

Settlement	Distance	Visual Assessment
		the development. In the centre of the settlement the built environment will screen views. From the more open areas on the south western edge and northern edge the turbines will appear in views which already contain the Spicer Hill turbines. The extension will fit well since the spacing is consistent and the turbines the same scale. No new views will open up as a result of the development and the only vistas affected would be ones which contain turbines. The settlement is considered to be of high sensitivity. Overall the magnitude of change would be low and the overall level of effect would be moderate, direct, negative and reversible.
Hepworth	3.6km	No views are predicted from Hepworth.
Denby Dale	3.8km	No views are predicted from Denby Dale.
Upper Cumberworth	3.9km	Although the ZTV indicates that there will be visibility from this settlement it would only be the very tips of the blades and with the built environment and intervening vegetation views are not predicted.
Settlements between 5-10km from Spicer Hill Wind Farm		
Shepley	5.0km	No views are predicted from Shepley.
Holmfirth	5.7km	No views are predicted from Holmfirth.
Skelmanthorpe	5.7km	Skelmanthorpe is situated to the north of the proposed development and the ZTV indicates that there will be some views of the turbines from the southern section of the settlement. Here the operational turbines are seen on the horizon partially screened by the topography, with the extension turbines appear between the two schemes helping them to appear as a single cohesive scheme rather than two separate schemes. Overall the development will occupy a minor extent of the vertical view and a minor/moderate extent of the horizontal view. The settlement is considered to be of high sensitivity. Overall the magnitude of change would be negligible and the overall level of effect would be moderate/minor, direct, negative and reversible.
Clayton West	6.8km	Clayton West is situated further along the A636 from Skelmanthorpe and the ZTV indicates that the majority of the settlement will have visibility of the turbines. Despite this the topography constrains views even further and as such even more of the development will be screened. Again the turbines when visible will appear as part of a large cohesive scheme with balanced spacing and limited overlapping. The settlement is considered to be of high sensitivity. Overall the magnitude of change would be negligible and the overall level of effect would be moderate/minor, direct, negative and reversible.
Stockbridge	7.2km	No views are predicted from Stockbridge.
Settlements between 10-15km from Spicer Hill Wind Farm		
Huddersfield	10.5km	No views are predicted from Huddersfield.
Meltham	10.5km	No views are predicted from Meltham.

Settlement	Distance	Visual Assessment
Darton	11.6km	Darton is situated to the north of Barnsley and the ZTV indicates that there will be visibility across the settlement. However at this distance and with the turbines seen on the horizon, it would be difficult to differentiate between the operational turbine and the three new turbines. The settlement is considered to be of high sensitivity. Overall the magnitude of change would be negligible and the overall level of effect would be moderate/minor , direct, negative and reversible.
Barnsley	12.0km	No views are predicted from Barnsley.
Settlements beyond 15km are unlikely to suffer any significant effects		

7.9.6 Assessment of Major Tourist and Transport Routes

An assessment of the potential for visual effects from all major routes within the study area has been undertaken. These routes comprise:

- A616/B6106 between New Mill and Penistone; and
- A629 between Shepley and Penistone.

A616/B6106 New Mill to Penistone

This is a route which passes through the valley along the western side of the Spicer Hill ridge following the path several rivers, including the Sledbrook and the Don. The first ~3km of the route passes through urban areas at Scholes and Hepworth, after which it becomes more rural, although there are still a number of properties and hamlets, including Victoria and Crows Edge. Approximately 7km into the route, the road turns east along the B6106 and along the River Don. Here it enters Millhouse Green and Thurlstone before arriving in Penistone. The section assessed runs for 11km and at its closest point is situated ~1.5km distance from the nearest turbine. The route is considered to be of medium sensitivity as it is a busy route through relatively developed landscapes.

The ZTV indicates that there will be no visibility for the first 3-4km, with visibility starting around Victoria and continuing for the remainder of the route until just after Millhouse. A number of viewpoints have been located on this route to give an indication of the impact on road users. **Viewpoint 5** from Victoria, **Viewpoint 4** from Crows Edge, **Viewpoint 13** from Hollin Lane and **Viewpoint 11** from Millhouse Green, illustrate the typical impact the development will have at various points on the route.

Travelling south-east for the 2km between Victoria and Crows Edge the turbines would be seen slightly obliquely with the Blackstone Edge turbines seen in front and more prominent. The extension turbines would sit behind this and cause some overlapping

but would not increase the extent of development on the horizon. Once past Crows Edge the overlapping is reduced and the spacing balanced, with the turbines further screened by the topography; during this section views would be oblique. This effect would last for ~2km until the road turns east at the B6106, where more direct views are available, briefly. However fairly quickly the views would become oblique as the route passes Viewpoint 13 at Hollin Lane, where the turbines would again be partially screened by the topography and fit well with the existing developments. For the final ~2km the development would be to the rear of the viewer.

When travelling in the other direction the views for the first ~3km would be similar to those experienced in **Viewpoint 11**, where the turbines are well screened by the topography and be indistinct from the existing developments. After the route turns north on the A616, views would initially be oblique, seen rising from behind the horizon to the right, although this effect would be brief as the development would quickly pass to the rear of the viewer.

For the route as a whole the magnitude of change is considered to be low which would result in a **moderate/minor** level of effect which would be not be significant.

A629 Shepley to Penistone

This is a busy route which runs along the lower parts of landscape below Spicer Hill and past the reservoirs at Ingbirchworth and Scout Dike. After the route departs Shepley it crosses the A635 at Lane Head and although fairly rural there is development along significant parts of the route at Park Head, Birds Edge, High Flatts, Ingbirchworth and Scout Dike. The final kilometre of the route travels along the B6462 and into Penistone. The section assessed runs for 8km and at its closest is ~2km distance from the nearest turbine. The route is considered to be of medium sensitivity as it is a busy route through relatively developed landscapes.

The ZTV indicates that the first ~1.5km of the route will not have any visibility of the development and that visibility would only begin after the route has crossed the A635. This would continue for the remainder of the route, bar a small section on the B6462 at the end of the route near Penistone. **Viewpoints 8** and **14** have been located along this route to give an illustration of how the development would appear to road users.

The first ~2km between the A635 and High Flatts would only have blade tip visibility which will generally be indistinct from the operational turbines and is likely to be screened by intervening vegetation. After this the road rises and more open views occur, which would be similar to those experienced in **Viewpoint 8**, where the turbines are seen on the horizon. Although prominent features, the view is oblique and due to

the balanced spacing the impact is fairly minimal as the turbines appear as a natural part of the existing scheme without increasing the visibility. Viewers will experience this for ~1km until the route reaches Ingbirchworth where the built environment screens views and once the route departs Ingbirchworth to the south the development will be to the rear.

When travelling in the opposite direction, as the B6462 departs Penistone the extension turbines will be visible to the left of the view on the horizon, occupying a minor extent of the view and adding ~5 degrees to the horizontal spread of turbines. Although visible they are seen in the same part of the landscape as the existing turbines and do not offer any visual confusion or clutter. As the route merges with the A629 the turbines appear more integrated with the existing schemes and offer less addition to the horizontal extent. In addition to this the views begin to become oblique. For ~1.5km there will be oblique views which are similar to **Viewpoint 14** until the route reaches Ingbirchworth at which point it will be screened from view and disappear to the rear of the viewer.

