10 NOISE

10.1 INTRODUCTION

This chapter presents an assessment of the potential noise effects of the proposed Spicer Hill Wind Farm ('the Development') on nearby noise sensitive receptors during the construction, operation and decommissioning phases. It takes account of the consultation responses that have been received in relation to the previous application for Spicer Hill Wind Farm (reference 2008/0804) pertaining to noise.

Cognisance has also been taken of new guidelines on best practice methods to be employed in wind farm noise assessments, as published in a recent article in the Institute of Acoustics *Acoustics Bulletin*[1].

The aim of the assessment is to predict the effects of noise at the nearest noise sensitive receptors (residential properties) and assess this against relevant standards and guidelines.

A glossary of acoustic terminology can be found at the end of this chapter.

A Noise Technical Appendix, included as Technical Appendix A10 in Volume III of this ES, presents descriptions of methodologies and data used in this assessment.

This chapter contains the following sections:

- Consultations – summary of consultation undertaken in relation to the noise assessment;
- Legislation and Guidance – documents used to inform scope and assessment;
- Methodology – details of survey and assessment methodology including significance criteria (details of when an effect is and is not significant);
- Baseline – identification of receptors, relevant desktop information and field result surveys;
- Assessment – identification of potential impacts, assessment of impacts;
- Mitigation – details of any mitigation proposed and mitigation already incorporated into the project design;
- Residual Effects – identification of any effects remaining after mitigation is applied;
- Summary of Effects – summary table identifying receptor, mitigation and residual effect for construction, operation and decommissioning; and
- Statement of Significance – details of any significant effects predicted as part of the assessment.

10.2 CONSULTATION

A Scoping exercise was undertaken in August 2007 to gather the views of key stakeholders regarding the form and content of the ES. The sole respondent in relation to the issue of noise was the Highways Agency highlighting the potential for noise to result in driver distraction. As recommended by the Highways Agency, the site has good approach visibility which would minimise the potential for distraction.

Consultation was carried out with Barnsley Metropolitan Borough Council (BMBC) Regulatory Services in order to agree certain aspects of the noise assessment methodology and locations for the baseline noise survey. Copies of consultation correspondence are included in Technical Appendix A10, and summarised as follows:

[1] Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects, Bowdler et al, Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics.

- Four baseline noise monitoring locations were agreed, as detailed in Section 10.5.3: *Measurement of Baseline Noise Levels*; and
- Noise from the turbines at the existing Royd Moor wind farm was to be considered as part of the existing background noise due to their being a long-established land use.

BMBC confirmed that over the operational lifespan of the existing Royd Moor Wind Farm two complaints have been received. The first dates from commissioning in 1994 and was satisfactorily resolved and the second was recorded in March 2008. This recent complaint related to mechanical noise emanating from one turbine and following maintenance, no further complaints have been received[2].

10.3 LEGISLATION AND GUIDANCE

The following guidance and information sources have been considered in carrying out this assessment:

- Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (as amended) (EIA Regulations);
- PPS22 Renewable Energy (2004)[3];
- PPG24 Planning and Noise (1994);
- ETSU-R-97 The Assessment and Rating of Noise from Wind Farms;
- The measurement of low frequency noise at three UK wind farms, Hayes McKenzie, The Department for Trade and Industry, URN 06/1412, 2006;
- Research into aerodynamic modulation of wind turbine noise. Report by University of Salford, Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2009;
- ETSU W/13/00385/REP: A Critical Appraisal of Wind Farm Noise Propagation[4]; and
- Prediction and Assessment of Wind Turbine Noise, Bowdler et al. (2009)[5].

10.3.1 Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (as amended)

The relevant provisions of this document are set out in Chapter 2: *Environmental Impact Assessment* of this ES.

10.3.2 PPS22 Renewable Energy

PPS22 provides guidance to local authorities on policy matters relating to renewable energy developments. In terms of noise, it states:

"*Renewable technologies may generate small increases in noise levels (whether from machinery such as aerodynamic noise from wind turbines, or from associated sources – for example, traffic). Local planning authorities should ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels. Plans may include criteria that set out the minimum separation distances between different types of renewable energy projects and existing developments. The 1997 report by ETSU for the Department of Trade and Industry should be used to assess and rate noise from wind energy development*".

The Companion Guide to PPS22[6] provides further details of technical aspects of renewable energy technologies. In terms of noise from wind turbines, it describes its character and

[2] J. Scott, pers. com.

[3] Planning Policy Statement 22: Renewable Energy, Office of the Deputy Prime Minister, 2004

[4] ETSU W/13/00385/REP: A Critical Appraisal of Wind Farm Noise Propagation, ETSU for the DTI 2000

[5] Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects, Bowdler et al, Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics.

[6] Planning for Renewable Energy, A Companion Guide to PPS22, Office of the Deputy Prime Minister 2004

sources, and restates that ETSU-R-97 should be used in the assessment process. It also states that there is no evidence that ground transmitted low frequency noise from wind turbines is at a sufficient level to be harmful to human health.

10.3.3 PPG24: Planning and Noise

PPG24 provides guidance to local authorities in England on the use of their planning powers to minimise the adverse effects of noise. It:

- Outlines considerations to be taken into account in determining planning applications both for noise-sensitive developments and for those activities which will generate noise;
- Recommends appropriate levels for exposure to different sources of noise; and
- Advises on the use of conditions to minimise the effects of noise.

It gives no specific guidance on the assessment of noise from wind farms.

10.3.4 ETSU-R-97

ETSU-R-97 provides a framework for the assessment and rating of noise from wind turbines and is now the accepted standard for wind farm developments in the UK, and the methodology has therefore been adopted for the present assessment.

ETSU-R-97 recommends the application of noise limits at the nearest noise-sensitive properties, to protect outside amenity and prevent sleep disturbance inside dwellings. It proposes that site-specific noise criteria are adopted based on the background noise. Noise from wind turbines and background noise both typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.

ETSU-R-97 states that the noise limits should apply to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question, and that an existing wind farm should not be considered as part of the prevailing background noise.

10.3.5 The measurement of low frequency noise at three UK wind farms

A study[7], published in 2006, by Hayes McKenzie on the behalf of the DTI investigated low frequency noise from wind farms. This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines. It also noted, however, that a phenomenon known as Aerodynamic Modulation was in some isolated circumstances (5 out of 126 operating wind farms in the UK) occurring in ways not anticipated by ETSU-R-97.

10.3.6 Research into Aerodynamic Modulation of wind turbine noise

A further study[8] was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with Amplitude Modulation. This report defined Amplitude Modulation (AM) as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency. Its aims were to ascertain the prevalence of AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

[7] 'The measurement of low frequency noise at three UK wind farms', Hayes Mckenzie, The Department for Trade and Industry, URN 06/1412, 2006

[8] 'Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.

The study concluded that AM has occurred at only a small number (4 of 133) of wind farms in the UK, and only for between 7% and 15% of the time. It also states that the causes of AM are not well understood as yet, and that prediction of the effect is not currently possible. The study recommends against further research into the phenomenon at this stage, and no revision to the current guidelines (ETSU-R-97) on wind farm noise assessment is recommended.

10.3.7 ETSU W/13/00385/REP: A Critical Appraisal of Wind Farm Noise Propagation

This document is discussed in Section 10.4.2: *Prediction of Noise Levels.*

10.3.8 Prediction and Assessment of Wind Turbine Noise

An article in the March / April 2009 Edition of the Institute of Acoustics' *Acoustics Bulletin*[9] set out a number of preferred procedures for the prediction and assessment of wind farm noise and the form in which some information should be presented to support an environmental noise assessment for a proposed wind farm development. The authors of the article included members of the Noise Working Group responsible for the preparation of ETSU-R-97, and a sample of those who represent both developers and objectors groups. The recommendations in the article are intended to enhance the quality of wind farm noise assessments and usefully limit areas of disagreement between parties acting for developers and those acting for objectors, and supplement the recommendations of ETSU-R-97.

The following issues were addressed:

- The acquisition of baseline data;
- The prediction of wind turbine noise immission level at receptors locations; and
- The significance of low-frequency noise, infrasound and ground-borne vibration.

Details of how the recommendations of this article have been applied in the assessment are provided in the relevant sub-sections of Section 10.4: *Methodology*.

10.3.8.1 Vibration and Low Frequency Noise

The IOA Bulletin article[9] concludes that:

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

10.4 METHODOLOGY

The assessment of the effect of noise from the operation of the proposed wind farm has been conducted in accordance with ETSU-R-97. ETSU-R-97 specifies the use of the $LA_{90,10min}$ descriptor for both background noise and turbine noise and assumes free-field conditions. (see Section 10.10 Glossary) All references to noise levels in this chapter therefore refer to this descriptor unless otherwise stated. Similarly, unless otherwise stated all wind speeds refer to a height of 10 m above ground level.

10.4.1 Baseline Noise Survey

ETSU-R-97 provides a method for determining existing background noise. Typically, the baseline assessment requires the measurement of background noise at sensitive receptors, along with wind speed at the location of proposed turbines, 10 m above ground level. Predicted noise levels from the proposed wind farm are then compared with criteria based on noise limits specified in ETSU-R-97.

[9] Ibid.

ETSU-R-97 states that the noise limits should apply to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question, and that an existing wind farm should not be considered as part of the prevailing background noise.

There can be practical difficulties inherent in trying to fulfil this requirement: it can be difficult to obtain the agreement of the operator of an existing wind farm to shut down their turbines so that a survey can be carried out for another project; alternatively correcting measured background noise levels by subtracting a calculated level for the existing wind turbines may be inaccurate.

During consultation with the Council it was agreed that the existing turbines are to be considered a component of the prevailing background noise for the purposes of the current assessment. Notwithstanding this, the assessment carried out includes the contribution of noise from Royd Moor within the predicted noise levels and measures were taken during the baseline noise survey to minimise the effects of noise from the existing turbines in order that the above requirement of ETSU-R-97 is fulfilled as far as reasonably practicable.

The recommendations of the *Acoustics Bulletin* article with respect to background noise data relate principally to the measurement and use of wind speed data, against which background noise measurements are correlated. The article recommends measuring wind speeds at two heights, H1 and H2, H1 being not less than 60% of the proposed turbine hub height and H2 being between 40% and 50% of proposed hub height. For each ten minute period the mean wind speed measured at height H1 should be corrected to hub height using a specified procedure, which takes account of the wind shear conditions occurring during that 10-minute period. The calculated hub height wind speed is then corrected to 10 m height using the procedure specified in BS EN 61400-11:2003[10] Section 8.1, which applies a standardised wind shear profile. This allows for site-specific wind shear characteristic to be taken into account and for a comparison with measured wind turbine noise emissions to be made on a like-for-like basis.

The article goes on to state that where background noise surveys are carried out for sites where wind speeds can only be measured at 10 m height, then the noise assessment should take account of the wind shear variations using a method which should be clearly explained. This correction could be applied either to the background noise levels or to the noise immission levels at receptors. However, reliance on 10 m measured wind speeds should be avoided where possible: the procedure above is preferred. Where noise assessments are based solely on measured 10 m height wind speeds, then noise limits in Planning Conditions must also refer to measured 10 m height wind speeds, measured at the same (or equivalent) location as that adopted for the background noise surveys.

At the time of the baseline noise survey, the only available option for measuring wind speeds was a 10 m anemometer mast. At this stage, no corrections for wind shear have been made as insufficient information on the shear characteristics of the site is available. However, the potential for effects arising from variations in wind shear is discussed in Section 10.6.3: *Effect of Enhanced Wind Shear*.

10.4.2 Prediction of Noise Levels

ETSU-R-97 does not provide guidance on appropriate prediction techniques. However, a review of wind farm noise propagation was carried out on behalf of ETSU in 2000[11]. This review examined a number of alternative prediction techniques and provided recommendations on appropriate methods. Based on these, the prediction method used for

[10] BS EN (IEC) 61400-11:2003 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques
[11] ETSU W/13/00385/REP: A Critical Appraisal of Wind Farm Noise Propagation, ETSU for the DTI 2000

this assessment was that detailed in ISO 9613[12] with the exception that barrier attenuation has been omitted.

The *Acoustics Bulletin* article also recommends the use of the ISO 9613-2 method in calculating the levels of wind turbine noise at receptor locations ('immission levels'), with the following specific measures:

- The turbine sound power levels should be stated, and whether these are measured levels, measured levels with an allowance for measurement uncertainty, warranted levels or generic level;
- The atmospheric conditions assumed should be stated, with 10°C and 70% Relative Humidity preferred;
- The ground factor assumed should be either:
  - (i) G=0 (hard ground), together with measured sound power levels; or
  - (ii) G=0.5 (mixed ground); together with manufacturer's warranted sound power levels, or measured sound power levels plus an allowance for measurement uncertainty.
- A receiver height of 4.0 m;
- Barrier attenuation should not be included; and
- The predicted noise levels ($L_{Aeq,t}$) may be converted to the required $L_{A90,10min}$ by subtracting 2 dB.

The above procedure has been followed in the prediction of noise levels, with manufacturer's warranted sound power levels employed and a ground factor of G=0.5. This varies from the assessment presented in the original ES, where soft ground (G=1) was assumed, together with warranted sound power data and a receiver height of 2.0 m. The result of this is an increase in predicted noise levels, relative to those that would be obtained using the previous procedures, of approximately 2 dB(A).

A computer model (SoundPLAN) has been used to implement the methodology specified in ISO 9613.

The predicted noise levels are worst-case (downwind) levels based upon conservative assumptions of the attenuation during propagation. Noise levels in practice are likely to be lower than predicted for the majority of the time.

10.4.3 Noise Sources

The candidate wind turbine model for the purposes of the noise assessment has been revised from the WinWinD 1 MW to the Enercon E70 Mode II 2.3 MW, with a maximum blade tip height of 95 m. Enercon have provided guaranteed noise emission data and a measurement test report for this turbine model. Table 10.1 details the turbine's noise emissions (sound power levels) in relation to the wind speed at 10 m AGL. A +1 dB safety margin is applied to the guaranteed values as recommended by Enercon. The manufacturer's data is included in Appendix 10. Enercon guarantee that the noise emissions are free of tonal or impulsive elements.

[12] ISO 9613-2: 1996 Acoustics – Attenuation of sound During Propagation Outdoors – part 2: General Method of Calculation.

Table 10.1: Noise Emissions – Enercon E70 Mode II 2.3 MW, Hub Height 64 m[13]

Wind Speed at 10 m AGL, ms^{-1}	4	5	6	7	8	9 and above
Manufacturer's Guaranteed Sound Power Level, L_{WA}, dB(A)	90.8	93.6	98.8	101.4	103.1	104.5
Sound Power Level Assumed for Assessment, L_{AW}, dB(A)	91.8	94.6	99.8	102.4	104.1	105.5

Turbine selection is likely to be subject to a competitive procurement process. A warranty will be sought from the manufacturer of the model selected that noise emissions will not exceed those assessed, *i.e.*, those detailed in Table 10.1, and that the turbine selected will be free of tonal or impulsive elements such that would require a penalty to be added under the terms of ETSU-R-97.

Noise Levels have also been calculated for the Royd Moor wind turbines, using a sound power level of 98 dB(A) at all wind speeds, based on information provided in the Environmental Statement for Royd Moor. It has been assumed that the spectrum of the WinWinD turbines, corrected to the appropriate broadband sound power level provides a fair representation of the noise from the existing turbines. T

Nearby wind farms at Hazelhead and Blackstone Edge have also been included in the predicted noise levels.

Noise levels for the Hazelhead turbines have been calculated, assuming the Sound Power Levels detailed in Table 10.2 under 'Assessment Envelope', which take into account the characteristics of the most common turbines within the size range consented (80 m rotor diameter, 60 m hub height). The Vestas V80 1/3-octave spectrum was assumed.

Table 10.2: Noise Emissions, Hazelhead Turbines

Turbine Model	Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)								
Vestas V80	n/a	n/a	103.9	104.8	105.3	105.3	105.3	n/a	n/a
Nordex N80	98.0	100.5	102.5	103.0	103.5	104.0	104.0	104.5	105.0
Assessment Envelope	**98.0**	**100.5**	**103.9**	**104.8**	**105.3**	**105.3**	**105.3**	**105.3**	**105.4**

Noise levels for the Blackstone Edge Wind Farm have been calculated using noise emission data detailed in the Blackstone Edge Wind Farm Environmental Statement[14], reproduced in Table 10.3.

