2012) The Impact of Wind Farms on Scottish Tourism

8. Cultural Heritage

This chapter assesses the impact of the proposed Ingliston Farm wind turbine on those known cultural heritage or archaeological features within the area. This assessment focuses on the impacts upon Listed Buildings and noted archaeological features within the immediate area of the turbine. This includes important Scheduled Ancient Monuments and Gardens and Designed Landscapes (GDLs) within the wider area.

8.1. Methodology

The construction of a single wind turbines at the location proposed will have no direct impact on known archaeological sites or features.

The potential impact of the proposal on the setting of *inter alia* Gardens & Designed Landscapes within a 25km radius of Ingliston Farm has been assessed as part of Chapter 5: Landscape & Visual.

This assessment therefore focuses on how the development might impact on the setting of any sensitive cultural heritage sites and has been carried out in accordance with Historic Scotland's 'Managing Change in the Historic Environment – Setting' dated October 2010. In the case of this development, potential impacts mainly relate to the landscape context, the surrounding landscape character, and the impact on the aesthetic qualities of the site. Where relevant, discussion will be provided on whether the development will impact upon the historical understanding of the site.

Initially a desk-based study was completed using Historic Scotland's available GIS databases. All A Listed buildings and Scheduled Monuments within a 5km radius were identified (see Drawing ING007). For completeness, a search of B and C Listed buildings within 1km of the proposed turbine location was undertaken; no additional sites were identified as a result.

As requested by Angus Council, the non-scheduled archaeological site at Auchterhouse Hill has also been included within the assessment.

The assessment focuses mainly on the visual impact on these sites; the matrix used to assess the overall impact is detailed in Table 24 below.

Magnitude	Sensitivity			
		High	Medium	Low
	High	Major	Major/Moderate	Moderate
	Medium	Major/Moderate	Moderate	Moderate/Minor
	Low	Moderate	Moderate/Minor	Minor
	Negligible	Moderate/Minor	Minor	Minor/None

Table 24: Overall impact assessment matrix

The guide in Table 25 and Table 26 below is used to determine the magnitude and sensitivity of the potential impact on cultural heritage receptors.

Magnitude	Description	Definition
High	Dominant	Receptor(s) are within 500m of the development
Medium	Conspicuous	Receptor(s) are between 500m - 2km of the development
Low	Apparent	Receptor(s) are within 2km - 5km of the development
Negligible	Inconspicuous	Receptor(s) are > 5km of the development

Table 25: Magnitude of impact

Sensitivity	Definition
High	• Category A and B Listed buildings • Gardens & Designed Landscapes • Scheduled Ancient Monuments • Non-statutory sites of high significance (of international or national importance)
Medium	• Category C listed buildings • Archaeological sites on the Sites & Monuments Record (of regional or local importance) • Conservation Areas • Country Parks
Low	• Archaeological sites of lesser importance • Non – Inventory Gardens and Designed Landscapes

Table 26: Cultural Heritage Sensitivity

8.2. Baseline Assessment

8.2.1. Relevant Legislation, Policy and Guidance

- Historic Environment (Amendment) (Scotland) Act 2011;
- Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997;
- Ancient Monuments and Archaeological Areas Act 1979;
- Town and Country Planning (Scotland) Act 1997 as amended by Planning etc. (Scotland) Act 2006;
- Scottish Historic Environment Policy;
- PAN 2/2011 Planning and Archaeology;
- Scottish Planning Policy 2010;
- Local Plan Policy ENV19: Archaeological Sites and Ancient Monuments; and
- Local Plan Policy ENV18: Listed Buildings.

8.2.2. Site Context

An assessment was carried out for any sensitive sites within 5km of the Ingliston Farm turbine. Details of these sites are shown in Table 27 below. These sites are shown relative to the turbine in Drawing ING007 within the appendices.

Site	Description	Distance to Ingliston Farm turbine (km)
Castleward, burial mound	Scheduled Ancient Monument	0.5
Denoon Law, fort	Scheduled Ancient Monument	1.1
Wester Denoon, burial mound	Scheduled Ancient Monument	1.3
Hatton of Eassie, ring-ditch	Scheduled Ancient Monument	2.1
Balkeerie, unenclosed settlement	Scheduled Ancient Monument	2.2
Newmill, ring ditch	Scheduled Ancient Monument	2.2
Carlunie Hill, cairn	Scheduled Ancient Monument	2.4
Castleton Motte	Scheduled Ancient Monument	2.6
Carlunie Hill, hut platforms	Scheduled Ancient Monument	2.7
West Nevay, burial mound	Scheduled Ancient Monument	2.8
Nevay Church, Kirkinch	Scheduled Ancient Monument	3.2
Mains Of Rochelhill, Dovecot	A Listed Building	3.2
Eassie Old Church and cross slab	Scheduled Ancient Monument	3.3
Kinpurney Hill, fort	Scheduled Ancient Monument	3.3
Cookston Farm, enclosure	Scheduled Ancient Monument	3.8
Newton of Glamis, unenclosed settlement	Scheduled Ancient Monument	3.9
Newton of Glamis, enclosure	Scheduled Ancient Monument	3.9
Braideston, enclosures	Scheduled Ancient Monument	4.1
Cardean, Roman camps	Scheduled Ancient Monument	4.7
Auchterhouse Hill	Archaeological Site	4.7
Glamis Manse, cross slab	Scheduled Ancient Monument	4.9
Glamis, Kirkwynd, St Fergus's Church, Strathmore Aisle	A Listed Building	4.9
Glamis Castle, Dovecot	A Listed Building	5.0

Table 27: Cultural heritage sites within 5km of Ingliston Farm

8.3. Impact Assessment

This impact assessment discusses the potential direct and indirect impacts that may occur at the cultural heritage receptors outlined within the baseline section. Outwith any direct disturbance on known cultural heritage sites the main impact will be visual. In relation to rural settings any development seen in principal views to or from a designated site can be considered as affecting its setting.

8.3.1. Assessed Impacts

With regard to the potential for direct impacts, it is noted that no known archaeological sites or features lie within the extent of construction works for the turbines, crane pad/laydown areas or access road. Any potential impacts (during construction and operation) are therefore expected to be visual. This chapter discusses the potential impact on the sites described within the baseline assessment.

Table 28 below provides details of cultural heritage sites identified within 5km, along with the demonstrated extent of the theoretical turbine visibility, sensitivity, magnitude and potential impact according to the methodology described in Chapter 8.1.

Further discussion is then provided on those sites where there is a theoretical major or major/moderate impact.

Name	Theoretical visibility	Sensitivity	Magnitude	Overall Potential Impact
Castleward, burial mound	Nacelle and blades	High	High	Major
Denoon Law, fort	Full	High	Medium	Major/Moderate
Wester Denoon, burial mound	Nacelle and blades	High	Medium	Major/Moderate
Hatton of Eassie, ring-ditch	Nacelle and blades	High	Low	Moderate
Balkeerie, unenclosed settlement	Nacelle and blades	High	Low	Moderate
Newmill, ring ditch	Nacelle and blades	High	Low	Moderate
Carlunie Hill, cairn	Full	High	Low	Moderate
Castleton Motte	Nacelle and blades	High	Low	Moderate
Carlunie Hill, hut platforms	None	High	Low	N/A
West Nevay, burial mound	Nacelle and blades	High	Low	Moderate
Nevay Church, Kirkinch	Nacelle and blades	High	Low	Moderate
Mains Of Rochelhill, Dovecot	None	High	Low	N/A
Eassie Old Church and cross slab	Full	High	Low	Moderate
Kinpurney Hill, fort	Full	High	Low	Moderate
Cookston Farm, enclosure	Nacelle and blades	High	Low	Moderate
Newton of Glamis, unenclosed settlement	Full	High	Low	Moderate
Newton of Glamis, enclosure	Full	High	Low	Moderate
Braideston, enclosures	Nacelle and blades	High	Low	Moderate
Cardean, Roman camps	Nacelle and blades	High	Low	Moderate
Auchterhouse Hill	Full	Medium	Low	Moderate/Minor
Glamis Manse, cross slab	Nacelle and blades	High	Low	Moderate

Glamis, Kirkwynd, St Fergus's Church, Strathmore Aisle	Nacelle and blades	High	Low	Moderate
Glamis Castle, Dovecot	Full	High	Low	Moderate

Table 28: Assessed impact on cultural heritage sites

20 of the 23 heritage assets listed above only have a theoretical moderate/minor or moderate impact. As such, it is considered that the proposed turbine at Ingliston Farm will not have a significant level of impact on the setting of these heritage assets. With the exception of the Scheduled Ancient Monument (cairn) at Carlunie Hill, these are not assessed further.

As outlined in Table 28, the cairn at Carlunie Hill is considered to only have a moderate impact from the proposed development. However, as requested by Angus Council in pre-application discussions, visualisations have been prepared from this heritage asset. As highlighted by Drawings ING051-053, it is considered that the presence of a wind turbine at Ingliston Farm does not impact significantly upon the setting of this heritage asset, especially given that the existing setting is in such close proximity to the Ark Hill wind farm.

The three sites for which there is a theoretical major or major/moderate impact are discussed in more detail below.

8.3.2. Castleward, burial mound

Although the turbine is within 0.5km of the proposed development, it is considered that the impact upon the setting of this heritage asset will not be significant, for the following reasons:

1. As demonstrated in Drawing ING016, the SAM only has theoretical visibility of the turbine nacelle and blades, as opposed to full visibility of the turbine;

2. It is considered that the consented and operational wind farms and single turbine developments within the immediate vicinity of the SAM create a setting and a baseline level of impact which the proposed development does not significantly increase upon; and

3. Following initial consultation with Angus Council it is understood that a primary consideration for wind turbine developments within the area is their impact upon the interaction between key SAMs across the prominent hilltops of the wider Sidlaw Hills. Such monuments will include those at Kinpurney Hill, Auchterhouse Hill and Denoon Law. The proposed turbine will not significantly impact upon interactive views from the SAM at Castleward in the direction of any of the other prominent monuments within the upland area. The other SAMs are generally to the east, south east, south and south west of Castleward. The turbine is located due north of the SAM. As such, it is not expected to impinge upon interactive views between the noted monuments.

8.3.3. Denoon Law, fort

Drawings ING042-044 highlight the visual impact the proposed development will have on the SAM at Denoon Law. There is full visibility of the turbine from the monument and the visualisations prepared highlight that the turbine will be a prominent feature but only in views to the east. It is considered that the turbine would relate well to the vertical scale of upland landform in this viewing direction. With no horizontal spread the majority of the wider views of the lowland areas to the north and west remain open and these are considered to be the primary views in relation to the setting of this defensive feature. The single turbine proposed at Ingliston Farm is therefore not considered to impact significantly upon the existing setting of this heritage asset, especially given the presence of other turbines within the vicinity having changed the current setting of the monument in the wider landscape.

8.3.4. Wester Denoon, burial mound

As highlighted by Drawing ING016, the burial mound at Wester Denoon will only have theoretical visibility of the nacelle and blades of the proposed development. The SAM is also on the periphery of this level of visibility, and after further assessment it can be concluded that none of the turbine tower will be theoretically visible. Given the distance to the turbine, the level of theoretical visibility, and the presence of other turbines within the vicinity having changed the current setting of the monument in the wider landscape, it is not considered that there will be a significant impact upon this heritage asset.

8.4. Mitigation Measures

No groundwork or construction will be undertaken within, or adjacent to recorded sites of cultural heritage. Therefore there have been no mitigation measures proposed at this stage.

8.5. Conclusions

This assessment has examined the expected impact of the proposed Ingliston Farm turbine on cultural heritage sites.

With regard to the potential for direct impacts, it is notable that no known archaeological sites are within the proposed construction area for the turbines, crane pad/set down areas or access road. The primary consideration was whether the turbine would have a significant impact on the setting of the sites through significant visual impact as stated in the relevant National and Local policy.

From an initial desk based assessment of the surrounding area, 23 high sensitivity cultural heritage assets were found within 5km of the Ingliston Farm development site. In assessing the setting of these sites it was determined that for three sites there is a potential significant impact upon the monuments. This is primarily due to their proximity to the proposed development. However, as outlined in the sections above, it is considered that the proposed turbine will not significantly impact upon these heritage assets.

It is considered that any adverse impacts on the remaining 20 heritage sites would not be significant. This is due to the distance (>2km) from the proposed turbine location, which reduces the potential for views of the turbine being considered 'dominant' or 'conspicuous'.

As such, it is considered that the proposed development at Ingliston Farm will not have a significant impact on nearby heritage assets.

9. Ecology

The ecological impact of the Ingliston Farm developments has been assessed by Ecologist EnviroCentre Ltd. The ecology report is attached within the appendices of this Supporting Environmental Document. The potential ecological impact of the development is summarised as follows:

"No further survey of the site is necessary.

While the borrow pit will mean the loss of an area of improved grassland, this habitat is widespread and common throughout the surrounding area and is considered to have low ecological value. The borrow pit will be reinstated once works are complete and in time the vegetation will regenerate. The borrow pit is unlikely to cause any lasting ecological impacts.

A bird survey is not necessarily required if construction work can be either timed to avoid the bird breeding season or a pre-construction check of any vegetation to be removed is undertaken immediately prior to works.

Natural England has developed guidance that provides information on how best to site turbines to avoid impacts to bat species. This guidance states that:

"A bat survey should normally be recommended for applications for turbines that will be located within 50m of the following features:

- *Buildings or other features or structures that provide potential as bat roosts, including bridges, mines etc;*
- *Woodland;*
- *Hedgerows;*
- *Rivers or lakes; and*
- *Within or adjacent to a site designated for bats (SSSI or SAC)."*

Therefore, 50m should be the minimum distance between the tip of the turbine blade to the nearest feature which may be used by bats. This distance should not be measured from the base of the turbine but instead should take into account the height of the feature. In order to accurately measure this stand-off distance from the blade tip Natural England have produced the following equation:

$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$, *where:*

b = the minimum distance;

bl = blade length (27m);

hh = hub height (50m); and

fh = feature height (2m).

At Ingliston Hill the minimum distance equates to 60.2m.

As the proposed turbine is located approximately 75m from the nearest linear feature, it is unlikely to affect any feature that may be used by roosting, foraging or commuting bats.

No further survey for bats is required."

10. Shadow Flicker

Under certain combinations of geographical position, time of day and time of year, the sun may pass behind a turbine rotor and cast a shadow over neighbouring properties. When the blades rotate a shadow forms for short periods and this effect is known as 'shadow flicker'. Shadow flicker is considered an issue when the blade shadow passes over a narrow opening, such as a neighbouring property's window. The main cause for concern is the potential annoyance to homeowners. This is an issue that can be completely mitigated, if required, through understanding the periods of concern and controlling the turbine appropriately during these periods.

This chapter considers the potential shadow flicker impact on local properties from the operation of the proposed Ingliston Farm wind turbine.

10.1. Methodology

The effect of shadow flicker can be assessed using specialist software. This software models the shadow flicker from the following geometric considerations:

- The position of the sun at a given date and time;
- The size and orientation of the windows that may be affected; and
- The size of the proposed turbines that would cast the shadow.

Within this assessment, the sensitivity of any identified receptors is assumed to be High due to the direct impact on local residential amenity.

10.2. Baseline Assessment

10.2.1. Relevant Legislation, Policy and Guidance

The Scottish Government's web based Specific Advice Sheet – Onshore Wind Turbines (most recently updated in October 2012) states:

"Under certain combinations of geographical position, time of day and time of year, the sun may pass behind the rotor 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 occurs only within buildings where the flicker appears through a narrow window opening. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the potential site".

"Where this could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule 10 rotor diameters), "shadow flicker" should not be a problem. However, there is scope to vary layout/reduce the height of turbines in extreme cases."

10.2.2. Site Context

There are no properties within 10 rotor diameters of the turbine location. The nearest residential property, at Easter Denoon, is at the approximate grid reference of E334985 N743907 and is shown in Figure 11 below (marked as H1).

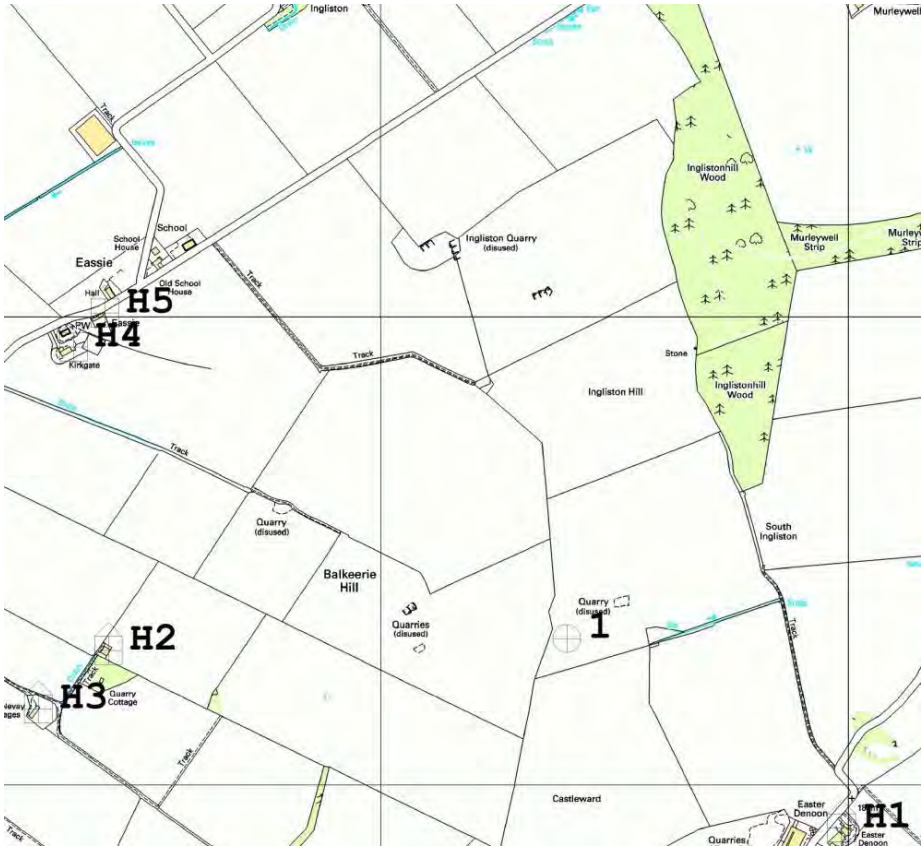


Figure 11: Properties assessed for shadow flicker impacts

10.3. Impact Assessment

A map assessment was undertaken to demonstrate the extent of shadow flicker at the site assuming the worst case assumptions. This map is shown in Figure 12 for the proposed development. The contours mark the number of hours of potential impact to an individual window at 2m above ground level. Each contour represents 50 hours of shadow flicker events per annum.

Figure 12: Theoretical shadow flicker zone surrounding the Ingliston Farm turbine

The calculated flicker events are detailed in Table 29 below.

House	Days per year	Max hours per day	Mean hours per day	Total hours per year
H1	0	0	0	0
H2	0	0	0	0
H3	0	0	0	0
H4	0	0	0	0
H5	0	0	0	0

Table 29: Summary of theoretical shadow flicker impacts

10.4. Conclusion

The following conclusions have been made regarding shadow flicker considerations and the proposed wind development:

- A shadow flicker assessment was completed using Windfarm Software to quantify the areas of potential impact. The model was run using conservative, worst – case assumptions;

- No shadow flicker impacts are expected at nearby properties; and
- Screening from trees has not been considered during this assessment. This means that, if there were potential flicker effects, these will be greatly reduced.

The above assessment considered worse case conditions for the effects of shadow flicker. Therefore shadow flicker should not be considered to be a sustained concern in terms of local residential amenity.

11. Noise

This chapter assesses whether a wind turbine at Ingliston Farm is likely to cause a noise disturbance to the nearest residential dwellings. The chapter will initially provide an overview of relevant policy, wind turbine noise and site context before assessing the extent of wind turbine derived noise on the nearest residents.

11.1. Methodology

A desk based assessment has been carried out in accordance with the relevant guidelines (discussed further in Chapter 11.2.2). Following recent discussion with Angus Council, particular attention has been made to the Institute of Acoustics 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (2013). Within the guidance it is outlined that the following parameters should be set when calculating noise predictions:

- A ground factor of G=0.5;
- The use of warranted manufacturer data or, if warranted data is not available, the use of measured data. In the scenario where measured data is used, an uncertainty factor provided by the manufacturer, multiplied by a margin of 1.645, should be used to ensure that suitable uncertainties have been incorporated. This is highlighted within the IEC 61400-11 standard;
- The adoption of a receiver height of 4.0m is recommended (regardless of time of day), as it has the effect of reducing the potential over-sensitivity of the calculation to the receiver region ground factor compared to lower receiver heights; and
- Atmospheric conditions of 10^{o}C and 70% humidity are recommended to represent a reasonably low level of air absorption.

