6. Noise

6.1 Introduction

6.1.1 This chapter has been prepared by Neil Parnell of Entec UK Ltd. Neil, an Associate Member of the Institute of Acoustics, holds a Diploma in Acoustics and Noise Control, a Certificate of Competence in Environmental Noise Measurement, MRes Marine Technology and BSc (Hons) Environmental Physical Sciences. The chapter assesses the effects of construction and operational noise upon residential receptors surrounding the proposed wind farm.

6.2 Context

Site Context

6.2.1 Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. Noise is often therefore an important consideration in the determination of planning applications.

6.2.2 Construction noise effects are normally of a temporary nature and comprise both moving and static sources. Assessment allows the temporary impact of construction noise to be understood and for suitable mitigation measures to be identified to minimise any adverse effects. The assessment of construction noise can also consider the effects of increased traffic levels where appropriate. In the context of the Blackstone Edge site, the two nearest properties are considered for effects in relation to direct noise from the construction, New Maythorn Farm and Spicer House, in addition to properties along the main access route to site for traffic noise.

6.2.3 When operational, wind turbines emit two types of noise – mechanical noise and aerodynamic noise. The main sources of mechanical noise are from internal components housed within the nacelle, such as the gearbox and generator. Mechanical noise from a modern wind turbine is negligible as the nacelles are insulated to reduce noise emissions and the various mechanical components housed within the nacelle are acoustically isolated to prevent structure borne noise. Aerodynamic noise occurs from the movement of the blades passing through the air. At higher wind speeds aerodynamic noise is usually masked by the increasing sound of wind blowing through trees and around buildings at the receptor location. In the context of the Blackstone Edge site, the two nearest properties are considered for effects in relation to noise from the development, New Maythorn Farm and Spicer House.

Policy Context

National

- Planning Policy Guidance Note 24: Planning and Noise
- Planning Policy Statement 22: Renewable Energy

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Regional

6.2.4 No regional policies are relevant to noise.

Local

- Policy ES12 'Wind Energy Generation' B) states that proposals for wind energy generation will be assessed with regard to the following:

"The impact on residential amenity with particular reference to noise, visual outlook, and shadow flicker and flashing from turbine blades."

Legislative Context

- ETSU-R-97 The Assessment and Rating of Noise from Windfarms

6.3 Methodology

Data Gathering

6.3.1 Information regarding noise emissions from a number of proposed turbines was obtained in order to predict noise levels at receptors. This information also included noise levels from the existing Royd Moor site and the recently consented Hazlehead site, taken from the associated planning application for each site.

6.3.2 Traffic data was obtained from chapter 10, Traffic and Transport.

Survey Work

6.3.3 Measurements of background noise levels at two receptors surrounding the site were taken for a period of around fourteen days and correlated with wind speeds measured at the site. These measurements are covered in depth in Section 6.4.

Scope of Study

Approach to Scoping

6.3.4 Initial modelling of operational noise emissions from the proposed wind turbines was undertaken to determine properties at which noise levels would necessitate a full assessment in accordance with ETSU-R-97.

6.3.5 This information was used to develop the approach to the noise assessment and consultation was undertaken with the Environmental Health Department of Barnsley Metropolitan Borough Council to agree the methodology.

Effects Requiring Further Consideration

6.3.6 The following effects have been scoped in:

- operational noise;
- construction noise (including construction traffic and grid connection);

Effects Not Requiring Further Consideration

6.3.7 The following effects have been scoped out:

- operational traffic noise.

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Assessment and Evaluation Methodologies

Overview of Construction and Decommissioning Noise Assessment Procedure

6.3.8 It is anticipated that the overall duration of the construction stage would be approximately 6 - 9 months, as detailed in Chapter 4. During the construction period a range of different activities would take place within the site, for example, there would be delivery of materials to the site, earthmoving within the site and turbine installation.

6.3.9 Advisory Leaflet (AL) 72 Noise control on building sites provides some guidance on acceptable levels of construction noise, stating that between 07:00 to 19:00 in rural, suburban and urban areas away from main road traffic and industrial noise sources, the noise level should not exceed 70 dB(A) when measured outside the nearest occupied room. An assessment of construction noise is made following the methodology laid out in British Standard (BS) 5228 Noise and Vibration Control on Construction and Open Sites.