For the route as a whole the magnitude of change is considered to be low which would result in a **moderate/minor** level of effect which would be not be significant.

7.10 Assessment of Cumulative Visual Effects

7.10.1 Wind Energy Development Included in the CLVIA

The cumulative assessment includes existing wind energy developments (those operating or under construction), proposals with planning permission, and those that are currently the subject of undetermined applications within a 15km radius of the Spicer Hill site. Other known pre-application wind energy development proposals have been identified as part of the assessment process and considered in outline only, due to the more limited information available in connection with these proposals.

All wind energy developments included or referred to in this assessment out to 15km are illustrated on a plan in **Figure 7.7** and listed in **Table 7.4**. These are the key projects which are likely to have some level of cumulative impact with Spicer Hill Extension, potentially appearing simultaneously or successively in views.

The Royd Moor turbines have been removed from the final photomontages to provide a realistic impression of the resulting impact.

7.10.2 Cumulative Baseline

Two or more wind farms are required for the occurrence of a cumulative visual effect. This assessment has therefore considered the development of Spicer Hill Extension in addition to the other wind farm sites in the landscape in order to test the landscape capacity of the area and provide conclusions for the CLVIA relevant to this proposal.

Figure 7.6 shows the location of all of the turbines that are currently operational within the immediate vicinity of the Spicer Hill Extension. As can be seen there are currently three different developments along the ridge, although it should be noted that Royd Moor will be decommissioned before the Spicer Extension turbines are constructed. The pattern of turbines is slightly chaotic with Royd Moor forming two distinct lines where the turbines are fairly close together and the other two schemes have greater spacing and are set out in triangular, rather than linear, arrangement.

A series of potential cumulative ZTVs for these projects are illustrated in **Figure 7.7**. The findings from the analysis of the cumulative visibility maps and cumulative viewpoint assessment have been used to form a conclusion as to the level of overall cumulative visual effects during operation as experienced by various receptors.

Scoped Wind Farm Sites

Due to the uncertainty of projects at the scoping stage where turbine numbers, locations and heights are either unknown or subject to change, cumulative ZTVs have not been produced. Any cumulative impact would not be a true representation of what may happen in reality.

7.10.3 Cumulative Viewpoint Assessment

Each viewpoint assessed as part of the viewpoint assessment has also been considered cumulatively with all other wind energy projects identified within the 15km cumulative study area. However it was generally found that as Spicer Hill Extension fits within the visual envelope created by the Spicer Hill and Blackstone Edge projects that significant cumulative effects were not possible. Typically the three new turbines would be seen within the existing pattern and would neither significantly extend the operational schemes nor add a new feature on a separate section of the horizon.

7.11 Summary of Assessment

7.11.1 Introduction

The proposed Spicer Hill Extension is located in an area of moorland to the north west of Penistone on Spicer Hill and adjacent to Whitley Common. The project has been

designed to have the least impact on the landscape character, the ABLV and the National Park. The design strategy was to provide a natural extension to the existing turbines at Spicer Hill and Blackstone Edge, both of which include three similarly scaled turbines. The methodology for the Landscape and Visual Impact Assessment (LVIA) adopted the guidelines set out by the Landscape Institute and the Institute for Environmental Management and Assessment. Consultation was conducted with representatives from Barnsley Metropolitan Borough Council to discuss and agree the scope of the assessment and choice of assessment viewpoints.

7.11.2 Landscape Design

The project would comprise three turbines with a hub height of no greater than 57m and a maximum turbine height of 93m to blade tip. The turbine sizes, layout, number and location have been specifically chosen to fit with the operational developments at the above sites. Utilising turbines or a similar design and scale and following a similar pattern would allow the three new turbines to fit within the visual envelope without creating clutter or visual confusion. In addition to this the scheme is dependent on the removal of the Royd Moor turbines which are at the end of their life cycle. These are older machines which are orientated in two linear rows and at present have an unusual visual relationship with the larger turbines. The removal of these and the construction of the Spicer Hill Extension will improve the design and appearance of the scheme with the new turbines improving the spacing between Blackstone Edge and Spicer Hill, creating a consistent, cohesive nine turbine development.

The associated infrastructure of site access tracks and sub-station has been carefully designed with the access road and the substation located sensitively to minimise visual impact. There will be no significant effects resulting from the construction and operation of the associated infrastructure, although negative effects are anticipated during the temporary construction period. These would be restored and mitigated on completed of the construction period.

7.11.3 Landscape Assessment

The proposed Spicer Hill Extension is located within the Yorkshire Southern Pennine Fringe LCT, within the Yorkshire and the Humber Landscape Character Assessment and would affect a proportion of part of this area. As an area of farmland which is currently being used as a wind farm site, this area has a low to medium landscape sensitivity and there would be no significant or unacceptable effects on the wider landscape character area. The Yorkshire Southern Pennine Fringe is a transitional landscape that covers the landscape between Barnsley and other settlements and the Dark Peaks and would be suitable for a development such as this, as it is able to accommodate these features without losing any of its existing features or altering its

character, particularly as the development will take place within an operational wind farm. The removal of the Royd Moor turbines will also improve the impact on the landscape character.

Considering the wider area, the assessment has concluded that there would be no significant indirect effects from any of the other landscape character types or within the study area.

Effects on Designated Landscapes

The landscape of the site area is designated locally as an ABLV and as such there will be some minor direct effects on this designated landscape. These effects would be mitigated by the presence of the existing turbines and no important landscape features would be removed. Any other effects would be as a result of indirect landscape effects from designated areas within the study area. The assessment has concluded that there would be no significant direct or indirect landscape effects on designated landscape areas including National Parks, Areas of Borough Landscape Value or Registered Parks and Gardens. A number of the viewpoints included within the LVIA were located within these landscapes in order to fully understand the impact on them. There were no significant effects found from these locations and as such the character and setting of these designations would remain intact.

7.11.4 Visual Assessment

The viewpoint analysis is presented in **Appendix 7a** and indicates that there would be no significant visual effects occurring beyond ~2km from the Wind Farm. Out of the fifteen viewpoints assessed only two were assessed as experiencing significant effects. The conclusions from the viewpoint assessment have been used to form a view as to the level of overall visual effects within the study area.

Visual Effects: Construction Period

There will be no significant visual effects resulting from the construction period and visibility of the ground based activity. Views of concentrated areas of construction could however lead to a temporary and negative effect that in some cases may appear more disruptive than the finished development. Post construction, the appearance of the site would recover a calmer visual character with negligible levels of activity visible on site from the nearest visual receptors.

Visual Effects: Operational Period

No significant effects were found from the any of closest settlements, and typically settlements which currently had views of the operational turbines would have views of the extension, however the new turbines would generally be indistinct from the

existing turbines and would not add to the visual impact. None of the residential properties assessed inside 1km were found to have significant visual effects on either their environs or from their windows. Again this was as a result of only properties which already have views of turbines being affected and in those cases the removal of Royd Moor and the construction of the Spicer Hill Extension would actually simplify and improve views.

7.11.5 Cumulative Landscape and Visual Effects

With the three turbines fitting into an existing development the cumulative impacts will be limited to the relationship with Blackstone Edge and Spicer Hill. As the development does not significantly increase the horizontal spread (in a number of instances it is completely within the existing envelope) it should not cause the present cumulative relationships with Spicer/Blackstone and other schemes in the area to increase. The design and scale of the project has been specifically chosen as to fit within the existing development, keeping an even spacing and appear similar in design and scale.