In line with the above guidance, predicted noise levels have been calculated based on measured sound power information provided by the manufacturer and have been compared with the noise limits set out within ETSU-97.

The measured and warranted sound power data from the manufacturer and extracts from the ReSoft Windfarm software used to complete the assessment can be viewed in Appendix C.

The extent of turbine noise has been quantified using International Standard ISO 9613 "Acoustics – Attenuation of Sound during Propagation Outdoors" and from this work it has been considered that further detailed noise survey work is not required for the proposed turbine location and model.

11.2. Baseline Assessment

11.2.1. Turbine Noise

Wind turbines generate noise as they rotate. Wind turbine derived noise will occur above the "cut-in" wind speed and below the "cut-out" wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring. The cut-in wind speed for the proposed turbine is 3 meters per second (m/s) and the cut out wind speed is normally around 25m/s (measured at hub height). Above wind speeds of 8 – 12m/s, background noise begins to exceed turbine noise as shown in Figure 13. Therefore, it is within the range 3 to 12m/s that turbine noise is typically most audible.

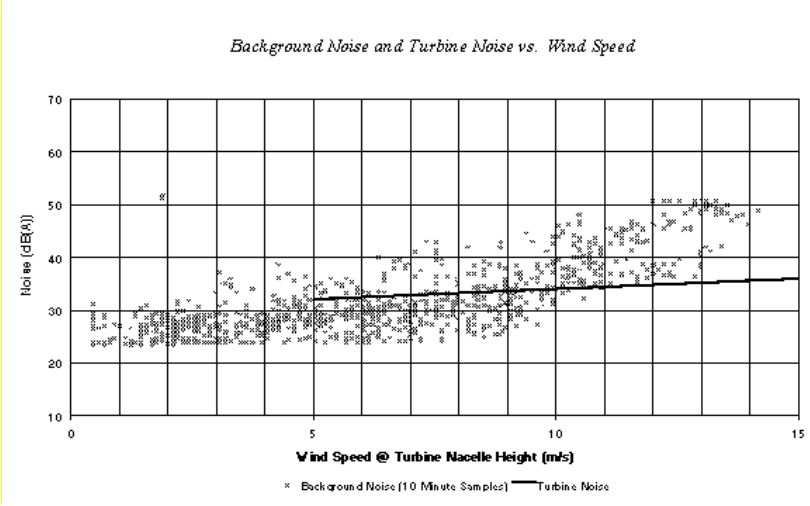


Figure 13: Background Noise and Wind Turbine Noise vs. Wind Speed[16]

During the operational phase there are two potential sources of noise from a wind turbine; aerodynamic noise from the movement of the blades through the air, and mechanical noise from the operation of turbine engine components (e.g. gearbox and generator) in the nacelle.

Modern wind turbines have been designed to be considerably quieter than earlier turbine models and significant progress has been made in recent years in achieving lower noise signatures. Well designed modern wind turbines are generally quiet in operation and compared to the noise of road traffic and construction activities in other locations, the noise from wind turbines is very low.

Aerodynamic noise can be minimised through careful attention to blade design, whilst mechanical noise can be minimised through innovative design and noise insulation materials within the nacelle.

The locational and turbine specific noise details for this project are provided in Table 30 below and the noise data has been provided from EWT documentation for their Directwind 54 turbine which is proposed for this site.

Turbine	EWT Directwind 54
Easting	334397
Northing	744313
Height ASL	235m
Measured sound power level at 95% operation (10m/s) including uncertainty factor of 1.15dB (0.7dB uncertainty factor provided by the manufacturer x 1.645, as outlined in Section 11.1).	100.65dBA

Table 30: Turbine details used in this assessment

11.2.2. Relevant Legislation, Policy and Guidance

The following policy and guidance documents were utilised in the completion of this chapter:

[16] Graph taken from The Assessment & Rating of Noise from Wind Farms, The Working Group on Wind Turbine Noise, September 1996.

- Scottish Planning Policy;
- Institute of Acoustics 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise';
- PAN 1/2011 Planning and Noise and accompanying Technical Advice Note;
- Specific Advice Sheet – Onshore Wind Turbines (which replaces PAN 45 Renewable Energy Technologies);
- BS 5228 Parts 1 & 2 – Code of Practice for Noise and Vibration Control on Construction and Open Sites; and
- ETSU-R-97 The Assessment and Rating of Noise from Wind Farms.

The Scottish Government's online guidance (last updated in October 2012) states:

"The Report 'The Assessment and Rating of Noise from Wind Turbines' (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions".

ETSU (1997) suggests that current practice on controlling wind farm noise should be by the application of noise limits at the nearest noise-sensitive properties. These noise limits should be applied to external locations and should apply only to those areas frequently used for relaxation or activities for which a quiet environment is highly desirable. The report suggests that noise limits should be set at a $LA90_{10min}$ of no more than 5 dB(A) above background, subject to a minimum of 35-40 dB(A) for daytime and 43 dB(A) for night-time. These limits are applicable up to a wind speed of 12 m/s measured at 10 m height on the site. However, the report also states both day and night-time lower fixed limits can be increased to 45 dB(A) to increase the permissible margin above background where the occupier of the property has some financial interest in the wind farm.

11.2.3. Site Context

The 5 residential locations closest to the proposed turbine are numbered in Figure 14 below with details provided in Table 31.

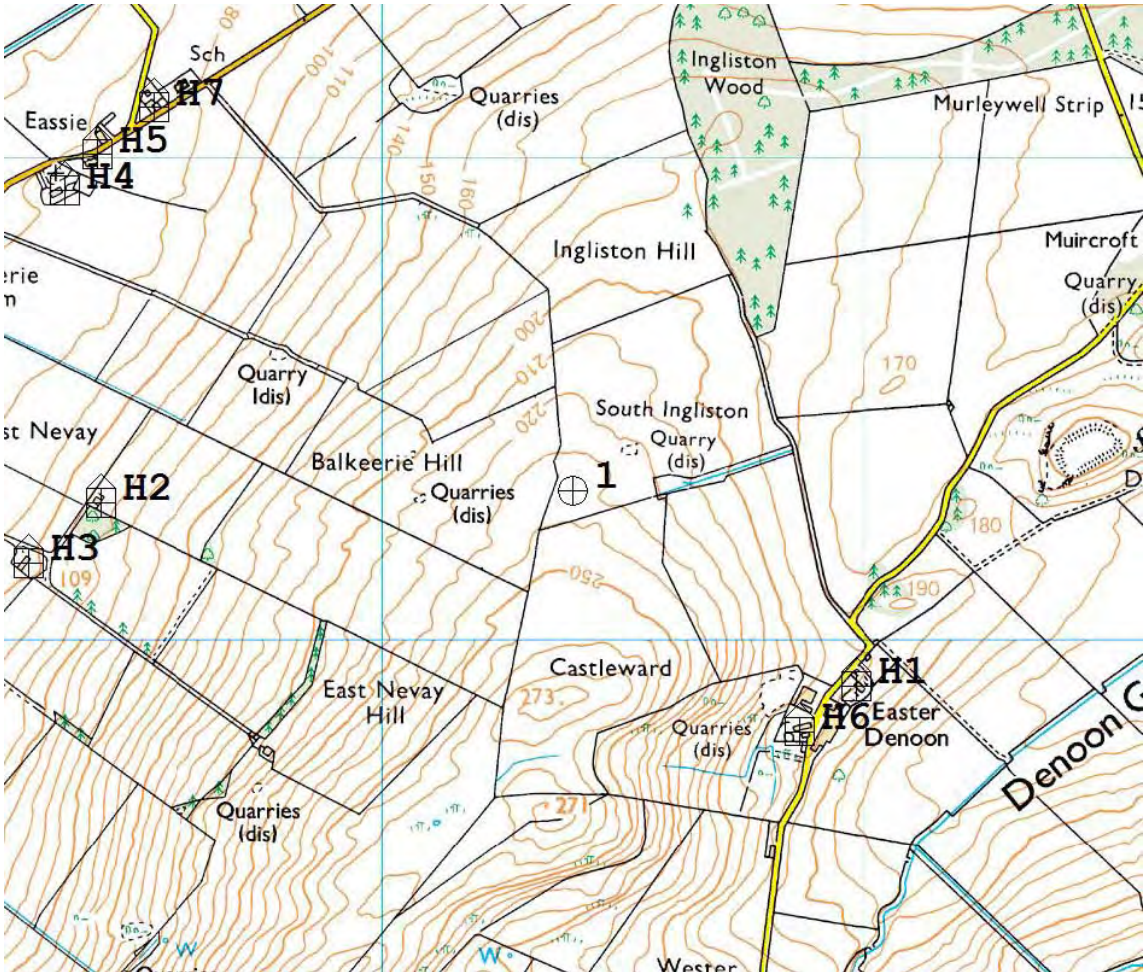


Figure 14: Residential areas surrounding the proposed turbine

House	Easting	Northing	Distance to turbine
H1	334985	743907	714m
H2	333417	744287	978m
H3	333268	744163	1138m
H4	333343	744934	1223m
H5	333409	745008	1207m
H6	334866	743812	686m
H7	333528	745106	1176m

Table 31: Details of the dwellings in proximity to the proposed turbine

With regards to the existing sources of background noise in the area, the site was considered to be a relatively quiet rural area although there will be anthropogenic noise from farm vehicles and other vehicles on the public roads.

11.3. Impact Assessment

Noise related issues need to be considered for the construction, operational and decommissioning phases of the project.

11.3.1. Construction and decommissioning phases

During these phases there will be a number of short term noise impacts of varying intensity and these include:

- The transportation of abnormal loads (equipment and materials) to site will require the use of Heavy Goods Vehicles (HGV's). The majority of the transport route is likely to be via motorways and other busy regional roads so there is unlikely to be significant additional noise impacts for sensitive receptors along the majority of this route; and
- The construction/excavation of the borrow pit, foundations and ancillary structures (including the excavation of earth to lay foundations and underground cabling) is likely to have short-term noise impacts higher than background levels. In accordance with best practice, this type of construction work will take place during daylight hours to ensure minimal disturbance to nearby residential dwellings.

Given the single turbine nature of the development there will only be a short term noise impact from construction traffic and turbine components coming to and from site along local roads. These stages are therefore considered to have a negligible overall noise impact.

11.3.2. Operational phase

Although noise levels arising from wind turbines are fairly low relative to other anthropogenic sources, as the turbines are generally situated in rural environments there are often few other sources of noise. When wind speeds are high this is not a problem since any turbine noise is masked by wind induced noise effects, particularly that of the trees being blown. At lower wind speeds, however, or in particularly sheltered locations, the wind induced background noise may not be sufficient to mask the noise from the turbine. However, under these conditions, the generated noise levels may be so low as to generate very little impact.

As discussed, a desk-based noise impact was undertaken based on ISO 9613:

- ISO 9613 – 1: Attenuation of Sound During Propagation Outdoors, part 1: Calculation of the Absorption of Sound by the Atmosphere; and
- ISO 9613 – 2: Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation.

The propagation model described in Part 2 of the ISO 9613 standard provides for the prediction of sound pressure levels based on either short-term, down-wind (i.e., worst case) conditions, or long term, downwind overall averages. ISO 9613 is considered a conservative model as it assumes all receivers are downwind from the noise sources. In reality, when wind is blowing in the opposite direction (i.e. from receivers to sources), the source attributable noise levels are lower.

Turbine sound power levels

In this assessment, noise predictions for this site have been based on measured sound pressure levels. Table 32 below gives the calculated octave band sound power levels for the proposed turbine for wind speeds at 10m/s. An uncertainty factor of 1.15dB has been added to each sound power level to provide a more conservative assessment, as per the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'.

Octave Band Frequency (Hz)	Sound Power Level (dB(A))
63	82.75
125	88.95
250	94.25
500	95.55
1000	94.15
2000	91.65
4000	84.75
8000	72.95

Table 32: Octave band spectrum at 10m/s

11.3.3. Other Factors

Directivity Factor

The directivity correction describes the extent to which a point source radiates sound. For a wholly omnidirectional source (like a turbine nacelle), the directivity correction is 0.

Atmospheric Absorption

The atmospheric absorption depends on the relative humidity of the air, ambient temperature and ambient pressure. For this model, an ambient temperature of 10°C with a relative humidity of 70% was used in line with the Institute of Acoustics recommended atmospheric factors. This generated the octave band absorption coefficients used in the model, as shown in Table 33 below.

Frequency (Hz)	63	125	250	500	1,000	2,000	4,000	8,000
Absorption Coefficient (dB/km)	0.12	0.4	1.04	1.93	3.66	9.66	32.8	117.00

Table 33: Octave Band Absorption Coefficients

Ground Factor

The ground region parameter (i.e. how acoustically hard or soft the ground is) was set at 0.5 for the model. The ground region can be set between 0 (hard ground such as water or concrete) to 1.0 (grassland or farm land). In accordance with the Institute of Acoustics guidance, a ground factor of 0.5 was used in the model as the guaranteed turbine sound power level has been utilised.

Barrier Attenuation

There are no screening obstacles (i.e. barriers) included in this model.

11.4. Results

The ETSU Guidelines state that the L_{A90} noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5 dB less than the L_{Aeq} levels over the same period. Use of the L_{A90} descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

Noise predictions were carried out for a wind speed of 10m/s at 10m height. The receiver was set at a 4m height above ground level. The results are plotted in the form of noise contours shown in Figure 15 below. It should be noted that this represents downwind propagation in all

directions simultaneously, which clearly cannot happen in practice. The predicted turbine noise L_{Aeq} has been adjusted by subtracting 2dB to give the equivalent L_{A90} as suggested in ETSU-R-97. The L_{A90} figures with the uncertainty factor of 1.15dB outlined are included in Appendix C. These have been inserted manually into the ReSoft Windfarm software, to prepare the model in Figure 15 below.

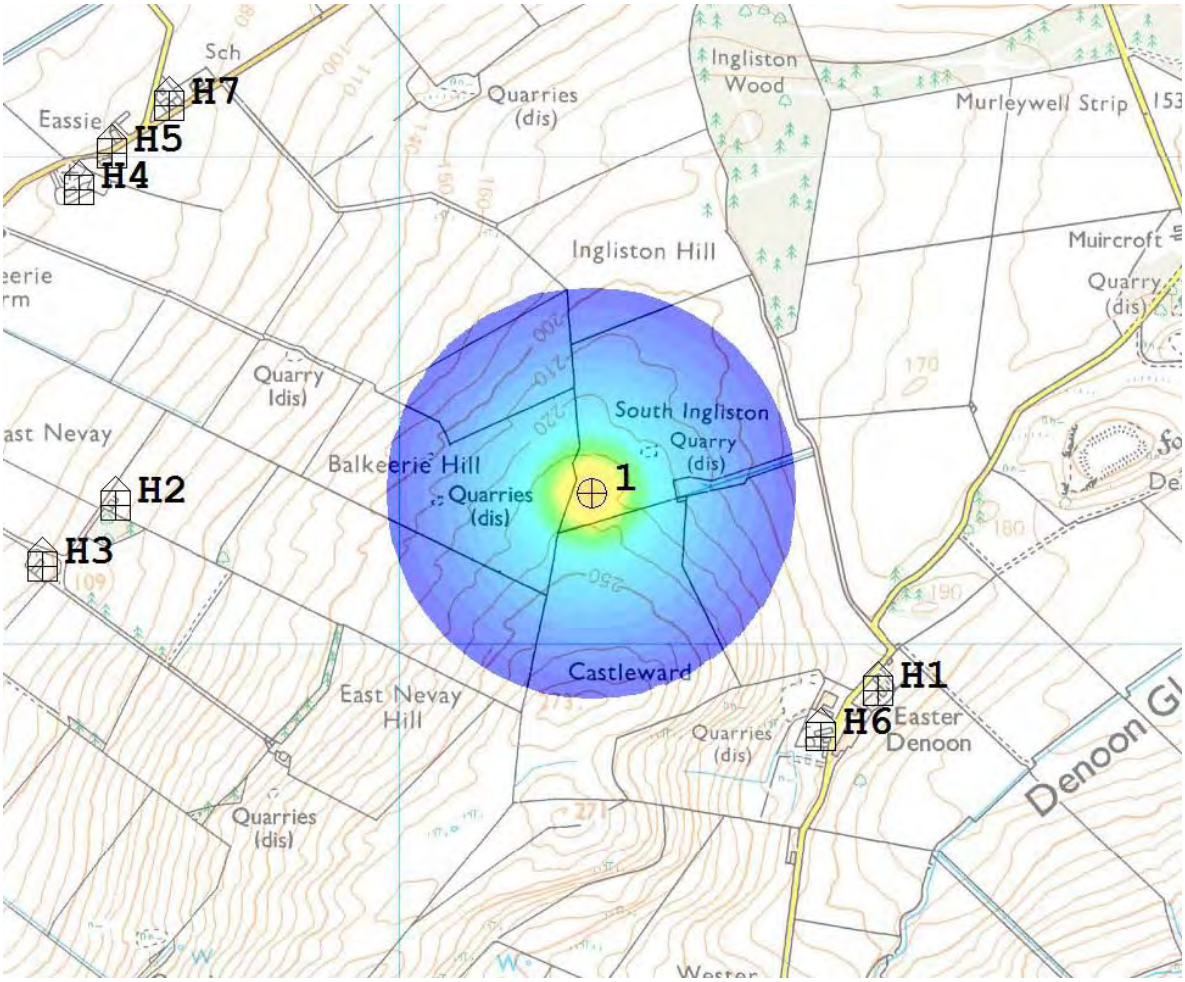


Figure 15: Ingliston Farm Noise Model (using ReSoft Windfarm and L_{A90} data)

As is shown by the above noise assessment, the maximum expected noise levels at the nearest residential areas will be under 35db(A). Based on the ETSU guidance this is considered to be within acceptable levels and background noise measurements are not considered necessary. It should also be noted that:

- Wind turbine noise is modelled at its rated power output and consequently the rated sound power level;
- The model assumes a direct line of sight and does not consider terrain; and
- The noise model assumes that the wind direction is always blowing from the wind turbine to each house simultaneously. Noise levels can be expected to be 2 dB less during cross winds (i.e. where the wind blows across a path between the turbine and the house).

The results of the noise assessment for each house shown in the baseline assessment are shown in Table 34 below.

House no	Predicted Noise (dB)
H1	29.75
H2	26.44
H3	24.83
H4	24.05
H5	24.18
H6	30.17
H7	24.47

Table 34: Calculated noise levels at surrounding properties

11.5. Mitigation

Construction

Several safeguards exist to minimise the effects of construction noise including:

- The various EC Directives and UK Statutory Instruments that limit noise emissions of a variety of construction plant;
- Guidance set out in BS 5228: 2008: Part 1 which covers noise control on construction sites; and
- The powers that exist for local authorities under the Control of Pollution Act 1974 to control environmental noise on construction sites.

As part of the construction contract, the contractor would be required to implement all committed mitigation measures including those set out in this Document. With a view to ensuring compliance with the agreed noise limits, the adoption of Best Practicable Means, as defined in the Control of Pollution Act 1974, is usually the most effective means of controlling noise from construction sites.

Other additional generic measures to be adopted for the control of noise are as follows:

- All site staff would receive appropriate environmental training at the beginning of the contract and throughout the construction;
- Silenced or sound reduced compressors would be used where necessary;
- Silencers or mufflers would be fitted to pneumatic tools where required;
- Deliveries would be programmed to arrive during daytime hours only and care would be taken to minimise noise when unloading vehicles;
- Delivery vehicles would be prohibited from waiting within the site construction compound with their engines running;
- Plant items would be properly maintained and operated according to manufacturers' recommendations, in such a manner as to avoid causing excessive noise; and
- Appropriate noise limits and working hours would be specified in the contract documents. It is assumed that construction activities would be undertaken during daytime periods only, between the hours of 07:00 to 19:00 hours Monday to Friday and 07:00 to 13:00 hours on Saturday.

Operation

The noise assessment demonstrates that the highest predicated noise level at the nearest residential dwellings to the proposed turbines is under 35 dB(A), which meets ETSU guidelines. On this basis, no mitigation is deemed necessary in relation to the operational phase of development.

11.6. Conclusions

The following conclusions have been made regarding noise considerations and the proposed wind development:

- The area is rural in nature and is expected to have relatively low background noise;
- The nearest property (house and or boundary) to the turbine is measured as being 686m from the turbine position;
- The proposed turbine (EWT Directwind 54) is a modern turbine design with a low noise signature compared with other turbines of a similar size;
- Noise modelling was completed for the proposed development using ReSoft Windfarm software and the guaranteed noise levels for the proposed wind turbine at normal operation. This model is based on ISO 9613;
- The noise at the nearest residential dwellings (applicant and non applicant owned) to the proposed turbine site is shown not to exceed 35 dB(A) (L_{A90}) at a wind speed of 10m/s and at a received height of 4m, in accordance with ETSU and the guidance from the Institute of Acoustics; and
- ETSU guidance states that in the above scenario the wind turbine development is not considered to require detailed background noise modelling as the turbine noise would be below what is expected to be seen as background noise in a low noise environment.