6.3.10 It is assumed that decommissioning noise will be generally less or, at worst realistic case, similar to that experienced during the construction period. It can therefore be assumed that noise relating to the decommissioning of the windfarm may also be perceptible at the receptors, but will be limited by restricting working hours and transport routes.

Overview of Traffic Noise Assessment Procedure

6.3.11 Following guidance presented in the Design Manual for Roads and Bridges, a noise assessment is only necessary for a change in traffic flow of greater than 25%. This equates to a change in noise levels of 1dB, which is noted as being the point at which adverse effects can occur.

6.3.12 Subject to the above screening criteria, the likely level of noise resulting from traffic movements can be predicted using the methodology found in the document Calculation of Road Traffic Noise. This model uses numbers, type of vehicle movement and speed of vehicles to calculate likely noise generated by traffic. Where sufficient data is available for the routes to site (generally the main road network), a comparison will be drawn between levels that would pertain should the development proceed compared with those that would pertain if they did not.

6.3.13 Given the low levels of traffic expected throughout the operational phase of the wind farm, this is not considered in the assessment.

Overview of Operational Noise Assessment Procedure

6.3.14 In England, advice specific to noise emanating from wind energy developments can be found in Planning Policy Statement 22. Paragraph 22 guides the assessment process as follows:

"The 1997 report by ETSU for the Department of Trade and Industry should be used to assess and rate noise from wind energy development."

6.3.15 Furthermore, Planning for Renewable Energy – A Companion Guide to PPS22, expands the point by presenting a discussion of the broad issues surrounding noise from wind farms, detailing why the ETSU-R-97 method is accepted over other possible assessment techniques. Experience has now demonstrated that the

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implementation of these recommendations has enabled the operation of wind farms without giving rise to noise difficulties. This methodology has therefore been adopted for the Blackstone Edge Wind Farm assessment.

6.3.16 The advice presented in the document was produced by the Working Group on Noise from Wind Turbines, a body comprising a number of interested parties including, amongst others, windfarm operators, environmental health officers, acoustic consultants and legal experts. The assessment approach was developed to address the shortcomings of other standards in addressing windfarm noise.

6.3.17 An explanation of noise terminology is provided in the Glossary and Abbreviations (Appendix A).

Noise limits

6.3.18 The acceptable limits for wind turbine operation noise are defined in ETSU-R-97. The test for operational noise is therefore whether or not the calculated windfarm noise levels at receptor properties lie below the noise limits derived in accordance with ETSU-R-97.

6.3.19 ETSU-R-97 provides a simplified approach if predicted operational noise at receptors is limited to an $L_{A90,10min\ of\ 35dB}$ in wind speeds up to 10ms-1 at 10m height. Preliminary modelling for the Blackstone Edge Wind Farm indicated that noise was likely to exceed this threshold at a number of properties surrounding the site. Hence, the guidance recommends that windfarm noise limits should be set relative to existing background noise levels, subject to a fixed minimum limit, and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. The wind speeds that should be considered range from the cut-in speed (the wind speed at which the turbine begins to generate power, commonly around 4ms-1) up to 12ms-1, the point at which wind turbines are usually at 95% of their rated power and thus no significant increases in noise emission are expected. Wind speeds are referenced to a 10m measurement height (V10).

6.3.20 The daytime noise limit is derived from background noise data measured during 'quiet daytime' at residential properties, which comprise:

- all evenings from 18:00 - 23:00; plus
- Saturday afternoons from 13:00 - 18:00; and
- all day Sunday 07:00 - 23:00.

6.3.21 The data is plotted against the concurrent wind speed data measured at the proposed Blackstone Edge Wind Farm site and a 'best fit' correlation is established.

6.3.22 In low noise environments (i.e. where background noise levels are less than 30-35dB(A)), ETSU-R-97 recommends that windfarm noise for quiet daytime periods should be limited to an absolute fixed level within the range $L_{A90,10min}$ 35-40dB or 5dB(A) above the prevailing background, whichever is the greater. The lower absolute fixed level selected for Blackstone Edge is 35dB(A), reflecting the relatively small size of the scheme.