7.12 Conclusion

The Spicer Hill Extension would be located within a landscape which has capacity for such a scaled development due to the presence of existing turbines on the site. Capacity is provided by the existing pattern of development which contains space for an extension without causing clutter or any visual confusion.

The extension turbines would be of the same scale as the two operational schemes and use the same turbine model as the existing Spicer Hill development and this combined with the consistent spacing would create a simple coherent nine turbine development.

The visual impact of the extension turbines is fairly limited especially as the new development would not significantly add to the horizontal spread of existing development, and would not appear out of place or unbalanced.

8 NOISE

8.1 Introduction

The following noise assessment considers the effect of substituting an operational wind project, nearing the end of its service life, with the proposed three turbine Spicer Hill Extension development. Although the generating capacity of the proposed development is similar to that of the existing wind farm it would be replacing, the size, number and position of the turbines differs significantly.

8.1.1 Terminology

Sound pressure level (SPL) is a logarithmic measure of the effective sound pressure of a sound relative to a reference value: 20 μ Pa. It is measured in decibels (dB) above this standard reference level. The SPL descriptors referenced in this report are:

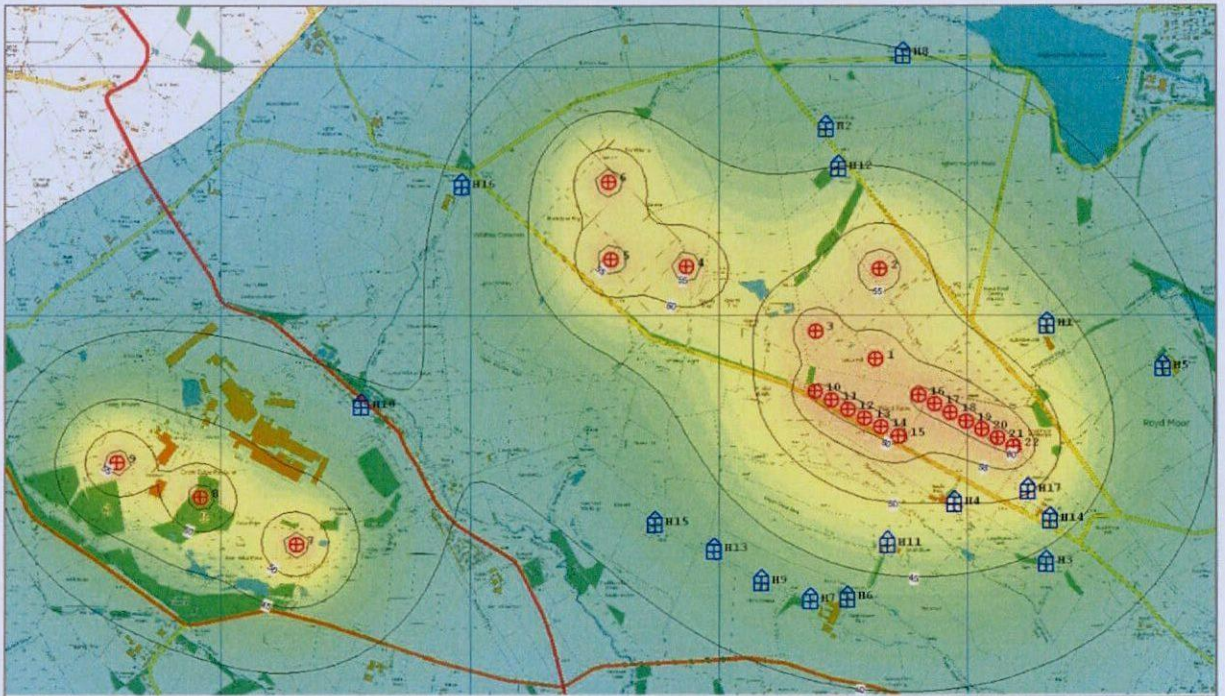
- $L_{A,eq}$ is the A-weighted equivalent continuous sound pressure level, which is a measure of the total ambient noise at a given place at a given time.
- $L_{A90,10min}$ is the A-weighted sound pressure level exceeded for 90 percent of the time in the averaging time period specified – in this case 10 minutes – and is the index most widely used for background noise level measurements.
- L_{WA} is the A-weighted sound power level – a measure of the total sound energy emitted by a source of noise (the reference value for sound power is $1 \times 10^{-12} \text{W}$).

ETSU-R-97 states that the $L_{A90,10min}$ descriptor should be adopted for the noise assessment and that 2dB (A) should be subtracted from $L_{A,eq}$ levels when converting them to $L_{A90,10min}$ values.

The wind speeds referred to in this report are:

- **Measured 10m wind speeds:** Values recorded from wind speeds measured or calculated at 10m height above ground level; and
- **Standardised 10m wind speeds (v_{10}):** Hub height wind speeds translated to 10m height above ground level assuming a standard roughness length of 0.05m. All turbine sound power levels are quoted with reference to standardised 10m wind speeds.

Figure 8.1 - Existing projects and indicative noise contour



Key:

Wind turbines: ⊕ 1-22 | **NSR locations:** 🏠 H1-H17

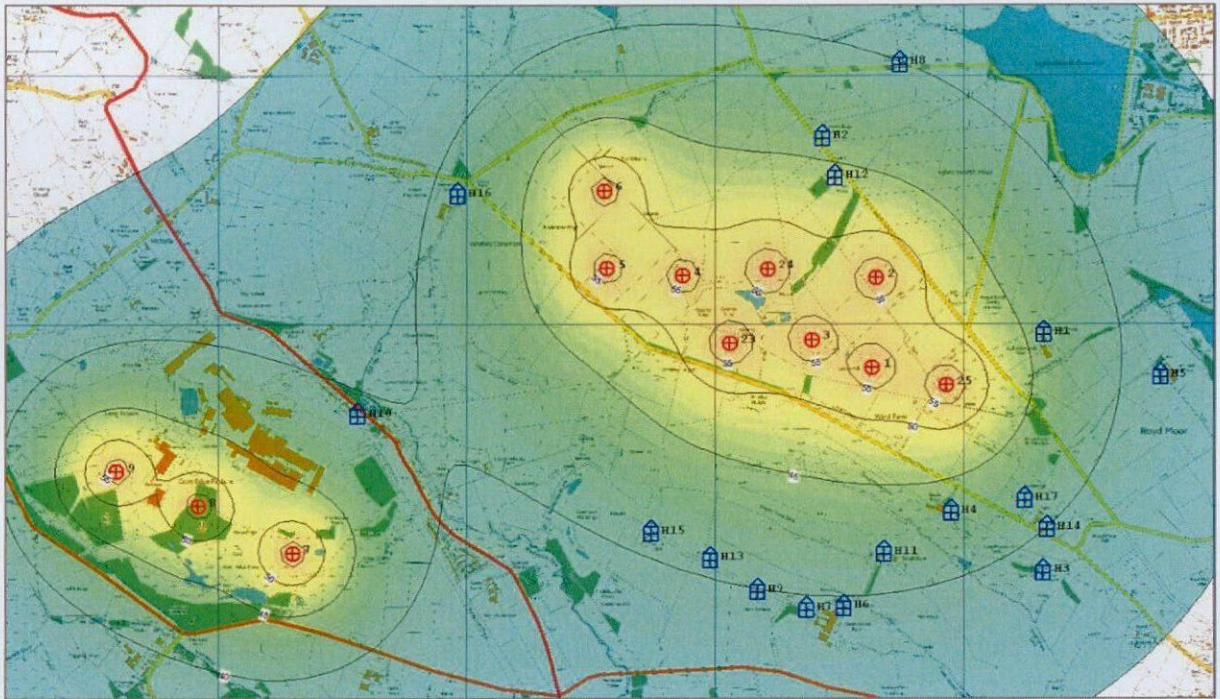
The above map shows the following projects:

- Spicer Hill Wind Farm (T1-3)
- Blackstone Edge Wind Farm (T4-6)
- Hazlehead Wind Farm (T7-9)
- Royd Moor Wind Farm (T10-22)

The noise contours show indicative L_{Aeq} turbine noise levels for 10m wind speeds of 10ms^{-1} .