Overall, noise impacts are predicted to be low and assessed levels are well within ETSU guideline limits.

12. Telecommunications

This chapter examines the proposed development of a wind turbine at the Ingliston Farm site with regards to the potential to interfere with telecommunications and television reception.

12.1. Methodology

To assess the potential impact on telecommunications, Locogen initially provided details of this development to the Office of Communications (Ofcom). Ofcom are the agency tasked with assessing the potential impacts of wind energy proposals on the civilian radio network (consists primarily of mobile phone operators and communication systems for public sector and utility companies). Ofcom responded with a list of those telecom links that are within a 500m radius of the proposed development. Information on the proposed development was also passed on to Atkins and the Joint Radio Company (JRC) who manage the scanning microwave and telemetry links of utility companies.

Ascertaining the potential impact on local television transmission signals previously involved the completion of the BBC wind farm assessment tool. This online assessment tool is no longer available and this is at least partially due to the move to a fully digital television reception network which is considered to significantly reduce the potential for impacts upon reception.

12.2. Baseline Assessment

The potential impacts are likely to be during the operational phase of the project. Various stakeholder bodies were contacted regarding the proposed development, the outcomes of the consultation and further assessment are provided below.

12.2.1. Telecommunications

Ofcom, Atkins and JRC were asked to give details of telemetry and microwave links within a 500m radius of the development. The outcome of this stakeholder contact has been summarised in Table 35 below.

Company	Responded	Links	Further issues
Ofcom	Yes	0	-
Atkins	Yes	0	-
JRC	Yes	0	-

Table 35: Overview of responses from telecommunication companies

12.2.2. Television Reception

With regard to domestic television reception the primary area of concern is that the presence and movement of the turbine causes shadow and/or reflection zones in the surrounding area. A worst case scenario is that television reception systems within these zones may be partially or totally impaired through the reception being blocked or mirrored by the presence of the turbine.

12.3. Impact Assessment

12.3.1. Telecommunications

Consultation with Ofcom and others found no telecommunications links within 500m of the proposed turbine locations. Development of the site therefore poses no interference risks to nearby telecommunication links.

12.3.2. Television Reception

Prior examples of instances where wind developments have impacted on television reception have involved analogue systems. Therefore a key factor to take into consideration is the UK's completed switch to an all digital broadcasting network. The following information was provided as to how this switch would be likely to significantly reduce the extent of any impact:

> *"Although analogue and digital terrestrial TV signals use different modulation systems, with different characteristics, digital signals will still be broadcast from the same transmitter sites, and in the same frequency ranges, as currently used for analogue TV. The propagation characteristics of both systems are also the same, and physical obstructions such as wind farms will therefore continue to have an effect on domestic reception in the all-digital environment. However, digital signals contain a number of error correction and recovery mechanisms, which mean that an apparently perfect picture can be decoded even in quite adverse reception conditions. The corollary of this robustness is that the failure of digital signals is abrupt: when reception conditions become too poor for the error correction systems to recover from, reception is completely lost. This is in contrast to analogue systems, where visible picture impairments become gradually worse as reception conditions deteriorate".* [17]

Therefore the recent move to digital will mean that the number of potential sites impacted upon will be reduced further due to fewer issues with partial picture distortion.

Overall, television reception issues are not perceived to be a significant concern due to the small scale of development, the limited number of dwellings in the immediate area, the move to digital reception, and the ability to rectify issues for those individual households that are affected.

12.4. Conclusions

On the basis of the above desk-based assessment, no specific mitigation measures are required in relation to telecommunications links.

Following the digital switch-over, loss of local television reception is unlikely to occur. Any impacts that do occur (expected to be minimal, if at all) can be appropriately mitigated at the expense of the developer.

[17] Peter Mandry, Senior Associate technical advisor for Ofcom

13. Aviation

Wind turbines can encroach on airspace and interfere with flight safety (both civilian and military), ground-based radar systems and aircraft navigation systems.

13.1. Methodology

Locogen have assessed the potential impact on aviation and radar through desk based assessment and stakeholder consultation. Stakeholders included the Ministry of Defence (MOD) and the Civil Aviation Authority (CAA).

13.2. Baseline Assessment

13.2.1. Relevant Legislation, Policy and Guidance

Guidance for assessing the potential impact on aviation considerations is provided in:

- Scottish Government 2002 – PAN 45: Renewable Energy Technologies and as superseded by online planning advice for 'Onshore Wind Turbines' (last updated October 2012);
- BWEA aviation guidance – www.bwea.com/aviation; and
- BERR 2002 (formerly DTI) – Wind Energy & Aviation Interests.

13.3. Impact Assessment

The vast majority of aviation impacts will be during the operational phase of the project. Due to the complexity in assessing aviation interests it is primarily left to the relevant statutory bodies to make their own views regarding the proposed development.

Locogen have completed a desk based assessment of the perceived effects of a wind turbine operation on specific aviation operations.

13.3.1. Civil Aviation

Figure 16 below illustrates that the site lies outwith the radar coverage area for both Edinburgh and Aberdeen airports and is well outwith the 15km safeguarding radius areas for both sites. Furthermore there is not considered to be a safeguarding impact on Dundee Airport, given that the turbine is located over 15km from the aerodrome reference point and that Dundee Airport has no site based radar operations.

It is concluded that objections will not be raised in relation to any of the above noted locations.

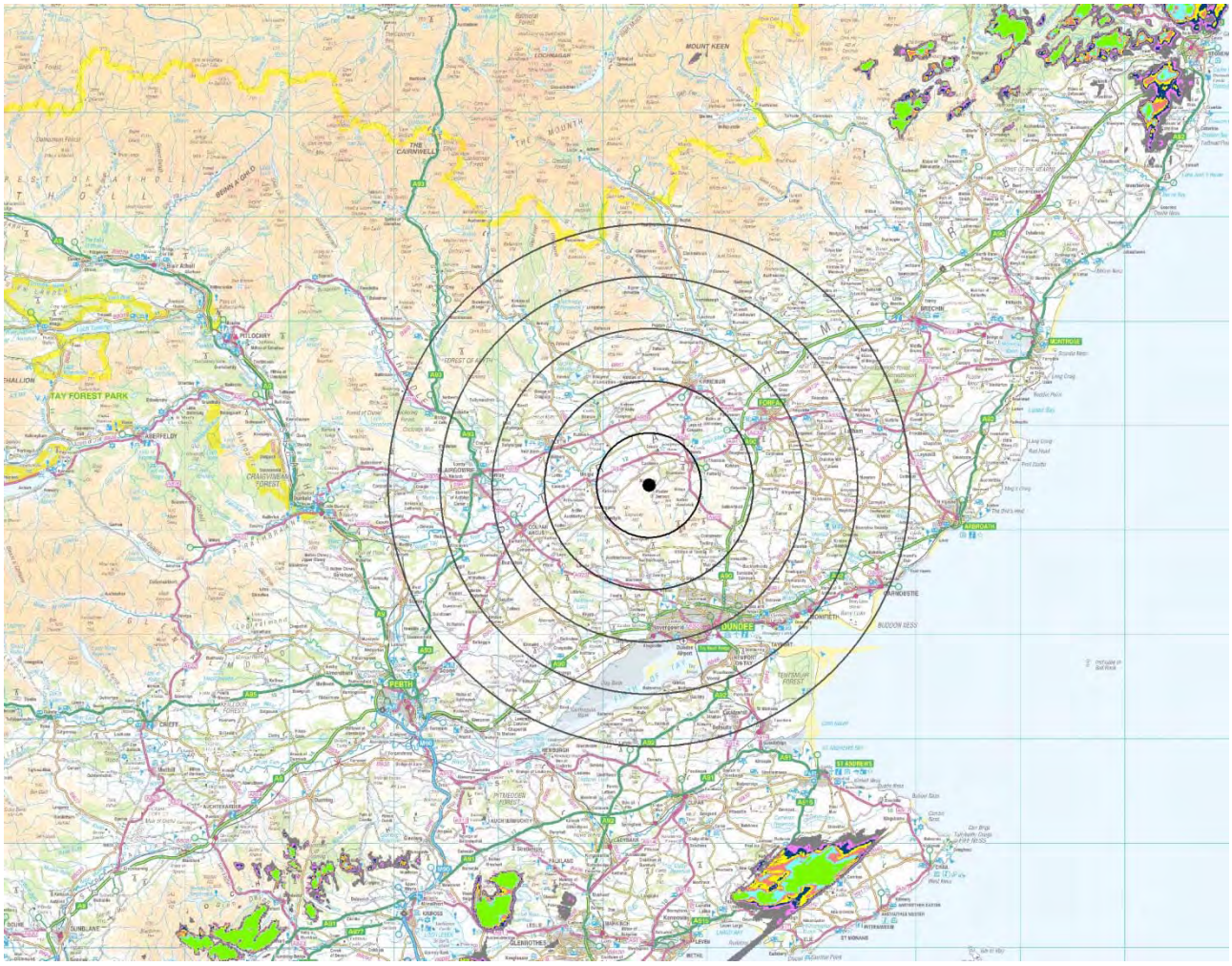


Figure 16: Edinburgh Airport (South) and Aberdeen Airport (North) radar visibility [Radii around turbine in 5km increments]

13.3.2. Military Aviation

It is understood that the Ministry of Defence (MoD) can no longer resource the provision of pre-application consultation advice. As such, no consultation has been initiated with the MoD. The site lies within a low priority military low flying zone and therefore should not raise concerns in relations to low flying military aircraft.

Based on desk-based GIS modelling, it is also considered that the Ingliston Farm site will not be visible to MoD radar at RAF Leuchars, which is located approximately 27km south south east of the proposed turbine location. It is therefore considered unlikely that the MoD will raise concerns over the radar visibility of the Ingliston Farm wind turbine.

13.3.3. NATS En-Route Ltd (NERL)

NATS En-Route Ltd (NERL) manages the UK's en-route air traffic outside of the individual air traffic control zones around airports. They therefore have a number of radar stations that provide radar coverage across the UK. As a first assessment tool this body provides radar visibility maps of the UK that allow wind developers to initially assess potential issues with regard to en-route navigational facilities. The zones where there would be radar visibility at 60m and 80m AGL are shown coloured red and green respectively in Figure 17 below. The proposed turbine is located outwith those areas having en-route radar visibility.

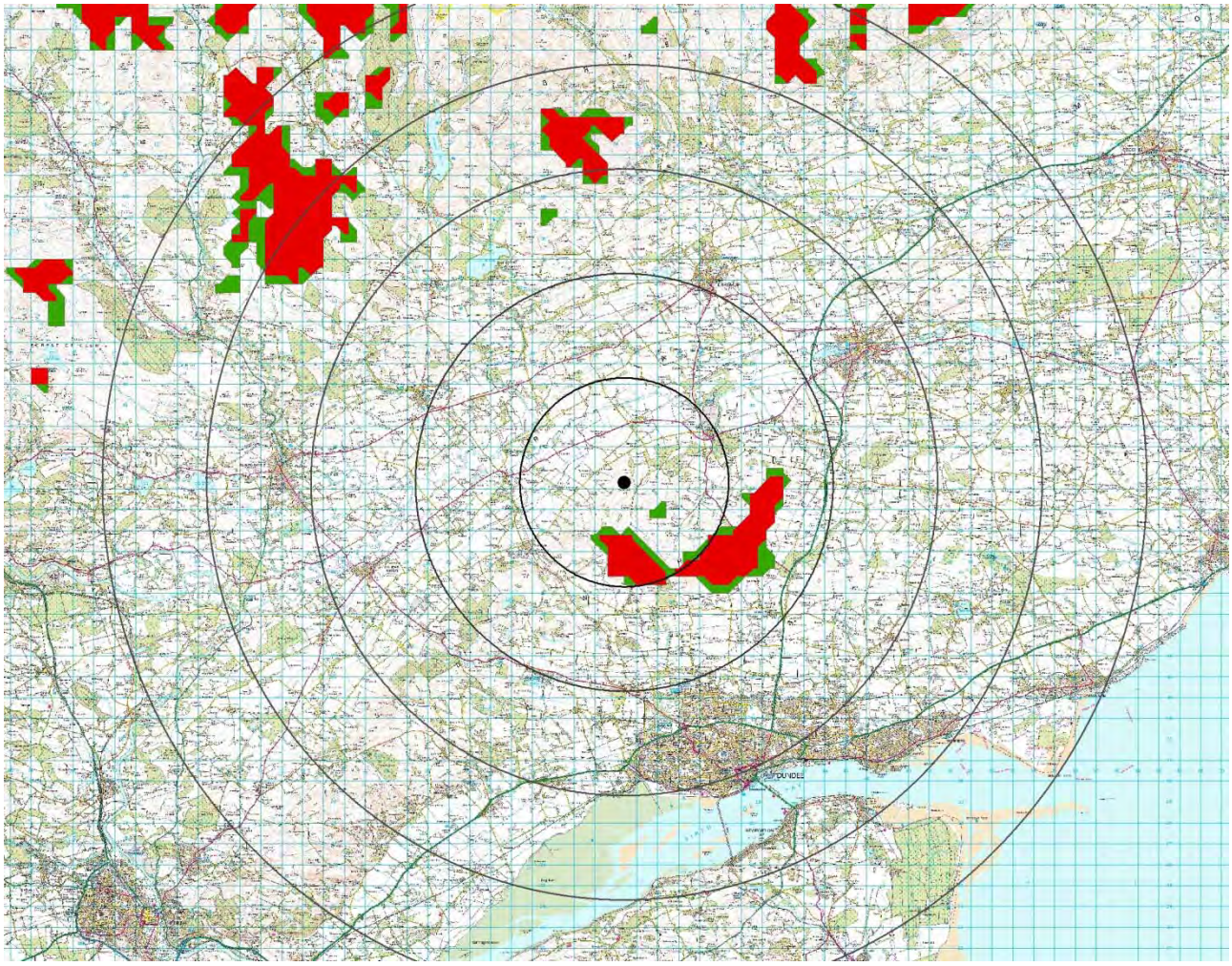


Figure 17: NERL radar visibility at 60m and 80m above ground level

13.3.4. Meteorological Station

There are no meteorological radar stations within 30km of the proposed turbine site.

13.4. Conclusions

The majority of aviation impacts will be assessed by statutory consultees once a planning application has been submitted. From an initial desk based assessment it is not expected that there will be an issue raised on the grounds of both civil and military aviation.

14. Public Safety

14.1. Baseline Assessment

Information is provided below on the national guidance relating to the operational safety of wind turbines. This is provided by PAN45 (2002) as superseded by the Scottish Government's online renewables planning advice for 'Onshore Wind Turbines'[18].

Equipment Safety: Companies supplying products and services to the wind energy industry operate to a series of international, European and British standards. The build-up of ice on turbine blades is unlikely to present problems on the majority of sites. When icing occurs the turbines' own vibration sensors are likely to detect the imbalance and inhibit the operation of the machines. Site operators also tend to have rigorous and computer aided maintenance regimes and control rooms can detect icing of blades. Danger to human or animal life from falling parts or ice is rare. Similarly, lightning protection measures are incorporated into wind turbines to ensure that lightning is conducted harmlessly past the sensitive parts of the nacelle and down into the earth.

Road Traffic Impacts: In siting wind turbines close to major roads, pre-application discussions are advisable with Transport Scotland's Trunk Roads Network Management (TRNM). This is particularly important for the movement of large components (abnormal load routing) during the construction period, periodic maintenance and for decommissioning. Although wind turbines erected in accordance with best engineering practice should be stable structures, it may be advisable to achieve a set back from roads and railways of at least the height of the turbine proposed, to assure safety. Driver distraction may, in some circumstances, be a consideration.

General Safety Standards: Companies supplying products and services to the wind energy industry operate to a series of international, European and British standards. A set of product standards for wind energy equipment has been developed by the International Electro-technical Commission - IEC 16400. There are a number of British Standards that correspond to it, for example, BS EN 61400-1: 1995 'Wind Turbine Generator Systems - Safety Requirements'.

Blade Loss: A possible but rare source of danger to human or animal life from a wind turbine would be the loss of a piece of the blade or, in most exceptional circumstances, of the whole blade. Many blades are composite structures with no bolts or other separate components. Even for blades with separate control surfaces on or comprising the tips of the blade, separation is most unlikely.

Lightning Strike: The possibility of attracting lightning strikes applies to all tall structures and wind turbines are no different. Appropriate lightning protection measures are incorporated in wind turbines to ensure that lightning is conducted harmlessly past the sensitive parts of the nacelle and down into the earth.

[18] http://www.scotland.gov.uk/Topics/Built-Environment/planning/National-Planning-Policy/themes/renewables/Onshore

14.2. Impact Assessment

General safety standards: The proposed EWT Directwind 54 turbine model meets the required international, European and British standards, including BS EN 61400-1: 1995.

Blade loss: As stated above, the turbine has been designed to meet the required safety standards and this includes suitable consideration of the risk of blade loss.

Ice throw: Modern turbine designs are able to accommodate blade heating systems for sites where there is a high likelihood of blade icing occurring. Direction will be sought from the manufacturer on the requirement for this technology and if blade heating is not utilised the turbine could be programmed to shut-down during periods of potential icing and not start up until climatic conditions where such that icing and ice throw were no longer considered to be an issue.

Lightning strike: As stated above, the turbine has been designed to meet the required safety standards and this includes appropriate lightning protection measures.

Proximity to roads, paths and railways: The nearest public road is the minor road to the south east of the site, at Easter Denoon. This road is over 600m away from the proposed turbine location at its nearest point. Given that this is well in excess of the height of the turbine, the turbine would sit well beyond the set-back distance recommended in the relevant guidance. Driver distraction is unlikely to be a concern given the distance to the turbines from public roads. To minimise distraction any signage on the turbine will be in line with Council guidelines.

Proximity to overhead transmission lines: An exclusion distance of 1.5 x tip height has been utilised to ensure safe operating distances between wind turbines and overhead power lines.

Proximity to pipelines: An exclusion distance of 1.5 x tip height from underground pipelines has been utilised to ensure safe operating distances between these and the proposed wind turbine.

Distance from buildings: The proposed siting means that the turbine is well in excess of fall-over distance with regard to off-site buildings.

14.3. Conclusions

On the basis of the above assessment, no issues in relation to public safety are anticipated.

The mitigation measures outlined within this Chapter would ensure safe operation of the turbines once installed and full turbine shutdown (if required) during operational periods when this is deemed necessary.

15. Summary & Mitigation

15.1. Residual Environmental Effects

The proposed development has the potential to have both positive and negative impacts on the receiving environment.

15.1.1. Potential Positive Effects

The potential positive effects on the environment include:

- Creation of an indigenous, local, secure, and sustainable energy resource;
- Direct economic and social benefits to the farming business;
- Direct and indirect economic and social benefits to the local community;
- Provision of a valuable new land use, which will not affect existing farming operations; and
- A direct neutral and indirect positive effect on climate.

15.1.2. Potential Negative Effects

The potential negative effects on the environment include:

- Visual impact of the proposed turbines on the surrounding landscape and heritage assets;
- Visual impact of the proposed turbines on surrounding residential dwellings; and
- Increase in local traffic during the construction stage.

15.2. Conclusions on Development and Impacts in Context

The following conclusions can be made from the completed environmental chapters:

- An assessment of landscape and visual impact concluded that the majority of receptors assessed would experience a low to moderate impact from the proposed turbine. Indeed, the extent of significant effects are very limited and given that the proposal includes a single turbine up to 77m in height within a landscape that has the capacity to absorb turbine developments of this nature, it is concluded that this proposal is acceptable in terms of the EIA regulations and local, regional and national policy. Some locally significant impacts have been noted but the single turbine nature of the project and generally low level of cumulative impact is considered to reduce the overall impact. It is therefore considered that the proposed development is acceptable in terms of landscape and visual impact;
- The turbine will provide the farmer with a crucial form of diversification and a sustainable long term income from the operation of the wind turbine. The overall impact on the local area and economy is considered to be positive through direct and indirect means;
- The proposed turbine is considered to be an acceptable distance from known archaeological sites and monuments;
- With the successful application of mitigating measures and best practice construction techniques, the wind turbine construction phase is not anticipated to have any significant, long term negative impacts on the habitats or locally occurring wildlife;

- Modelled noise and shadow flicker levels are predicted to comply with national and international guidelines and will not pose as nuisances to nearby dwellings;
- Concerns regarding telecommunications and civil aviation are not expected; and
- Construction traffic is a short term impact and its management will be coordinated with Angus Council.