Table 10.3: Noise Emissions, Blackstone Edge Turbines

Turbine Model	Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)								
Assessment Envelope	**93.9**	**100.3**	**102.4**	**103.3**	**104.5**	**105.5**	**106.2**	**106.2**	**106.2**

The predicted noise levels for Spicer Hill, Royd Moor, Hazelhead and Blackstone Edge have been logarithmically summed[15] and the total noise levels assessed.

[13] Enercon do not provide sound power levels for a hub height of 60m, those for 64m have been used rather than the 58m values as a worse-case measure.

[14] Proposed Blackstone Edge Wind Farm, Barnsley, South Yorkshire, Environmental Statement, January 2008, Entec UK Limited

10.4.4 Noise Limits

Separate noise limits apply for quiet day-time and night time, as outlined below.

Quiet daytime is defined in ETSU-R-97 as 18:00 – 23:00 every day, as well as 13:00 – 18:00 on Saturday and 07:00 – 18:00 on Sundays. During these periods, the guidance prioritises the protection of outdoor amenity for residents, by applying noise limits that would not significantly affect the enjoyment of areas such as gardens.

ETSU-R-97 proposes the adoption of a site standard of 5 dB(A) above the prevailing wind varying background noise level. This is based on wide experience in environmental acoustics that noise from a new source is unlikely to cause annoyance where the predicted increase is less than 5 dB (A) above the existing background.

In addition to the limit of 5 dB(A) above background, an allowance is included for a fixed lower limit to be applied at wind speeds or locations where background noise levels are low. Where the quiet daytime background noise level is less than 30-35 dB(A), the limit is defined as 35-40 dB(A). The value selected for the fixed lower limit depends on the following: the number of affected dwellings, the effect of noise limits on the output of the proposed wind farm, and the duration and level of exposure.

In this instance, the 40 dB(A) limit has been applied due to the proximity of the Development to the existing Royd Moor Wind Farm. The Royd Moor turbines were erected prior to the adoption of ETSU-R-97 and noise levels relating to the Development are not controlled by a planning condition.

The quiet daytime limit also applies to all other daytime periods, with the limits based on the quiet daytime background noise level.

Different standards apply at night, where sleep disturbance is the primary concern rather than the requirement to protect outdoor amenity. Night-time is considered to be all periods between 23:00 and 07:00. A limit of 43 dB(A) is recommended for night-time at wind speeds or locations where the background noise level is less than 38 dB(A). Where background noise levels exceed 38 dB(A) the limit is set to 5 dB(A) above the background noise level.

The noise limits derived from ETSU-R-97 for this assessment are therefore:

- Daytime: the higher of 40 dB(A) or 5 dB(A) above the derived quiet daytime background noise level; and
- Night-time: the higher of 43 dB(A) or 5 dB(A) above the derived night-time background noise level.

There is also provision for an increase in the fixed lower limit value where the occupier of the property has a financial interest in the proposed wind farm. In this situation, the limit for both daytime and night-time becomes the higher of 45 dB(A) or 5 dB(A) above the derived background noise level for the relevant period.

10.4.5 Significance Criteria

ETSU-R-97 does not define criteria for whether effects should be considered significant or not, but rather what levels of wind farm noise should be considered to be acceptable. It also provides guidance on managing wind turbine noise through the use of appropriate planning conditions. Therefore, no assessment in terms of significance has been made; the assessment instead determines whether the predicted levels of operational noise levels would comply with the requirements of ETSU-R-97.

[15] Sound levels are summed logarithmically, rather than arithmetically, see Appendix 10.1

10.5 BASELINE DESCRIPTION

10.5.1 Description of Local Noise Environment

The Development site is situated in a predominantly rural area, with the nearest settlement being Ingbirchworth, approximately 1 km away. Existing noise sources in the area include road traffic noise, agricultural machinery and activities, and the existing Royd Moor Wind Farm. The latter has been in operation since 1993 and as such, BMBC has indicated that in their view it would be acceptable to consider this to be a part of the existing background noise in the area.

10.5.2 Identification of Potential Noise Receptors

Potential receptors were identified through examination of Ordnance Survey Digital Mapping at 1:10,000 scale, aerial photographs showing the Development site, Ordnance Survey Address Layer 2 (OSAL2) Data[16] and site visits.

The extents of the noise assessment and baseline noise survey were defined by producing a noise contour plot for the area around the Development site (see Figure 10.1). This presents updated predicted noise levels for the highest noise emission level of the candidate turbine as contours. These were calculated using the same procedure as discussed in Section 10.4: *Methodology*, and include the calculated, worst-case, contribution from the existing Royd Moor and Hazelhead and Blackstone Edge turbines. Properties with the potential to be significantly adversely affected were identified using the noise contour plot thus allowing further assessment to be directed at appropriate receptors.

Figure 10.1 also shows 'Dwellings' identified in the OSAL2 Data, baseline noise and wind monitoring locations and the noise assessment locations employed (see below).

The lowest noise limit specified in ETSU-R-97 is 35 dB(A), therefore only properties located within the 35 dB(A) contour have been considered for assessment. All other properties will experience levels lower than 35 dB(A), and would therefore be in compliance with ETSU-R-97 should the Development be constructed.

Twelve properties have been selected for specific assessment, as detailed in Table 10.4 and shown in Figure 10.1. These represent the potentially most sensitive properties, i.e. those closest to the Development which may experience overall wind farm noise levels in excess of 35 dB(A). In addition, Sledbrook House (Crow Edge) has been included, as the noise contour plot indicates a number of properties in this region where the predicted overall wind farm noise level is slightly greater than 40 dB(A), the lower noise limit applied in the assessment, of which Sledbrook House is shown to have the highest predicted noise level . This latter property is intended to represent a worst-case, representative of all other properties within the 35 dB(A) contour not included in the assessment locations.

[16] A GIS dataset that combines OS building locations data from large-scale mapping with Royal Mail address data.

Table 10.4: Noise Assessment Locations[17]

Name	X	Y	Nearest Turbine	Separation, m
Annat Royd	421319	404955	2	717
Brown's Edge	420431	405746	2	599
Carr House	421318	403988	1	1,082
Eagle Nest	420948	404239	1	666
Far Royd Moor	421786	404783	1	1,155
Flash House Farm 1	420517	403855	1	977
Flash House Farm 2	420366	403847	1	1,014
Green Gate	420742	406043	2	861
Illians Corner[18]	420170	403920	1	1,016
Sledbrook House	418562	404629	3	1,853
Small Shaw	420679	404074	1	735
Spicer House	420481	405587	2	433
The Lanes	419980	404049	3	979
Whitley House	421332	404172	1	958

10.5.3 Measurement of Baseline Noise Levels

The baseline survey was carried out between the 12th of February and the 5th of March 2008, and in accordance with ETSU-R-97 as follows

- Type 1 measuring equipment, equipped with suitable windshields, was used. The equipment was calibrated at the start of the survey, and calibration checked after one week and at the end of the survey. no significant calibration drift occurred;
- Measurements were performed at a height of 1.4 m AGL, in free-field conditions, *i.e.*, a minimum of 3.5 m, and where possible at least 10 m, from any reflective surface other than the ground;
- Background noise levels were recorded at continuous 10-minute intervals, as $L_{A90,10min}$;
- Wind speeds were measured simultaneously at a height of 10 m AGL at a location representative of the proposed turbine locations (NGR 420720, 405058). The location of the wind speed measuring mast is shown in Figure 10.1;
- A rain gauge was installed on the wind mast to record levels of precipitation. Measurements obtained from any one-hour periods when rainfall was recorded were excluded from further analysis;
- Periods where the sound level meters recorded an over-range reading were also excluded; and
- An equivalent of a minimum of one week of data was obtained for each monitoring location, after exclusions are taken into account.

In order to minimise the effects of noise from the existing Royd Moor Wind Farm, the monitoring equipment was positioned, where possible, so that there was not a direct line of sight between the microphone and the wind turbines, due to screening by buildings or topography. The one exception to this was Whitley House where two to three turbines were visible.

Table 10.5 provides a summary of the background noise monitoring locations employed. Copies of survey records are included in Technical Appendix A10.

[17] NB the distances presented here are plan distances, those in the model outputs contained in Appendix 10 are slant distances, which take account of the relative elevations of the source and receiver.

[18] Illions Corner is the closest of a group of five properties (Illions Cottage, Illions Lodge, Illions Barn, Illions House, Illions Corner) situated close to one another. The group is identified on OS 1:10,000 scale Digital Mapping as Illion's cottage and was previously presented in this way.

Table 10.5: Baseline Noise Survey Locations

Location	Description of Monitoring Location	Grid Reference (NGR) of Monitoring Location	Noise Sources Present
Annat Royd	Edge of field NE of house	421349, 404973	Distant traffic, farm activities, dairy.
Brown's Edge	Corner of garden NE of house	420465, 405769	Distant traffic, farm machinery.
Whitley House	Garden E of house	421351, 404169	Dogs, traffic, wind.
Eagle Nest	Corner of garden east of house	420979, 404214	Farm traffic, wind, dogs.

The measured background noise levels and wind speeds have been correlated and sorted into quiet daytime and night-time periods, as defined in ETSU-R-97 (see Section 10.4.4: *Noise Limits*). Plots of background noise level against wind speed have been prepared (Charts 10.1 to 10.8) for each monitoring location for quiet daytime and night-time. A regression analysis was carried out, and lines of best fit added to each chart to represent the 'derived background noise level'.

The resident of Annat Royd stated that noise from their dairy was likely to be audible at times when milking was carried out (approximately 0530 to 0830 and 1630 to 1930). Measurements from this location were examined and results from these times that appeared elevated (*i.e.*, where there was a clearly discernible and sudden increase in the background noise levels to approximately 40-43 dB(A)) were excluded. This resulted in a reduction in the derived background noise levels of less than 2 dB(A), and is considered to be a conservative approach, as the noise from the milking activities could reasonably be considered as a normal part of the background noise in this location.

The results from each monitoring location were also examined to ascertain whether noise from the existing Royd Moor Wind Farm was contributing significantly to the prevailing background noise levels. This was achieved by excluding measurements from periods when the wind direction was such that the monitoring locations were downwind of Royd Moor (based on a range of 90 degrees either side of the direction from the centre of the wind farm to the monitoring location). This was found to have a minimal effect on the derived background noise levels (typically +/- < 0.5 dB(A)), and resulted in a reduction in the number of usable measurements for each location to below the minimum required by ETSU-R-97. Results from the full range of wind directions have therefore been included.

Table 10.6 details the derived background noise level for quiet daytime and night-time for each monitoring location for the assessment range of 4 ms^{-1} (cut-in) to 12 ms^{-1}

Table 10.6: Derived Background Noise Levels

Location	Period	Wind Speed, 10 m AGL, ms^{-1}								
		4	5	6	7	8	9	10	11	12
		Background Noise Level, $LA_{90,10min}$, dB(A)								
Annat Royd	Quiet Daytime	32.6	33.5	34.5	35.7	37.0	38.5	40.0	41.8	43.6
	Night-time	27.6	29.2	31.2	33.3	35.6	37.9	40.2	42.4	44.3
Brown's Edge	Quiet Daytime	31.0	32.0	33.2	34.5	36.0	37.7	39.5	41.5	43.6
	Night-time	27.3	28.9	30.8	33.0	35.3	37.7	40.3	42.8	45.3
Whitley House	Quiet Daytime	32.9	34.2	35.5	37.0	38.6	40.2	42.0	43.8	45.8
	Night-time	30.1	31.8	33.6	35.5	37.4	39.3	41.2	43.1	44.9
Eagle Nest	Quiet Daytime	36.9	38.4	39.9	41.2	42.3	43.3	44.2	45.0	45.5
	Night-time	35.8	37.4	38.8	40.2	41.3	42.4	43.3	44.1	44.7

The background noise levels obtained at Brown's Edge have been applied to the receptors where monitoring was not carried out. The results from this location were selected for the following reasons:

- The derived background noise levels from this location were generally the lowest of those obtained; and
- This location is farthest of the monitoring locations from the existing Royd Moor wind turbines and is therefore likely to be the least affected by noise from this source.

For the above two reasons, this approach is considered to be conservative.

Chart 10.1: Annat Royd - Quiet Daytime Background Noise Levels

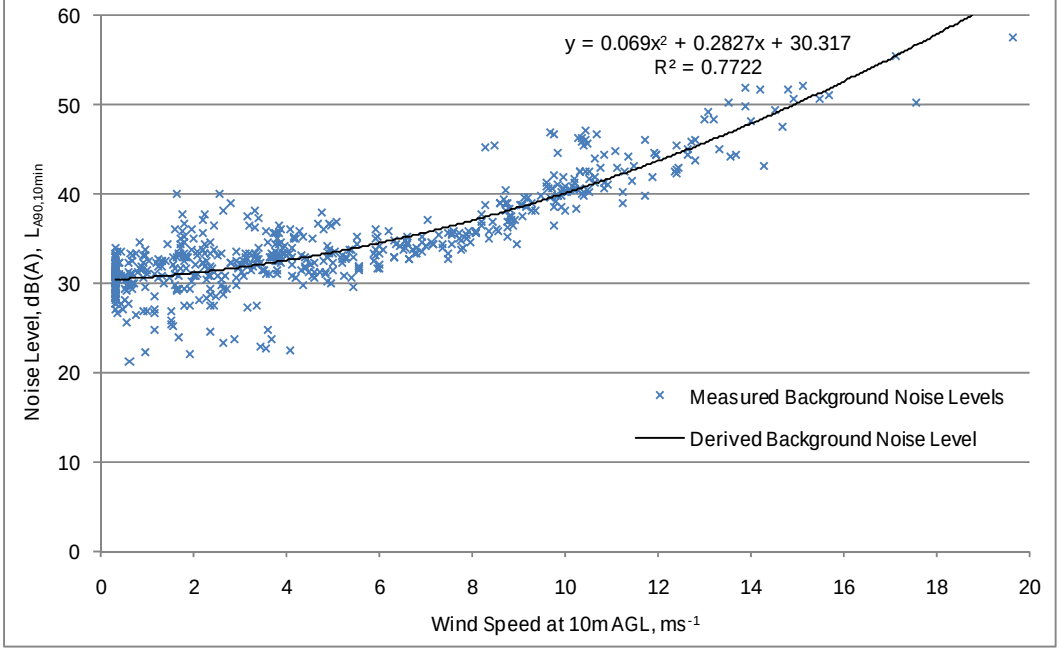
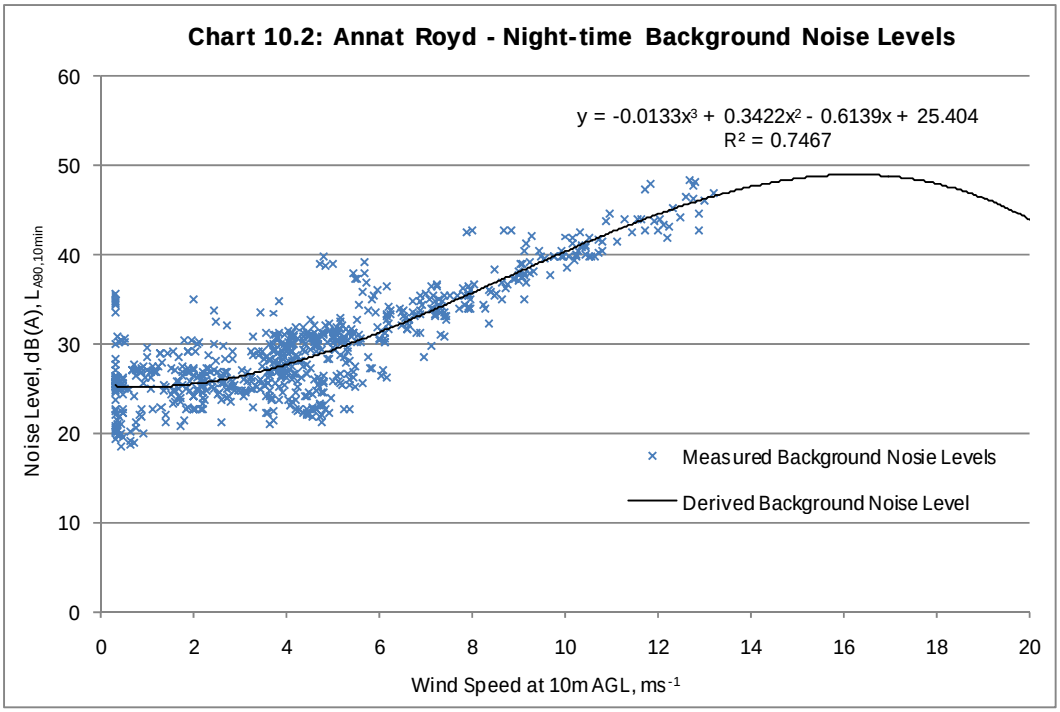