Turbines 10 -22 are 500kW Bonus machines built in 1993, which are significantly smaller than the other more recent projects. The proposed Spicer Hill Extension turbines are of the same scale as turbines 1-9 and are shown cumulatively in the following figure.

Figure 8.2 - Proposed cumulative layout with indicative noise contour



Key:

Wind turbines: ⊕ 1-25 | NSR locations: 🏠 H1-H17

The above map shows the same indicative L_{Aeq} level for 10m wind speeds of 10ms^{-1} . The proposed turbines are numbered 23, 24 and 25 and are considered cumulatively with the predicted noise from turbines 1-9.

The candidate model of the proposed three turbine development is the same 2.3MW E70 machine that currently operates at Spicer Hill. Detailed predictions of turbine noise from the operational and proposed turbines have been made and compared with measured background noise levels used to derive noise related constraints for the project. Using this data, an impact assessment has been made at each of the nearby noise sensitive receptors (NSRs) that considers:

- The likelihood of the project to meet the derived noise limits;
- Noise related planning conditions for the proposal, should it gain consent ;
- What the net effect of the substitution of projects will be for each receptor; and
- Construction phase noise including decommissioning.

8.2 Guidance

8.2.1 Potential Impacts

Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The impact of noise can therefore be a material consideration in the determination of planning applications. Noise impacts can arise from three distinct areas of the wind farm development:

- The construction of the wind farm;
- During operation of the wind turbines; and
- Resulting from increased traffic flow during the construction and operation stages.

8.2.2 Construction phase noise

Three wind farms of very similar scale have been constructed in the area during the last decade. When consulted, Barnsley Council indicated that they were not aware of any issues relating to noise that had occurred during the construction of the three wind farms. However, an indicative assessment using BS 5228-1¹⁰ is included. The methodology described by BS 5228-1 (2009) is suitable for the assessment of decommissioning noise and has also been used for this purpose.

The standard provides indicative noise level data for a variety of construction plant for use within the calculations and suggests appropriate fixed noise limits. The factors influencing the impact of plant noise are: the number and character of noise sources, the duration of activity and hours of work, the separation distance between source and receptor and reduction of noise by absorption or screening. Careful planning has the potential to avoid the most significant noise sources from being operated concurrently. Assessment of the significance of impacts can be made through comparison of predicted levels with defined criteria.

8.2.3 Operational noise

Guidance for assessing operational noise from wind farms is given in:

- 'ETSU-R-97: the Assessment and Rating of Noise from Wind Farms (1997)'; the Department of Trade and Industry. (usually referred to as the Noise Working Group Recommendations)

¹⁰ BS 5228-1 '*Code of practice for noise and vibration control on construction and open sites*', 2009
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The Institute of Acoustics (IOA) has since provided clarity on requirements for noise assessment of wind turbines in an attempt to encourage a standardised approach to this type of measurement:

- ‘Prediction and assessment of wind turbine noise – agreement about relevant factors for noise assessment from wind energy projects’, Acoustics Bulletin, March/April 2009, IOA; and
- ‘A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise’, May 2013, IOA; and the related Supplementary Guidance Notes that followed.

8.2.4 Noise Limits

In September 1996, the Noise Working Group published its recommendations in ETSU-R-97. The report describes a framework for the measurement of wind farm noise and includes suggested noise limits, derived with reference to existing standards and guidance relating to the emission of noise from various sources existing at that time.

The ETSU-R-97 guidelines recommend that the wind turbine noise should be limited to an absolute lower limit, of 35 - 40dB(A) [LA90,10min] for quiet daytime periods and 43dB(A) for night-time periods, or 5dB(A) above the background noise levels, whichever the greater.

Table 8.1 - ETSU assessment periods

The quiet daytime periods (amenity hours) are:	
18:00 - 23:00	Monday to Friday
13:00 - 23:00	Saturdays
07:00 - 23:00	Sundays
Night time periods are: 23:00 – 07:00 every day	

8.3 Consultation

Discussions with Barnsley Council (Environmental Health) throughout July 2014 resulted in a technical summary of the discussion points covered that would guide the assessment. These are reproduced below:

“Noise impact assessments will be conducted at the NSRs included in: Spicer Hill Wind Farm - Chapter 10: Noise Environmental Statement, and the approach to be taken is also broadly similar.

The agreed approach is to demonstrate that worst case predicted levels will meet total ETSU-R-97 limits:

- *Quiet Daytime limit: 40dB(A) or background plus 5dB, whichever is the greater.*

- *Night-time limit: 43dB(A) or background plus 5dB, whichever is the greater.*
- *Where a resident has a financial involvement in one or more of the nearby developments:*
Quiet Daytime & Night-time limit: 45dB(A) or background plus 5dB, whichever is the greater.

The nearby developments are:

- *Spicer Hill (3 x 2.3MW E70 turbines)*
- *Blackstone Edge (3 x 2.5MW N80 turbines)*
- *Hazlehead (3 x 2.0MW RePower MM82 turbines)*
- *Proposed Spicer Hill Extension (3 x 2.3MW E70 turbines)*

Predicted levels must be compliant with ETSU-R-97 and be calculated using octave band sound power data; following the IoA's "...Good practice guide...".

The background noise levels to be used are those detailed in Spicer Hill Wind Farm - Chapter 10: Noise Environmental Statement

Where these background levels are used as proxies for other locations, this should be detailed and justified.

Where a directly measured 10m wind speed has been used in existing documentation, this wind speed reference should be corrected to a standardised 10m wind speed reference. The method by which this is achieved should be detailed and justified.

Early indications are that the preferred layout will produce the highest noise levels at Spicer House. The resident at this property is financially involved in the proposed development. Should an exceedance of total limits be predicted at this property, it is agreed that this would not impede the planning application so long as:

- a) The exceedance is marginal*
- b) A mitigation strategy is included within the application showing that the required reduction in noise level can be achieved.*
- c) Post construction noise monitoring assess whether, in practice, any mitigation is required.*

As the proposed development would be replacing an existing project, an indication should be made as to whether there is predicted to be an increase or decrease in noise levels at each NSR."

8.4 Methodology

8.4.1 Construction phase noise

The assessment of construction noise follows BS 5228-1:2009, which provides guidance on the control of noise from construction activities and calculation methods for predicting the noise levels attributable to various construction plant.