In summary, based on the positive impacts of the development, and the low level of negative impacts which will be mitigated where required, it is considered Ingliston Farm is a suitable location for a wind turbine development at the scale proposed.

15.3. Development Plan & Supplementary Planning Guidance Compliance

This document, together with the accompanying drawings and specifications, has been prepared to assist Angus Council in considering the proposed development of a single wind turbine development at Ingliston Farm. It is considered that the proposed development is in accordance with planning policy at all levels in that there would be no demonstrable significant adverse impacts on the surrounding environment.

A summary of the relevant Development Plan and Local Plan policies is given in Table 36 below.

Policy	Policy Area	Comment
TAYPlan Strategic Development Plan Policy 6	Energy	The proposed development can be appropriately serviced in terms of access, grid connection and sustainable drainage. The proposed turbine have been sited so as to avoid any impacts on the oil and gas pipelines in the vicinity. After mitigation, there would be no significant adverse impacts, either individually or cumulatively, in relation to cultural heritage, nature conservation and protected species, residential amenity including noise and shadow flicker, tourism and recreation attractions, surface and ground water, and aviation and telecoms considerations. With regard to landscape and visual matters, taking into consideration the relevant Landscape Character Assessment, care has been taken to minimise potential impacts through sensitive siting and turbine selection.
Local Plan Policy S1	Development boundaries	This Supporting Environmental Document has demonstrated that the Ingliston Farm development will be within a scale and nature appropriate to the location. This has been shown through numerous assessments such as the LVIA, noise, ecological and shadow flicker.
Local Plan Policy S5	Safeguard Areas	No element of the proposed development will be within consultation zones of local hazards.
Local Plan Policy S6	Development Principles	The Supporting Environmental Document demonstrates the potential impact on the relevant principles set out in Schedule 1 of the Local Plan.

Policy	Policy Area	Comment
Local Plan Policy ER4	Wider Natural Heritage and Biodiversity	The Ecology assessment has demonstrated that the proposed development should not impact upon any species or habitats protected under British or European law.
Local Plan Policy ER5	Conservation of Landscape Character	The Landscape and Visual Impact Assessment has demonstrated in detail the impact of the Ingliston Farm turbine on the local and wider landscape. It is considered that the landscape will be capable of absorbing the wind turbine.
Local Plan Policy ER11	Noise Pollution	It has been demonstrated that the maximum expected noise output from the turbine will not have an adverse impact on local residents. The maximum noise level will be within the accepted noise limits detailed within national planning policy and planning guidance.
Local Plan Policy ER16	Development Affecting the Setting of a Listed Building	There would be no direct impact on known archaeological remains as a result of the development. An assessment of the proposed turbines on the setting of cultural heritage sites, including Scheduled Monuments and A Listed buildings, in the locality has been undertaken. The assessment concludes that, at worst, the effect of the development on the setting of identified cultural heritage assets is moderate and therefore not significant.
Local Plan Policy ER19	Archaeological Sites of Local Importance	
Local Plan Policy ER20	Historic Gardens and Designed Landscapes	As demonstrated within the Cultural Heritage and LVIA assessments, the Ingliston Farm turbine will not damage the characteristics or integrity of these sites. Chapter 5 of this report quantifies anticipated impacts on a variety of landscape designations, including designed landscapes, within 25 km of the site. In this respect, the effect of the development on the setting of such sites is not predicted to be significant.

Policy	Policy Area	Comment
Local Plan Policy ER34	Renewable Energy Development	It is considered that this application should be supported by Angus Council as the proposal demonstrates the following: a) The siting of the wind turbine has been chosen in order to minimise the impact on the local amenity; b) There is not considered to be unacceptable effects on the landscape character and sensitive viewpoints; c) There will be no unacceptable detrimental effects on any national heritage, scientific or historic sites; d) There will be no unacceptable effects of transmission lines as any new cabling will be buried underground; and e) The disruption to the local road network will be for a small period and minimal road upgrades are expected. This will be achieved without compromising road safety or causing unacceptable change to the environment.
Local Plan Policy ER35	Wind Energy Development	It is considered that this application should be supported by Angus Council as the proposal demonstrates the following: a) The selected location demonstrates the optimum location for wind development for the applicant while having minimal impact on the surrounding environment; b) It has been shown that the wind turbine will have no interference with birds; c) It has been demonstrated that there will be no unacceptable detrimental effects on residential amenity, existing land use and road safety with regards to shadow flicker and noise; d) There will be no interference with authorised aircraft activity; e) There will be no interference with telecommunication links within the area; f) The cumulative impact of the development with other wind developments in the area will be of an acceptable level; and g) The site will be reinstated to its original condition after decommissioning of the turbine.

Table 36: Summary of Development Plan and SPG compliance

Appendix A – Landscape & Visual Assessment Methodology

Landscape and Visual Impact Assessment Methodology

Although this application is not subject to an Environmental Impact Assessment (EIA), the approach taken for the assessing the landscape and visual effects follows the methods undertaken for a typical EIA wind energy development. This is based on the approach as set out in the *Guidelines for Landscape and Visual Impact Assessment* (Landscape Institute and Institute of Environmental Assessment, 2013). Other relevant best practice and policy guidance includes:

- Visual Assessment of Wind Farms Best Practice, University of Newcastle Scottish Natural Heritage Commissioned Report, (2002);
- Guidelines on the Environmental Impacts of Wind Farms and Small Scale Hydroelectric Schemes, Scottish Natural Heritage (2001);
- Visual Analysis of Wind Farms Good Practice Guidance, Scottish Natural Heritage (Draft 2005);
- Visual Representation of Windfarms: Good Practice Guidance, Scottish Natural Heritage (2007);
- Siting and Designing Windfarms in the landscape, Scottish Natural Heritage (2009); and
- Guidance, Cumulative Effect of Windfarms, Scottish Natural Heritage, (2012).

Evaluation of the Existing Environment – the Baseline

The baseline review for the landscape and visual resource has three elements:

1. Description – a systematic review and digest of existing information and policy relating to the existing landscape and visual resource;
2. Classification – analysis of the data to subdivide the landscape resource into discrete areas of similar and identifiable character and identify the visual receptors; and
3. Evaluation – Use of professional judgement to apply a sensitivity value to a landscape or visual resource with reference to specified criteria.

The baseline review is undertaken through desk-based data review followed by a site survey to verify the findings, and then analysis of the data. This process is described in detail in the following paragraphs.

Desk Based Data Review

Existing mapping, legislation, policy documents and other written, graphic and digital data relating to the proposal and broader study area was reviewed. This included the following documents:

- Scottish Planning Policy (2010);
- Typical Planning Considerations in Determining Planning Applications for Onshore Wind Turbines (web based renewables advice), Scottish Executive (October 2012);
- Fife Structure Plan 2006 – 2026 (2009);
- The Mid Fife Local Plan (2012);
- Wind Energy Supplementary Planning Guidance (2011);
- The Inventory of Historic Gardens and Designed Landscapes in Scotland;
- Tayside Landscape Character Assessment (1999);
- The Fife Landscape Character Assessment (1999);
- Ordnance Survey maps; and
- Digital sources of mapping and aerial photography.

The desk study also establishes the main users of the area, key viewpoints and key features, thus defining the visual baseline which requires to be verified on site. The potential visual receptors are identified and classified according to their associated use (settlements, footpaths, roads etc.). The aim of the baseline review of visual resources is to ensure that an appropriate range of viewpoints is included in the visual assessment. The potential extent of visibility of the proposed development as identified in the preliminary Zone of Theoretical Visibility (ZTV) provides the basis upon which the potential visual receptors are initially identified.

The desk study informs subsequent site work, which allows the confirmation of the Landscape Character Types (LCT) and Landscape Character Areas where applicable.

Site Survey

Field survey work is carried out to verify and, if required, refine the landscape character types identified within the study area, and to gain a full appreciation of the relationship between the proposed development, and the landscape.

The baseline visual resource is verified during the survey work and at this time, the validity of the list of representative viewpoints used in the LVIA. Since the ZTV is based on a 1:50,000 digital terrain model, it does not capture local landform. There are times when a viewpoint selected from analysis of the ZTV does not actually have any views to the proposed development. In some instances, this can be remedied by slight adjustments of the grid references, although the location must remain relevant to the particular receptor(s) for which the viewpoint was selected. It is also important to ensure that the viewpoints remain a representative selection of views. Wireframes supported the fieldwork, and observations are recorded with photographs.

Data Analysis

Analysis and reporting of the baseline resource took place after the completion of the desk and field surveys. The baseline landscape and visual review provides a description, classification, and evaluation of the landscape and visual resource of the study area.

The baseline review provides a robust description of the landscape and visual resource from which to assess the landscape and visual effects of the proposed development and to advise, in landscape and visual terms, on the development's acceptability in principle and upon its siting, layout and design. This involves identification of all the landscape and visual receptors and analysis of the sensitivity of each of these receptors to the proposed development.

Identification of Landscape and Visual Effects

The impact assessment aims to identify all the potential landscape, visual and cumulative effects of the development taking account of any proposed mitigation measures. This is carried out by:

- Assessing the magnitude of change brought about by the proposed development on each of the receptors identified in the baseline review;
- The effect is then predicted by combining the sensitivity of the receptor (as identified in the baseline review) with the magnitude of change; and
- Lastly, the significance of the predicted effect is assessed in a logical and well-reasoned fashion.

The assessment aims to describe the changes in the character and the landscape resources that are expected to result from the proposed development. It covers both landscape effects (changes in the fabric, character and key defining characteristics of the landscape); and the

visual effects (changes in available views of the landscape and the significance of those changes on people).

The table below identifies potential landscape and visual effects. Potential effects are those that could result from the construction and operation of a wind turbine, according to the project, site and receptor characteristics and their interactions. The inclusion of a potential effect in the table below (for example) does not imply that this will occur, or be significant. The assessment is based upon an assessment of the potential effects, in order to identify predicted effects.

Activity	Element	Potential Effects	Potential Sensitive Receptors
Construction	Construction plant, temporary construction compound, vehicle movements, new access tracks.	Temporary impacts on landscape fabric Temporary impacts on visual amenity	Landscapes character types Designated landscapes Gardens and designed landscapes Visual receptors
Operation	Presence of tracks, turbines, permanent site compound and substation	Long term but reversible impacts on landscape fabric Long term but reversible impacts on visual amenity Cumulative impacts with other wind farms	Landscapes character types Designated landscapes Historic gardens and designed landscapes Visual receptors including: residents, visitors, tourists, road users, walkers, cyclists
Decommissioning	Construction plant, temporary compound, vehicle movements	Temporary impacts on landscape fabric Temporary impacts on visual amenity	Landscapes character types Designated landscapes Historic gardens and designed landscapes Visual receptors including: residents, visitors, tourists, road users, walkers, cyclists

Potential Landscape & Visual Impacts

Extent of the study area and viewpoint selection

Maps of Zone of theoretical visibility (ZTVs) were prepared using digital terrain models. These represent the 'worst case' area of theoretical visibility where the proposed development may theoretically be seen. The ZTVs are based entirely on topographic factors and do not account for any screening effects provided by vegetation, buildings or minor variations in landform or the orientation of view. Therefore, the extent of any ZTVs tends to be greater than actual visibility and does not take account of climatic factors such as light conditions.

Drawing ING010 illustrates the ZTV for the proposed development and is then used as a basis for the further assessment and evaluation of the magnitude of visual impacts. This approach is described below.

Through the initial stages of the desk study, fourteen viewpoints were chosen to represent views experienced from a variety of receptors, within different landscape character types and

at a variety distances from the proposed development where the view may be apparent. The viewpoints agreed for the scheme are listed in the Supporting Environmental Document.

A study area centred on a 25 km radius from the proposed development has been used for the study of landscape, visual and cumulative effects. Given the relative scale of the development and the character of the landscape, significant effects are very unlikely to be experienced at distances over 15 km.

Landscape Sensitivity and Magnitude of Change

The sensitivity of the landscape resource is variable according to the existing landscape, its relationship to the proposed development, the nature of the development being assessed and the type of change being considered. The determination of the landscape's sensitivity to changes associated with the proposal is defined as High, Medium, Low or Negligible. This is based on the professional interpretation of the key landscape characteristics, the scale of the landscape and the nature of views, and the perceived landscape value as reflected by landscape designations (see table below).

Criteria	High	Medium	Low
Landscape designations and landscape value	Landscape designated for its national landscape value High landscape value, with very strong sense of place	Landscape designated for regional or local landscape value Medium landscape value	No designations present Low landscape value (i.e. industrial landscapes), with elements that detract from sense of place
Scale of Landscape	Small scale landscape	Medium scale landscape	Large scale landscape
Views	Enclosed, medium and short distance views	Open, medium distance views	Panoramic, open and long distance views
Cultural heritage interests that contribute to landscape character	Contains features or sites of national importance	Contains sites of regional importance	Few or no features of interest

Sensitivity of Landscape Receptors

As every proposed development and its interaction with the landscape are unique, there will be situations where predefined criteria will not accurately reflect the potential residual effects. In such cases, professional judgement takes precedence and is explained in the text. The criteria used for understanding the magnitude of landscape change are summarised below.

Level of Magnitude	Definition of Magnitude
High	Total loss or major alteration to key elements, features or characteristics of the baseline landscape so that the post development character and composition of the baseline landscape resource will be fundamentally changed.
Medium	Partial loss or alteration to one or more key elements, features or characteristics of the baseline landscape so that the post development character and composition of the baseline landscape resource will be partially, but noticeably changed.

Low	Minor loss of or to one or more key elements, features or characteristics of the baseline landscape so that the post development character and composition of the baseline landscape resource will be noticeably changed but the underlying character of the baseline landscape will be similar to the pre-development character.
Negligible	Very minor loss or alteration to one or more key elements, features or characteristics of the baseline landscape. Change to the landscape character will be barely distinguishable. No discernible effect upon the view

Definition of Landscape Magnitude of Change

Visual Receptor Sensitivity and Magnitude of Change

The sensitivity of visual receptors depends upon:

- The location of the viewpoint;
- The context of the view;
- The activity of the receptor, such as relaxing at home, taking part in leisure, recreational and sporting activities, travelling or working;
- Whether receptors are likely to be stationary or moving and how long they will be exposed to the change at any one time;
- The extent of the area or route from which the changes would be visible; and
- The frequency of the view (whether receptors will be exposed to the change daily, frequently, occasionally or rarely) and the duration of the view.

Visual receptor sensitivity is defined as High, Medium or Low and these definitions are described in the table below.

High	Medium	Low
Residents with views from the dwelling or curtilage		
Users of recognised national trails, whose attention or interest is likely to be focused on the landscape or on particular views	Other recreational routes, such as local footpath networks, used for dog walking, for example	People engaged in active outdoor sports or recreation and less likely to focus on the view
Road and rail users where appreciation of the landscape is an important part of the experience, such as scenic routes	Road and rail users likely to be travelling for other purposes than just the view, such as commuter routes	
Visitors to heritage assets or to other attractions, such as recognized beauty spots, where views of the surroundings are an important part of the experience	People at their place of work, where views are an important part of the setting and contribute to the quality of working life	People at their place of work whose attention is likely to be focused on their work or activity, not on their surroundings

Definition of Receptor Visual Sensitivity

In practice, a location may have different levels of sensitivity, according to the different receptors at that location. The specific combinations of factors that have influenced the judgement of sensitivity are described in the viewpoint baseline text.

The magnitude of visual change arising from the Development is described as High, Medium, Low or Negligible based on the overall extent of visibility (see the table below). For individual viewpoints it will depend upon the combination of a range of factors:

- The distance of the viewpoint from the development;
- The duration of effect;
- Extent of the development visible from the viewpoint (number and parts of turbine visible);
- The angle of view in relation to main receptor activity;
- The proportion of the field of view occupied by the development;
- The background to the development; and
- The extent of other built development visible, particularly vertical, elements.

Level of Magnitude	Description of change	Definition of Magnitude
High	Dominant	Highly noticeable change, affecting most key characteristics and dominating the experience of the landscape. The introduction of incongruous development A high proportion of the view is affected.
Medium	Conspicuous	Noticeable, partial change to a proportion of the landscape, affecting some key characteristics and the experience of the landscape. The introduction of some uncharacteristic elements. Some of the view is affected.
Low	Apparent	Minor change, affecting some characteristics and the experience of the landscape to an extent. The introduction of elements that are not uncharacteristic. Little of the view is affected.
Negligible	Inconspicuous	Little perceptible change. No discernible effect upon the view.

Definition of Visual Magnitude of Change

Other factors may also influence the visual effect. These relate to both human perception and to the physical environment itself. Factors which tend to reduce the apparent magnitude include the following:

- Sky-lining of front-lit turbines (where turbines are seen against the sky and the sun is behind the viewer, thus turbines reflect light and blend more easily into the brightness of the sky);
- Landform backdrop to back-lit turbines (where turbines are back-clothed by landform and the viewer sees them silhouetted with the light behind them. In this scenario the turbines are more likely to blend into the landscape);
- An absence of visual clues;
- Turbines do not form the focal point of the view;
- A complex and varied scene; and
- High relative elevation of view.

Factors which tend to increase the apparent magnitude include the following:

- Back-grounding of turbines (where turbines are seen against a backcloth of land);
- Visual clues;
- Turbines form the focal point of the view;

- A simple scene; and
- Low relative elevation of view.

Significance of Effects on Landscape and Visual Receptors

The significance of any identified landscape or visual effect has been assessed as Major, Moderate, Minor or Negligible effect. These categories have been determined by consideration of viewpoint or landscape sensitivity and predicted magnitude of change as described above, with the table below used as a guide to correlating sensitivity and magnitude to determine significance of effects. It should be noted that this is a guide only, and there will be times when the combination of sensitivity and magnitude yield a slightly different result from that predicted by the table. Where this discrepancy leads to prediction of significant effect, it is explained in the text.

Magnitude of Change				
Sensitivity	High	Medium	Low	Negligible
High	Major	Major/moderate	Moderate	Moderate/minor
Medium	Major /moderate	Moderate	Moderate/minor	Minor
Low	Moderate	Moderate/minor	Minor	Minor/none
Negligible	Moderate/minor	Minor	Minor/none	None

Assessment of significance of landscape and visual effects

Where overall effects are predicted to be Moderate-Major or greater (dark grey), these are considered to be equivalent to significant effects, as referred to in the *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations* 1999. Overall effects of major/moderate (mid grey) may be significant if experienced over an extensive proportion of a receptor, area or route. Changes of moderate or less are not likely to result in significant effects.

Sequential visual effects

Sequential visual effects typically occur when moving along a linear route, as the observer moves from one point to another and gains views of other wind developments or a different view of the same development. They were driven in both directions, noting where intervening vegetation, buildings or embankments would limit views and recording the elapsed time and distance from the turbines. This was then compared with the ZTV and conclusions drawn about the likely visibility of the turbines. Assessment of the significance of the sequential effect takes into account the direction of travel, the proportion of the journey affected and the relative distance from the turbines.

Cumulative Methodology

Although a Guide to Assessing the Cumulative Effects of Wind Energy Development has been produced (DTI Final Consultation Draft December 1999), there are as yet no formalised guidelines in Great Britain defining an approved methodology for the assessment of cumulative effects on landscape and visual amenity that have been approved and endorsed by the Landscape Institute. The approach used is therefore based on draft guidance notes on cumulative landscape and visual impact assessment of wind farm developments produced by SNH (2005) and the Guidelines for Landscape and Visual Impact Assessment, LI-IEMA 2002.

Scope of Cumulative Assessment

The Cumulative Landscape and Visual Impact Assessment (CLVIA) takes account of all sites which have potentially significant overlapping study areas, and that are in 'the public domain' i.e.:

- Any constructed wind farm;
- Any consented wind farm proposal; and
- Any wind farm proposal that has been lodged as a planning application to the relevant local planning authority or the Scottish Executive.

For the assessment of cumulative effects, the relevant wind farms are listed in Table 5.5.

Types of Cumulative Effect

Cumulative effects are those that occur, or may occur, as a result of more than one wind farm project being constructed. Potential cumulative landscape and visual effects arise from the combined effects of additional wind farm developments. Combined effects relate to the following:

- Extending visibility of wind turbines over parts of the study area from where there are currently existing wind farms visible, which give rise to extended combined visibility of wind turbines at particular locations in the landscape, which may be simultaneous or successive in nature;
- Extending visibility of wind turbines over parts of the study area from where there are currently no wind turbines visible, which may give rise to an extended sequential visibility of wind turbines across the landscape; and
- Both simultaneous and sequential visibility of wind turbines.