6.3.23 The night-time noise limit is derived from background noise data measured during the night-time 23:00 to 07:00 every day. As with the daytime data, this is plotted

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against the concurrent wind speed data and a 'best fit' correlation established. For night time periods the recommended limits are $L_{A90,10min}$ 43dB or 5dB(A) above prevailing background, whichever the greater.

6.3.24 The ETSU-R-97 noise criteria assume that the wind turbine noise contains no audible tones. Where tones are present a correction is added to the measured or predicted noise level before comparison with the recommended limits. The level of correction will depend on the amount by which the tone exceeds the audibility threshold.

Operational Noise Modelling

6.3.25 Whilst there are several noise propagation models available, the model used is that found in ISO 9613-2. The model takes account of:

- geometric divergence (attenuation with distance);
- air absorption;
- barriers (including buildings or topography);
- screening (including vegetation); and
- ground absorption and reflection.

6.3.26 The ISO 9613-2 algorithm has been chosen as being the most robust prediction method, based on the findings of a joint European Commission research project into windfarm noise propagation over large distances (Bullmore & Sloth, 1998). According to this research, this model (like all the others considered in the research) tends to over-estimate noise levels at nearby dwellings, rather than under-estimate it. The over-riding conclusion of the study was that the ISO 9613-2 algorithm tended to predict noise levels that would generally occur under down wind propagation conditions.

6.3.27 The other important outcome of the research was to demonstrate that under upwind propagation conditions, between a given receiver and the windfarm, the windfarm noise level at that receiver will be as much as 10dB(A) to 15dB(A) lower than the level predicted using the ISO 9613-2 algorithm.

6.3.28 Calculations were undertaken using LIMA noise propagation software. For the purposes of the present assessment, all noise level predictions have been based upon the following model parameters:

- a receiver height of 4.0m above local ground level - to represent the height of a typical bedroom window;
- hard ground (G = 0) - in reality the ground between the turbines and receptors is almost entirely porous, hence including an element of hard ground in the model is a conservative assumption since hard ground has virtually no absorptive properties; and
- air absorption based on a temperature of 10°C and 70% relative humidity.

6.3.29 ETSU-R-97 states the $L_{A90,10min}$ descriptor should be used for both the background noise and windfarm noise when setting limits and the $L_{A90,10min}$ is likely to be about

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1.5 to 2.5dB less than the $L_{Aeq,10min}$. The noise model predicts operational noise levels in terms of L_{Aeq}. In this instance it is assumed the $L_{A90,10min}$ is 1.5dB less than the $L_{Aeq,10min}$ presenting the most conservative case.

Cumulative Impacts

6.3.30 The Blackstone Edge Wind Farm is located less than 1km from the operational Royd Moor wind farm. In addition, planning permission has recently been granted for the development of a small wind farm known as Hazlehead, approximately 1.7km south west of the site. Schemes further afield are not considered as they would have negligible noise impact.

6.3.31 As agreed with the Environmental Health Officer of Barnsley MBC, in order to take account of the cumulative effects of all three schemes operating simultaneously, the noise modelling described below includes a contribution from all of the schemes.

6.3.32 The existing background noise measurements were undertaken with the Royd Moor turbines operating, but during site visits the Royd Moor site was not audible at either New Maythorn or Spicer House. The predicted noise levels associated with the Hazlehead and Royd Moor schemes were added to the predicted levels from the proposed Blackstone Edge turbines and the total wind turbine noise from all three sites assessed against ETSU guidelines.

6.3.33 Noise source data for the Royd Moor turbines was obtained from the wind farm operators. The equivalent data for the Hazlehead turbines was obtained from the Environmental Statement submitted in support of the planning application. In summary, the predicted noise levels below include the contribution of all three schemes operating simultaneously.

6.4 Description of Baseline Conditions

Off-Site

6.4.1 Background noise monitoring was undertaken at two properties surrounding the Blackstone Edge Wind Farm site, the locations of which are shown on Figure 6.1 and listed in Table 6.1. The equipment was left in-situ and data collected from 11 December 2006. The equipment was not recovered until 3 January 2007, however the batteries had expired earlier and no further data was logged after 26 December 2006.