Chart 10.2: Annat Royd - Night-time Background Noise Levels



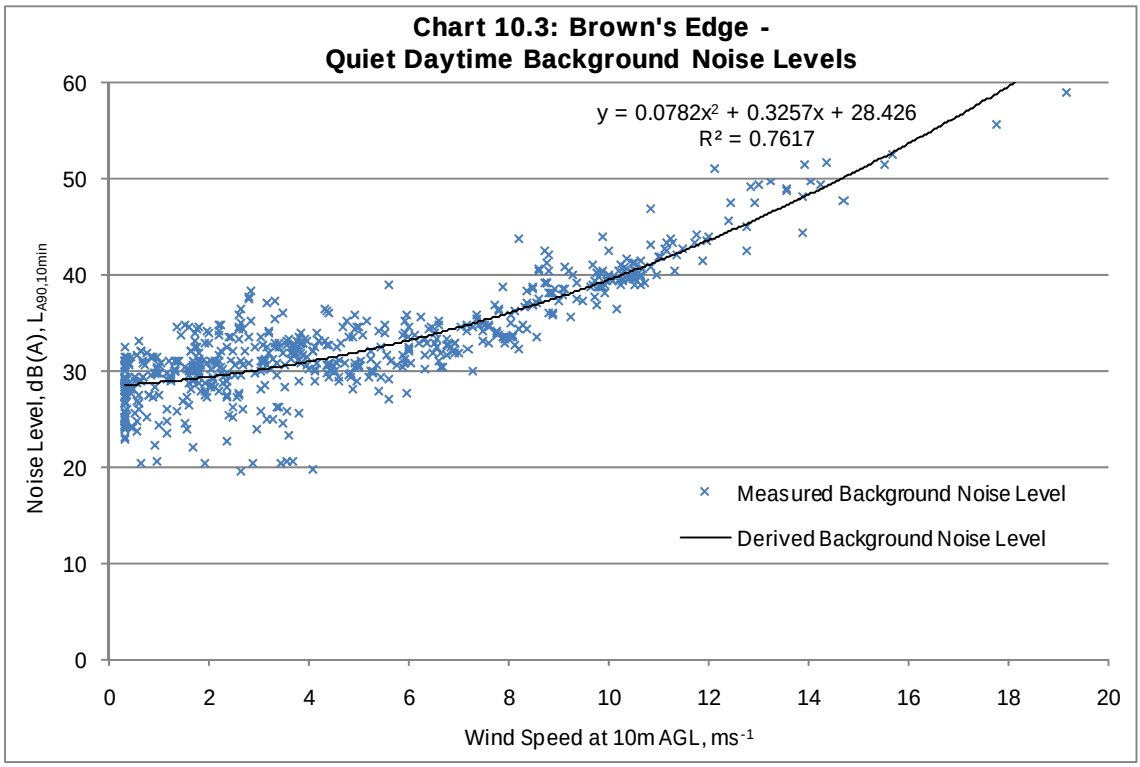


Chart 10.3: Brown's Edge -
Quiet Daytime Background Noise Levels
y = 0.0782x² + 0.3257x + 28.426
R² = 0.7617
Noise Level, dB(A), LA90,10min
Wind Speed at 10m AGL, ms-1
Measured Background Noise Level
Derived Background Noise Level
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

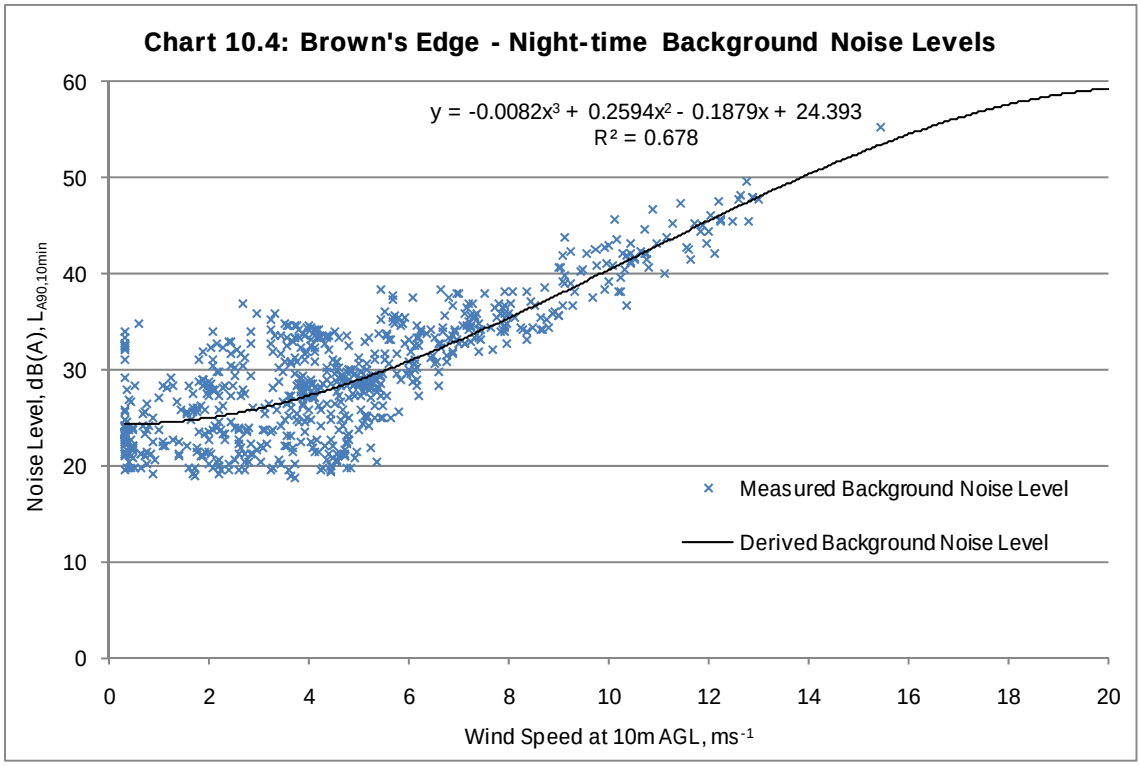


Chart 10.4: Brown's Edge - Night-time Background Noise Levels
y = -0.0082x³ + 0.2594x² - 0.1879x + 24.393
R² = 0.678
Noise Level, dB(A), LA90,10min
Wind Speed at 10m AGL, ms-1
Measured Background Noise Level
Derived Background Noise Level
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

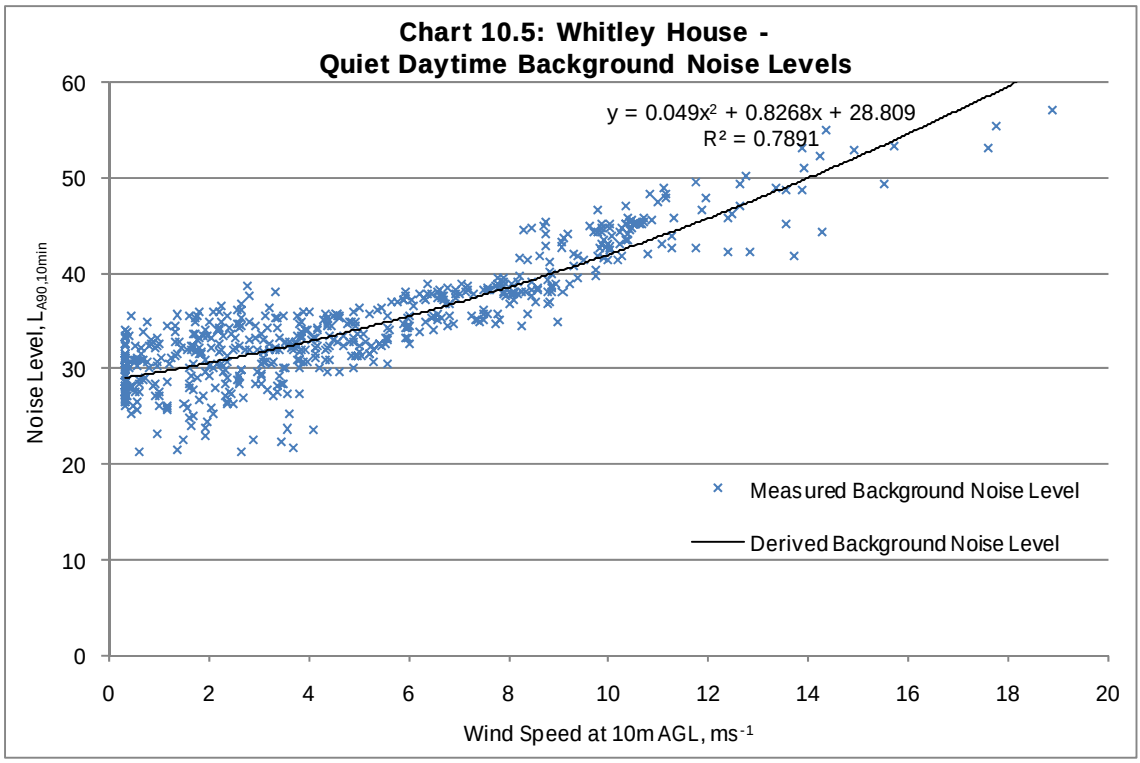


Chart 10.5: Whitley House -
Quiet Daytime Background Noise Levels
y = 0.049x² + 0.8268x + 28.809
R² = 0.7891
Measured Background Noise Level
Derived Background Noise Level
Noise Level, L_A90,10min
Wind Speed at 10m AGL, ms-1
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

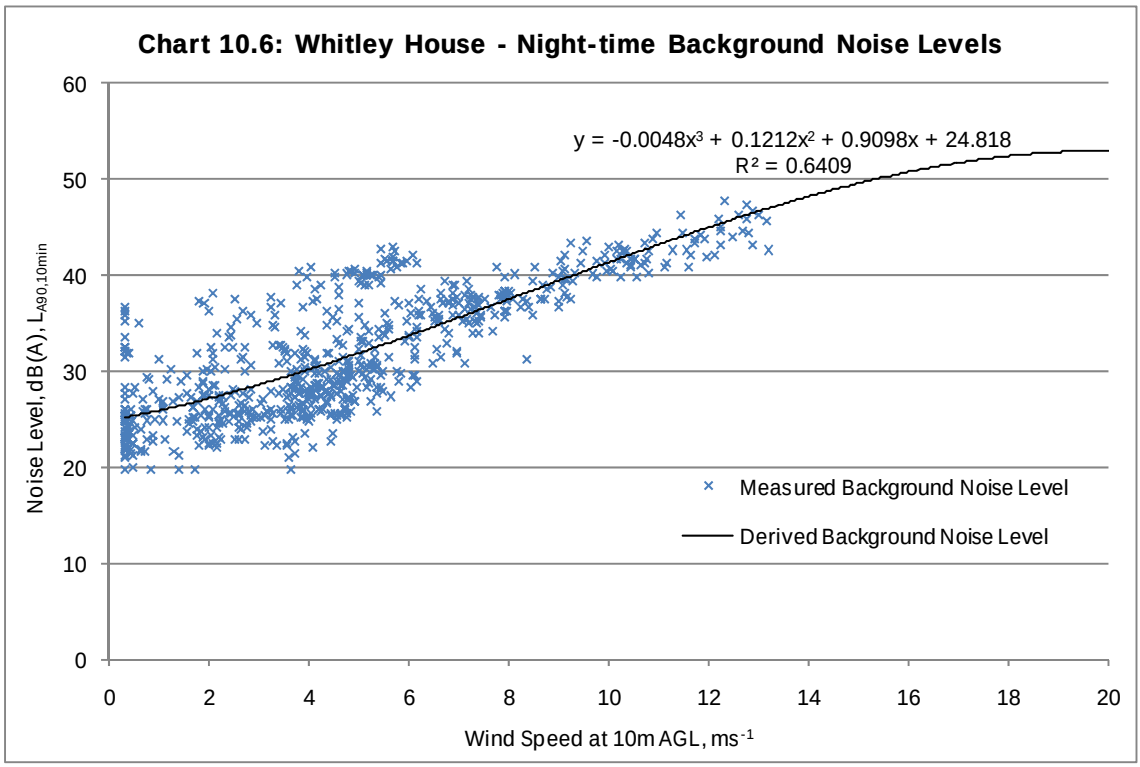


Chart 10.6: Whitley House - Night-time Background Noise Levels
y = -0.0048x³ + 0.1212x² + 0.9098x + 24.818
R² = 0.6409
Measured Background Noise Level
Derived Background Noise Level
Noise Level, dB(A), L_A90,10min
Wind Speed at 10m AGL, ms-1
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

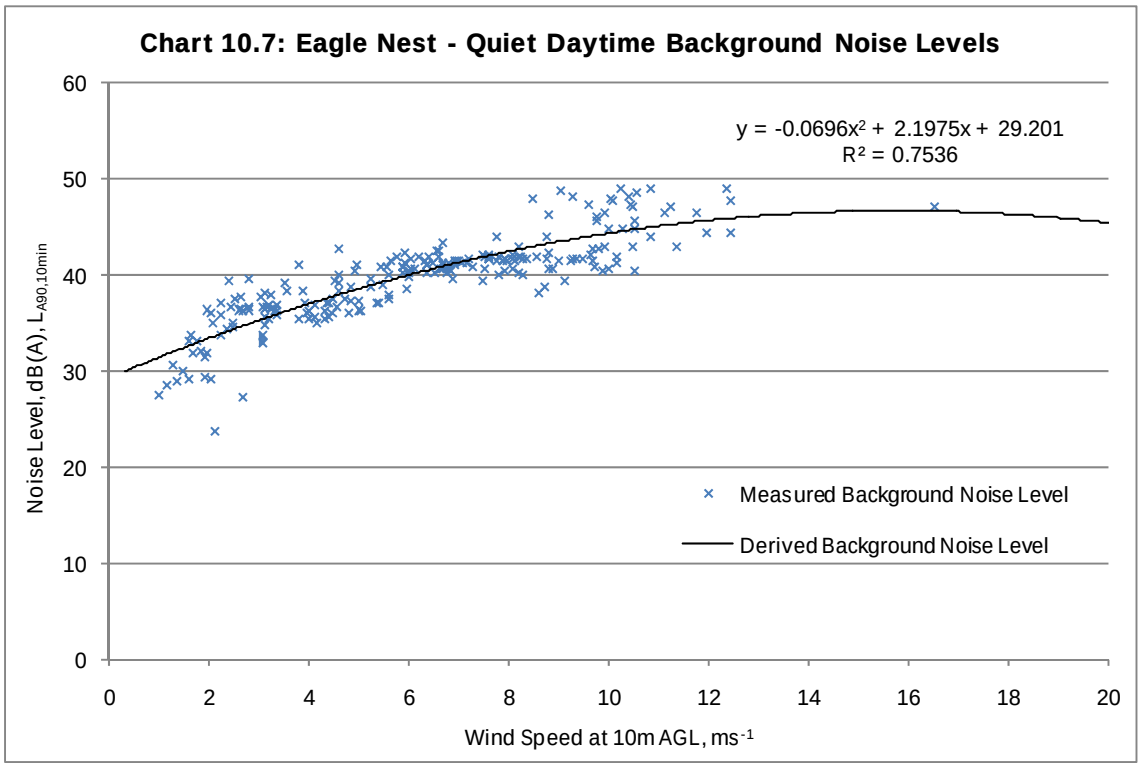


Chart 10.7: Eagle Nest - Quiet Daytime Background Noise Levels
y = -0.0696x² + 2.1975x + 29.201
R² = 0.7536
Measured Background Noise Level
Derived Background Noise Level
Noise Level, dB(A), LA90,10min
Wind Speed at 10m AGL, ms-1
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