In relation to simultaneous visibility, cumulative effects occur where more than one wind farm is visible in the same direction from a particular place. Where wind farms are visible in more than one direction from that place, this is defined as successive visibility. In relation to the sequential visibility, cumulative effects occur where the observer has to move to another viewpoint to see the second wind farm, so they appear in sequence, depending on speed of travel and distance between the viewpoints.

The assessment of potential cumulative landscape and visual effects is carried out in the same generic way as that of non-cumulative effects. Professional judgements are made in relation to the magnitude of change caused by the wind farm to the existing landscape and visual baseline.

Magnitude of Cumulative Change

Cumulative landscape and visual effects may result from additional changes to the baseline landscape or visual amenity caused by the proposed development in conjunction with other wind farm developments. The emphasis of the assessment is on the changes the proposal would bring to the existing landscape, which incorporates wind farm developments as part of its baseline landscape character and visual amenity.

The assessment therefore identifies the cumulative magnitude of change relative to existing visual impacts of wind farms rather than the combined impact of all the wind farms visible. The magnitude of cumulative change arising from the proposed development is assessed as high, medium, low or negligible, based on interpretation of the following largely quantifiable parameters, to take account of cumulative change:

- The number of existing and proposed developments and wind turbines visible;

- The distance to existing and proposed developments;
- The direction and distribution of existing and proposed developments; and
- The landscape setting, context and degree of visual coalescence of existing and developments.

The principle of magnitude of cumulative change makes it possible for the development to have a major effect on a particular receptor while having only a minor cumulative effect. For example, if the magnitude of change of Wind Farm 1 on Receptor 1 is high (for example, if it is 1 km from the receptor) the effect of Wind Farm 1 on Receptor 1 is likely to be major. In terms of a cumulative effect on this receptor, Wind Farm 2 may be visible, but if it is located, for example, 25 km from the receptor, the magnitude of cumulative change is likely to be low (Wind Farm 2 will be of limited visibility at 25 km) and the cumulative effect is therefore minor.

A significant cumulative effect is likely to only occur if both Wind Farm 1 and Wind Farm 2 are both fully visible, at close distances from the receptor, possibly in the same direction of view and forming a large developed proportion of the skyline. On the basis of professional interpretation of the above parameters, the magnitude of cumulative change arising at both landscape and visual receptors from each of the existing wind farms and the proposed development, both individually and in combination with each other, has been evaluated for the proposed development.

Significance of Cumulative Effects

SNH guidance on cumulative assessment describes the need for understanding whether the Development crosses the threshold of acceptability for the total number of wind farms in an area. As no existing methodology exists for identifying when a landscape has reached its capacity in terms of wind farms, it is necessary to revert back to SNH and Local Authority Guidance which seeks to identify the landscape objectives and policies for the area.

The level of any identified cumulative landscape or visual effect has been assessed as major, major/moderate, moderate, moderate/minor, minor, minor/none or none, in relation to the sensitivity of the receptor and the predicted magnitude of change as outlined above. As in the case of non-cumulative effects, the matrix shown above is used to bring together receptor sensitivity and magnitude of change.

Appendix B – Ecology & Ornithology Report

AC57

Ingliston Hill Single Turbine
Extended Phase 1 Habitat Survey

September 2013

EnviroCentre Document No.	5674
EnviroCentre Project No.	164621J
Status	Final
Project Author	Karen Hassard
Project Reviewer	Kate Kennedy
Date of Issue	September 2013

EnviroCentre
Craighall Business Park
8 Eagle Street
Glasgow
G4 9XA

t 0141 341 5040
f 0141 341 5045
w *www.envirocentre.co.uk*
e *info@envirocentre.co.uk*

Offices
Glasgow
Banchory

Summary

- A phase 1 habitat survey and protected species survey was undertaken at Ingliston Hill to inform plans to install a single wind turbine and borrow pit which will be restored once the works have been completed.

- The survey area does not support any sites designated for nature conservation value at a local or national level. Several Sites of Special Scientific Interest (SSSI's) were recorded within 10km of the site however these are not connected by structure or function to the site.

- The survey included a search for suitable habitat for and evidence of protected species (i.e. otters, water voles, badgers, red squirrels, bats and birds).

- Although suitable habitat for a range of protected species was identified within the site, no direct field evidence was recorded.

- No European Protected Species licences are likely to be required.

- General mitigation measures are provided.

Ingliston Hill Single Turbine
Phase 1 Habitat Survey

Table of Contents

Appendices

List of Tables

1. INTRODUCTION

1.1 Remit

EnviroCentre was commissioned by Loco$_2$gen to undertake an Extended Phase 1 Habitat Survey at a site to the south east of Eassie in Angus. The survey was requested to inform a planning application to erect a single wind turbine and associated borrow pit.

The survey aimed to identify all broad habitat types within the site boundary and an appropriate buffer zone, whilst identifying those habitats, which may support populations of protected species (e.g. bats and badgers) and may consequently require further investigation. Consideration is also given to potential ornithological issues associated with the proposed development.

This report sets out the methods by which the survey was undertaken, an account of baseline results, interpretation of the results and a consideration of mitigation, compensation and any requirement for additional, species specific survey work.

1.2 Site Description

The 'site' refers to the proposed turbine location plus a buffer zone of a 500m radius. The site is located at National Grid Reference NO 34396 44336 approximately 1km to the south east of Eassie in Angus.

The site slopes steeply from south to north and is dominated by improved and semi improved grassland, currently used as grazing. The site is surrounded by a mixture of farmland and woodland.

A site location plan is located in Appendix A of this report and photographs are provided in Appendix B.

1.3 Proposed Development

The proposed development will see the erection of a single EWT 500kW turbine at the site. The turbine will be capable of generating 500kW of energy and will have a hub height of 50m and a rotor diameter of 54m. There will also be an associated borrow pit that will be restored once the aggregates have been taken.

1.4 Protected Species/ Legislation

European and National legislation along with Planning Policy and guidance relevant to the site is listed below. Cognisance has been taken of this legislation in the preparation of this report:

- The Wildlife and Countryside Act 1981 (as amended);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- Protection of Badgers Act 1992 (as amended); and
- Local and UK Biodiversity Action Plans.

2. METHODS

All survey work was undertaken and verified by experienced and competent ecologists. The survey followed standard methods endorsed by Scottish Natural Heritage (SNH) and the Chartered Institute of Ecology and Environmental Management (CIEEM)[1]. This section provides summary details of the methods adopted.

2.1 Desk Study

Prior to the Phase 1 survey a desk study was undertaken. This included a search of the NBN Gateway[2] and Scottish Natural Heritage's SiteLink website[3], and the Woodland Trust[4] to identify records of the following within a 10km radius of the site:

- Statutory designated sites (Special Protection Areas (SPAs), Special Areas of Conservation (SACs), and Sites of Special Scientific Interest (SSSI);
- Non-statutory designated sites (e.g. Ancient Woodland Inventory, Local Wildlife Sites and Local Nature Reserves);
- Legally protected or notable species/populations (e.g. the presence of bat roosts or badgers);
- UK Biodiversity Action Plan[5] and Tayside Local Biodiversity Action Plan[6] priority habitats and species.

2.2 Phase 1 Habitat Survey

The baseline ecological data for the site was obtained by undertaking an Extended Phase 1 Habitat Survey following guidelines set out by the Joint Nature Conservation Committee (JNCC)[7]. This is a nationally adopted method for baseline ecological survey. Scientific plant names are used in the text and nomenclature follows that of the standard British flora[8].

The site was surveyed on 30th August 2013 when conditions were bright and clear with an air temperature of 17°C.

The survey aimed to identify and map broad habitat types in the proposed development site and its environs and to identify those habitats suitable for, or direct signs of, sensitive or protected faunal species.

A habitat map has been provided in Appendix C of this report while target notes are presented in Appendix D.

2.3 Protected Species Survey

Based on the outcomes of the desk study (see section 3.1) and the habitats found within the site, searches for direct evidence and suitable habitat for the following species were made:

- Otter *(Lutra lutra)*;
- Water vole *(Arvicola terrestris);*
- Badger (*Meles meles*);
- Red squirrel (*Sciurus vulgaris*)

[1] IEEM – Guidance on Survey Methodology, Winchester (2006)
[2] NBN Gateway website, available at: www.searchnbn.net
[3] Scottish Natural Heritage Site Link website available at: www.snhi.gov.uk
[4] Woodland Trust www.woodlandtrust.org.uk
[5] UK Biodiversity Action Plan from http://www.ukbap.org.uk
[6] Tayside Biodiversity Action Plan: Available at http://www.angus.gov.uk/biodiversity/actionplan.htm
[7] JNCC – Handbook for Phase 1 Habitat Survey (1991)
[8] Stace, C.A. 1995 New Flora of the British Isles. Cambridge University Press.

- Bats (various species); and
- Birds (various species).

2.3.1 Otter Survey

The otter survey extended along both banks of any streams within the site, where access allowed. The survey followed best practice guidelines[9] and a search was made for suitable habitat along with field signs, including:

- Spraints (otter faeces/droppings used as territorial signposts. Often located in prominent positions and can be placed on deliberate piles of soil or sand);
- Footprints;
- Feeding remains (can often be a useful indication of otter presence);
- Paths/Slides (otter can often leave a distinctive path from and into the watercourse);
- Holts: holts (underground shelter) are generally found:
    - Within trees roots at the edge of the bank of a river;
    - Within hollowed out trees;
    - In naturally formed holes in the river banks that can be easily extended;
    - Or preferably in ready-made holes created by other large mammals or humans such as badgers sett, rabbit burrows or outlet pipes; and
- Couches/lay-ups (couches or lay-ups are places for lying up above ground are usually located near a watercourse, between rocks or boulders, under dense vegetation).

Where evidence of otter activity was identified, a grid reference was taken at the location and photographs were taken for further interpretation.

2.3.2 Water Vole Survey

The otter survey extended along both banks of any streams on site, where access allowed, and followed standard guidelines[10]. Water voles tend to confine their activity to within 3 m of the bank edge along a watercourse where field signs are to be found. Field evidence includes:

- Faeces: 8-12 mm long, 4-5 mm wide; cylindrical and blunt ended pellets; colour variable with food type. Most droppings left in latrines near the nest, at range boundaries and at water entry points;
- Latrine sites: Concentrations of faeces, often with fresh droppings on top of old ones;
- Runways: Often 5-9 cm broad and multi-branched; usually within 2 m of water's edge and often forming tunnels through vegetation; leading to water's edge or burrows;
- Burrows: 4-8 cm diameter, wider than high; eroded entrances then contract down to typical size; entrances located at water's edge; however some entrances be up to 3m from the water; no spoil heaps;
- Nests: size and shape of a rugby ball, often in base of rushes, sedges or reeds;
- Feeding stations: located along runways, or at platforms along water's edge; usually a pile of cut/chewed vegetation in sections approximately 10 cm long; vegetation ends show marks of two large incisors. Piles of chopped grass, sedge or rush stems, rush pith and leaves;
- Lawns: Short, grazed vegetation around land entrances, often used during nursing periods;

[9] Chanin, P (2003). Natural Life Series, Monitoring the European Otter. Natural England.
[10] Strachan, R. (1998). Water Vole Conservation Handbook. Wildlife Conservation Research Unit, Oxford.

- Footprints: Difficult to tell from rat; adult hind foot 26-34 mm (heel to claw); stride 120mm (smaller than rat); occur at water's edge and lead into vegetation; and
- Sound: Characteristic 'plop' when a vole enters the water.

Emphasis was placed on locating latrine sites. Latrine sites are the most useful sign for recording purposes. They indicate whether there is definite presence of water voles at a site and are used for determining the approximate number of animals within the colony.

Given the aggressive predation on water vole by American mink (*Mustela vison*), all signs of this species were also searched for. Field signs included spraints, footprints and prey remains.

2.3.3 Badger

2.3.3.1 Habitat Suitability

The survey area was searched in its entirety to identify any potential habitat suitable for foraging and commuting badgers.

Badgers require suitable ground conditions for sett creation (e.g. soil that is free draining and can easily be excavated). Continuous well connected linear vegetation, such as tree lines and hedgerows, provide good foraging, sheltering and commuting habitats for badgers and native berry producing trees and shrub species offer a seasonal food resource for badgers.

2.3.3.2 Sett Survey

A badger sett is any structure or place which displays signs indicating current use by badger/located within an active badger territory. Setts comprise of a series of underground tunnels and chambers which form the home of a badger social group (clan). Although normally recorded in sloped, sandy soil in woodland habitats, it should be noted that badgers will excavate setts in a wide range of environs including urban settings.

Setts can be located anywhere within the territory of the clan and more than one sett can often be in use. Within one territory badgers may maintain a main sett with several annexe or satellite setts. Setts are identified by a number of characteristic features. These features include:

- A network of broad, concave entrances;
- Well-worn paths between entrances and foraging areas;
- Piles of excavated soil beside entrances (spoil heaps); and
- Piles of bedding materials beside entrances.

Diagnostic footprints and hair found around a sett can often confirm the presence of badgers and provide evidence of recent use. Fresh soil on spoil heaps can indicate recent use.

2.3.3.3 Field Signs

Badger field signs not only provide evidence of the species, but also give an indication of badger movements and how they utilise their territory. Badger field signs are described in Neal & Cheeseman[11] , Bang & Dahlstrøm[12] , and in SNH (2001)[13] and include:

[11] Neal, E. & Cheeseman, C. (1996). Badgers. Poyser Natural History, London.
[12] Bang P. and Dahlstrom P. 1980. Collins guide to animal tracks and signs. London, Collins.
[13] SNH (2001). Scotland's Wildlife: Badgers and Development (http://www.snh.org.uk/publications/online/wildlife/badgersanddevelopment/default.asp).

- Badger guard hair;
- Footprints;
- Snuffling (badgers use their snout to turn over vegetation or soft soil to forage for bulbs and invertebrates);
- Scratching posts (marks on tree trunks/ fallen trees where badgers have left claw marks);
- Breach points (gaps in fences or crossing points over roads);
- Dung pit (single faeces deposit placed in a small excavation); and
- Latrines (collection of faecal deposits often used by badger clans to mark home range boundaries).

2.3.4 Red Squirrel

The walkover survey followed best practice guidance[14] which involves the initial identification of suitable habitat (primarily coniferous woodland) within the survey area. In addition, the survey focused on searching for two distinct signs of squirrel activity. Note that neither of these methods accurately distinguishes between red or grey squirrels.

The signs of squirrel activity searched for are dreys and the remains of pine cones which have been stripped of their edible parts. The following methods are adopted:

- Drey count – dreys are the nests made by both species of squirrels in trees. Dreys are easily distinguishable from bird nests as they are normally 50 cm in diameter and 30 cm deep. They are normally located close to the main stem of the tree at a height of 3 m or more.
- Feeding transects – Where cone producing trees (conifers) are evident, a 50m x 1m transect is laid out through the woodland and evidence of squirrel feeding is searched for. Although the two species of squirrel cannot be distinguished from feeding remains, the manner in which squirrels break open seeds and nuts, which are then left on the forest floor, is diagnostic from other groups of animals.

2.3.5 Bat Roost Potential Survey (BRP)

The BRP is designed to identify those structures and features present within a site which may provide suitable habitat for roosting bats and may therefore require further survey work. Bats utilise a variety of roosts throughout the year, depending on their seasonal needs (e.g. breeding or hibernating etc.) and on the prevalent climatic conditions.

The BRP survey was conducted in accordance with the assessment criteria set out by the Bat Conservation Trust[15] and comprised a ground based visual inspections of all trees on site.

In general, it is accepted that mature, broad-leaved trees are preferred by bats, particularly Oak (*Quercus* spp.) and Beech (*Fagus sylvatica*). It is also known that for trees to be used by bats, they must be part of a wider habitat network that allows protected foraging, commuting and dispersal. The criteria used to assess the suitability of buildings and trees for bat roosts can be found in Table 1.

[14] Gurnell J, *et al* (2001). Forestry Commission Practice Note 11. Forestry Commission, Edinburgh.
[15] Bat Conservation Trust (2007). Bat Surveys – Good Practice Guidelines. Bat Conservation Trust, London.

Table 1: Bat Roosting Features and Field Signs

Features of buildings used as bat roosts	Features of trees used as roosts	Signs indicating possible use by bats
Gaps/cracks in wood barge boards, soffits and fascia boards	Cavities/ Loose bark	Tiny scratches around entry point
Gaps in end tiles, ridge tiles and eaves	Woodpecker holes	Staining around entry point
Gaps in lead flashing and roofing felt	Cracks/splits in major limbs	Bat droppings in/around/below entrance
Cavities in masonry	Behind thick ivy growth	Audible squeaking at dusk or during warm weather
Broken or hanging tiles	Within dense epicormic growth	Flies around entry point
Ventilation ducts, damaged drainage, overflow pipes	Existing bird and bat boxes	Smoothing of surfaces around cavity

Trees are more likely to be used for roosting by bats if they are part of a wider habitat network that allows protected foraging, commuting and dispersal.

According to their roosting suitability, trees are categorised as follows:

- Known roost
- Category 1*: Trees with multiple, highly suitable features capable of supporting larger roosts;
- Category 1: Trees with definite bat potential, supporting fewer features than category 1* trees or with potential for use by single bats;
- Category 2: Trees with no obvious potential, although the tree is of a size and age that elevated surveys may result in cracks or crevices being found; or the tree supports some features which may have limited potential to support bats; and
- Category 3: Trees with no potential to support bats.

2.3.6 Birds

A desk study was undertaken to identify the potential sensitivity of avian species to the proposed wind turbine development.

The desk study was supported by a search for suitable nesting features during the Phase 1 Habitat Survey.

2.4 Constraints

The protected species surveyed for are transient in nature and this survey provides a snapshot of the activity on site.

3. SURVEY RESULTS

3.1 Desk Study

The results of the desk study are provided in the table below.

Table 2: Desk Study Results

Source	**Information Provided**			
SiteLink	**Site name**	**Designation**[16]	**Distance and orientation**	**Features**
	River Tay	SPA	3.1km N	Otter, salmon, lamprey
	Auchterhouse Hill	SSSI	4.8km S	Subalpine dry heath
	Forest Muir	SSSI	8km N	Lowland wet heath, spring fen
	Loch of Kinnordy	SSSI, SPA, RAMSAR	7.5km N	Eutrophic loch, open water transition fen, breeding bird assemblage, breeding bird assemblage, non-breeding grey-lag and pink footed goose.
Local Plan	No non-statutory designations are applicable to the site.			
Sketchmap	**Woodland name**		**Distance and orientation**	**Category (Antiquity Woodland Categories**[17]**)**
	Balgownie Muir Plantation		0.5km NE	Long-established (of Plantation origin)
	Templeton Myers		1.7km SW	Long-established (of Plantation origin)
NBN Gateway	**Species occurring within 5km of the site**		**Distance and orientation**	**Source/date**
	European Water Vole (*Arvicola terrestris*)		Three records, closest 3km N	Biological records centre (20/05/2008)
	Brown Hare (*Lepus europaeus*)		Two records 4.5 km W and E	Biological records centre (20/05/2008)
	Otter (*Lutra lutra*)		Three records, closest 2.5km N	JNCC (02/12/2004)
	Eurasian Badger (*Meles meles*)		One record, 4.5km NE	Biological Records Centre (20/05/2008)
	Common pipistrelle bat (*Pipistrellus pipistrellus*.)		Three records, closest 3km W	SNH (12/04/2007)

[16] Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar wetland designation (RAMSAR).
[17] Definition of antiquity categories, available from: http://www.snh.org.uk/publications/on-line/advisorynotes/95/95.html

	Soprano pipistrelle bat (*Pipistrellus pygmaeus)*	Three records, closest 3km W	SNH (12/04/2007)
	Brown long-eared bat (*Plecotus aurius*)	Two records, closest 4km SW	SNH (12/04/2007)
	Red squirrel (*Sciurus vulgaris*)	Eight records, closest 1.5km NW	SWT (19/04/2013)
JNCC	JNCC Article 17 reporting maps (2008) show that the distribution and range of the following species include that of the site area: Common pipistrelle (*Pipistrellus pipistrellus*), Brown long-eared (*Plecotus auritus*) Daubentons (*Myotis daubentonii*), Natterers (*Myotis nattereri*) and Soprano (*Pipistrellus pygmaeus*)		
LBAP (Tayside) and UKBAP	The following bat species are listed in UKBAP and LBAP and potentially relevant to the site: **Species:** • Badger (LBAP); • Daubentons bat(UKBAP); • Soprano pipistrelle (UKBAP); • Otter (UKBAP and LBAP); • Water vole (UKBAP);and • Red squirrel(UKBAP) Please note that other bat species are included as UKBAP priority species but are not included here as they are not considered to be relevant to the region.		