The exact construction schedule is not yet known, however, through the experience of delivering similar projects, an estimate of likely impacts can be made. These should be treated as indicative. The quantity of construction traffic has also been estimated.

Although BS5228 does not specify absolute noise limits relating to construction activities, it does provide detailed guidance on the steps that can be taken to minimise potential noise and vibration effects. DoE Advisory Leaflet AL 72 (1976) suggests that in rural areas during daytime periods, the façade level $L_{Aeq,12hr}$ from construction sites should be no more than 70dB(A), and no more than 60dB(A) during the evening, and this has been used to apply constraints to the noise due to construction on the site.

During the construction phase of the project it is expected that noise levels in the area will be greater due to the operation and movement of plant, in comparison to the turbine construction tasks. In BS 5228-1:2009 the ABC method outlined in E3¹¹ sets out the following for classifying the significance of the construction noise:

“Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,T}$ Period, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact.”

As the works and operation of plant on this site are to be limited to the daytime periods: Monday to Friday (07.00–19.00) and Saturdays (07.00–13.00), the cut off value, for significant construction noise impact, is deemed to be 65dB(A) $L_{Aeq,T}$. It is possible that, due to weather constraints, the erection of the turbines could occur outside of the working hours defined above. The lower cut-off limit of 55dB(A) and 45dB(A) would therefore apply dependent on time of day.

The methodology for determining the levels of the construction noise (set out in BS 5228-1:2009 F2.3.2) involves calculating the total sound pressure level at the nearest

¹¹ BS 5228-1:2009 ‘Code of practice for noise and vibration control on construction and open sites’, p119
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sensitive receptor for a construction task, $L_{Aeq(12hr)}$, [equation 1], by summing the total potential sound power level for a given construction phase [equation 2] and subtracting a correction for its distance from the nearest property, K_s [equation 3]. These three equations are shown below:

$$[1] L_{Aeq,T} = L_{WA} - K_s$$

$$[2] L_{WA} = 10\log\{10^{(L_{activity1}/10)} + 10^{(L_{activity2}/10)} \dots\}$$

$$[3] K_s = 25\log(R)+1 \text{ [for } R > 25\text{m]}$$

There may also be a requirement to add in the existing ambient noise levels to these levels to determine whether combined construction tasks and background noise levels exceed the 65dB(A) limit.

8.4.2 Operational noise

8.4.2.1 Wind turbine noise propagation model

The International Standard ISO 9613, 'Acoustics – Attenuation of Sound During Propagation Outdoors - Part 2', noise propagation model has been used for the turbine noise calculations. L_{Aeq} noise propagation was modelled using WindFarm v4.2.1.7 by ReSoft Ltd, which implements the ISO 9613:2 model. L_{A90} levels were derived by subtracting two decibels from the L_{Aeq} values as per the ETSU-R-97 guidance.

The follow input parameters are assumed and are consistent with current guidance. Unless otherwise stated, octave band calculations were carried out with measured noise levels obtained via the turbine manufacturer assuming atmospheric attenuation coefficients corresponding to 10°C and 70% humidity, a ground attenuation factor of $G=0.5$ (representing semi-soft ground), and a receptor height of 4m. No topographical screening or reinforcement is deemed applicable to the calculations in this case.

The attenuation of noise as it travels through the air varies with frequency. The atmospheric attenuation coefficients are tabulated below.

Table 8.2 - Attenuation coefficients used for the noise propagation model

Octave band (Hz)	63	125	250	500	1000	2000	4000	8000
Attenuation Coefficient	0.0001	0.0004	0.0010	0.0019	0.0037	0.0097	0.0328	0.1170

8.4.2.2 Sound Power Levels – E70

The proposed candidate turbine model is the 2.3MW Enercon E70 machine with a hub height of 57m. The following table shows the measured octave band levels for the candidate turbine model with the associated measurement uncertainty (Q). These levels are also used to calculate the contribution from the existing Spicer Hill turbines.

Table 8.3 - Extracted from test report 049SE206/01 regarding noise emission of wind turbine (WT) type ENERCON E-70 E4 2.3 MW (Mode II), hub height 57m

L_{Aeq} (dB)	Standardised 10m wind speeds (m/s)				
Octave band (Hz)	6	7	8	9	10
63	80.8	83.4	85.8	85.8	88.2
125	88.5	90.6	94.1	94.7	96.8
250	93.4	95.2	97.1	98.9	99.3
500	92.4	94.8	96.0	98.7	97.9
1000	87.5	90.3	93.6	94.1	96.4
2000	82.8	85.3	89.7	89.4	93.1
4000	77.8	81.4	82.9	85.2	86.2
8000	74.6	78.5	76.4	81.7	78.6
Uncertainty (Q)	0.85	0.84	0.84	0.90	0.90
Total (Q x 1.645)	1.40	1.38	1.38	1.48	1.48

The total uncertainty figure is derived from $Q \times 1.645$ as per current guidelines¹² (where Q = measurement uncertainty). The following table shows warranted broadband levels.

Table 8.4 - Warranted broadband levels as a function of wind speed¹³

Standardized 10m wind speed (m/s)	5	6	7	8	9	10	95% rated power
Broadband SPL (L_{Aeq} (dB))	93.6	98.5	101.3	102.9	104.5	104.5	104.5

The maximum sound power of this turbine is deemed to be represented by that measured at 95% of its rated power, in this case 104.5dB(A) corresponding to a v_{10} wind speed of 10.3ms^{-1} . Therefore no increase in SPL is expected at integer wind speeds above 10ms^{-1} . For wind speeds below 6ms^{-1} , a 2.2dB reduction per integer wind speed is assumed, corresponding to the reduction in summed octave band levels observed between 6ms^{-1} and 7ms^{-1} . **Table 8.4** shows that the rate of reduction in broadband levels will initially be greater than 2.2dB, therefore levels from this turbine are likely to be lower than predicted for wind speeds below 6ms^{-1} . The described approach results in the following sound power levels¹⁴.

¹² Institute of Acoustics, "A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise", p20, 2013

¹³ Noise Report: *SIAS-04-SPL E-70 E4 OM II 2_3 MW Rev1_0-eng-eng.doc*

¹⁴ Italicised values are extrapolations

Table 8.5 - Sound Power levels for the Enercon E70 used in the assessment

L _{Aeq} (dB)	v ₁₀ wind speeds (m/s)									
Octave band (Hz)	3	4	5	6	7	8	9	10	11	12
63	74.2	76.4	78.6	80.8	83.4	85.8	85.8	88.2	88.2	88.2
125	81.9	84.1	86.3	88.5	90.6	94.1	94.7	96.8	96.8	96.8
250	86.8	89.0	91.2	93.4	95.2	97.1	98.9	99.3	99.3	99.3
500	85.8	88.0	90.2	92.4	94.8	96.0	98.7	97.9	97.9	97.9
1000	80.9	83.1	85.3	87.5	90.3	93.6	94.1	96.4	96.4	96.4
2000	76.2	78.4	80.6	82.8	85.3	89.7	89.4	93.1	93.1	93.1
4000	71.2	73.4	75.6	77.8	81.4	82.9	85.2	86.2	86.2	86.2
8000	68.0	70.2	72.4	74.6	78.5	76.4	81.7	78.6	78.6	78.6
Uncertainty (Q)	N/A	N/A	N/A	0.85	0.84	0.84	0.90	0.90	N/A	N/A
Total (Q x 1.645)	1.40	1.40	1.40	1.40	1.38	1.38	1.48	1.48	1.48	1.48

8.4.2.3 Sound Power Levels – N80

Both Blackstone Edge and Hazlehead Wind Farms operate Nordex N80 2.5MW machines with a hub height of 60m. The following octave band levels are available, valid for the N80 turbine with a hub height up to 80m. As no measurement uncertainty is declared, a total uncertainty of 2dB(A) is assumed for each integer wind speed following IoA guidance¹⁵.