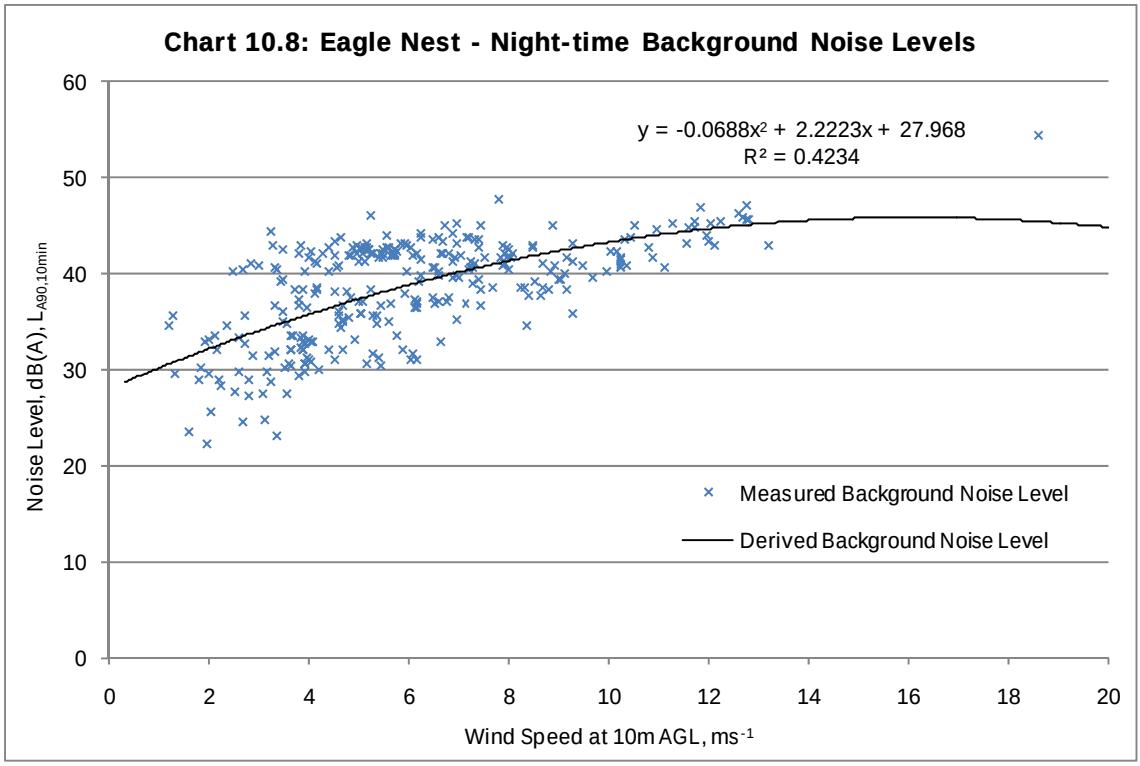


Chart 10.8: Eagle Nest - Night-time Background Noise Levels
y = -0.0688x² + 2.2223x + 27.968
R² = 0.4234
Measured Background Noise Level
Derived Background Noise Level
Noise Level, dB(A), LA90,10min
Wind Speed at 10m AGL, ms-1
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20

10.6 ASSESSMENT OF EFFECTS

10.6.1 Potential Construction and Decommissioning Effects

It is anticipated that construction of the Development will take approximately 6 months (see Chapter 3: *Project Description* of this ES). The construction programme will be phased, and it is therefore unlikely that construction activities would occur simultaneously at any particular location. Consequently, it is unlikely that construction noise would affect any particular property for more than a short period of time, throughout the entire period.

The following legislation, guidance and standards are of particular relevance to construction noise:

- The Control of Pollution Act 1974 (CoPA 1974);
- The Environmental Protection Act 1990 (EPA 1990); and
- BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites

10.6.1.1 The Control of Pollution Act 1974

CoPA 1974 provides Local Authorities in England, Scotland and Wales with powers to control noise and vibration from construction sites.

Section 60 of the Act enables a Local Authority to serve a notice to persons carrying out construction work of its requirements for the control of site noise. This may specify plant or machinery that is or is not to be used; the hours during which construction work may be carried out; the level of noise or vibration that may be emitted; and provide for changes in circumstances. Appeal procedures are available.

Section 61 of the Act allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works. This is not mandatory, but is often to the advantage of the developer, as once consent is issued, the Local Authority is no longer able to take action under Section 60. It does not, however, prevent nuisance action under EPA 1990. The application is expected to give as much detail as possible about the works to be carried out, the methods to be used and the measures that will be taken to minimise noise and vibration.

10.6.1.2 The Environmental Protection Act 1990

The EPA 1990 applies in England and Wales, and specifies mandatory powers available to Local Authorities in respect of any noise that either constitutes or is likely to cause a statutory nuisance, which is also defined in the Act. A duty is imposed on Local Authorities to carry out inspections to identify statutory nuisances, and to serve abatement notices against these. Procedures are also specified with regards to complaints from persons affected by a statutory nuisance.

10.6.1.3 BS 5228:2009 Code of Practice for Noise and Vibration Control on Construction and Open sites

BS 5228:2009 supersedes the previous version of the standard, issued in 1992 to 1997, and is published in two parts: Part 1- Noise and Part 2- Vibration. The discussion below relates mainly to Part 1- Noise, however, the recommendations of Part 2 in terms of vibration are broadly very similar.

It refers to the need for the protection against noise and vibration of persons living and working in the vicinity of and those working on construction and open[19] sites. It recommends procedures for noise and vibration control in respect of construction operations.

The revised standard stresses the importance of community relations, and states that early establishment and maintenance of these relations throughout the carrying out of site operations will go some way towards allaying people's fears.

There is also increased emphasis on the protection of persons on site from excessive noise exposure.

In terms of neighbourhood nuisance, the following factors are likely to affect the acceptability of construction noise:

- Site location, relative to the noise sensitive premises;
- Existing ambient noise levels;
- Duration of site operations;
- Hours of work;
- The attitude of local residents to the site operator; and
- The characteristics of the noise produced.

Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the operation.

Measures to control noise are described, including:

- Control of noise at source by, *e.g.*:
  - Substitution of plant or activities by less noisy ones;
  - Modification of plant or equipment to reduce noise emissions;
  - The use of noise control enclosures;
  - The siting of equipment and its method of use;
  - Equipment maintenance;
- Controlling the spread of noise, *e.g* by increasing the distance between plant and noise-sensitive premises or by the provision of acoustic screening.

Another key revision to the standard is the inclusion of a discussion of noise control targets, and example criteria for the assessment of the significance of noise effects. These are not mandatory.

Methods of calculating the levels of noise resulting from construction activities are provided, as are updated source levels for various types of plant, equipment and construction activities.

At the present time, sufficient information on the construction activities and methods to be employed to allow an accurate assessment of construction noise is not available. This is likely to only become available following consent and appointment of a main contractor.

Following consent of the development, and appointment of a main contractor, an application will be made to the Local Authority under s.61 of The Control of Pollution Act 1974 (as amended) to carry out the necessary construction work on site. This will include detailed method statements, predictions of noise levels at the worst-affected nearby houses (prepared according to BS 5228:2009), and identification of noise-control measures, such as the best-practice measures detailed in Section 10.7.1 below.

[19] An open site is a site such as an open-case coal mine, landfill site or similar

The effects of construction traffic are assessed in Chapter 11: *Traffic*. Where significant increases in traffic are identified, it can reasonably be assumed that significant noise effects would occur at properties situated adjacent to the transport routes.

Noise during decommissioning will be similar in nature to that during construction, and will be managed through best practice to ensure compliance with standards and guidelines appropriate at the time.

10.6.2 Potential Operational Effects

The potential effects of noise from operation of the Development, in conjunction with the existing Royd Moor and consented Hazelhead and Blackstone Edge Wind Farms, on each of the receptors identified in Table 10.2 are assessed below.

10.6.2.1 Annat Royd

Table 10.7 details the background noise levels, noise limits and predicted noise levels at Annat Royd. In the final two rows, the overall noise level is compared with the noise limits. A negative value indicates that the overall noise levels are below the limits. As the occupants of Annat Royd are understood to have a financial interest in Blackstone Edge[20], and the limits defined in ETSU-R-97 apply to the cumulative effects of all wind turbines, the 45 dB(A) fixed lower limit specified in ETSU-R-97 for such circumstances has been applied.

Table 10.7 Noise Assessment for Annat Royd

		Wind Speed at 10 m AGL, ms^{-1}								
		4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		dB(A), $L_{A90,\ 10min}$								
Background Noise Level	**Day**	32.6	33.5	34.5	35.7	37.0	38.5	40.0	41.8	43.6
	Night	27.6	29.2	31.2	33.3	35.6	37.9	40.2	42.4	44.3
Noise Limits	**Day**	45.0	45.0	45.0	45.7	45.0	45.0	45.0	46.8	48.6
	Night	45.0	45.0	45.0	45.7	45.0	45.0	45.2	47.4	49.3
Predicted - Royd Moor		39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3	39.3
Predicted - Hazelhead		12.1	14.6	18.0	18.9	19.4	19.4	19.4	19.4	19.5
Predicted - Blackstone Edge		19.2	25.6	27.7	28.6	29.8	30.8	31.5	31.5	31.5
Predicted - Spicer Hill		25.3	28.1	33.0	35.8	37.4	39.0	39.0	39.0	39.0
Overall Predicted Noise Level		**39.5**	**39.8**	**40.5**	**41.2**	**41.7**	**42.5**	**42.5**	**42.5**	**42.5**
Assessment	**Day**	-5.5	-5.2	-4.5	-4.5	-3.3	-2.5	-2.5	-4.3	-6.1
	Night	-5.5	-5.2	-4.5	-4.5	-3.3	-2.5	-2.7	-4.9	-6.8

Charts 10.9 and 10.10 show the assessment detailed in Table 10.7 in a graphical format.

As demonstrated by Table 10.7 and Charts 10.9 and 10.10, the overall predicted noise levels at Annat Royd are lower than the limits and would therefore comply with the requirements of ETSU-R-97.

[20] Annat Royd resident, Pers Com

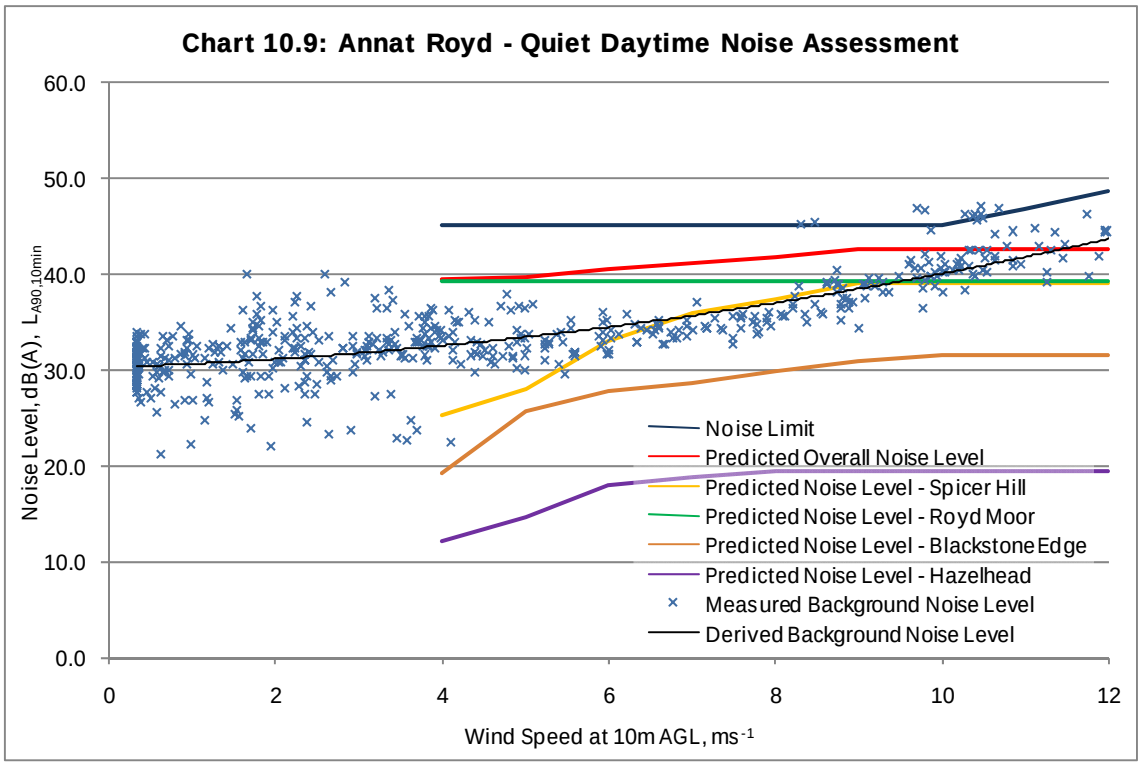


Chart 10.9: Annat Royd - Quiet Daytime Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

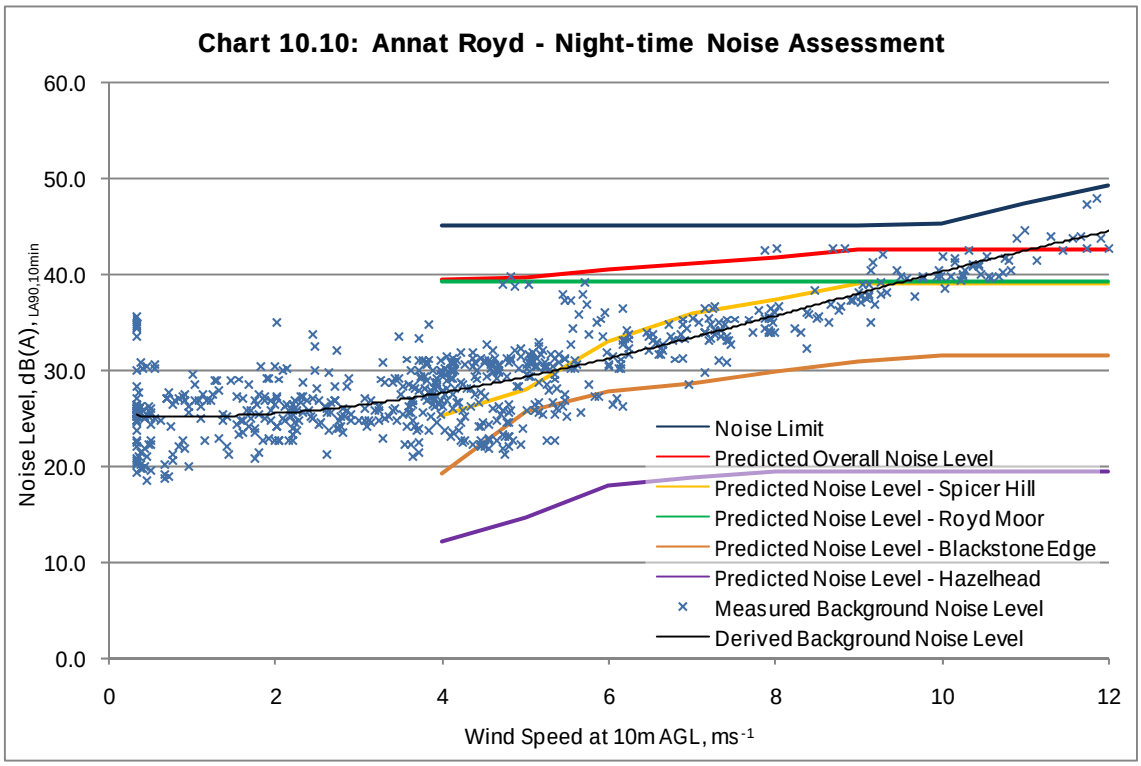


Chart 10.10: Annat Royd - Night-time Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

10.6.2.2 Brown's Edge

Table 10.8 details the background noise levels, noise limits and predicted noise levels at Brown's Edge. In the final two rows, the predicted overall noise level is compared with the noise limits. A negative value indicates that the predicted noise levels are below the limits.

Table 10.8: Noise Assessment for Brown's Edge

		Wind Speed at 10 m AGL, ms^{-1}								
		4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		dB(A), $L_{A90, 10min}$								
Background Noise Level	**Day**	31.0	32.0	33.2	34.5	36.0	37.7	39.5	41.5	43.6
	Night	27.3	28.9	30.8	33.0	35.3	37.7	40.3	42.8	45.3
Noise Limits	**Day**	40.0	40.0	40.0	40.0	41.0	42.7	44.5	46.5	48.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.3	47.8	50.3
Predicted - Royd Moor		31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
Predicted - Hazelhead		14.3	16.8	20.2	21.1	21.6	21.6	21.6	21.6	21.7
Predicted - Blackstone Edge		25.8	32.2	34.3	35.2	36.4	37.4	38.1	38.1	38.1
Predicted - Spicer Hill		25.6	28.4	33.3	36.1	37.7	39.3	39.3	39.3	39.3
Predicted Overall Noise Level		**33.7**	**36.0**	**38.1**	**39.6**	**40.8**	**42.0**	**42.2**	**42.2**	**42.2**
Assessment	**Day**	-6.3	-4.0	-1.9	-0.4	-0.2	-0.7	-2.3	-4.3	-6.4
	Night	-9.3	-7.0	-4.9	-3.4	-2.2	-1.0	-3.1	-5.6	-8.1

Charts 10.11 and 10.12 show the assessment detailed in Table 10.8 in a graphical format.