Table 6.1 Noise Monitoring Locations

Receptor	Easting#	Northing#	Monitoring Position
Spicer House	420479	405628	Yard to northwest of house
New Maythorn Farm	418963	405515	Northeast corner of garden

#GPS coordinates

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6.4.2 A 10m high meteorological monitoring mast was installed on the site concurrently to collect simultaneous 10 minute-averaged wind speed, direction and rain data. Figure 6.2 shows the range of wind speeds and directions which were recorded over the monitoring period. Where rainfall occurred, the noise and wind speed data has been excluded from the assessment and is not presented within the figures. During the survey, wind speeds up to around 14ms-1 were recorded during both quiet daytime and night-time periods. Winds were generally south-westerly.

6.4.3 The equipment used for the background noise monitoring comprised Rion NL-31 Class 1 integrating logging sound level meters. These were enclosed in an environmental case with sufficient battery power to enable approximately 10 days continuous logging at the required 10 minute averaging periods, logging the L_{A90}, L_{A50}, L_{A10}, L_{Aeq}, L_{Amax}, and L_{Amin}. The measurement systems were fitted with appropriate wind and rain protection for the microphone to maintain Class 1 measurement accuracy. All microphones were located a sufficient distance away from reflective façades in a location deemed to be representative of background noise at the property, away from any obvious local sources of noise. Photographs of the measurement location are provided in Appendix C.

6.4.4 The sound level meters were calibrated on deployment and recovery. The batteries were changed and the meter calibrated once during the survey. No significant drifts in calibration were noted at any point.

6.4.5 The upper graphs on Figure 6.3 and Figure 6.4 present charts showing the 10 minute average wind speed plotted against noise levels measured for the same period, together with a calculated 'best fit' line, for both day and night-time periods at the two locations. The charts exclude periods of rainfall.

6.4.6 A summary of the measured levels is provided in Table 6.2, together with a qualitative description of the background noise environment. In general, it was noted that the ambient noise environment at the receptors was dominated by natural sources, including the wind blowing through trees, and animals. Distant traffic was also audible at both locations. The existing Royd Moor Wind Farm was not audible at either location during the survey visits.

6.4.7 The values of the best-fit background noise curve and subsequent noise limit derived following the ETSU-R-97 procedure described in Section 6.3 are detailed later in Table 6.5 and Table 6.6.

Table 6.2 Summary of Background Noise Levels at Receptors

Receptor	Quiet Daytime $L_{A90,10min}$	Night-Time $L_{A90,10min}$	Construction Hours $L_{Aeq,10min}$	Description of Noise Environment
Spicer House	21 - 62	19 - 61	27 - 66	Birdsong, wind in trees, distant traffic
New Maythorn Farm	21 - 63	19 - 64	32 - 74	Wind, livestock, aircraft, wildlife, distant traffic, agricultural activity

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Predicted Future Baseline

6.4.8 It is reasonable to assume that over time, background noise levels in the vicinity of the wind farm will increase gradually in line with increased traffic levels.

6.5 Mitigation

6.5.1 Mitigation, offsetting and enhancement proposals are outlined below. No mitigation measures are identified for operational noise as the site complies with the noise limits derived. Significant effects associated with construction traffic noise are forecast to occur for a short period only (three days), therefore no mitigation is proposed.

Construction and Decommissioning

6.5.2 Construction noise is transient in nature and can generally be controlled by following standard industry practices, applying best practicable means and using modern, well-maintained and serviced items of plant.

6.5.3 No specific mitigation is required with regards to construction noise. However, general guidance for controlling construction noise is given in British Standard 5228. E.ON propose to implement the following mitigation measures concerning construction noise:

- Restricted hours of working (08:00 to 19:00 Monday to Friday, 08:00 - 13:00 Saturdays and no audible activities Sundays) to avoid sensitive periods. Any requirement to work outside of these periods would only occur through prior agreement with the local planning authority (for example turbine erection requires low wind speed conditions and may require longer working hours if conditions are poor at the time).
- All construction activities to be undertaken in accordance with good practice as set out in BS5228:1997.
- All employees on the Blackstone Edge Wind Farm construction site will be advised of quieter methods of operating plant and tools, and to report any damage to noise control measures as soon as they are identified.
- Where practicable, for any particular activity, locally available and suitable plant, machinery and working practices would be adopted. All equipment will be maintained in good working order and will be fitted with appropriate noise controls at all times (e.g. silencers, mufflers and acoustic hoods).
- Construction plant capable of generating significant noise and vibration levels will be operated in a manner to minimise the duration of the higher magnitude levels.
- The site will register with the Considerate Constructors Scheme, a government endorsed scheme which encourages good practice on construction sites. Registered sites provide a commitment to comply with a Code of Practice which details how the construction site should present itself to and interact with the general public, and includes guidance on managing noise emissions.