Table 8.6 - Octave band levels taken from Nordex document K0818_008388_EN Revision-02 2010-04-26

L _{Aeq} (dB)	v ₁₀ wind speeds (m/s)									
Octave band (Hz)	3	4	5	6	7	8	9	10	11	12
63	79.2	83.2	85.7	87.7	88.4	88.9	89.4	89.7	89.7	89.7
125	85.8	89.8	92.3	94.3	95.0	95.5	96.0	96.3	96.3	96.3
250	86.6	90.6	93.1	95.1	95.8	96.3	96.8	97.1	97.1	97.1
500	84.4	88.4	90.9	92.9	93.6	94.1	94.6	94.9	94.9	94.9
1000	84.1	88.1	90.6	92.6	93.3	93.8	94.3	94.6	94.6	94.6
2000	83.2	87.2	89.7	91.7	92.4	92.9	93.4	93.7	93.7	93.7
4000	79.6	83.6	86.1	88.1	88.8	89.3	89.8	90.1	90.1	90.1
8000	71.7	75.7	78.2	80.2	80.9	81.4	81.9	82.2	82.2	82.2

Stated octave band levels above 10ms⁻¹ appear to replicate those at 10ms⁻¹. Therefore, as with the E70 machine, maximum sound power is expected to be reached by 10ms⁻¹. The range of wind speeds relevant to the assessment should represent cut-in to maximum sound power. In this case, 3ms⁻¹ is deemed to be a representative cut-in wind speed and 10ms⁻¹ representative of maximum sound power for all turbines.

¹⁵ Institute of Acoustics, "A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise", p20 [footnote 6], 2013

Measurement uncertainty is not identified within the document therefore 2.0dB has been assumed.

The octave band levels shown above are used to calculate the noise levels predicted to occur at the named properties. Predicted levels are inclusive of the stated total measurement uncertainties.

8.4.2.4 Sound Power Levels – MM82

Hazlehead wind farm operates REPower MM82 2.0MW machines with a hub height of 59m. Octave spectra and broadband sound power values with measurement uncertainty were available for the MM82 turbine with a hub height of 80m. Octave spectra were scaled by broadband values at each wind speed. The total uncertainty figure is derived from $Q \times 1.645$ as per current guidelines¹⁶ (where Q = measurement uncertainty).

Table 8.7- Octave band levels taken from WindTest document WT 5482/06 (extract WT 5427/06) 2006

$L_{Aeq}(dB)$	v10 wind speeds (m/s)							
Octave band (Hz)	5	6	7	8	9	10	11	12
63	80.7	83.5	84.3	84.2	84.0	84.1	84.5	84.8
125	88.6	91.4	92.2	92.1	91.9	92.0	92.4	92.7
250	95.6	98.4	99.2	99.1	98.9	99.0	99.4	99.7
500	95.9	98.7	99.5	99.4	99.2	99.3	99.7	100.0
1000	92.8	95.6	96.4	96.3	96.1	96.2	96.6	96.9
2000	90.2	93.0	93.8	93.7	93.5	93.6	94.0	94.3
4000	85.7	88.5	89.3	89.2	89.0	89.1	89.5	89.8
8000	76.2	79.0	79.8	79.7	79.5	79.6	80.0	80.3
Broadband	100.7	103.5	104.3	104.2	104.0	104.1	104.5	104.8
Uncertainty (Q)	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.9
Total ($Q \times 1.645$)	1.15	1.15	1.15	1.15	1.15	1.15	1.32	1.48

Levels for v_{10} wind speeds of $3ms^{-1}$ and $4ms^{-1}$ (not shown) were extrapolated and assume a further reduction of 2.8dB per integer v_{10} wind speed that is observed between broadband levels of $5ms^{-1}$ and $6ms^{-1}$.

The octave band levels shown above are used to calculate the noise levels predicted to occur at the named properties. Predicted levels are inclusive of the stated total measurement uncertainties.

8.4.2.5 Sound Power Levels – Bonus 500kW

On-site measurement of the Bonus turbines at Royd Moor would have been a practical possibility if control of those turbines was within the influence of the developer; the difference between operational levels and shut-down levels could have been

¹⁶ Institute of Acoustics, "A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise", p20, 2013

evaluated at a number of on-site locations while neighbouring developments remained operational. As this is not the case, the proposed method is to use the turbine manufacturer's data to predict what the change will be for each NSR.

As previously shown, the E70 and N80 turbines have well documented and comparable noise data from which it is a straight forward matter to predict the resulting immisions. Noise information for the older Bonus turbines at Royd Moor is less detailed. Information provided in the Environmental Statement for Royd Moor includes a broadband sound power level of 98.0dB(A) for the 500kW Bonus machines at a reference wind speed of 8ms^{-1} .

Sound power spectra were available for the Bonus 600kW variant. This turbine uses the same stall regulation system as the 500kW version and includes the same twin generator and gearbox arrangement. Therefore the measured spectra of the 600kW variant can reasonably expected to be a good approximation of the 500kW version, and are used as such. The spectra are measured at a reference wind speed of 8ms^{-1} . Broadband levels at adjacent integer wind speeds vary by 1.0dB per ms^{-1} .

Table 8.8 - Derived sound power octave band levels for the Bonus 500 kW

Octave Band Centre Frequency (Hz)	A-Weighted Sound Power Level dB(A)				
Standardised 10m wind speed	6	7	8	9	10
63	75.1	76.1	77.1	78.1	79.1
125	82.5	83.5	84.5	85.5	86.5
250	87.6	88.6	89.6	90.6	91.6
500	89.9	90.9	91.9	92.9	93.9
1000	90.5	91.5	92.5	93.5	94.5
2000	87.9	88.9	89.9	90.9	91.9
4000	86.1	87.1	88.1	89.1	90.1
8000	78.7	79.7	80.7	81.7	82.7
Sum	96.0	97.0	98.0	99.0	100.0

As no associated measurement uncertainty was available for the spectra from which the levels above were derived, 2dB has been assumed.

The levels shown above are not maximum levels as higher levels can be expected up to 95% of rated power, occurring between 12ms^{-1} and 13ms^{-1} , when the turbine will yaw out of the wind into partial stall as a means of controlling power output. This method of control is known to produce more noise than the more familiar pitch controlled type. However levels for v_{10} wind speeds of 6ms^{-1} to 10ms^{-1} are assessed, covering the most sensitive range of wind speeds in terms of exceedence and potential audibility.

8.4.2.6 Sound power data for taller hub heights

Both Nordex and REPower sound power data refer to turbines that have a hub height of 80m rather than the ~60m hub heights installed at Blackstone Edge and Hazlehead. A turbine on an 80m tower would reach rated power (and therefore maximum sound power) at a lower v_{10} wind speed than a turbine on a 60m tower due to the increase in wind speed with height. This means that the sound power data used for Nordex and REPower will be an overestimate of that produced by the installed turbines at wind speeds below rated power; maximum levels will be the same but will be reached at a higher v_{10} wind speed.