As demonstrated by Table 10.8 and Charts 10.11 and 10.12, the overall predicted noise levels at Annat Royd are lower than the limits and would therefore comply with the requirements of ETSU-R-97.

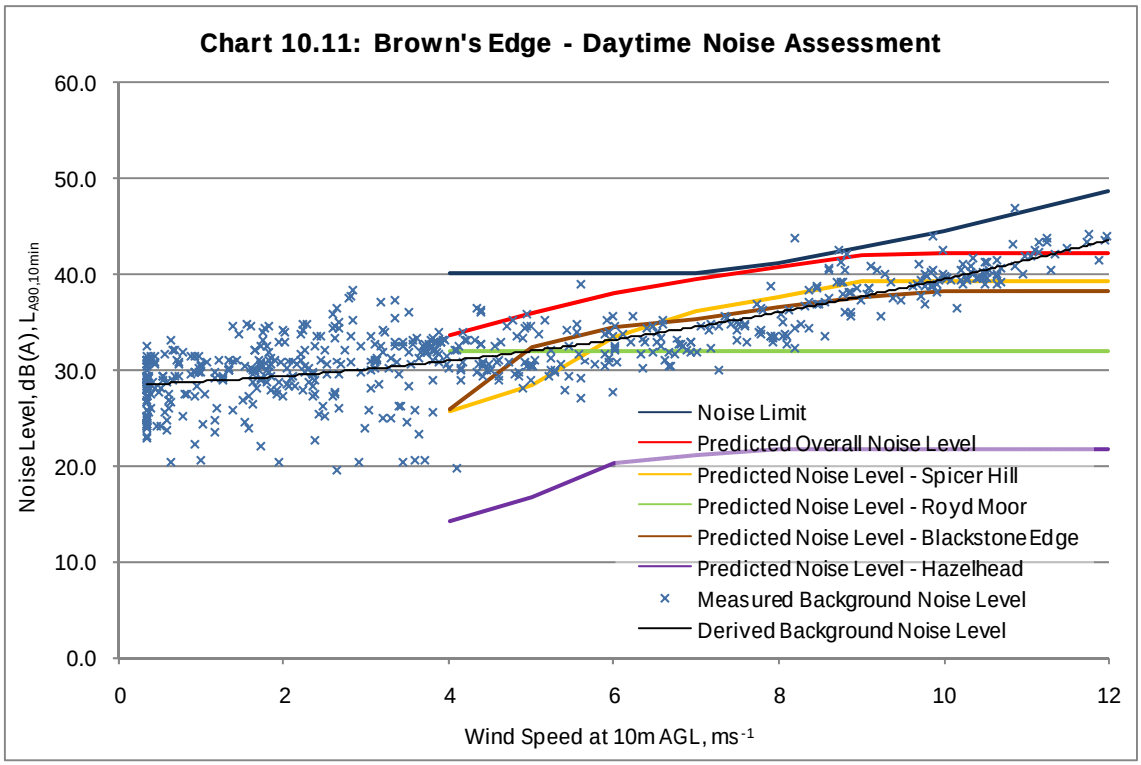


Chart 10.11: Brown's Edge - Daytime Noise Assessment
Noise Level, dB(A), $L_{A90,10min}$
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

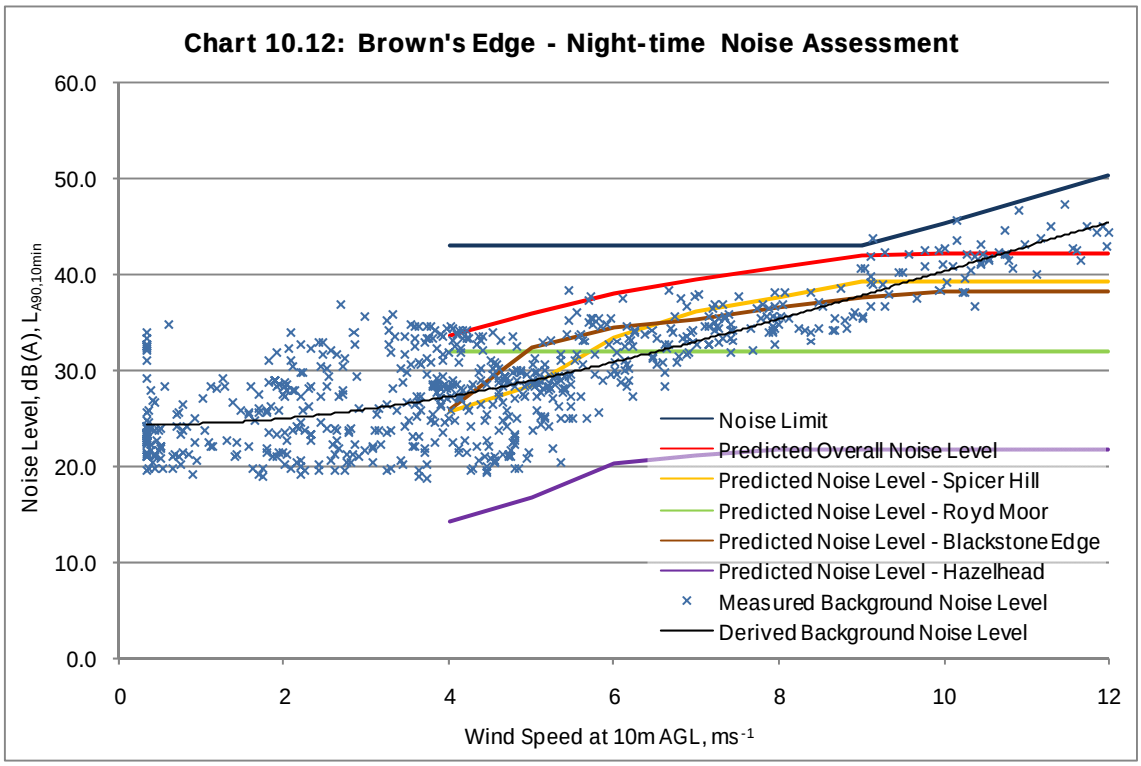


Chart 10.12: Brown's Edge - Night-time Noise Assessment
Noise Level, dB(A), $L_{A90,10min}$
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

10.6.2.3 Whitley House

Table 10.9 details the background noise levels, noise limits and predicted noise levels at Whitley House. In the final two rows, the predicted overall noise level is compared with the noise limits. A negative value indicates that the predicted overall noise levels are below the limits.

Table 10.9: Noise Assessment for Whitley House

		Wind Speed at 10 m AGL, ms^{-1}								
		4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		dB(A), $L_{A90, 10min}$								
Background Noise Level	**Day**	32.9	34.2	35.5	37.0	38.6	40.2	42.0	43.8	45.8
	Night	30.1	31.8	33.6	35.5	37.4	39.3	41.2	43.1	44.9
Noise Limits	**Day**	40.0	40.0	40.5	42.0	43.6	45.2	47.0	48.8	50.8
	Night	43.0	43.0	43.0	43.0	43.0	44.3	46.2	48.1	49.9
Predicted - Royd Moor		39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9	39.9
Predicted - Hazelhead		13.0	15.5	18.9	19.8	20.3	20.3	20.3	20.3	20.4
Predicted - Blackstone Edge		17.3	23.7	25.8	26.7	27.9	28.9	29.6	29.6	29.6
Predicted - Spicer Hill		21.5	24.3	29.2	32	33.6	35.2	35.2	35.2	35.2
Predicted Overall Noise Level		**40.0**	**40.1**	**40.4**	**40.8**	**41.1**	**41.5**	**41.5**	**41.5**	**41.5**
Assessment	**Day**	0.0	0.1	-0.1	-1.2	-2.5	-3.7	-5.5	-7.3	-9.3
	Night	-3.0	-2.9	-2.6	-2.2	-1.9	-2.8	-4.7	-6.6	-8.4

Charts 10.13 and 10.14 show the assessment detailed in Table 10.9 in a graphical format. They also detail the individual contributions that the existing Royd Moor and proposed Spicer Hill wind turbines make to the overall predicted noise levels.

It can be seen from Charts 10.13 and 10.14 that Royd Moor would contribute the majority of the overall predicted noise level at Whitley House. At wind speeds of 4 to 5 ms^{-1}, the increase in noise due to Spicer Hill, relative to that from Royd Moor is 0.1 to 0.2 dB(A). This is unlikely to constitute a perceptible change in the levels of wind farm noise, as differences of less than 1 dB(A) in environmental noise are generally not noticeable.

As demonstrated by Table 10.9 and Charts 10.13 and 10.14, the overall predicted noise levels at Whitley House are lower than the limits with the exception of quiet daytime wind speeds of 4 ms^{-1}, where the limits are predicted to be met exactly and at 5 ms^{-1} where they are predicted to be exceeded by 0.1 dB(A).

The conservative assumptions employed in the prediction process (see Section 10.4.2: *Prediction of Noise Levels*) mean that noise levels occurring in practice are likely to be lower than those predicted. Therefore, although a marginal theoretical exceedence of the limits set by ETSU-R-97 has been predicted, in *practice*, it is likely that the overall noise levels would comply with the requirements of ETSU-R-97.

Upon decommissioning of Royd Moor (currently scheduled for 2018), the noise levels due to the remaining wind farms would be substantially lower than the limits.

Mitigation measures for the above effects are proposed in Section 10.7.2: *Operational Noise Mitigation Measures*.

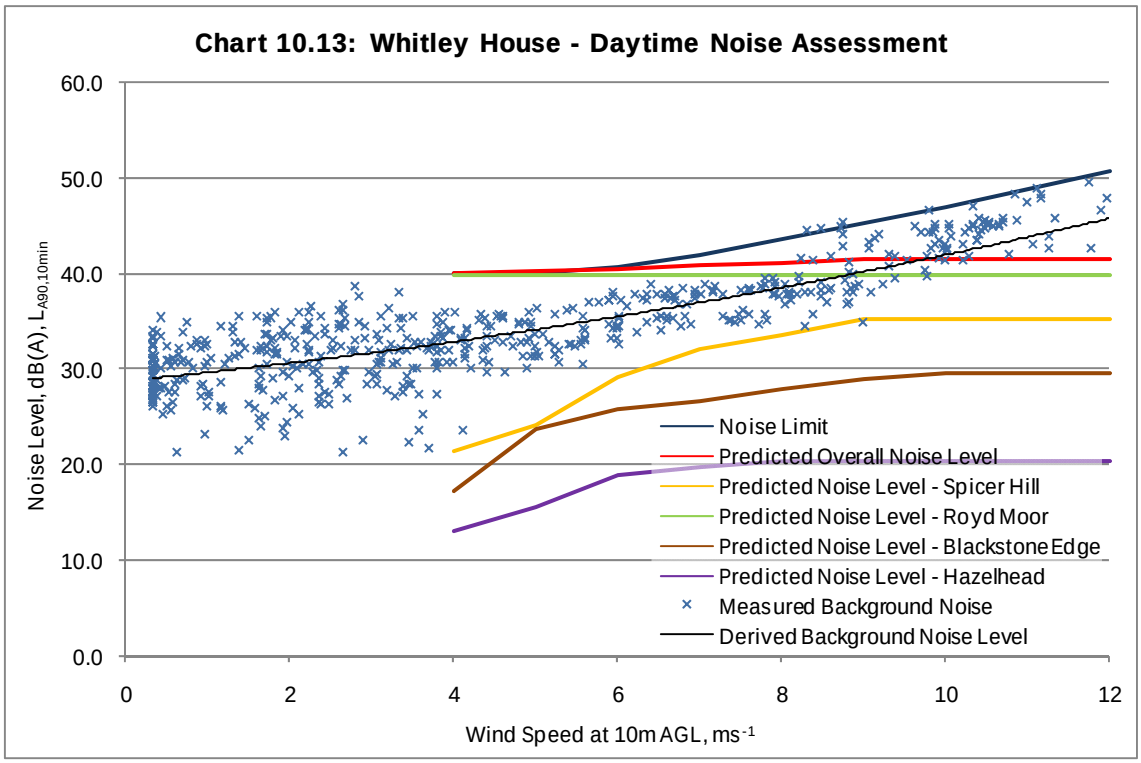


Chart 10.13: Whitley House - Daytime Noise Assessment
Noise Level, dB(A), $L_{A90,10min}$
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise
Derived Background Noise Level

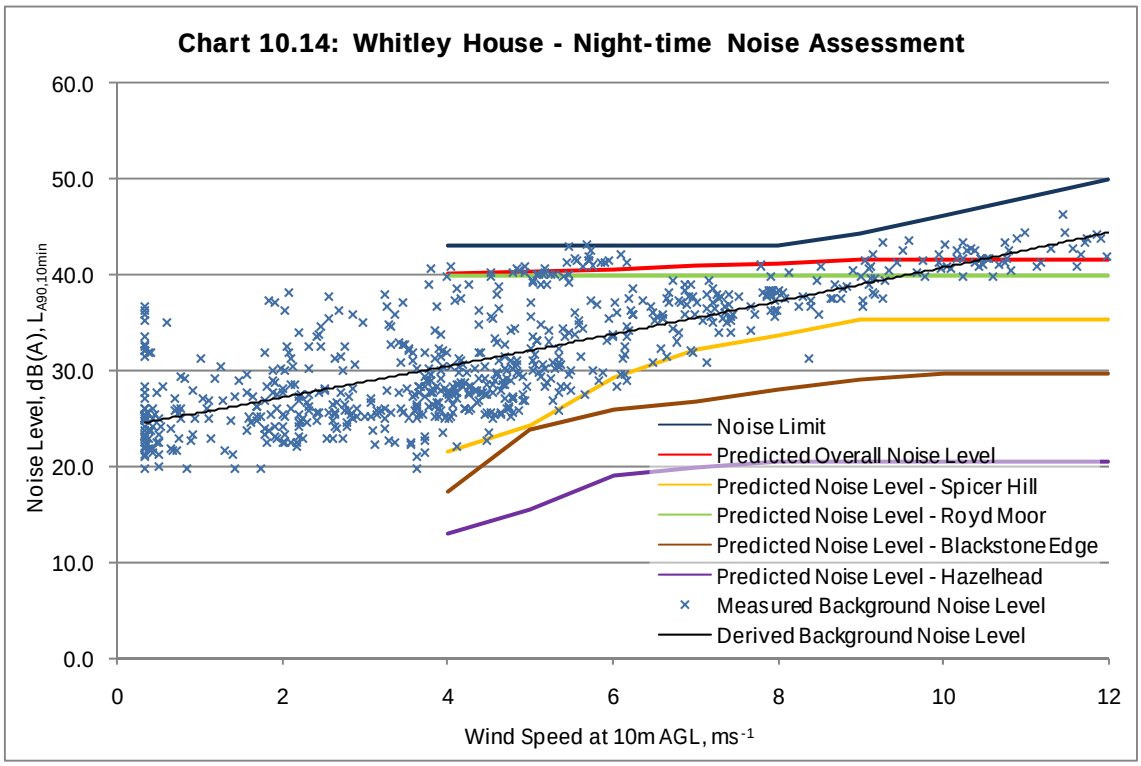


Chart 10.14: Whitley House - Night-time Noise Assessment
Noise Level, dB(A), $L_{A90,10min}$
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

10.6.2.4 Eagle Nest

Table 10.10 details the background noise levels, noise limits and predicted overall noise levels at Eagle Nest. In the final two rows, the predicted noise level is compared with the noise limits. A negative value indicates that the predicted noise levels are below the limits.