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6.6 Assessment of Potential Effects

Construction and Decommissioning Noise

6.6.1 Construction noise may arise through the operation of large items of plant on site, such as heavy goods vehicles, excavators, dumper trucks and cranes. In terms of plant operations on site, it is likely that the most noise-intensive period of activity will occur during the laying of turbine foundations, which may require piling of the bases and filling with concrete over a short period of time.

6.6.2 The nearest receptor to the turbines, New Maythorn Farm, is situated 616m from the nearest turbine location and a similar distance from any access tracks; distance attenuation alone over this separation is greater than 55dB. Thus, it is not anticipated that levels will exceed the AL72 recommended limit of 70dB(A) for construction site noise, given that the combined sound power level of plant operating at the turbine location would have to exceed 133dB(A) for this to occur, which is highly unlikely. Typical combined sound power levels for construction activities would be more likely to be in the region of 116-120 dB(A). Limited potential for occasionally significant noise effects may occur when work is closest to the receptors, though such effects will be short-lived and transient in nature, given that the access tracks to the turbines lie within the site boundary itself. It is assumed that decommissioning noise will be less than, or as a worst-case, comparable with construction noise.

6.6.3 The site is to be connected to the electricity distribution network by underground cable. It is understood this will be laid alongside the existing road network. Typical plant for this operation would include two excavators (one carrying the cable drum), a roller, delivery lorry and small dumper. Using BS5228 methodology, based on this plant operating 66% of the time, at a distance of 10m from the nearest property, noise levels of 56dB(A) are predicted. This is significantly below the AL72 criterion of 70dB(A). It should also be noted that the operations would be mobile and would only be in proximity of a single property for a short period.

Traffic Noise

6.6.4 Traffic noise consists of two main parts:

- vehicle engine/exhaust noise; and
- tyre noise.

6.6.5 Noise from traffic travelling along a road consists of a contribution from a number of different sources. The overall traffic noise level is influenced by traffic flow, speed and composition (% HGVs), road gradient and road surface. The noise experienced by a nearby receptor is dependent upon the separation distance from the road and any intervening ground cover and/or screening.

6.6.6 As noted in Chapter 10, the maximum traffic impact associated with the construction of the wind farm will occur during month four, when 128 two-way HGV trips per day are forecast for three days during the concrete deliveries. For the remainder of the scheme, when concrete deliveries are not taking place, a maximum of 18 daily two-way trips is forecast.

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6.6.7 Details of the more typical level of movements and base traffic levels are also given in Chapter 10 for Royd Lane and the A628, the access route to site. The resulting changes are as follows:

- **Non-concrete delivery days** - maximum of 18 two-way HGV trips per day - due to high existing numbers of HGV movements on the A628, this 3.2% change in traffic results in a less than 1dB change in noise levels. For Royd Lane, lower existing traffic levels mean that the change in HGV movements is around 30%. However, this also equates to a change in noise levels of less than 1dB. Hence traffic noise impacts for non-concrete pouring days are not considered significant.

- **Concrete delivery** – maximum 128 two-way HGV trips per day for three days – for the A628, this is a 23% increase in HGV movements, again resulting in a change in traffic noise of less than 1dB. For Royd Lane this increase represents a 213% change in traffic noise levels and subsequent increase in traffic noise levels of 3.2dB. This level of change will be perceptible at the properties, and is thus considered a significant effect for the three days of concrete deliveries.

Operational Noise

6.6.8 There is a range of commercially available turbines that would be appropriate to the Blackstone Edge Wind Farm site. The final selection of turbine will follow a competitive tendering process and thus the actual model of turbine may differ from that on which this assessment has been based. However, the final choice of turbine will be required to comply with the noise criterion levels which have been established for the site within this noise assessment.