The JNCC collation of taxon designations includes those species that are included within the following items:

- Bern Convention (Appendices 1, 2 and 3);
- Biodiversity Action Plan (BAP) UK priority species list;
- Global IUCN Red List;
- Habitats Directive (Annex 2 (priority species), Annex 2 (non-priority species), Annexes 4 and 5);
- Nationally Rare/Scarce (not based on IUCN criteria);
- National Red Lists (including red listings based on IUCN guidelines);
- Species of principal importance in Scotland (NERC section 41 & 42 lists, Scottish Biodiversity List);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (Schedules 2, 3 & 4) and
- Wildlife and Countryside Act 1981 (Schedules 1, 5 & 8).

The table below lists notable plant species included within the JNCC collation of taxon designations recorded for the 10 km grid square in which the site is located (NO34 between 1993-2013)

Vernacular name	Scientific name
Annual Knawel	*Scleranthus annuus*
Balm-leaved Figwort	*Scrophularia scorodonia*
Black-bindweed	*Fallopia convolvulus*
Bluebell	*Hyacinthoides non-scripta*
Bogbean	*Menyanthes trifoliata*
Box	*Buxus sempervirens*
Charlock	*Sinapis arvensis*
Chicory	*Cichorium intybus*
Corn Mint	*Mentha arvensis*
Dropwort	*Filipendula vulgaris*
Harebell	*Campanula rotundifolia*
Heath Cudweed	*Gnaphalium sylvaticum*
Heather	*Calluna vulgaris*
Hoary Cinquefoil	*Potentilla argentea*
Lesser Tussock-sedge	*Carex diandra*
Masterwort	*Peucedanum ostruthium*
Melancholy Thistle	*Cirsium heterophyllum*
Monk's-rhubarb	*Rumex alpinus*
Moschatel	*Adoxa moschatellina*
Petty Whin	*Genista anglica*
Primrose	*Primula vulgaris*
Sun Spurge	*Euphorbia helioscopia*
Wild Pansy	*Viola tricolor*
Wood Crane's-bill	*Geranium sylvaticum*

3.2 Phase 1 Habitat Survey

This section describes the habitats identified within the site. When considering this section, reference should be made to the supporting maps, target notes and photographs provided in the appendices of this report.

A total of eight habitat types were identified within the site boundaries.

- A2.2 scattered scrub;
- A3.1 broad-leaved scattered trees;
- B1.2 semi-improved grassland;
- B3 improved grassland;
- C3.1 tall ruderal vegetation;
- J2.5 wall;
- J2.6 dry ditch; and
- J3.4 fence.

Scattered scrub

Scrub is seral or climax vegetation dominated by locally native shrubs, usually less than 5m tall. This habitat is present along the field boundary to the south of the turbine location and throughout the fields in the south of the site. The species composition is primarily gorse *(Ulex europaeus*).

Broad-leaved scattered trees
Scattered trees are located within the fields in the east of the site and along the dry ditch to the east of the proposed turbine location. The species include sycamore (*Acer pseudoplatanus)*, ash (*Fraxinus excelsior)* and willow (*Salix* sp.) There is a beech (*Fagus sylvatica)* tree line present immediately to the north east of the site, adjacent to the coniferous plantation. These trees may provide suitable nesting habitat for birds and commuting corridors for bats.

Semi-improved grassland
Semi-improved grassland is a transition category made up of grassland which have been modified by artificial fertilisers, slurry and intensive grazing and consequently have a range of species which are less diverse and natural than unimproved grassland. This is the dominant habitat on site.. The species composition includes cocks foot (*Dactylis glomerata*), fescues (*Festuca* sp.), common bent (*Agrostis capillaris*), perennial ryegrass (*Lolium perenne*), daisy (*Bellis perennis*), white clover (*Trifolium repens*) and creeping buttercup (*Ranunculus repens)*.

Improved grassland
This habitat is similar to that above but has undergone more intensive grazing reducing its overall species diversity. This habitat is present in the field of the proposed turbine location and in the north and east of the site.

Tall ruderal
Areas of tall ruderal vegetation were present along the field boundaries throughout the site and adjacent to the dry ditch to the east of the proposed turbine location. The species present within this habitat included rosebay willowherb *(Chamerion angustifolium)*, common nettle *(Urtica dioica),* broadleaf dock *(Rumex obtusifolius)*, and ragwort *(Jacobaea vulgaris)*. The longer vegetation may provide suitable cover and shelter for commuting mammals.

Wall
A stone wall is present along the field boundary in the south west of the site.

Dry ditch
A dry ditch was present to the east of the turbine location, no standing water was recorded and the ditch was noted to be overgrown with tall ruderal vegetation.

Fence
A post and wire fencing is the dominant field boundary within the site and surrounding area. A deer fence is present along the east site boundary adjacent to the coniferous woodland.

3.2.1 Faunal Species

During the site walk-over, an assessment was made of the potential presence of nationally or internationally protected species and species of local importance as highlighted during the desk study. The following sections present the results of the survey.

3.2.1.1 Otter Survey

No otter field signs were identified during the survey.

No suitable habitat for otters was identified within the site as the ditch was recorded to be dry.

3.2.1.2 Water Vole Survey

No water vole field signs were identified during the survey.

No suitable habitat for water voles was identified within the site as the ditch was recorded to be dry.

3.2.1.3 Badger Survey

Habitat Survey

The survey identified steeply sloping improved and semi-improved grassland fields separated by post and wire fencing and tall ruderal vegetation. In most places soils appeared to be free draining, providing both a suitable substrate for sett excavation and foraging. In general, the survey area presented many of the features required by sheltering and commuting badgers, particularly the tall ruderal vegetation and scattered scrub.

Sett Survey

Despite suitable habitat for badgers being identified, there was no evidence of badger setts at the site. Although several rabbit warrens were recorded.

Field Signs Survey

Although generic mammal field signs were identified at the site, such as mammal paths and breaches in the fence, there was no evidence of badger field signs.

3.2.1.4 Red Squirrel Survey

As demonstrated in the Phase 1 habitat survey, there was no suitable habitat for this species within the survey area.

3.2.1.5 Bat Roost Potential Survey

While the scattered trees did not present any of the features listed in table 1, the trees are of a size and age that elevated surveys may result in cracks or crevices being found. These trees were considered to be Category 2. The willow trees along the dry ditch in the east of the site were recoded as immature and multi-stemmed with no potential to support roosting bats. These were considered to be Category 3 trees.

The survey area supports a limited number of linear vegetation features which could support foraging and commuting bats. The mitigation section below provides recommendations for how to avoid affecting foraging and commuting bats.

3.2.1.6 Birds

No evidence of nesting birds was found during the survey. While the scattered scrub and trees around the site may provide suitable nesting habitat for birds the proposed turbine location, located on improved grassland, is unlikely to affect breeding birds.

4. FURTHER SURVEY AND MITIGATION

4.1 Further Survey

No further survey of the site is necessary.

While the borrow pit will mean the loss of an area of improved grassland, this habitat is widespread and common throughout the surrounding area and is considered to have low ecological value. The borrow pit will be reinstated once works are complete and in time the vegetation will regenerate. The borrow pit is unlikely to cause any lasting ecological impacts.

A bird survey is not necessarily required if construction work can be either timed to avoid the bird breeding season or a pre-construction check of any vegetation to be removed is undertaken immediately prior to works.

Natural England has developed guidance[18] that provides information on how best to site turbines to avoid impacts to bat species. This guidance states that:

"*A bat survey should normally be recommended for applications for turbines that will be located within 50 m of the following features:*

- *buildings or other features or structures that provide potential as bat roosts, including bridges, mines etc;*
- *woodland;*
- *hedgerows;*
- *rivers or lakes; and*
- *within or adjacent to a site designated for bats (SSSI or SAC)."*

Therefore, 50m should be the minimum distance between the tip of the turbine blade to the nearest feature which may be used by bats. This distance should not be measured from the base of the turbine but instead should take into account the height of the feature. In order to accurately measure this stand-off distance from the blade tip Natural England have produced the following equation[19]:

$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$

b = the minimum distance
bl = blade length (27m)
hh = hub height (50m)
fh = feature height (2m)

At Ingliston Hill the minimum distance equates to **60.2m**.

As the proposed turbine is located approximately **75m** from the nearest linear feature, it is unlikely to affect any feature that may be used by roosting, foraging or commuting bats.

No further survey for bats is required.

[18] Natural England (2009). Natural England Technical Information Note TIN059 – Bats and Single Large Wind Turbines: Joint Agencies Interim Guidance
[19] Natural England (2012). Natural England Technical Information Note TIN051 – Bats and Onshore Wind Turbines (second edition)

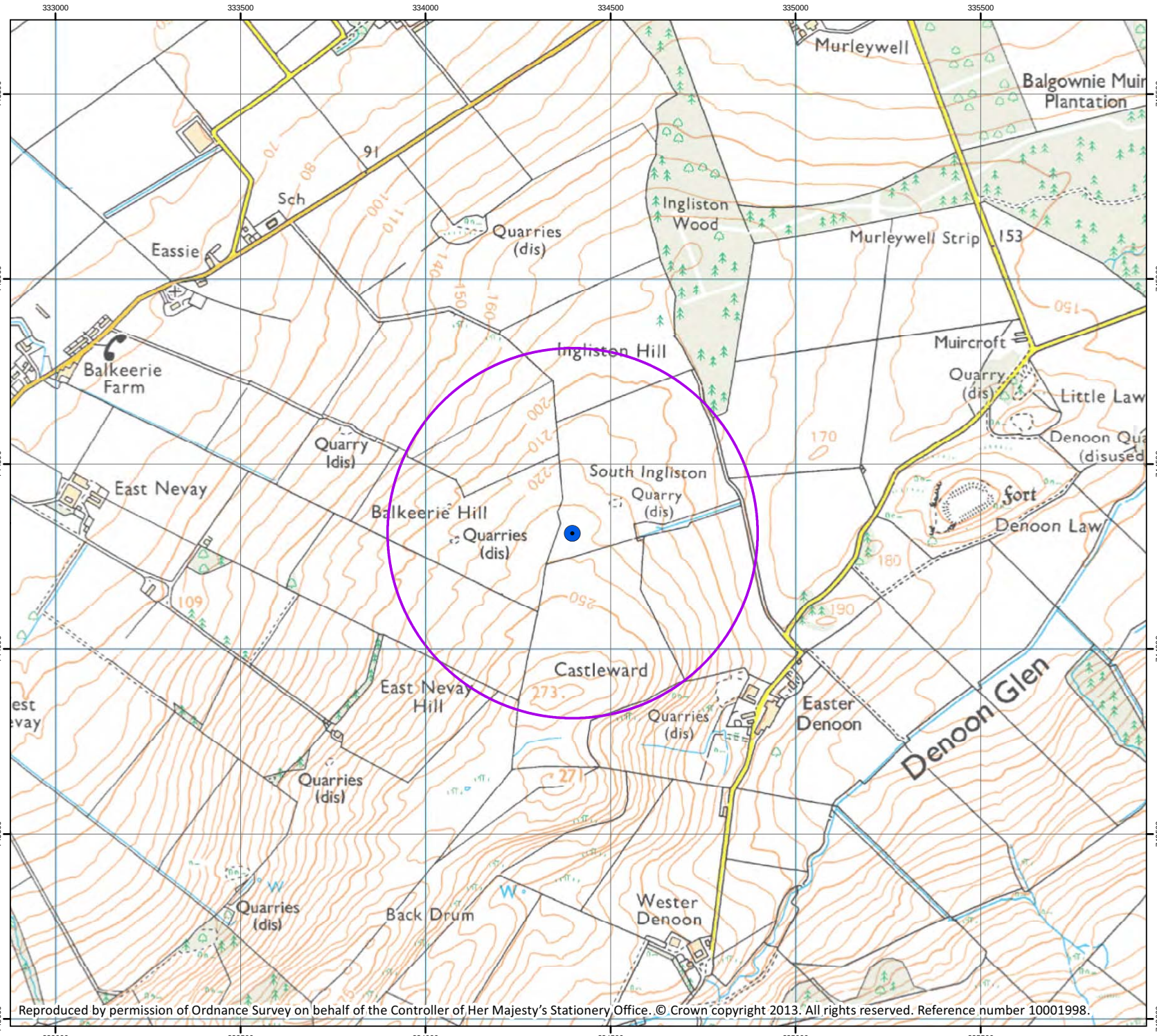
4.2 Protected Species Licensing

It is unlikely that a protected species licence will be required for this development. Should a protected species, or evidence of a protected species, be discovered on site the licensing requirement will require to be reviewed.

4.2.1 General Good Practice Mitigation During Construction

1. Any vegetation removal should be undertaken outside the bird nesting season, which runs from March to August. If vegetation removal is planned during the nesting season, a suitably qualified ecologist should inspect the area for the presence of nests up to a maximum of one day prior to removal. If an active nest is discovered the vegetation cannot be removed and must be left until the young have fledged. In this scenario alternative approaches to the works should be proposed.
2. Any trenches or pits should be covered when unattended or a shallow angled plank inserted to allow animals to escape, should they become trapped inside them. The ends of any pipeline should be capped when unattended, or at the end of each working day to prevent animal access.
3. In the event that a protected species is discovered on site all work in that area must stop immediately and an ecologist contacted. Details of the local police Wildlife Crime Officer, SNH Area Officer and Scottish Society for the Prevention of Cruelty to Animals (SSPCA) relevant Officer could be held in site emergency procedure documents.

Appendix A: Site Location Plan



AC57

Legend

- Survey Area
- Turbine Location

Do not scale this map

Client	Locogen
Project	Ingliston Hill Single Turbine
Title	Site Location Plan
Status	FINAL
Drawing No.	164621 - 001
Revision	
Scale	1:10,000
A3	
Date	10 Sept 2013
Drawn	FR
Checked	xx
Approved	FR

ENVIRO Centre
Craighall Business Park, Eagle Street, Glasgow, G4 9XA
Tel: 0141 341 5040
Fax: 0141 341 5045

Appendix B: Site Photographs

Photograph 1: A view of the proposed turbine location.

Photograph 2: A view of the deer fence along the east site boundary.

Photograph 3: A breach in the deer fence along the east site boundary.

Photograph 4: A view of the improved grassland habitat that dominates the site.

Photograph 5: A view of the tall ruderal vegetation along the filed boundary in the east.

Photograph 6: A view of the scattered sycamore trees in the east of the site.

Photograph 7: A view of the rubble pile associated with the former quarry to the east of the proposed turbine location.

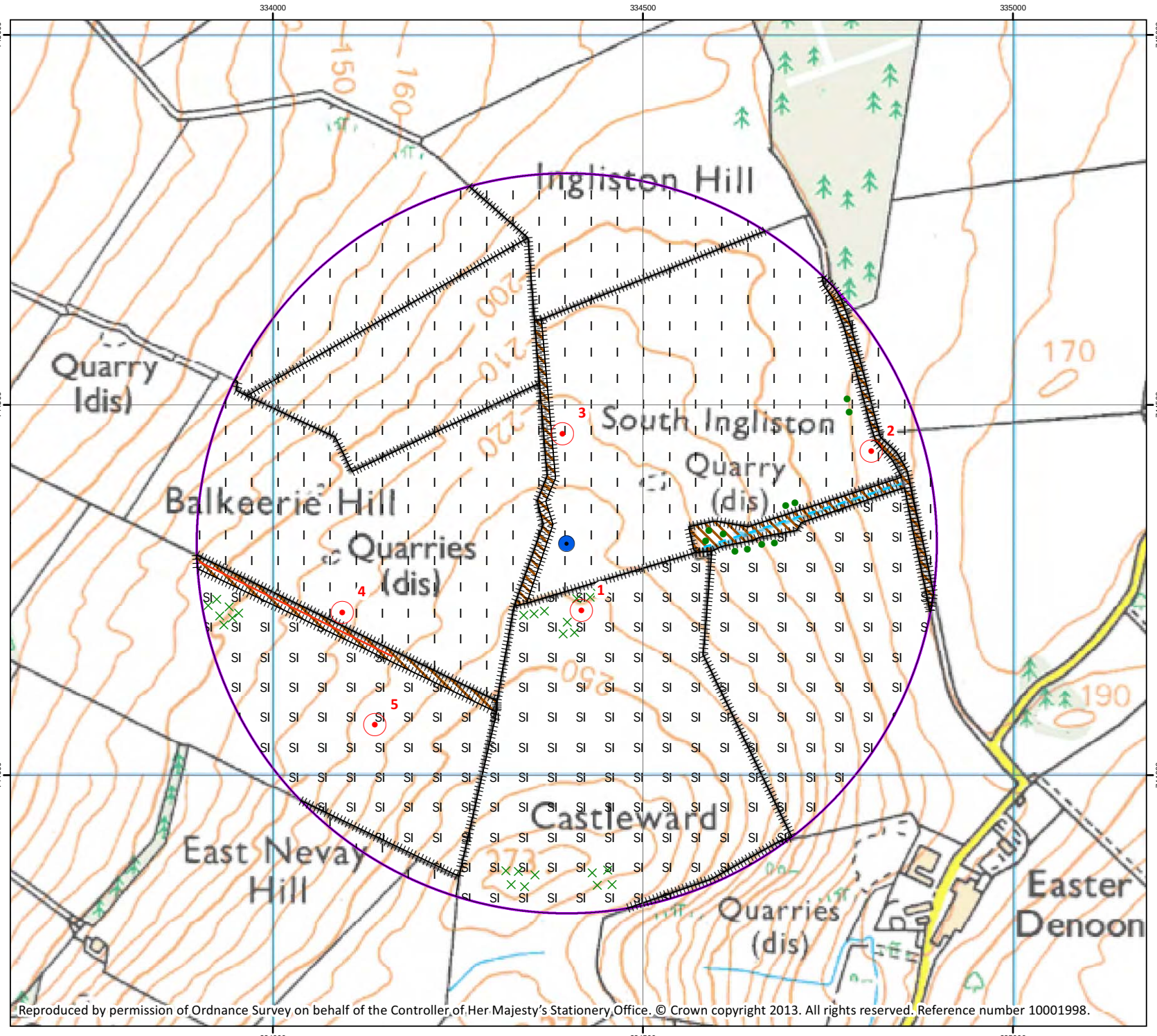
Photograph 8: A view of the scattered gorse scrub.

Photograph 9: A view of one of the many rabbit holes present within the site.

Photograph 9: A view of the stone wall along a field boundary in the west of the site.