Table 10.10: Noise Assessment for Eagle Nest

		Wind Speed at 10 m AGL, ms^{-1}								
		4	5	6	7	8	9	10	11	12
		dB(A), $L_{A90, 10min}$								
Background Noise Level	**Day**	36.9	38.4	39.9	41.2	42.3	43.3	44.2	45.0	45.5
	Night	35.8	37.4	38.8	40.2	41.3	42.4	43.3	44.1	44.7
Noise Limits	**Day**	41.9	43.4	44.9	46.2	47.3	48.3	49.2	50.0	50.5
	Night	43.0	43.0	43.8	45.2	46.3	47.4	48.3	49.1	49.7
Predicted - Royd Moor		43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4
Predicted - Hazelhead		15.2	17.7	21.1	22.0	22.5	22.5	22.5	22.5	22.6
Predicted - Blackstone Edge		19.4	25.8	27.9	28.8	30.0	31.0	31.7	31.7	31.7
Predicted - Spicer Hill		24.7	27.5	32.4	35.2	36.8	38.4	38.4	38.4	38.4
Predicted Overall Noise Level		**43.5**	**43.6**	**43.9**	**44.2**	**44.4**	**44.8**	**44.8**	**44.8**	**44.8**
Assessment	**Day**	1.6	0.2	-1.0	-2.0	-2.9	-3.5	-4.4	-5.2	-5.7
	Night	0.5	0.6	0.1	-1.0	-1.9	-2.6	-3.5	-4.3	-4.9

Charts 10.15 and 10.16 show the assessment detailed in Table 10.8 in a graphical format.

As demonstrated by Table 10.8 and Charts 10.15 and 10.16, the overall predicted noise levels at Eagle Nest are lower than the limits specified by ETSU-R-97, with the exception of daytime wind speeds up to 5 ms^{-1} and night-time wind speeds up to 6 ms^{-1}.

It can be seen from Charts 10.15 and 10.16 that Royd Moor would contribute the majority of the overall predicted noise level at Eagle Nest. At wind speeds of 4 to 6 ms^{-1}, the increase in noise due to Spicer Hill, relative to that from Royd Moor is 0.1 to 0.5 dB(A). The greatest of these increases would occur where the exceedence is smallest and vice versa. Where exceedences are predicted, there is unlikely to be a perceptible change in the levels of wind farm noise relative to that currently present, as differences of less than 1 dB(A) in environmental noise are generally not noticeable.

Upon decommissioning of Royd Moor (currently scheduled for 2018), the noise levels due to the remaining wind farms would be substantially lower than the limits.

Mitigation measures for the above effects are proposed in Section 10.7.2: *Operational Noise Mitigation Measures*.

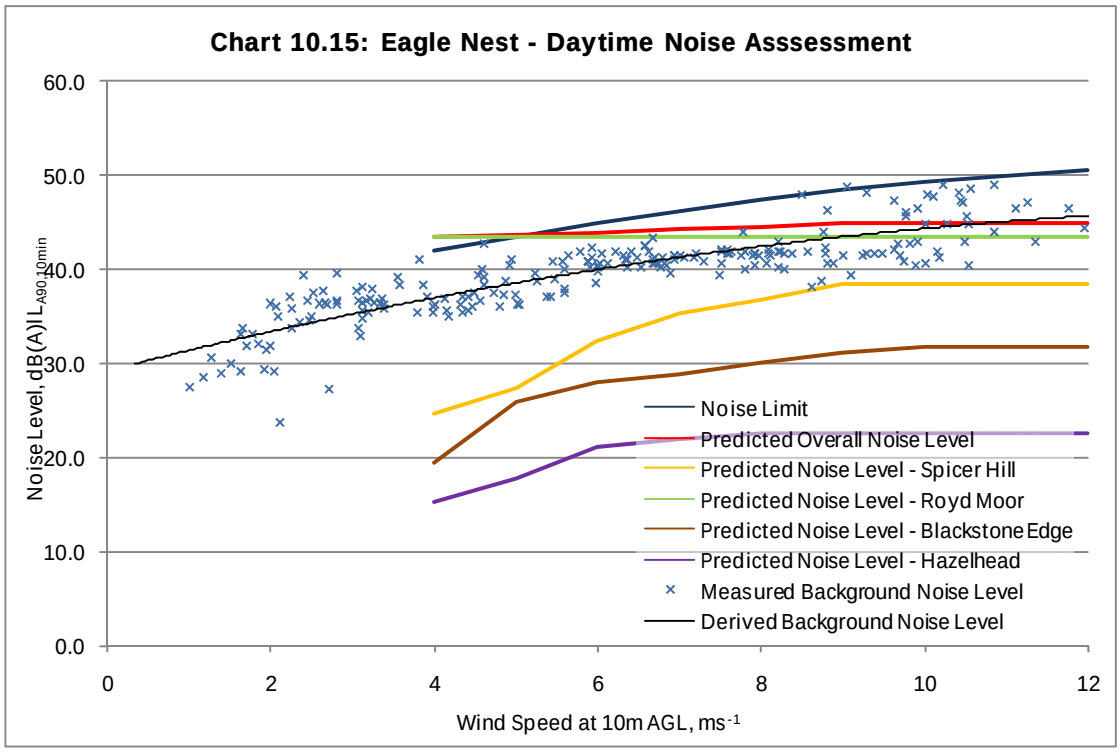


Chart 10.15: Eagle Nest - Daytime Noise Asssessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A) $L_{A90,10min}$
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

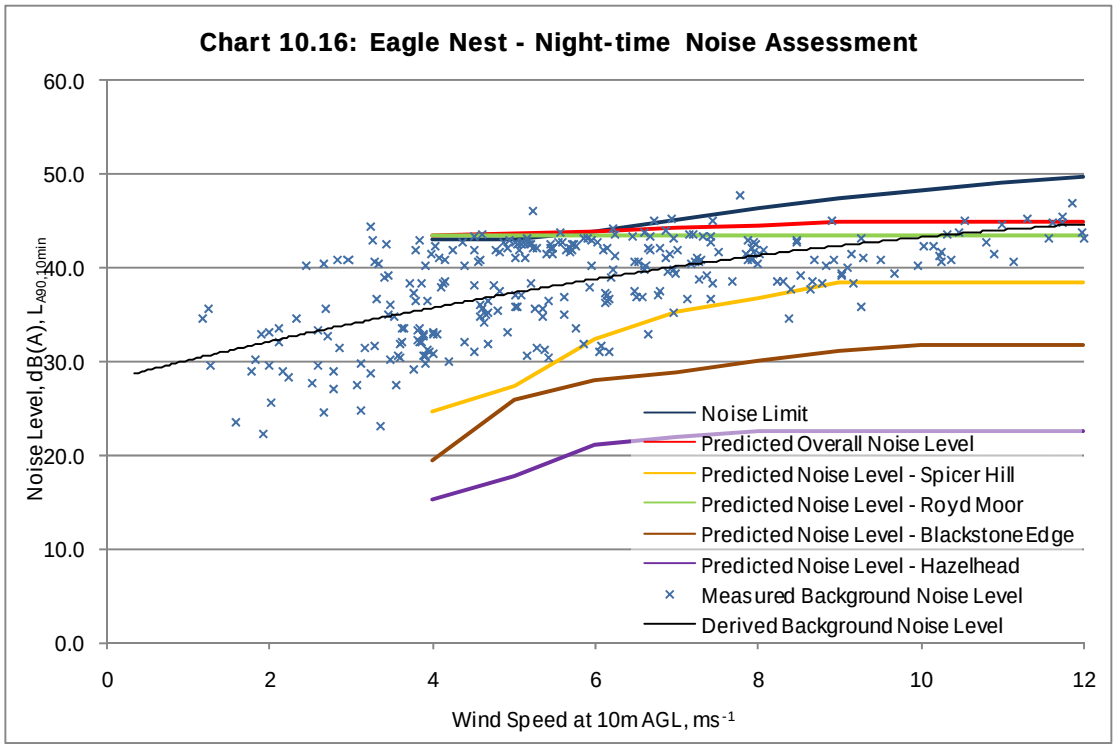


Chart 10.16: Eagle Nest - Night-time Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), $L_{A90,10min}$
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms^{-1}
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

10.6.2.5 Spicer House

Table 10.11 details the background noise levels, noise limits and predicted noise levels at Spicer House. It has been assumed that background noise levels at this property are similar to those at the nearby Brown's Edge monitoring location. A fixed lower limit of 45 dB(A) (for financial involvement) has been applied at this property for both daytime and night-time. The property is owned by the developer and is unoccupied at the time of writing. In the final two rows, the predicted overall noise level is compared with the noise limits. A negative value indicates that the predicted noise levels are below the limits.

Table 10.11: Noise Assessment for Spicer House

		Wind Speed at 10 m AGL, ms^{-1}								
		4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		dB (A), $L_{A90, 10min}$								
Background Noise Level	**Day**	31.0	32.0	33.2	34.5	36.0	37.7	39.5	41.5	43.6
	Night	27.3	28.9	30.8	33.0	35.3	37.7	40.3	42.8	45.3
Noise Limits	**Day**	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.5	48.6
	Night	45.0	45.0	45.0	45.0	45.0	45.0	45.3	47.8	50.3
Predicted - Royd Moor		33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4	33.4
Predicted - Hazelhead		14.4	16.9	20.3	21.2	21.7	21.7	21.7	21.7	21.8
Predicted - Blackstone Edge		26.2	32.6	34.7	35.6	36.8	37.8	38.5	38.5	38.5
Predicted - Spicer Hill		28.2	31.0	35.9	38.7	40.3	41.9	41.9	41.9	41.9
Predicted Overall Noise Level		**35.2**	**37.3**	**39.6**	**41.3**	**42.5**	**43.8**	**44.0**	**44.0**	**44.0**
Assessment	**Day**	-9.8	-7.7	-5.4	-3.7	-2.5	-1.2	-1.0	-2.5	-4.6
	Night	-9.8	-7.7	-5.4	-3.7	-2.5	-1.2	-1.3	-3.8	-6.3

Charts 10.17 and 10.18 show the assessment detailed in Table 10.11 in a graphical format.

As demonstrated by Table 10.11 and Charts 10.17 and 10.18, the overall predicted noise levels at Spicer House are lower than the limits and would therefore comply with the requirements of ETSU-R-97.

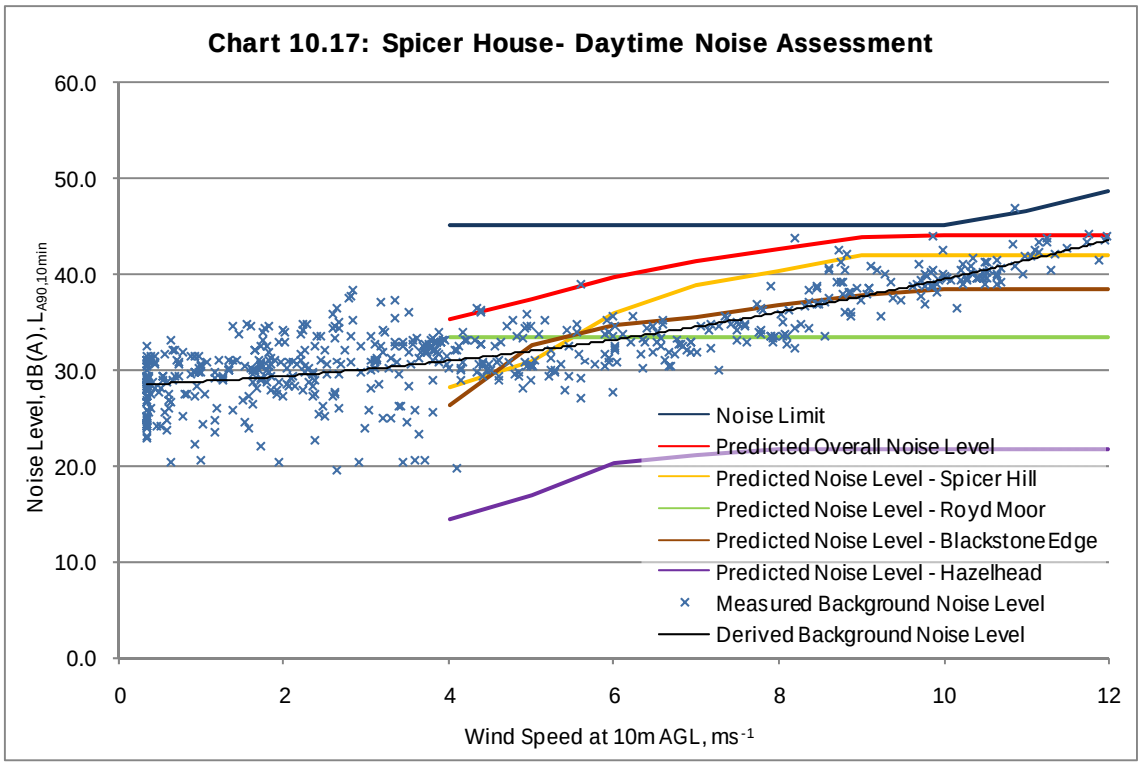


Chart 10.17: Spicer House- Daytime Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

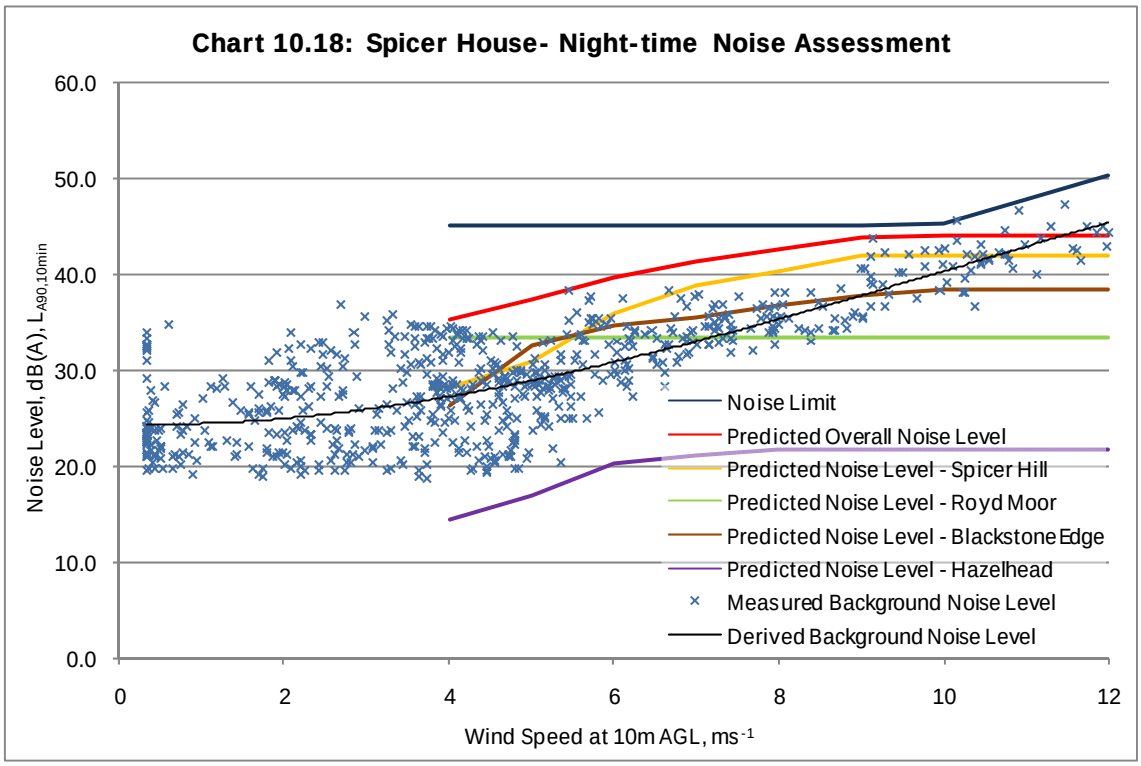


Chart 10.18: Spicer House- Night-time Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

10.6.2.6 Small Shaw

It has been assumed that the background noise levels obtained at Brown's Edge (the lowest obtained and the furthest monitoring location from Royd Moor) are representative of those at Small Shaw. Table 10.12 details these background noise levels, the noise limits, predicted noise levels and assessment for Small Shaw.