8.4.2.7 Modelled distances

‘Line of sight’ distances are used and refer to the minimum (slant) distance from the hub of the nearest turbine to a height of 4m at the receptor location. Receptor locations are given in the following table with distances to the proposed development; shown to the nearest 10m.

Table 8.9 - Distance of location to the nearest proposed turbine

Location ID	Easting	Northing	Name	Minimum distance to proposed turbines (m)
1	421319	404955	Annat Royd	440
2	420431	405746	Brown's Edge	570
3	421318	403998	Carr House	850
4	420948	404239	Eagle Nest	520
5	421786	404783	Far Royd Moor	860
6	420517	403855	Flash House Farm 1	990
7	420366	403847	Flash House Farm 2	1070
8	420742	406043	Green Gate	980
9	420170	403920	Illions Cottage ¹⁷	1010
10	418562	404629	Sledbrook House	1530
11	420679	404074	Small Shaw	730
12	420481	405587	Spicer House	450
13	419980	404049	The Lanes	880
14	421332	404172	Whitley House	710
15	419742	404155	Middle Cliff	830
16	418963	405515	New Maythorn Farm	1120
17	421243	404288	Windmill Nursery	560

Three additional locations are included that were not considered in the Spicer Hill Wind Farm Environmental Statement. Middle Cliff is included as predicted levels at this location are, by a small margin, the highest for any of the properties to the south of

¹⁷ Illions Cottage is chosen to represent a number of properties at this location

the proposed turbines. New Maythorn Farm has been included to represent properties lying to the west of the site; its location was taken from the environmental statement submitted for Blackstone Edge Wind Farm. Windmill Nursery, near the existing Royd Moor Wind Farm is also included although it is not clear that this is a sensitive receptor.

8.4.2.8 Background noise levels

The background noise levels measured for the Spicer Hill Wind Farm and detailed in Chapter 10 of the Environmental Statement are used. These levels are referenced to measured 10m wind speeds while the required reference is v_{10} wind speeds. The conversion methodology is described in the section that follows. Where there is no background data for a particular Noise Sensitive Receptor (NSR), a proxy location is used based on the position of that location relative to the location where background noise levels were measured. Where the selection of background data is not a clear choice, the lowest levels were used.

8.4.2.9 Impact assessment – existing projects

Levels from the Royd Moor Wind Farm were considered cumulatively with the other three operational projects (shown in **Figure 8.1**) giving 'worst case' L_{A90} levels at the defined NSR locations.

8.4.2.10 Impact assessment – proposed layout

Cumulative turbine levels are calculated by summing the predicted levels from each of the individual developments. Cumulative levels at each NSR are compared with criteria derived from the appropriate background noise levels. Where an exceedence of criteria is shown, mitigation is proposed.

8.4.2.11 Wind speed reference conversion

A methodology for achieving this conversion is detailed in IoA GPG SGN No 4¹⁸ - *Deriving corrections for data referenced against wind data measured at 10m*. Section 4.1.3 permits historic on-site wind data to be used from which wind shear exponents are derived. It is recommended that the data coverage is a minimum of 1 year. Section 3 gives guidance on how the met-mast data should be analysed such that erroneous or unrepresentative data are identified and removed. Section 4.2 details the steps to be followed in generating the necessary exponents. These are:

- Check data coverage and instrumentation specification for compliance with IoA's GPG;

¹⁸ Institute of Acoustics, "A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise, SGN4: Wind Shear" p8, 4.1.3 - 2014

- Derive hub height and 10m wind speeds for each measurement period using power law if these heights are not directly measured; in which case they can be used directly;
- Remove erroneous or unrepresentative data;
- Calculate wind shear exponents between hub height and 10m for each measurement period;
- Bin the calculated exponents according to the measured 10m wind speed reference for each amenity period; and
- Correct measured 10m referenced data by extrapolating these wind speeds to hub height according to wind speed bin and amenity period. Hub height wind speeds are 'standardised' to 10m height using 'Log law' and a standard roughness length of (0.05m).

8.5 Baseline

8.5.1 Background noise levels

The development site is situated in a predominantly rural area, the nearest settlement being Ingbirchworth, 1.3km away. Existing noise sources in the area include road traffic noise, agricultural machinery and activities, and the existing wind farms. Historic background noise profiles were processed to provide baseline noise levels from which noise limit criteria were derived. This process requires on-site wind shear to be characterised which was achieved through the analysis of previously recorded data: A 50m met-mast was installed at the site (gps: SE 19556 05205) in September 2008 and recorded wind data over a two year period as 10 minute average values. The mast was fitted with instruments at the following heights above ground level.

Table 8.10 - Met-mast instrumentation¹⁹

Instrument	Height above ground level (m)
Anemometer 1	50.7
Anemometer 2	50.7
Wind Vane 1	48.7
Anemometer 3	34.0
Anemometer 4	34.0
Anemometer 5	20.0
Wind Vane 2	20.0

¹⁹ Original installation report available to relevant parties upon request

Having anemometer pairs at the two upper heights enabled wind shadow effects from the met-mast itself to be easily removed. Occasional icing of the upper instruments was detected and these data points were removed. The data coverage was very high and very few erroneous records were detected. Exponents were calculated between the upper two heights enabling hub height and 10m wind speeds to be calculated for each 10 minute period. Exponents were then binned with reference to the measured 10m wind speeds; the results are shown in **Figure 8.3**.

Figure 8.3 - Wind shear exponents per wind speed bin



Table 8.11 - Wind shear exponents per wind speed bin

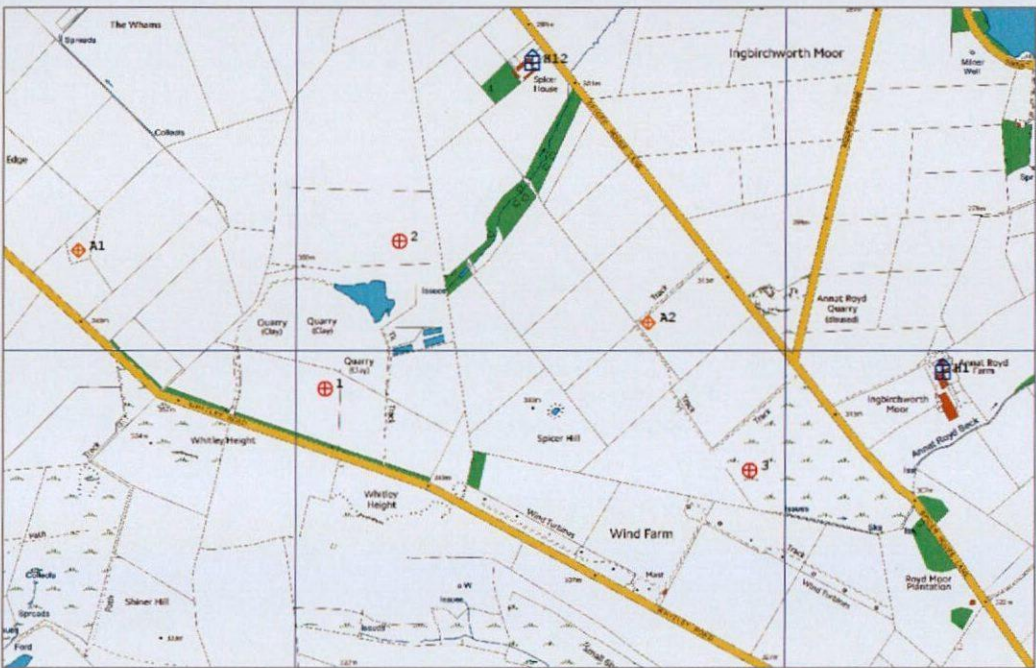
Measured 10m wind speeds	2	3	4	5	6	7	8	9	10	11	12	13
Night-time data count	4043	4741	4763	4588	3864	2761	1979	1438	1164	1015	749	534
Night-time exponent	0.334	0.279	0.239	0.207	0.189	0.174	0.160	0.151	0.140	0.132	0.129	0.127
Quiet daytime data count	2804	3881	4181	4157	3477	2827	2236	1891	1345	1134	876	605
Quiet daytime exponent	0.299	0.245	0.210	0.181	0.162	0.145	0.134	0.126	0.119	0.118	0.115	0.116