6.6.9 A number of candidate wind turbines satisfying the proposed dimensions for the site have been assessed for noise compliance, including the Vestas V80, the Nordex N80 and the Repower MM82. It was concluded that all of these machines would satisfy the noise limits derived in this assessment. In order to maintain simplicity of this noise assessment and consistency with the rest of the ES, this assessment considers only the Repower MM82.

6.6.10 The turbine MM82 turbine has a nominal power of 2MW. Noise data for this turbine has been obtained from the following sources:

- sound power levels for integer wind speeds - *Sound Power Level of REpower MM82*[i]; and

- one-third octave spectra - *Summary of results of then noise emission measurement, in accordance with IEC 61400-11, of a WTGS of the type REpower MM82*[ii].

6.6.11 At a reference wind speed of V10 = 10ms-1 (i.e. wind speed at 10 metres height, as referred to in ETSU-R-97) the turbine operates with its maximum sound power level L_{WA} = 105.5dB. The data provide an indication of the variation in sound output with wind speed over the range 4 to 12ms-1 as detailed in Table 6.3. In order to take account of any measurement uncertainty and thus present the worst case, the values have been increased by the 0.7dB uncertainty quoted in the test report referred to above from which the one-third octave spectra was taken.

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Table 6.3 Repower MM82 Sound Power Levels

	Wind Speed at 10m Height (V_{10}) ms^{-1}							
	3	4	5	6	7	8	9	10
Data as provided by Repower	89.2	93.2	99.6	101.7	102.6	103.8	104.8	105.5
Data used for modelling#	89.9	93.9	100.3	102.4	103.3	104.5	105.5	106.2

#Sound power levels increased by 0.7dB to account for measurement uncertainty

6.6.12 The sound emitted by wind turbines consists of a number of different frequencies, some of which are more dominant than others. These frequencies are grouped together into what are known as octave bands or spectra. Within each spectrum the highest frequency is twice the lowest frequency and the octave bands are defined by the centre frequency. The addition of these spectra will give an overall sound power level for the turbine. The amount of absorption over a given distance depends on the frequency of the noise - high frequencies are absorbed more readily than low frequencies.

6.6.13 Third-octave spectra data for the Repower MM82 turbine are detailed in Table 6.4. These were determined in a wind speed of V10 = 8ms-1. The spectrum is scaled to the appropriate total sound power level detailed in Table 6.3 by the modelling software.

Table 6.4 One-Third Octave Band Spectra of Repower MM82

Centre Frequency (Hz)	L_{WA} (dB)	Centre Frequency (Hz)	L_{WA} (dB)	Centre Frequency (Hz)	L_{WA} (dB)
50	77.5	315	95.3	2,000	89.4
63	81.7	400	95.2	2,500	87.2
80	85.8	500	93.4	3,150	84.2
100	89.4	630	92.4	4,000	81.9
125	92.3	800	91.6	5,000	77.2
160	93.8	1,000	90.8	6,300	73.0
200	95.9	1,250	90.5	8,000	66.1
250	95.8	1,600	91.0	10,000	59.4

6.6.14 Noise levels have been predicted for the two closest residential properties to the wind farm, as shown on Figure 6.1. The predicted noise levels also include a contribution from the Royd Moor and Hazlehead turbines.

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6.6.15 Table 6.5 and Table 6.6 present the following information for each integer wind speed for both properties for daytime and night-time respectively:

- values of the background noise curve, measured as described in Section 6.3;
- the noise limits derived from the background noise curve, in accordance with ETSU-R-97;
- the predicted turbine noise levels, based on the above data and including the contribution of the Royd Moor and Hazlehead turbines; and
- the margin by which the turbine noise meets the noise limit.

6.6.16 Figure 6.3 and Figure 6.4 present this information graphically. It should be noted that the predicted turbine noise is equal for both day and night-time; the assessment is presented separately to take account of the different noise limits which are applicable.