Table 10.12: Noise Assessment for Small Shaw

		Wind Speed at 10 m AGL, ms^{-1}								
		4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		dB(A), $L_{A90, 10min}$								
Background Noise Level	**Day**	31.0	32.0	33.2	34.5	36.0	37.7	39.5	41.5	43.6
	Night	27.3	28.9	30.8	33.0	35.3	37.7	40.3	42.8	45.3
Noise Limits	**Day**	40.0	40.0	40.0	40.0	41.0	42.7	44.5	46.5	48.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.3	47.8	50.3
Predicted - Royd Moor		39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8	39.8
Predicted - Hazelhead		15.8	18.3	21.7	22.6	23.1	23.1	23.1	23.1	23.2
Predicted - Blackstone Edge		19.7	26.1	28.2	29.1	30.3	31.3	32.0	32.0	32.0
Predicted - Spicer Hill		23.6	26.4	31.3	34.1	35.7	37.3	37.3	37.3	37.3
Predicted Overall Noise Level		**40.0**	**40.2**	**40.7**	**41.2**	**41.6**	**42.2**	**42.2**	**42.2**	**42.2**
Increase Relative to Royd Moor		0.2	0.4	0.9	1.4	1.8	2.4	2.4	2.4	2.4
Assessment	**Day**	0.0	0.2	0.7	1.2	0.6	-0.5	-2.3	-4.3	-6.4
	Night	-3.0	-2.8	-2.3	-1.8	-1.4	-0.8	-3.1	-5.6	-8.1

Charts 10.19 and 10.20 present the above assessment in a graphical format.

The predicted noise levels would exceed the limits at daytime wind speeds of up to 8 ms^{-1} by up to 1.2 dB(A) (6 ms^{-1}).

It can be seen from Table 10.12 and Charts 10.19 and 10.20 that the majority of the predicted overall noise level at Small Shaw would result from Royd Moor. The increase in overall wind farm noise relative to that from Royd Moor alone is detailed in Table 10.12.

As discussed in Section 10.4.2: *Prediction of Noise Levels*, the revisions to the noise prediction methodology have resulted in an increase in the predicted noise levels, relative to that which would have been obtained using the method employed in the previous Spicer Hill ES, of approximately 2 dB(A). On the previous basis, the predicted overall noise levels would therefore not exceed the limits.

Mitigation measures for the above predicted exceedences are discussed in Section 10.7.2: *Operational Noise Mitigation Measures* below.

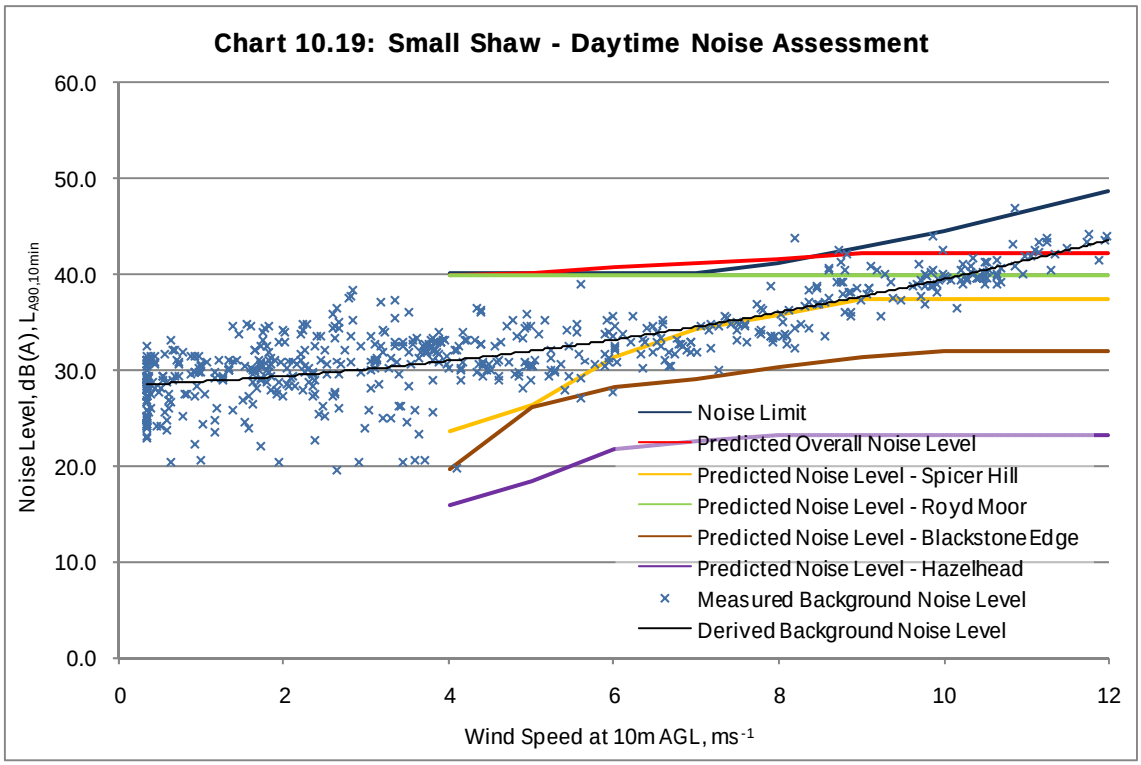


Chart 10.19: Small Shaw - Daytime Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

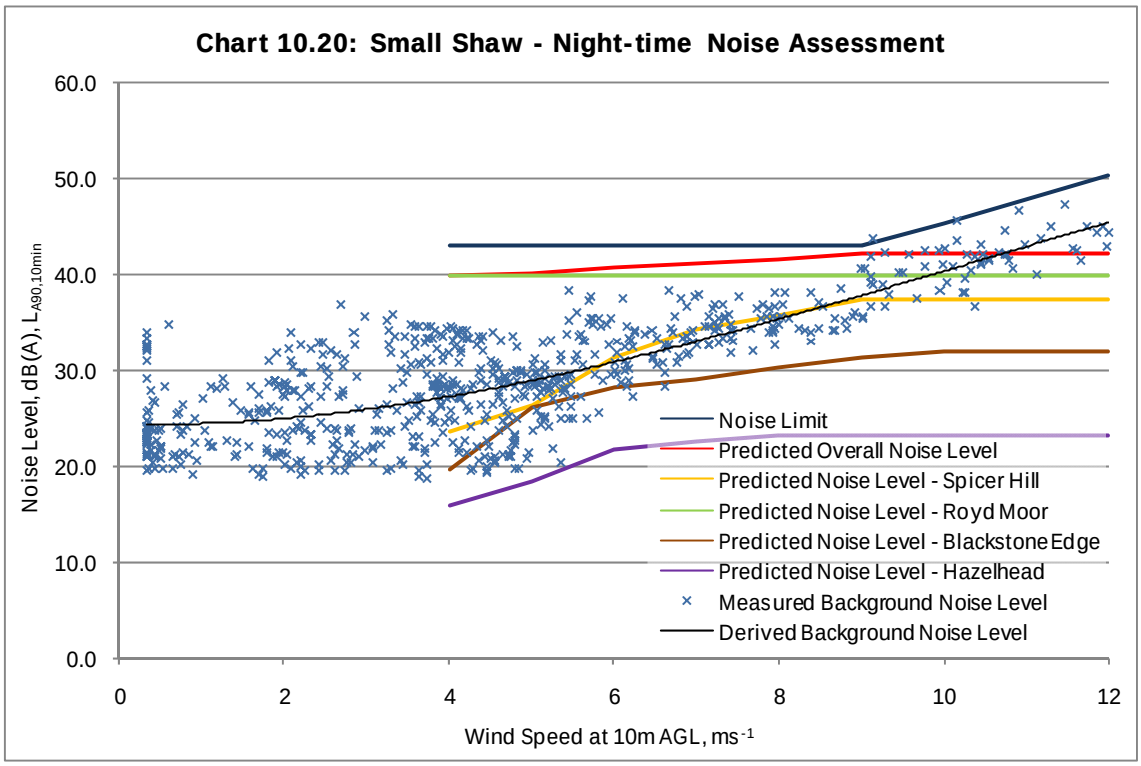


Chart 10.20: Small Shaw - Night-time Noise Assessment
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Noise Level, dB(A), LA90,10min
0
2
4
6
8
10
12
Wind Speed at 10m AGL, ms-1
Noise Limit
Predicted Overall Noise Level
Predicted Noise Level - Spicer Hill
Predicted Noise Level - Royd Moor
Predicted Noise Level - Blackstone Edge
Predicted Noise Level - Hazelhead
Measured Background Noise Level
Derived Background Noise Level

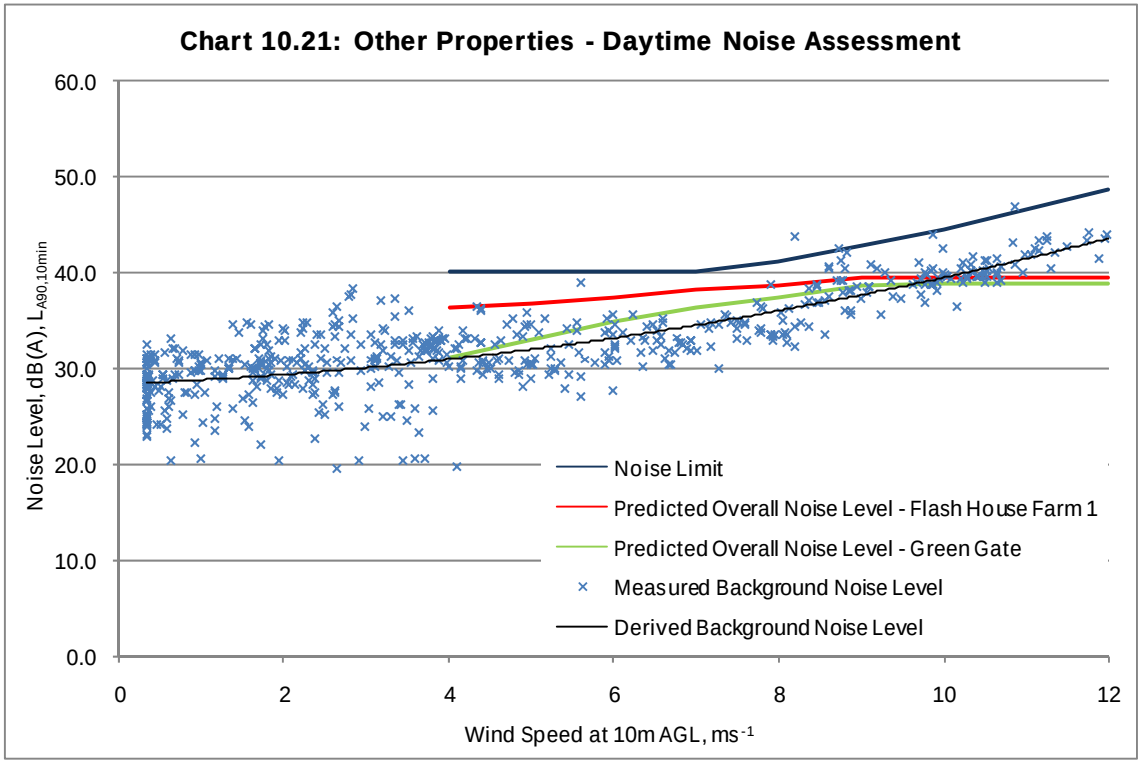
10.6.2.7 Other Properties

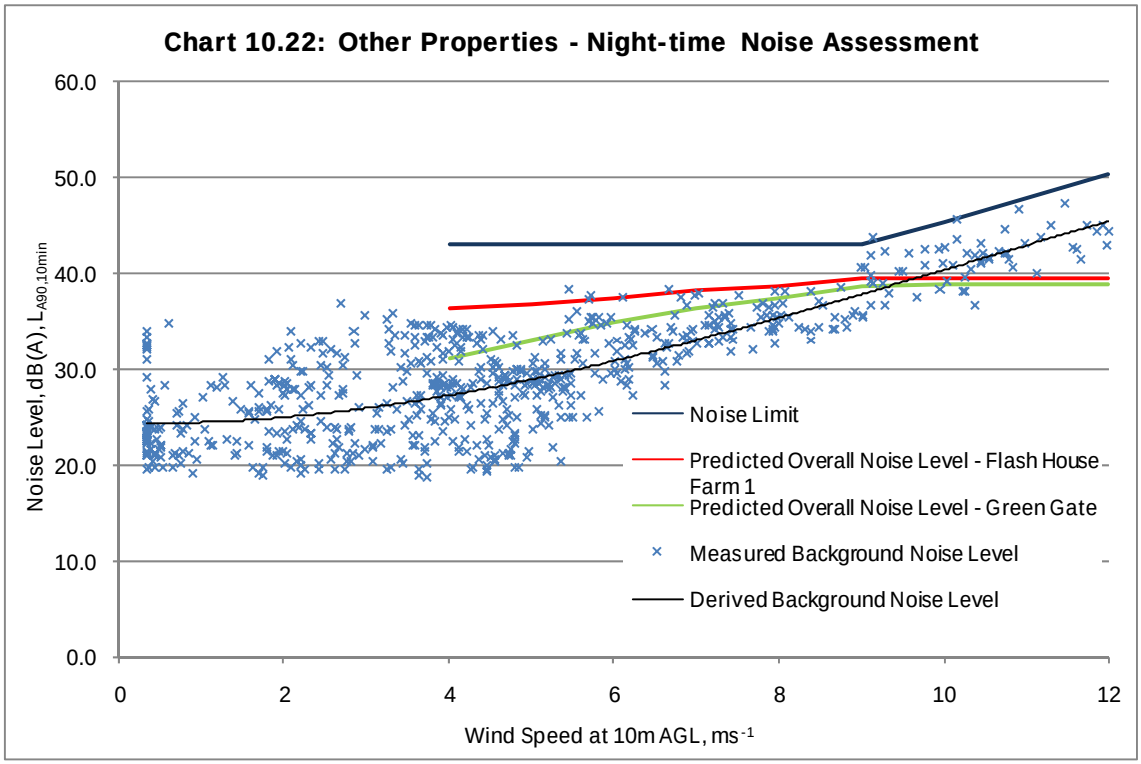
Table 10.13 details the assumed background noise levels (from Brown's Edge), noise limits, predicted overall noise levels and assessment of noise for the remaining properties identified in Table 10.4.

Table 10.13: Noise Assessment for Other Properties

		Wind Speed at 10 m AGL, ms^{-1}								
		4	5	6	7	8	9	10	11	12
		dB(A), $L_{A90, 10min}$								
Background Noise Level	**Day**	31.0	32.0	33.2	34.5	36.0	37.7	39.5	41.5	43.6
(Brown's Edge)	**Night**	27.3	28.9	30.8	33.0	35.3	37.7	40.3	42.8	45.3
Noise Limits	**Day**	40.0	40.0	40.0	40.0	41.0	42.7	44.5	46.5	48.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.3	47.8	50.3
Predicted Overall Noise Level										
Carr House		36.2	36.4	36.9	37.3	37.8	38.3	38.4	38.4	38.4
Far Royd Moor		34.9	35.3	35.9	36.6	37.2	37.9	38.0	38.0	38.0
Flash House Farm 1		36.4	36.8	37.5	38.1	38.7	39.4	39.4	39.4	39.5
Flash House Farm 2		35.7	36.3	37.1	37.8	38.4	39.2	39.3	39.3	39.3
Green Gate		31.2	33.0	34.9	36.3	37.4	38.6	38.8	38.8	38.8
Illians Corner		35.4	36.1	37.1	37.8	38.5	39.3	39.4	39.4	39.4
The Lanes		35.2	36.0	37.2	38.0	38.8	39.6	39.8	39.8	39.8
Sledbrook House		32.7	35.4	38.5	39.4	40.0	40.3	40.5	40.5	40.5
Assessment	**Day**									
Carr House		-3.8	-3.6	-3.1	-2.7	-3.2	-4.4	-6.1	-8.1	-10.2
Far Royd Moor		-5.1	-4.7	-4.1	-3.4	-3.8	-4.8	-6.5	-8.5	-10.6
Flash House Farm 1		-3.6	-3.2	-2.5	-1.9	-2.3	-3.3	-5.1	-7.1	-9.1
Flash House Farm 2		-4.3	-3.7	-2.9	-2.2	-2.6	-3.5	-5.2	-7.2	-9.3
Green Gate		-8.8	-7.0	-5.1	-3.7	-3.6	-4.1	-5.7	-7.7	-9.8
Illians Corner		-4.6	-3.9	-2.9	-2.2	-2.5	-3.4	-5.1	-7.1	-9.2
The Lanes		-4.8	-4.0	-2.8	-2.0	-2.2	-3.1	-4.7	-6.7	-8.8
Sledbrook House		-7.3	-4.6	-1.5	-0.6	-1.0	-2.4	-4.0	-6.0	-8.1
Assessment	**Night**									
Carr House		-6.8	-6.6	-6.1	-5.7	-5.2	-4.7	-6.9	-9.4	-11.9
Far Royd Moor		-8.1	-7.7	-7.1	-6.4	-5.8	-5.1	-7.3	-9.8	-12.3
Flash House Farm 1		-6.6	-6.2	-5.5	-4.9	-4.3	-3.6	-5.9	-8.4	-10.8
Flash House Farm 2		-7.3	-6.7	-5.9	-5.2	-4.6	-3.8	-6.0	-8.5	-11.0
Green Gate		-11.8	-10.0	-8.1	-6.7	-5.6	-4.4	-6.5	-9.0	-11.5
Illians Corner		-7.6	-6.9	-5.9	-5.2	-4.5	-3.7	-5.9	-8.4	-10.9
The Lanes		-7.8	-7.0	-5.8	-5.0	-4.2	-3.4	-5.5	-8.0	-10.5
Sledbrook House		-10.3	-7.6	-4.5	-3.6	-3.0	-2.7	-4.8	-7.3	-9.8

Charts 10.21 and 10.22 show the assessment details in Table 10.12 in a graphical format. For clarity, only overall predicted noise levels for Flash House Farm 1 and Green Gate are shown in the Charts. Noise levels at the remaining properties fall between those for Flash House Farm 1 and Green Gate.