A 'power law' exponent of ~ 0.160 with respect to a 58m hub height is roughly equivalent to a 'standardised' wind profile as defined by 'log law' (roughness length = 0.05m). Therefore measured 10m and v_{10} wind speed references approximately coincide at 8ms^{-1} during night-time periods and at 6ms^{-1} during quiet daytime periods; there will be little or no change in background level as a result of wind speed reference conversion under these two scenarios. The general effect of standardising the wind speeds reference will be a downward adjustment of background levels at lower wind

speeds (where above standard shear exponents are calculated) and an upward adjustment at higher levels (where shear exponents are below standard conditions).

The 10m met-mast installed for the background noise assessment detailed in the Spicer Hill Environmental Statement was located at grid reference: SE 20720 05058. The following figure shows the relative met-mast positions; A1 is the 50m mast and A2 is the 10m mast.

Figure 8.4 - Met Mast positions relative to the proposed turbine positions



Key:

Wind turbines: ⊕ 1,2,3 | **Met-masts:** ◆ A1,A2 | **NSR locations:** 🏠 H1,H12

The mast positions are 1170m apart and A1 is ~10m higher in altitude. Both positions are relevant to the proposed turbines. A2 is in an open position being several hundred metres from any significant obstacles; it is between 390m and 750m from the Royd Moor turbines that have a rotor diameter of 40m. A2 is therefore more than 10 rotor diameters from all but one of the turbines; this is sufficient distance to limit the shading effect of the rotors on the mast such that the wind speed measurement should not be significantly effected when winds arrive from southerly directions. Wind shear measured at A1 is therefore deemed appropriate for wind speed reference conversion of background noise levels referenced to A2 (measured 10m wind speeds). A separation distance of up to 5km is can be considered, so long as topographic

features are similar²⁰. The following background noise levels were measured for the noise impact assessment of the existing Spicer Hill Wind Farm.

Figure 8.5 - Night-time periods

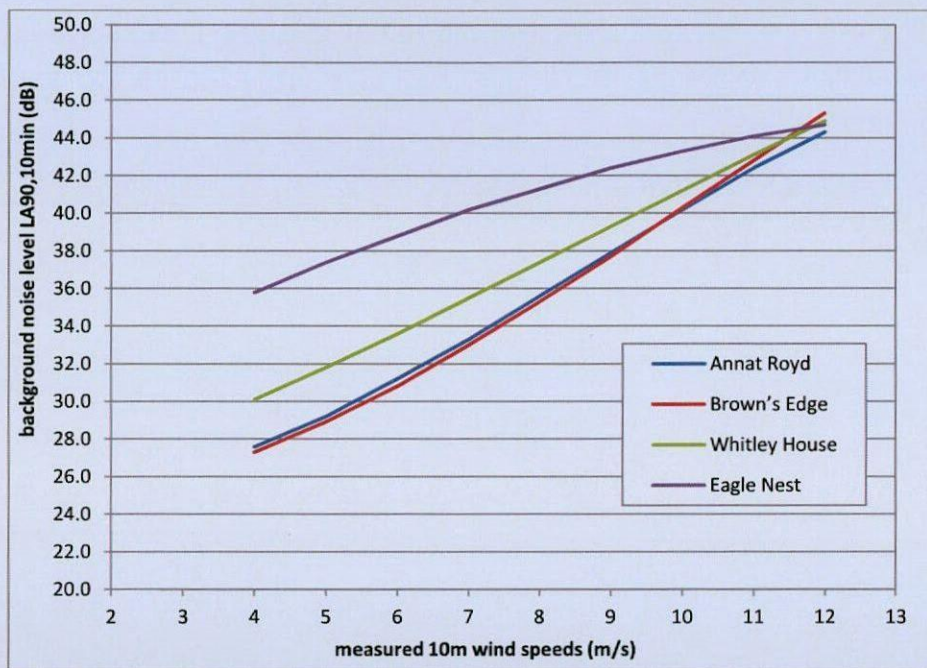
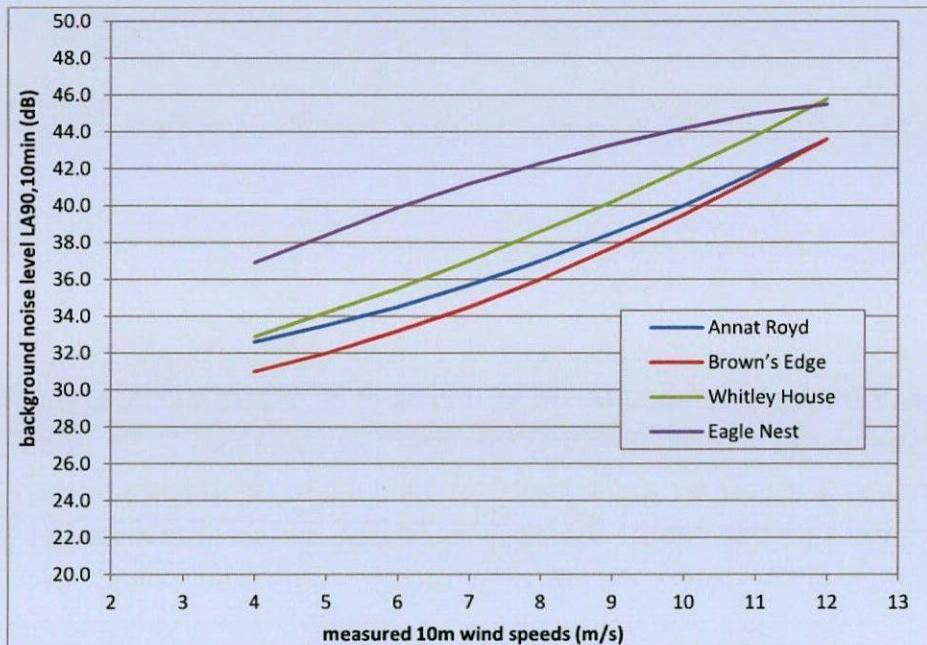


Figure 8.6 - Quiet daytime periods



²⁰ Institute of Acoustics, "A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise, SGN4: Wind Shear" p8, 4.1.3 - 2014