Appendix C: Phase 1 Habitat Map

AC57



Legend

- Target Note
- Turbine Location
- Survey Area

JNCC Code

- A2.2 - Scattered Scrub
- A3.1 - Scattered Broadleaved Trees
- B4 - Improved Grassland
- B6 -Semi-Improved Grassland
- C3.1 - Tall Ruderal
- J2.4 - Post & Wire Fence
- J2.5 - Wall
- J2.6 - Dry Ditch

Do not scale this map

Client: Locogen

Project: Ingliston Hill Single Turbine

Title: Phase 1 Habitat Survey

Status: FINAL

Drawing No.: 164621 - 001

Revision:

Scale: 1:5,000

A3

Date: 10 Sept 2013

Drawn	Checked	Approved
FR	xx	FR

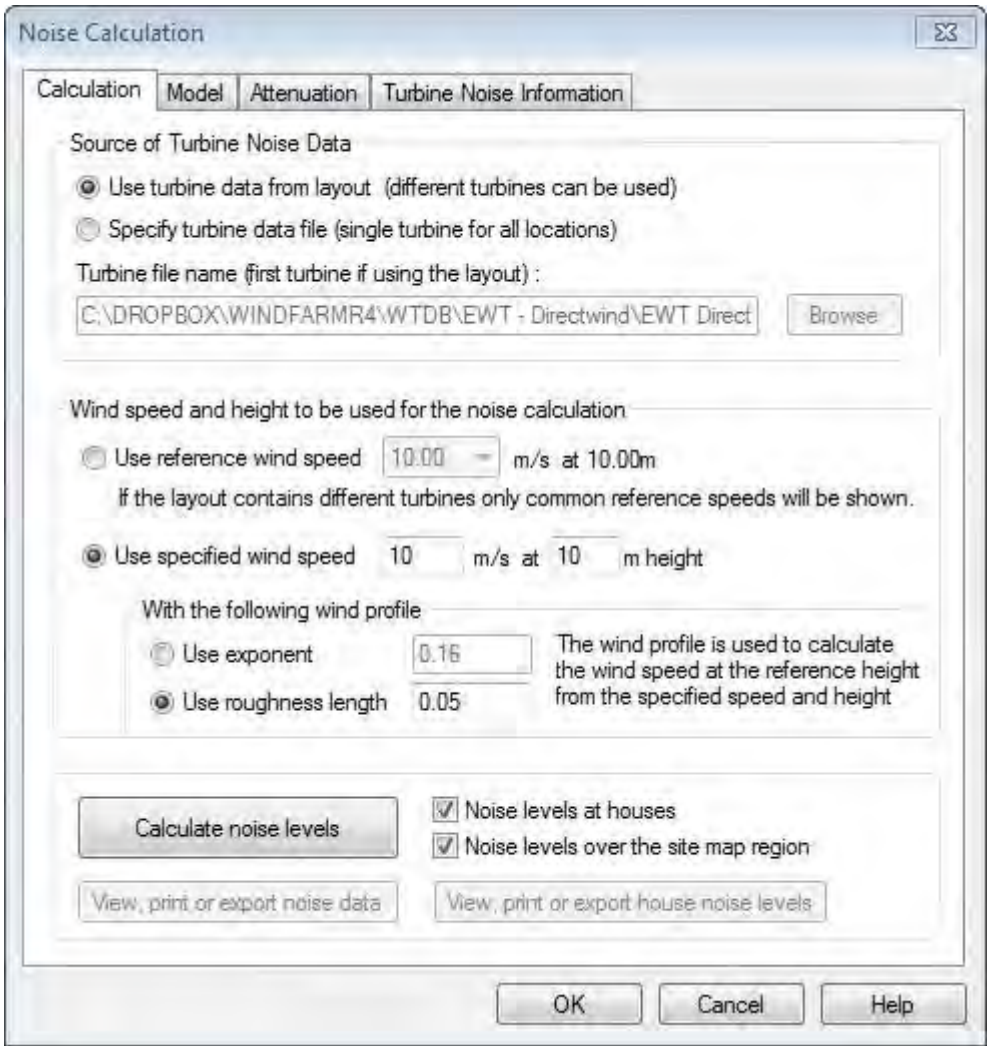
ENVIRO Centre
Craighall Business Park, Eagle Street, Glasgow, G4 9XA
Tel: 0141 341 5040
Fax: 0141 341 5045

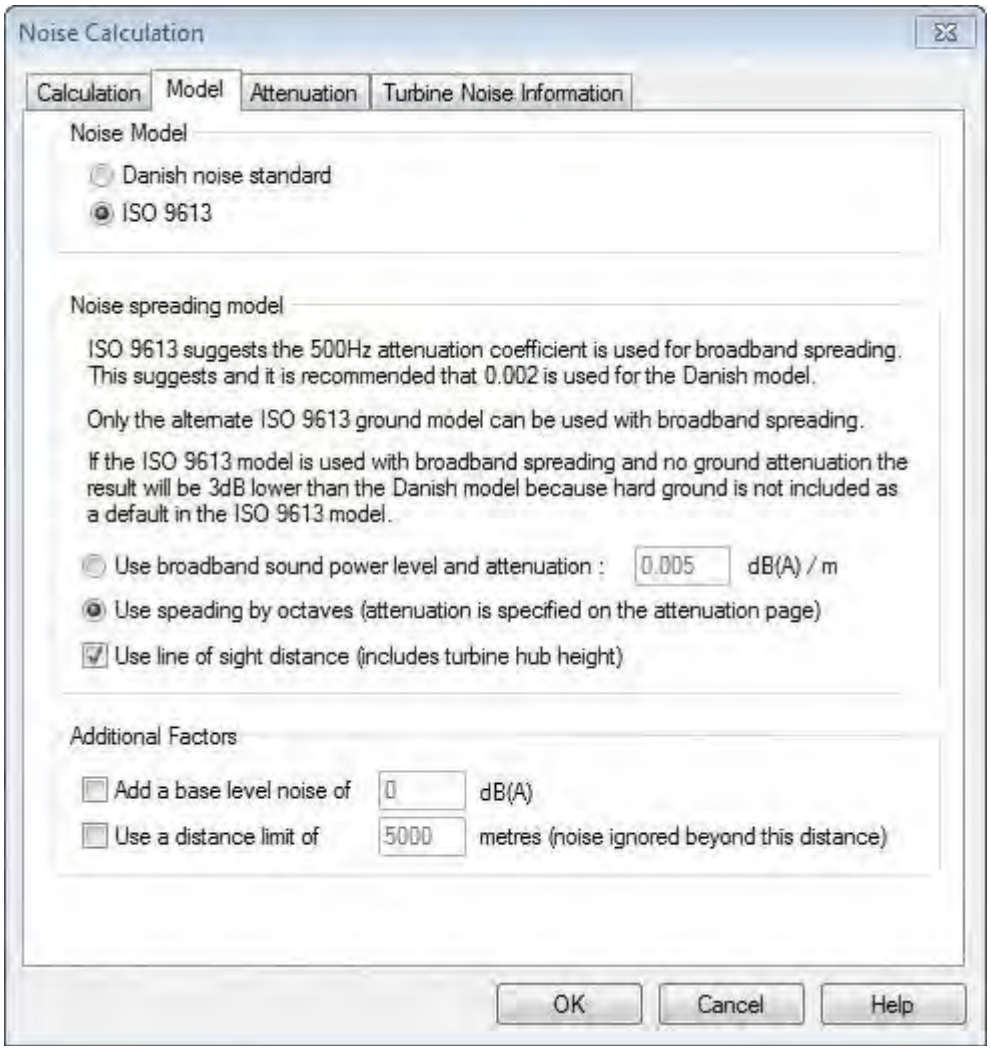
Appendix D: Target Notes

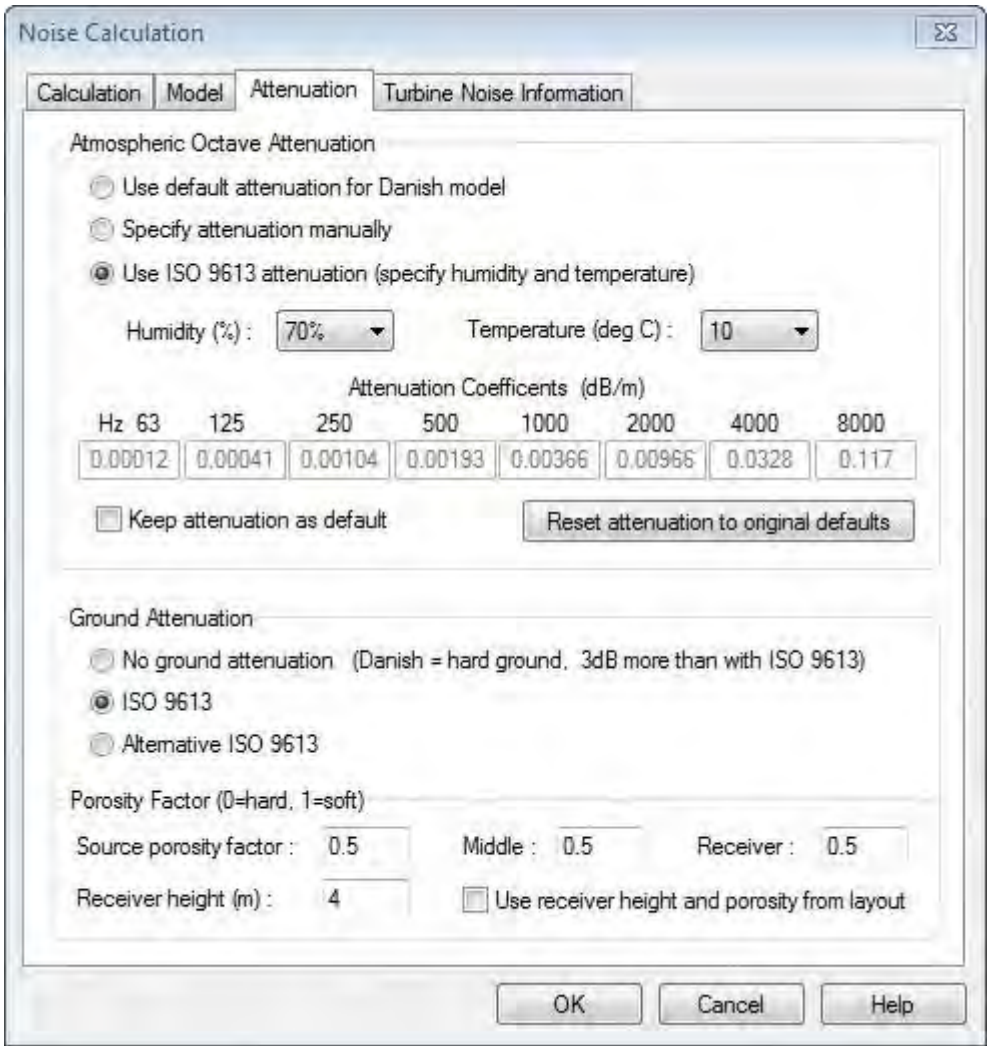
Date of Survey: 30th August 2013
Recorder Name: Karen Hassard
Weather Conditions: Bright and clear with an air temperature of 17°C.

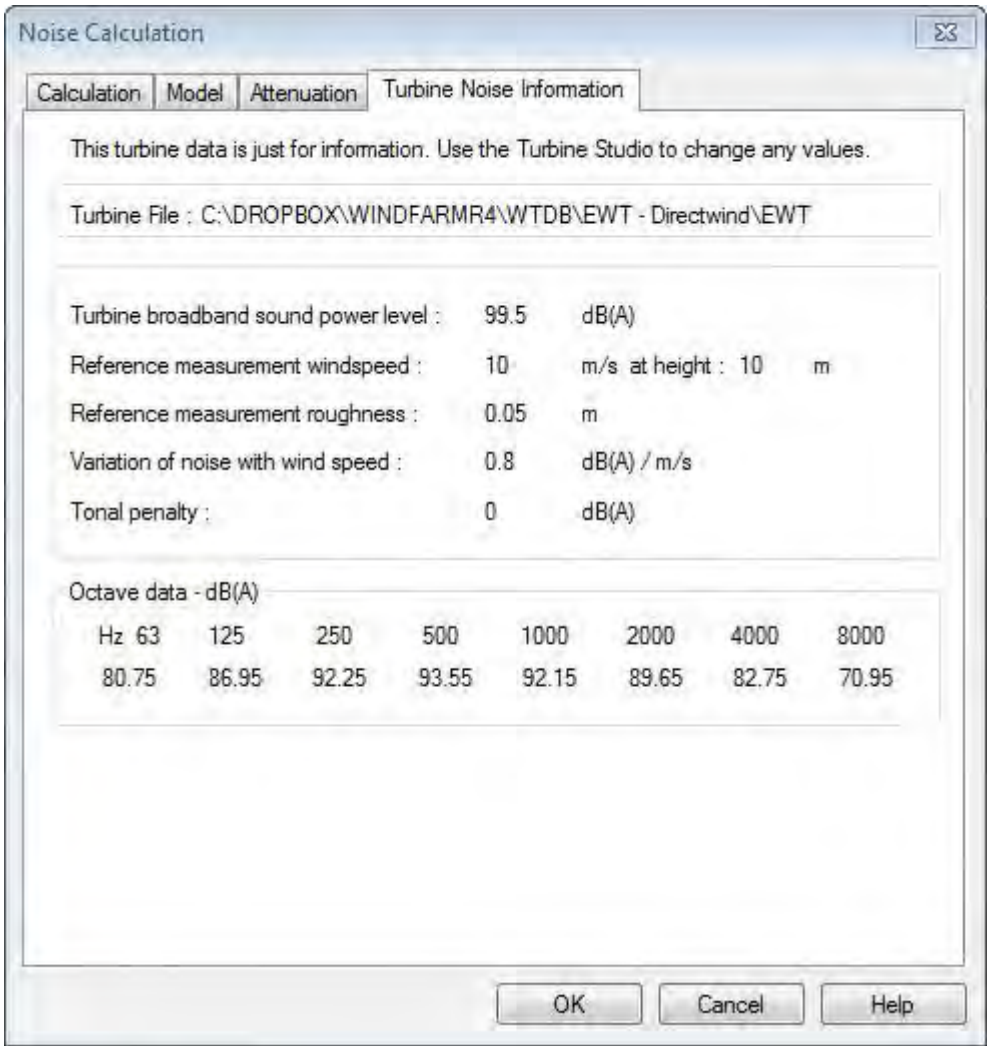
Target Note	Details
1.	**Feature:** Scattered scrub **Description:** This habitat is present to the south of the proposed turbine location. Although it is not continuous it may provide a suitable commuting and foraging route for gap tolerant bat species such as pipistrelles.
2.	**Feature:** Post and wire fencing **Description:** A deer fence is present along the east site boundary adjacent to the coniferous woodland. A breach was discovered in the bottom of the fence but no evidence of badger was identified.
3.	**Feature:** Tall ruderal **Description:** tall ruderal vegetation was present along the field boundary to the west of the proposed turbine location. The longer vegetation may provide suitable cover and shelter for commuting mammals.
4.	**Feature:** Wall **Description:** A stone wall is present along the field boundary in the south west of the site. It may provide suitable shelter for reptiles and amphibians.
5.	**Feature:** Rabbit warrens **Description:** Rabbit holes were recorded in the field to the south west of the turbine. These looked similar to badger holes from the outside but were identified to split into smaller holes just inside the entrance. These tunnels were considered too small for badger. No badger field signs were identified.

Appendix C – Manufacturer's Noise Data and ReSoft Windfarm Report Exports


Noise Calculation
Calculation
Model
Attenuation
Turbine Noise Information
Source of Turbine Noise Data
Use turbine data from layout (different turbines can be used)
Specify turbine data file (single turbine for all locations)
Turbine file name (first turbine if using the layout) :
C:\DROPBOX\WINDFARMR4\WTDB\EWT - Directwind\EWT Direct
Browse
Wind speed and height to be used for the noise calculation
Use reference wind speed
10.00
m/s at 10.00m
If the layout contains different turbines only common reference speeds will be shown.
Use specified wind speed
10
m/s at
10
m height
With the following wind profile
Use exponent
0.16
Use roughness length
0.05
The wind profile is used to calculate the wind speed at the reference height from the specified speed and height
Calculate noise levels
Noise levels at houses
Noise levels over the site map region
View, print or export noise data
View, print or export house noise levels
OK
Cancel
Help


Noise Calculation
Calculation
Model
Attenuation
Turbine Noise Information
Noise Model
Danish noise standard
ISO 9613
Noise spreading model
ISO 9613 suggests the 500Hz attenuation coefficient is used for broadband spreading. This suggests and it is recommended that 0.002 is used for the Danish model.
Only the alternate ISO 9613 ground model can be used with broadband spreading.
If the ISO 9613 model is used with broadband spreading and no ground attenuation the result will be 3dB lower than the Danish model because hard ground is not included as a default in the ISO 9613 model.
Use broadband sound power level and attenuation :
0.005
dB(A) / m
Use speading by octaves (attenuation is specified on the attenuation page)
Use line of sight distance (includes turbine hub height)
Additional Factors
Add a base level noise of
0
dB(A)
Use a distance limit of
5000
metres (noise ignored beyond this distance)
OK
Cancel
Help


Noise Calculation
Calculation
Model
Attenuation
Turbine Noise Information
Atmospheric Octave Attenuation
Use default attenuation for Danish model
Specify attenuation manually
Use ISO 9613 attenuation (specify humidity and temperature)
Humidity (%) :
70%
Temperature (deg C) :
10
Attenuation Coefficents (dB/m)
Hz 63 125 250 500 1000 2000 4000 8000
0.00012 0.00041 0.00104 0.00193 0.00366 0.00966 0.0328 0.117
Keep attenuation as default
Reset attenuation to original defaults
Ground Attenuation
No ground attenuation (Danish = hard ground, 3dB more than with ISO 9613)
ISO 9613
Alternative ISO 9613
Porosity Factor (0=hard, 1=soft)
Source porosity factor : 0.5
Middle : 0.5
Receiver : 0.5
Receiver height (m) : 4
Use receiver height and porosity from layout
OK
Cancel
Help


Noise Calculation
Calculation
Model
Attenuation
Turbine Noise Information
This turbine data is just for information. Use the Turbine Studio to change any values.
Turbine File : C:\DROPBOX\WINDFARMR4\WTDB\EWT - Directwind\EWT
Turbine broadband sound power level : 99.5 dB(A)
Reference measurement windspeed : 10 m/s at height : 10 m
Reference measurement roughness : 0.05 m
Variation of noise with wind speed : 0.8 dB(A) / m/s
Tonal penalty : 0 dB(A)
Octave data - dB(A)
Hz 63 125 250 500 1000 2000 4000 8000
80.75 86.95 92.25 93.55 92.15 89.65 82.75 70.95
OK
Cancel
Help

Project name : INGLISTON FARM
Layout name : INGLISTON FARM.WFL

Noise data file name : NINGLISTON.WFN
Created : 14:23:37 28-Aug-2013
Revised : 09:37:44 18-Sep-2013
Revision : 47
Title :
Author :
Comment :

Turbine noise data : From the layout
Turbine file (first) : ..\WTDB\EWT - Directwind\EWT Directwind - Measured 500kW ocata

NOISE MODEL
Noise standard : ISO 9613
Noise spreading model : Octaves
Use line-of-sight distance: Yes

ATMOSPHERIC ATTENUATION
Source of attenuation : ISO 9613
Humidity : 70 %
Temperature : 10 deg C
Attenuation coefficients
63 Hz : 0.00012
125 Hz : 0.00041
250 Hz : 0.00104
500 Hz : 0.00193
1000 Hz : 0.00366
2000 Hz : 0.00966
4000 Hz : 0.03280
8000 Hz : 0.11700

GROUND ATTENUATION
Formulation : ISO 9613
Source porosity : 0.50
Middle porosity : 0.50
Receiver porosity : 0.50
Receiver height : 4.00

WIND SPEED
Turbine reference : No
Wind speed : 10.00
Wind speed height : 10.0
Wind profile Z0 : 0.0500

ADDITIONAL FACTORS
Base noise level : None
Distance limit : None

House ID	Easting	Northing	Altitude	Noise (db)
1	334985	743907	0	29.75
2	333417	744287	0	26.44
3	333268	744163	0	24.83
4	333343	744934	0	24.05
5	333409	745008	0	24.18
6	334866	743812	0	30.17
7	333528	745106	0	24.47

EWT	Emergya Wind Technologies BV
	DW54

Category:	Specification	Page 1 / 11
Doc code:	S-1005030	

Created by:	RH	Creation Date:	09-05-12
Checked by:	LE	Checked Date:	09-05-12
Approved by:	TY	Approved Date:	09-05-12

Title:

Specification

Sound power level DW54 - 500kW

Revision	Date	Author	Approved	Description of changes
01	17-08-12	RH	TY	corrected format
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Emergya Wind Technologies BV
Building 'Le Soleil' - Computerweg 1 - 3821 AA Amersfoort - The Netherlands
T +31 (0)33 454 0520 - F +31 (0)33 456 3092 - www.ewtinternational.com

Contents

1 Introduction

Following information with regard to the sound power level measurements, are distillated from measurement data of a *DIRECT**WIND*** 54 500kW turbine, located at the Elbaweg in Venhuizen, the Netherlands.

The measurements were performed by a third party according to the International Standard IEC 64100-11 December 2002: "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques ".

2 Measurements

The measurements have been performed by measuring the sound pressure levels in the third octave bands of 25 Hz to 10,000 Hz at the reference point downwind of the operating turbine. The background noise level was measured during standstill of the turbine.

Measurements were carried out on the ground on a hard board according to the IEC standard. This method doubles the pressure on the microphone which raises the sound pressure level with +6 dB(A) compared to free field measurements.

The measured sound pressure levels can be found in Appendix 2 measured sound pressure levels.

3 Results

The sound power levels are calculated from the measured sound pressure levels according to IEC-61400-11. The wind velocities have been corrected for a reference roughness Z_0 of 0.05m by applying a factor of 1.1 on the measured wind velocity, and the sound power levels have been calculated for a reference height of 10m.

Sound power level Lwa in dB(A)		**middle frequency of the octave bands [hz]**								
Wind speed at a height of 10m		**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Wind 5 m/s	95.0 dB(A)	67.3	76.3	82.5	89.0	90.3	87.9	85.3	80.6	71.0
Wind 6 m/s	96.6 dB(A)	68.2	78.0	84.1	90.7	92.0	89.5	86.7	81.4	72.4
Wind 7 m/s	97.7 dB(A)	69.5	79.3	85.5	91.8	93.0	90.7	88.0	82.2	72.9
Wind 8 m/s	98.8 dB(A)	70.9	80.7	86.9	92.6	94.1	92.0	89.2	83.0	72.8
Wind 9 m/s	99.7 dB(A)	72.4	82.1	88.3	93.5	94.7	92.9	90.3	83.5	72.0
Wind 10 m/s	99.5 dB(A)	72.2	81.6	87.8	93.1	94.4	93.0	90.5	83.6	71.8

Table 3.1 gives the calculated sound power levels at the different wind speeds, and the calculated octave band power levels. Figure 3.1 gives the calculated 3rd octave band sound power levels, the values for these can be found in Appendix 1 Third octave band sound power levels.