As demonstrated by Table 10.12 and Charts 10.19 and 10.20, the predicted overall noise levels are lower than the limits at each of the properties and would therefore comply with the requirements of ETSU-R-97.

10.6.3 Effect of Enhanced Wind Shear

Wind Shear is the term used to describe the variation of wind speed with height. Generally, wind speed increases with increasing height. The relationship between the wind speed at 10 m and hub height will vary according to a number of conditions, including:

- Ground 'roughness' – the presence or absence of vegetation, hedges, walls, trees, shelter belts, buildings etc;
- Relative temperature of ground and atmosphere;
- Atmospheric stability (degree of mixing of atmospheric layers); and
- Presence or absence of temperature inversions.

The wind shear profile will therefore vary with both site location and time. Enhanced wind shear is most common at night due to increased temperature differences between the ground and atmosphere and increased atmospheric stability. This can include part of the evening period defined in ETSU-R-97 as 'Quiet Daytime'.

The manufacturer's noise emission data used in the assessment is produced according to the standard BS EN (IEC) 61400-11:2003[21]. This requires that turbines' noise emissions are quoted relative to wind speed at 10 m AGL. This 10 m wind speed is calculated from the hub height wind speed, using a standardised wind shear profile. Under some circumstances this may not be representative of wind shear conditions occurring on a particular site.

The effect of wind shear greater than that assumed would be to cause the turbine noise levels to increase more rapidly with increasing 10 m wind speed. The maximum noise level is not increased however. This effect can be visualised as the predicted noise level curve on the assessment charts being shifted to the left and compressed into a narrower range of wind speeds.

A shift of -1 ms^{-1} in the 10 m wind speed for a given noise level would be a reasonable assumption for upland UK sites at times when conditions favourable to wind shear enhancement occur.

In order to assess the potential for problems to occur due to enhanced wind shear, it is necessary to consider whether the effect could result in noise limits being exceeded.

In the first instance, a comparison of the maximum predicted noise level with the minimum noise limit for a particular location can be made. Where the maximum predicted noise level is less than the minimum limit, then enhanced wind shear would not cause limits to be exceeded.

The next factor to be considered is how much of a wind speed shift (*i.e.* the change in wind speed for a certain noise level) would be required for the predicted noise levels to exceed the limits. This is dependent on two factors: the gradient of the wind speed vs. noise curve and the margin between the noise level and the limit. Where the noise level increases only slowly with increasing wind speed or there is a large margin between the predicted noise levels and limits a large shift in wind speed would be necessary for enhanced shear to cause limits to be exceeded, resulting in a low likelihood of limits being exceeded. Conversely, where the noise level increases rapidly with increasing wind speed, or the margin between the noise level and limit is small, a smaller wind speed shift could increase the likelihood of exceedences occurring.

The above factors are considered for each of the receivers assessed below.

[21] BS EN 61400-11:2003 Wind Turbine Generator Systems – Part 11: Acoustic Measurement Techniques, BSI 2003

10.6.3.1 Annat Royd

At Annat Royd, the maximum predicted noise level is 42.5 dB(A), and the minimum limit for both daytime and night-time 45 dB(A). Therefore, enhanced wind shear could not cause limits to be exceeded at this location.

10.6.3.2 Brown's Edge

Here, the maximum predicted noise level is 42.2 dB(A) (9 to 12 ms^{-1}). The minimum night-time limit is 43 dB(A) (4 to 7 ms^{-1}) and the minimum daytime limit 40.0 dB(A) (4 to 7 ms^{-1}) . Enhanced night-time wind shear would not result in exceedences of the limits.

However, during quiet daytime wind speeds of 7 to 9 ms^{-1}, the gradient of the overall predicted noise level curve is steep, and the margin between the predicted overall noise level and the limit is small (-0.2 to -0.7 dB(A)). A shift of -1 ms^{-1} in the predicted overall noise levels would result in an exceedence of the limits by 0.8 dB(A) at 7 ms^{-1}, and 1.0 dB(A) at 8 ms^{-1}. The limits at 9 ms^{-1} would not be exceeded.

There is therefore a possibility of exceedence of the noise limits at Brown's Edge due to enhanced wind shear. The exceedences are, however, likely to be minor (less than 1.0 dB (A)).

10.6.3.3 Whitley House

The maximum predicted noise level at Whitley House is 41.5 dB(A) (9 to 12 ms^{-1}), compared with minimum night-limits of 43 dB(A) (4 to 8 ms^{-1}) and minimum daytime limits of 40 dB(A) (4 to 5 ms^{-1}). Enhanced night-time wind shear would not result in exceedences of the limits.

The gradient of the quiet daytime overall noise level curve is small, although the margin between predicted levels and limits at low wind speeds is also small. Therefore, there is some possibility of enhanced wind shear causing exceedences of the limits, although these are likely to minor (much less than 1.0 dB(A)).

10.6.3.4 Eagle Nest

The maximum predicted noise level at Eagle Nest is 44.8 dB(A) (9 to 12 ms^{-1}), and the minimum limits 41.9 dB(A) during quiet daytime and 43 dB(A) at night (4 to 5 ms^{-1}).

At Eagle Nest, the gradient of the overall predicted noise level curve is very small, although some minor exceedences of the limits are predicted, even without taking enhanced wind shear into account. Therefore, there is some possibility of enhanced wind shear causing exceedences or increased exceedences of the limits, although these are likely to minor (less than 1.0 dB(A)).

10.6.3.5 Spicer House

With a maximum overall predicted noise level of 44.0 dB(A), and minimum limits of 45.0 dB(A) during both quiet daytime and night-time, enhanced wind shear could not cause limits to be exceeded at this location.

10.6.3.6 Small Shaw

Small Shaw has maximum overall predicted noise levels greater than the minimum daytime limit of 40 dB(A). Exceedences of the limits have been predicted and discussed in Section 10.6.2.7. The gradient of the overall predicted noise level curve for this location is small, so any increases in exceedences due to enhanced wind shear are likely to be minor.

10.6.3.7 Other Properties

Predicted overall noise levels at the other properties considered are lower than the minimum night-time limit enhanced wind shear could therefore not cause limits to be exceeded.

10.6.3.8 Conclusions of Wind Shear Assessment

A semi-quantitative assessment of the potential for enhanced wind shear to result in exceedences of the noise limits has been carried out. This has concluded that enhanced wind shear at night would not cause breaches of limits.

Enhanced wind shear can also occur during evening periods (1800-2300) however, and there is potential for exceedences to occur at some properties as a result. These exceedences, however, are likely to be minor, less than 1 dB(A).

It should be borne in mind that the predicted noise levels are worst-case (downwind) levels based upon conservative assumptions of the attenuation during propagation. Noise levels in practice are likely to be lower than predicted for the majority of the time.

10.7 MITIGATION

10.7.1 Construction and Decommissioning Noise Mitigation Measures

Following consent of the Development, and appointment of a main contractor, an application will be made to the Local Authority under s.61 of The Control of Pollution Act 1974 (as amended) to carry out the necessary construction work on site. This will include detailed method statements, predictions of noise levels at the worst-affected nearby houses (prepared according to BS 5228:1997), and identification of noise-control measures, such as the best-practice measures detailed below:

- Operations shall be limited to times agreed with the Local Authority's Environmental Health Department;
- The site contractors shall publicise the construction programme (e.g. in local newspapers, through mailings to local residents, through an on-site information board at the site access, and on the developer's website) for the commencement and duration of operations, and named contacts for daytime and out of hours;
- Establishment of a community liaison group (comprising representatives from the nearest communities and the developer) that shall meet regularly prior to and during the construction period to facilitate communication between the parties and ensure that opportunities are taken to minimise noise nuisance through effective project management;
- The contractors shall be required to select the quietest item of suitable plant available for all site operations where practicable;
- Phasing of the work programme to reduce the combined effects arising from several noisy operations;
- Where necessary and practicable, containing noise from fixed plant and equipment within suitable acoustic enclosures or behind acoustic screens;
- Requiring all sub-contractors appointed by the main contractor to be formally and legally obliged, through contract, to comply with all environmental noise conditions; and
- Where practicable, night time working will not be carried out. However, any plant and equipment required for operation at night (23:00 - 07:00) shall be mains electric powered where practicable. Any night-time lighting rigs, pumps or other equipment shall be powered using mains electricity or silenced and suitably shielded to ensure compliance with World Health Organisation (WHO) night-time noise criteria at the nearest residential properties, assuming open windows.

Similar measures would apply during decommissioning to ensure compliance with standards or legislation relevant at the time.

10.7.2 Operational Noise Mitigation Measures

Some minor exceedences of the ETSU-R-97 limits have been predicted to occur at certain properties. Where these have been predicted however, the majority of noise affecting the properties in question would result from Royd Moor Wind Farm rather than the Development. Notwithstanding, the following sequential mitigation strategy is proposed:

- During the turbine procurement process, turbines will be sought for which the warranted sound power levels are such that noise levels predicted on the basis used in the above assessment are below the limits, or present no increase (less than 0.1 dB) in the overall predicted noise level relative to the combined effect of Royd Moor, Hazelhead and Blackstone Edge. This may require selection of an alternative turbine model or manufacturer, or modification of the turbines' power curves. In the event that this is not possible, the turbine will be selected to provide the minimum possible predicted exceedence of limits or increase in overall noise level;
- Compliance monitoring will be carried out during the commissioning process in order to determine the actual noise levels occurring at the nearby properties. This will include measuring noise levels with the Spicer Hill turbines shutdown to allow for comparison with noise from the other nearby windfarms to be made; and
- Should the result of this indicate exceedence of limits and that this is due to noise from the Development (i.e. the noise level measured with Spicer Hill in operation (as well as Royd Moor, Hazelhead and Blackstone Edge) is greater than that measured without Spicer Hill) then further noise management measures will be identified in consultation with the turbine manufacturers. These may include measures such as:
  - Modification of turbines' power curves to reduce noise output at specific wind speeds; or
  - Shutting down specific turbines at specific wind speeds or directions.

It is anticipated that a full-size meteorology mast will be installed on-site in the near future, which will allow for acquisition of long-term wind data at a range of heights. This will allow for wind shear profiles on site to be quantified, and these taken into account during the turbine procurement process so that the potential for exceedence of limits due to enhanced wind shear is minimised as far as is reasonably practicable.

10.8 RESIDUAL EFFECTS

10.8.1 Construction Effects

Application of the above measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction process is operated in compliance with the relevant legislation.

10.8.2 Operational Effects

The aim of the above mitigation strategy (10.7.2) is in the first instance to prevent exceedence of the noise limits defined in ETSU-R-97 (as detailed in the above assessment). In some instances this may not be possible, due to noise resulting from the other existing and consented wind farms, principally Royd Moor. In this event, the mitigation will ensure that no measurable (to 0.1 dB(A)) or perceptible increase in wind farm noise occurs at any of the noise-sensitive receptors.

10.8.3 Decommissioning Effects

The proposed mitigation measures will ensure that noise during construction is decommissioning as far as is reasonable practicable.

10.9 CUMULATIVE EFFECTS

The cumulative effects of noise from the existing Royd Moor and consented Hazelhead and Blackstone Edge wind farms are included in the assessment carried out above.

10.10 GLOSSARY OF ACOUSTIC TERMINOLOGY

The following items of acoustic terminology have been referred to in the preceding chapter. Terms in italics are defined elsewhere in the glossary.

Background Noise: The background noise level is the under lying level of noise present at a particular location for the majority (usually 90%) of a period of time. As such it excludes any short-duration noises, such as individual passing cars (but not continuous traffic), dogs barking or passers-by. Sources of background noise typically include such things as wind noise, traffic and continuously operating machinery (e.g. air conditioning or generators).

Decibel (dB): The decibel is the basic unit of noise measurement. It relates to the pressure created by the sound (Sound Pressure) and operates on a logarithmic scale, ranging upwards from 0 dB. 0dB is equivalent to the normal threshold of hearing at a *frequency* of 1000Hz. Each increase of 3 dB on the scale represents a doubling in the Sound Pressure, and is typically the minimum noticeable change in sound level under normal listening conditions. For example, while an increase in noise level from 32 dB to 35 dB represents a doubling in sound pressure, this change would only just be noticeable to the majority of listeners.

dB(A): Environmental noise levels are usually discussed in terms of dB(A). This is known as the A-weighted sound pressure level, and indicates that a correction factor has been applied, which corresponds to the human ear's response to sound across the range of audible *frequencies*. The ear is most sensitive in the middle range of frequencies (around 1000-3000Hz), and less sensitive at lower and higher frequencies. The A-weighted noise level is derived by analysing the level of a sound at a range of frequencies and applying a specific correction factor for each frequency before calculating the overall level. In practice this is carried out automatically within noise measuring equipment by the use of electronic filters, which adjust the frequency response of the instrument to mimic that of the ear.

Façade: A façade noise level is one measured at, or very close to, the façade of a building. These are typically 3 dB higher than free-field levels, due to reflection.

Free Field: This term refers to a location where the propagation (movement) of sound is not affected by the presence of obstacles or surfaces which would cause reflections (echoes).

Frequency: The frequency of a sound is equivalent to its pitch in musical terms. The units of frequency are Hertz (Hz), which represents the number of cycles (vibrations) per second.

Immission: The opposite of emission. In this case the noise levels arriving at or affecting a receiver.

$LA_{90,t}$: This term is used to represent the *A-weighted* sound pressure level that is exceed for 90% of a period of time, t. This is used as a measure of the *background noise* level.

$LA_{eq,t}$: This term is known as the *A-weighted* equivalent, continuous sound pressure level for a period of time, t. It is similar to an average, and represents the sound pressure level of a sound of continuous intensity that would result in an equal quantity of sound energy as a sound which varies in intensity.

Low frequency noise: Noise at the lower end of the range of audible frequencies (20Hz – 20kHz). Usually refers to noise below 250Hz. Should not be confused with infrasound, which is sound below the lowest audible frequency, 20Hz.

Noise: Unwanted sound. May refer to both natural (e.g. wind, birdsong etc) and artificial sounds (e.g. traffic, noise from wind turbines, etc)

Noise contour plot: A diagram showing lines of equal sound levels (Isobels) in a similar manner to height contours on an Ordnance Survey map or isobars (lines of equal pressure) on a weather map.

Noise sensitive receptors: Locations that may potentially be adversely affected by the addition of a new source of noise. Can include residential properties, outdoor areas and sensitive species.

Sound power (W): The sound energy radiated per unit time by a sound source, measured in watts (W).

Sound power level (L_w): Sound power measured on the decibel scale, relative to a reference value (W_o) of 10^{-12}W.

Sound pressure (P): The fluctuations in atmospheric pressure relative to atmospheric pressure, measured in Pascals (Pa).

Sound pressure level (L_p): Sound pressure measured on the decibel scale, relative to a sound pressure of 2×10^{-5} Pa.

Tonal element: A characteristic of a sound where the sound pressure level in a particular frequency range is greater than in those frequency ranges immediately above higher or lower. This would be perceived as a humming or whining sound.

Vibration: In this context, refers to vibration carried in structures such as the ground or buildings, rather than airborne noise.