Table 6.5 Noise Assessment Results - Daytime

Wind Speed V_{10} (ms^{-1})	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
New Maythorn								
Background noise curve	32.6	34.3	36.1	37.8	39.5	41.2	43.0	44.7
ETSU-R-97 derived noise limit	37.6	39.3	41.1	42.8	44.5	46.2	48.0	49.7
Predicted turbine noise*	26.7	31.5	37.7	39.7	40.5	41.6	42.6	43.2
Margin under noise limit#	-11.0	-7.9	-3.4	-3.1	-4.0	-4.6	-5.4	-6.5
Spicer House								
Background noise curve	30.5	32.1	33.8	35.5	37.1	38.8	40.5	42.1
ETSU-R-97 derived noise limit	35.5	37.1	38.8	40.5	42.1	43.8	45.5	47.1
Predicted turbine noise*	25.2	29.4	37.7	39.1	39.8	40.7	41.5	42.1
Margin under noise limit#	-10.3	-7.7	-1.1	-1.4	-2.3	-3.1	-3.9	-5.0

Noise levels are dB $L_{A90,10min}$

*Includes contribution from Hazlehead and Royd Moor turbines

#Negative values indicate the predicted turbine noise lies under noise limit

Table 6.6 Noise Assessment Results - Night-time

Wind Speed V_{10} (ms^{-1})	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
New Maythorn								
Background noise curve	29.5	31.4	33.3	35.2	37.1	39.0	40.8	42.7

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Wind Speed V_{10} (ms^{-1})	3	4	5	6	7	8	9	10
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	44.0	45.8	47.7
Predicted turbine noise*	26.7	31.5	37.7	39.7	40.5	41.6	42.6	43.2

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Table 6.7 (continued) Noise Assessment Results - Night-time

Wind Speed V_{10} (ms^{-1})	3	4	5	6	7	8	9	10
Margin under noise limit#	-16.3	-11.5	-5.3	-3.3	-2.5	-2.3	-3.3	-4.5
Spicer House								
Background noise curve	27.5	29.3	31.1	32.9	34.6	36.4	38.2	40.0
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.0
Predicted turbine noise*	25.2	29.4	37.7	39.1	39.8	40.7	41.5	42.1
Margin under noise limit#	-17.8	-13.6	-5.3	-3.9	-3.2	-2.3	-1.7	-2.9

Noise levels are dB $L_{A90,10min}$

*Includes contribution from Hazlehead and Royd Moor turbines

#Negative values indicate the predicted turbine noise lies under noise limit

6.6.17 It can be seen from Table 6.5 and Table 6.6 that the worst-case noise levels predicted are over 1dB below the ETSU-R-97 derived noise limits at Spicer House and over 2dB below at New Maythorn.

Other Operational Noise Issues

Tonality

6.6.18 The manufacturer's noise reports also provide information on the tonal noise characteristics of the Repower MM82 wind turbine. A number of tones were identified during the measurements, the audibility of which were assessed as in excess of -13dB. Thus, the turbine would incur no tonal penalty under ETSU-R-97.

6.6.19 The manufacturer of the turbine eventually installed at the site would be required to demonstrate that the turbine noise contains no tonal components which would require a penalty when assessed in accordance with ETSU-R-97 or, where tonal components warrant a penalty, the noise limits specified herein are met taking into account any penalty appropriate.

Wind Shear

6.6.20 The emission levels detailed above are referenced to a wind speed at a height of 10m. In consideration of the fact that the wind speed at hub height will be greater than that experienced at 10m above ground level the standard practice for measuring the noise emitted by a wind turbine (BS EN 61400-11:2003) includes a procedure for determining wind speed at 10m height from the measured level at hub height, based upon accepted wind shear profiles for particular ground conditions.

6.6.21 Meteorological conditions can lead to a change in the stability of the atmosphere and associated wind shear profile; hence the wind speed at hub height may differ from that encountered under test conditions for the same wind speed at 10m above ground level. This may result in higher or lower noise emissions from the turbine. However, recent data presented by Botha demonstrates that the extent to which the stability of the atmosphere can change is influenced by the topography of the site.

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Where the surrounding terrain is complex in nature, as at the Blackstone Edge Wind Farm site, the potential changes will be much less significant than for a site in a flat area. Consequently, for this site it is not considered necessary to make adjustments to the noise emissions quoted above to reflect the potential phenomenon of enhanced wind shear.

Infrasound and Low Frequency Noise

6.6.22 Information published by the British Wind Energy Association presents a review of a number of sources of information on low frequency noise. Based upon these sources, it is concluded that levels lie below the threshold of perception even for those who are particularly sensitive to such noise, even on the actual windfarm site itself.