Sound power level Lwa in dB(A)		**middle frequency of the octave bands [hz]**								
Wind speed at a height of 10m		**31.5**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Wind 5 m/s	95.0 dB(A)	67.3	76.3	82.5	89.0	90.3	87.9	85.3	80.6	71.0
Wind 6 m/s	96.6 dB(A)	68.2	78.0	84.1	90.7	92.0	89.5	86.7	81.4	72.4
Wind 7 m/s	97.7 dB(A)	69.5	79.3	85.5	91.8	93.0	90.7	88.0	82.2	72.9
Wind 8 m/s	98.8 dB(A)	70.9	80.7	86.9	92.6	94.1	92.0	89.2	83.0	72.8
Wind 9 m/s	99.7 dB(A)	72.4	82.1	88.3	93.5	94.7	92.9	90.3	83.5	72.0
Wind 10 m/s	99.5 dB(A)	72.2	81.6	87.8	93.1	94.4	93.0	90.5	83.6	71.8

Table 3.1 Sound power levels and the octave band data

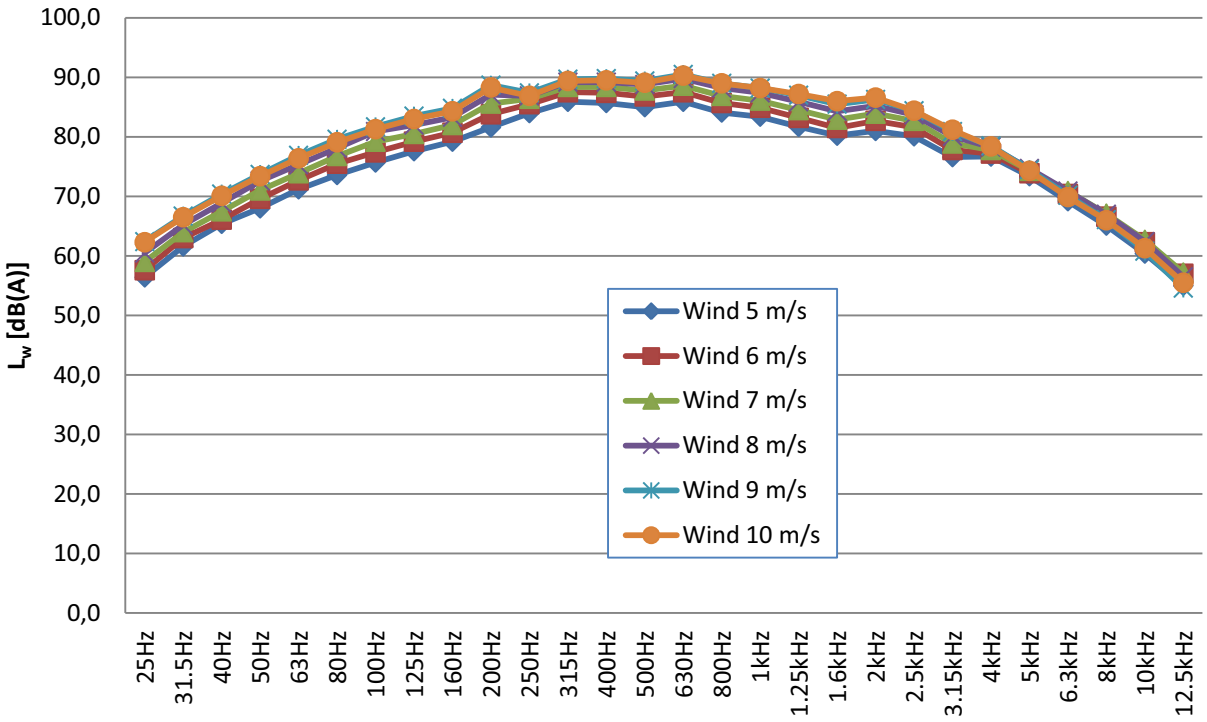


Figure 3.1 The 3rd octave band Sound Power Level spectra

3.1 Corrected sound power level graphical

Figure 3.2 and table 3.2 below provides all the calculated sound power levels at the different wind speeds at reference conditions (h = 10 m and z_0 = 0.05 m) and after correction for the background noise. The figure also gives the 4th order regression on this curve:

$$L_W = 0.0033V_{wind}^4 - 0.1327V_{wind}^3 + 1.7261V_{wind}^2 - 7.8733V_{wind} + 106.02\ dB(A)$$

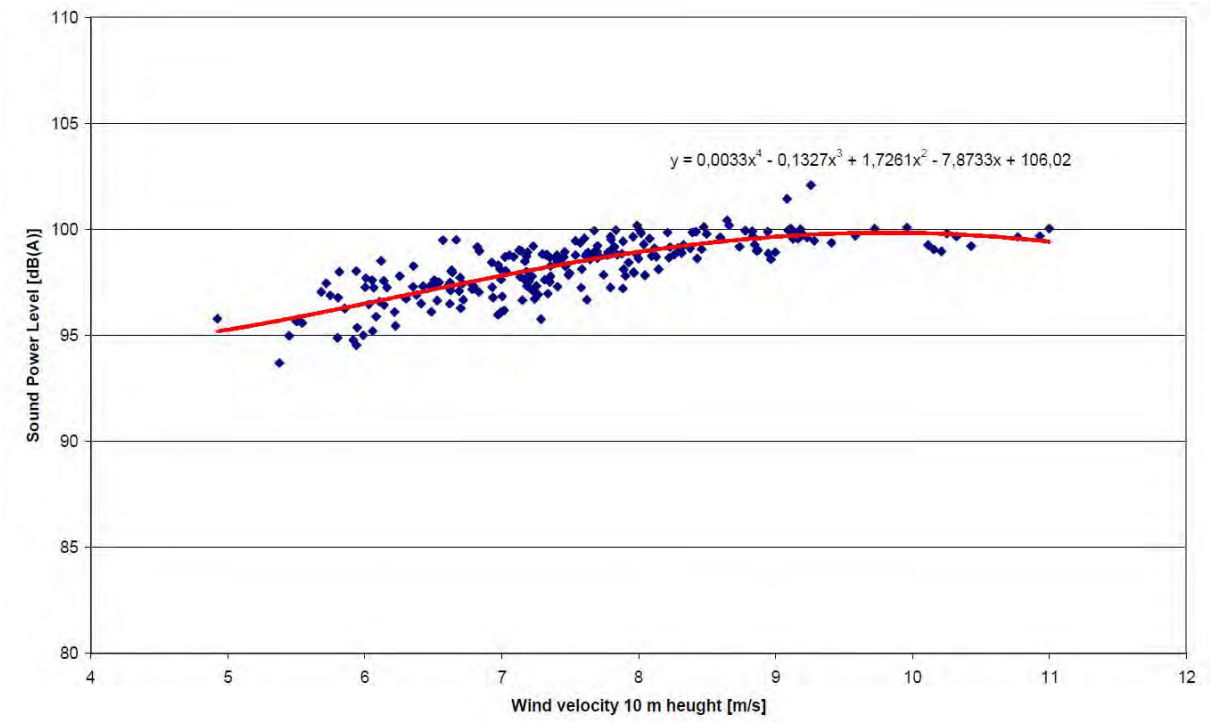


Figure 3.2 the calculated sound power level at different wind speeds

Sound power level with 4th Order regression in dB(A) **Wind speed at a height of 10m**	
Wind 5 m/s	95.3 dB(A)
Wind 6 m/s	96.5 dB(A)
Wind 7 m/s	97.8 dB(A)
Wind 8 m/s	98.9 dB(A)
Wind 9 m/s	99.6 dB(A)
Wind 10 m/s	99.8 dB(A)

Table 3.2 Sound Power Levels with 4th Order regression

3.2 Tonal Audibility

The audibility of the tones in the sound was analysed at the reference position and is given in Table 3.3 Tonal Audibility. The most important frequencies are 2.2 and 4.4 kHz. In Table 3.3 also the tonal penalty according to ETSU-R-97 (The assessment and rating of noise from wind farms – September 2006) is given. For the tone level of 3.3, the ETSU penalty of 2.5 dB can be found in Figure 3.3. No penalties are incurred for audibility levels below 2.0 dB.

According to ETSU-R-97, the tonal penalty should be added at the receiver for the specific wind speed at which the tonal audibility is present.

Wind @ 10 m ([m/s]	5	6	7	8	9
ΔL_A [dB(A)]	3.3	0.9	1.5	0.7	-0.7
ETSU Penalty [dB]	2.5	-	-	-	-

Table 3.3 Tonal Audibility

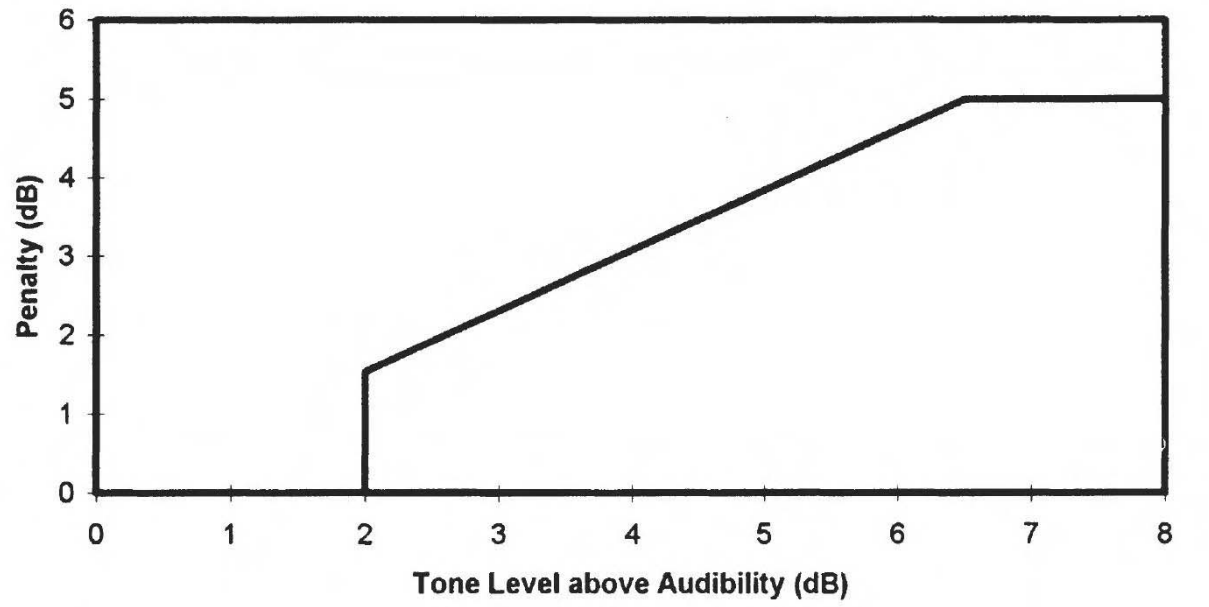


Figure 3.3 Tonal penalty according to ETSU-R-97

3.3 Uncertainty

The following Table 3.4 gives the number of measurements and the uncertainty in dB(A) for each different wind speed.

Wind Class	Number of measurements	Uncertainty [dB(A)]
Wind 5 m/s	4	1.7
Wind 6 m/s	37	1.4
Wind 7 m/s	77	1.2
Wind 8 m/s	68	0.9
Wind 9 m/s	26	0.9
Wind 10 m/s	9	0.7

Table 3.4 Number of measurements and uncertainty

Appendix 1 Third octave band sound power levels

V10[m/s]	25Hz	31.5Hz	40Hz	50Hz	63Hz	80Hz	100Hz	125Hz	160Hz
Wind 5 m/s	56,4	61,6	65,4	68,0	71,2	73,6	75,7	77,6	79,2
Wind 6 m/s	57,6	63,0	66,1	69,6	72,7	75,5	77,4	79,2	80,7
Wind 7 m/s	59,0	64,0	67,5	71,0	73,9	76,8	79,2	80,5	82,0
Wind 8 m/s	60,5	65,2	68,9	72,6	75,3	78,1	80,9	82,0	83,3
Wind 9 m/s	62,4	66,7	70,4	73,7	76,9	79,6	81,7	83,5	84,8
Wind 10 m/s	62,3	66,5	70,1	73,4	76,4	79,1	81,3	83,0	84,3

V10[m/s]	200Hz	250Hz	315Hz	400Hz	500Hz	630Hz	800Hz	1kHz	1.25kHz
Wind 5 m/s	81,6	84,0	85,9	85,7	85,0	85,9	84,1	83,4	81,7
Wind 6 m/s	83,8	85,5	87,5	87,4	86,8	87,5	85,7	84,9	83,2
Wind 7 m/s	85,6	86,4	88,4	88,4	87,8	88,6	86,9	86,1	84,5
Wind 8 m/s	87,1	86,9	89,2	89,2	88,8	89,8	88,2	87,4	85,9
Wind 9 m/s	88,7	87,4	89,7	89,8	89,4	90,5	89,0	88,2	87,0
Wind 10 m/s	88,3	86,9	89,4	89,5	89,1	90,3	89,0	88,2	87,2

V10[m/s]	1.6kHz	2kHz	2.5kHz	3.15kHz	4kHz	5kHz	6.3kHz	8kHz	10kHz	12.5kHz
Wind 5 m/s	80,2	81,0	80,1	76,6	76,7	73,4	69,2	65,1	60,4	55,0
Wind 6 m/s	81,5	82,7	81,6	77,8	77,2	73,9	70,4	66,6	62,3	57,0
Wind 7 m/s	82,9	83,9	82,7	78,9	77,8	74,3	70,9	67,1	62,7	57,2
Wind 8 m/s	84,3	85,2	83,7	80,1	78,3	74,7	70,9	67,0	62,4	56,5
Wind 9 m/s	85,5	86,3	84,4	80,9	78,5	74,5	70,2	66,1	60,8	54,6
Wind 10 m/s	86,0	86,6	84,4	81,2	78,4	74,3	69,9	66,0	61,3	55,5

Appendix 2 measured sound pressure levels

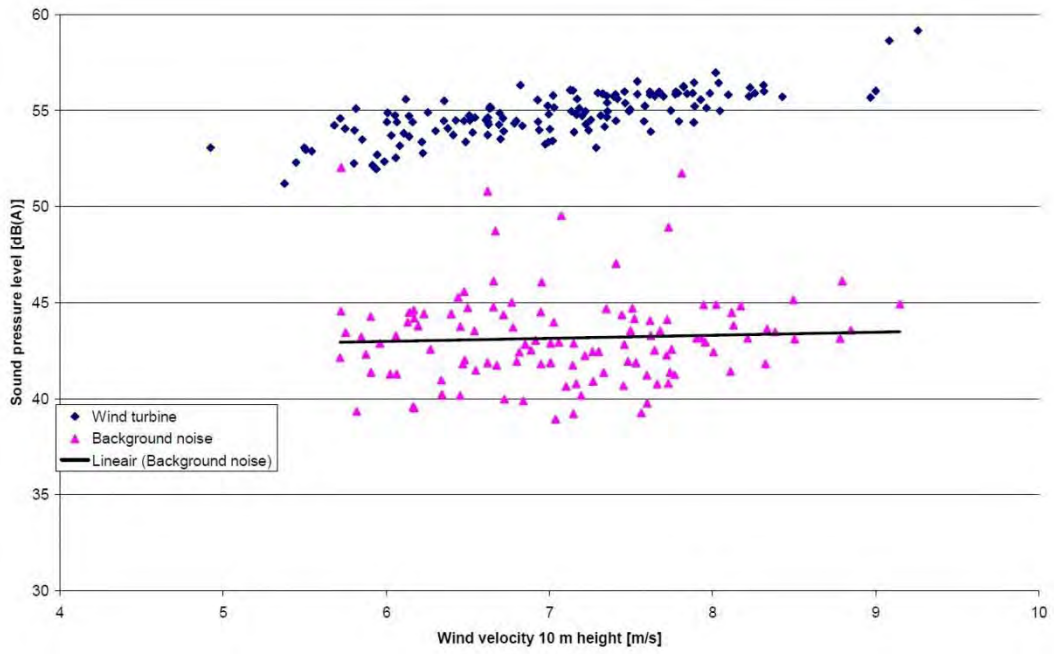


Figure 0.1 Measured sound pressure levels 11 November 2011

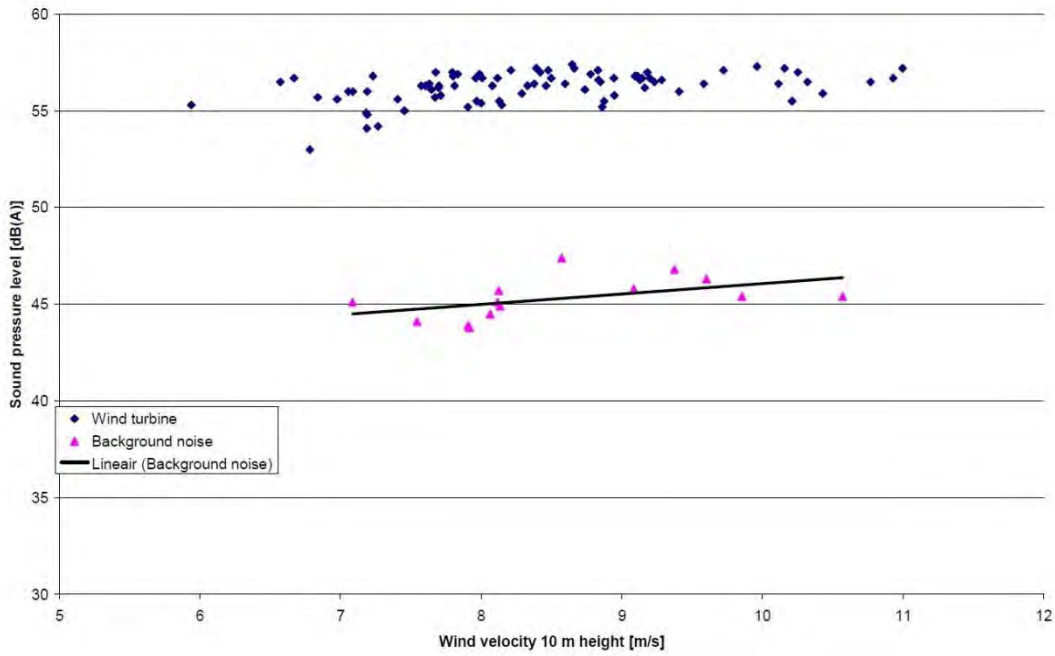


Figure 0.2 Measured sound pressure levels 15 February 2012

EWT	Emergya Wind Technologies BV
	Engineering

Category:	Specification	Page 1 / 2
Doc code:	S-1005020	

Created by:	TY	Creation Date:	07-12-11
Checked by:	MS	Checked Date:	07-12-11
Approved by:	TY	Approved Date:	07-12-11

Title:

Specification

Sound power warranty levels DW52/54 500kW

Revision	Date	Author	Approved	Description of changes
02	14-03-12	AB	TY	Modifications based on new IEC measurements
01	09-12-11	AB	TY	correction
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Emergya Wind Technologies BV
Building 'Le Soleil' - Computerweg 1 - 3821 AA Amersfoort - The Netherlands
T +31 (0)33 454 0520 - F +31 (0)33 456 3092 - www.ewtinternational.com

EWT	Category:	Specification	Revision: 02
	Title:	Sound power warranty levels DW52/54 500kW	Page 2 / 2
	Doc code:	S-1005020	

Sound power levels

The warranted sound power levels are presented with reference to IEC 61400-11:2002.

V_{wind} at 10m height	**DW52**	**DW54**
5 m/s	96,5 dB(A)	97.0 dB(A)
6 m/s	97.5 dB(A)	98.0 dB(A)
7 m/s	98.5 dB(A)	99.0 dB(A)
8 m/s	99.5 dB(A)	100.0 dB(A)
9 m/s	100.3 dB(A)	100.5 dB(A)
10 m/s	100.5 dB(A)	100.5 dB(A)

Sound power level Lw in dB(A)

The warranted sound power levels are based on actual measurements executed by an independent noise measurement institute according to the preferred methods set out in IEC-61400-11.

Uncertainty levels are included in the warranted sound power levels.

At 5m/s a maximum tonal noise penalty of 2,5dB shall be considered according to ETSU-R-97 guidelines.

The measured third octave sound power levels are available upon request.

The values given in the table are valid for normal operational mode (rotation speed 0-24 RPM)

The calculation of the standardized wind speed at 10m height according to IEC 61400-11 is based on a terrain roughness length Z_0=0,05m.

In case validation measurements have to be performed, they should be executed according to the preferred methods set out in IEC-61400-11 by an independent measurement institute which is accredited to ISO/IEC 17025 to conduct measurements of wind turbine noise emissions.

EWT reserves the right to make modifications or adjust settings in order to comply with the warranted sound power levels.