6.6.23 More recently, the Department of Trade and Industry commissioned report The Measurement of Low Frequency Noise at Three UK Wind Farms presents the results of a number of measurements taken at sites throughout the UK. The study concluded that modern wind turbines are not sources of infrasound at levels which could be injurious to health of a windfarm neighbour. Furthermore, the report goes on to describe how some low frequency noise measurements inside properties near to a windfarm were above the threshold of audibility. However, at all of the measurement sites low frequency noise associated with traffic movement along local roads was greater than that associated with the windfarm.

6.6.24 In the discussion of noise within the technical annex on wind energy, the Companion Guide to PPS22 goes on to state in paragraph 45:

"There is no evidence that ground transmitted low frequency noise from wind turbines is at a sufficient level to be harmful to human health."

Aerodynamic Modulation

6.6.25 The noise limits derived following the procedure recommended by ETSU-R-97 take into account the phenomenon of aerodynamic modulation (occasionally termed amplitude modulation or blade swish) to a certain extent and thus afford receptors some protection. However, the Department of Trade and Industry study into low frequency noise referred to above also investigated the phenomenon of aerodynamic modulation.

6.6.26 It was found that internal noise levels associated with aerodynamic modulation were above the threshold of audibility at some properties. While measurements indicated these were not high enough to awake occupiers of a room, they could result in difficulties returning to sleep once awoken.

6.6.27 Following publication of the report, the Department of Trade and Industry published a guidance note to advise planning authorities on the issue. It states that concerns apparently relating to the phenomenon have been expressed at 5 out of 126 windfarms throughout the UK. It is categorically stated that ETSU-R-97 should continue to be used for the assessment of noise from windfarms.

6.6.28 Given that little is known about the causes or locations where the phenomenon occurs, that there is currently no method of dealing with the issue, and that it only

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occurs at a small number of UK sites, it is not considered necessary to further consider the issue for Blackstone Edge Wind Farm.

6.7 Summary of Significance Evaluation

6.7.1 Table 6.7 summarises the evaluation of effects.

Construction and Decommissioning Noise

6.7.2 As outlined in Section 6.4, construction noise is not anticipated to exceed the AL72 criteria of 70dB(A) at the nearest receptors to the site, given the high separation distance and compact nature of the site working areas, including access tracks. It is accepted that the works may be audible at the nearest receptors, and that limited potential for occasionally significant noise effects may occur when work is closest to the receptors, though such effects will be short-lived and transient in nature. It is assumed that decommissioning noise will be less than, or as a worst-case comparable with construction noise. Consequently, noise from the construction and decommissioning of the scheme is assessed as not significant.

Traffic Noise

6.7.3 For the road network assessed in Chapter 10, Traffic and Transport, the greatest increase in traffic will occur during the three days when concrete deliveries are taking place. This will result in a change in traffic noise levels of over 3dB on Royd Lane, which is considered a significant impact. However, this is only the case for Royd Lane; the wider road network is afforded a level of not significant. Furthermore, this will only occur for three days during the construction programme, the maximum credible impact for the remainder of the programme is not significant for all road sections.

Operational Noise

6.7.4 The assessment has derived noise limits for the windfarm using the methodology specified in ETSU-R-97 The Assessment and Rating of Noise from Wind Farms. These limits are repeated in Table 6.6, together with the predicted noise levels from the operation of the windfarm at the two properties assessed. The margin by which the predicted turbine noise lies within the limit are also specified. It can be seen that the predicted windfarm noise levels lie in excess of 1dB below the limits (as indicated by negative values in the table).

6.7.5 Figure 6.3 and Figure 6.4 demonstrate this point graphically. Consequently, taking into account these facts and the other issues discussed in Section 6.4, including low frequency noise, wind shear, tonality and aerodynamic modulation, it is concluded that the windfarm will have no significant effects in relation to operational noise.

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Table 6.8 Summary of Effects and Evaluation of Significance

Receptor and summary of predicted effects	Type of effect[1]	Significance[2]
Construction/decommissioning noise on residential receptors	-ve	NS
Traffic noise on residential receptors for three days of concrete delivery	-ve	S
Operational noise on residential receptors	-ve	NS

Key/footnotes:

1. Type of effect	-ve = negative + ve = positive N = Neutral ? = unknown	**2.**	S or NS	Significant Not-significant

6.8 References

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