



ARCUS

MOORSHIELD WIND TURBINES PLANNING APPLICATION

APPENDIX **2.4**: NOISE ASSESSMENT

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1 INTRODUCTION

Arcus Consultancy Services Ltd (Arcus) has been commissioned by Moorshield Wind Farm Ltd to carry out an assessment of the noise effects of the proposed Moorshield Wind Turbines in East Renfrewshire (the Development). This report presents details of the methodology and results of the assessment.

The aim of the assessment is to predict the levels of noise potentially produced by the Development at the nearest noise sensitive receptors and assess these against relevant standards and guidelines.

This Report is supported by the following Figures and Annex:

- Annex A: Cumulative Noise Emission Data;
- Annex B: Figure 1: Assessment Locations;
- Annex B: Figure 2: Cumulative Noise Contour Plot; and
- Annex C: Alternative Soame Noise Condition Wording.

This Report is structured as follows:

- Legislation, policy and guidance;
- Assessment methodology;
- Baseline conditions;
- Assessment of potential effects;
- Mitigation;
- Residual effects;
- Summary; and
- Glossary.

2 LEGISLATION, POLICY AND GUIDANCE

2.1 Construction Noise

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

- The Control of Pollution Act 1974 (CoPA 1974)¹;
- The Environmental Protection Act 1990 (EPA 1990)²; and
- BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites³.

2.1.1 *The Control of Pollution Act 1974*

CoPA 1974 provides Local Authorities with powers to control noise and vibration from construction sites.

Section 60 of the CoPA 1974 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 CoPA 1974 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,

¹ UK Government (1974) Control of Pollution Act 1974 [Online] Available at: <https://www.legislation.gov.uk/ukpga/1974/40> [Accessed 20/02/2020]

² UK Government (1990) Environmental Protection Act 1990 [Online] Available at: <http://www.legislation.gov.uk/ukpga/1990/43/contents> [Accessed 20/02/2020]

³ BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites, BSI 2014

but is often advantageous for the developer, as once consent is issued, the Local Authority is no longer able to take action under Section 60 of CoPA 1974 or Section 80 of the EPA 1990, provided the works are carried out in accordance with the Section 61 consent. It does not, however, prevent nuisance action under Section 82 of the EPA 1990. Any 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.

2.1.2 *The Environmental Protection Act 1990*

The EPA 1990 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 CoPA 1974. 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.

2.1.3 *BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites*

BS 5228:2009+A1:2014 (BS 5228) 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 sites. It recommends procedures for noise and vibration control in respect of construction operations. The standard is published in two parts: Part 1 - Noise and Part 2 - Vibration. The discussion below relates mainly to Part 1, however, the recommendations of Part 2 in terms of vibration are broadly very similar.

The 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 concerns. 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; and
- Controlling the spread of noise, e.g. by increasing the distance between plant and noise-sensitive premises or by the provision of acoustic screening.

The standard also includes a discussion of noise control targets, and example criteria for the assessment of the significance of noise effects. These are not mandatory.

2.2 Operational Noise

The following guidance and information sources have been considered in the assessment of operational noise:

- The Scottish Government's web-based planning information on onshore wind turbines (last updated May, 2014)⁴;
- Planning Advice Note 1/2011 (PAN 1/2011): Planning and Noise⁵;
- ETSU-R-97: The Assessment and Rating of Noise from Wind Farms⁶;
- East Renfrewshire Council *Local Development Plan Supplementary Planning Guidance – Renewable Energy*⁷; and
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise⁸.

2.2.1 Scottish Government Planning Information on Onshore Wind

The Scottish Government has published web-based information which provides advice to local authorities on the planning issues associated with wind farm development. With respect to noise from wind farms, it states that ETSU-R-97: The Assessment and Rating of Noise from Wind Farms:

"...describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions."

With regard to current best practice guidance, it is stated that:

"The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice."

The information goes on to refer to PAN 1/2011 as providing advice on the role of the planning system in controlling noise, and states that the associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.

2.2.2 PAN 1/2011: Planning and Noise

PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. It promotes the principles of good acoustic design and the appropriate location of new potentially noisy development. An associated Technical Advice Note offers advice on the assessment of noise impact and includes details of the legislation, technical standards and codes of practice appropriate to specific noise issues.

Appendix 1 of the Technical Advice Note: Assessment of Noise describes the use of ETSU-R-97 in the assessment of wind turbine noise.

2.2.3 ETSU-R-97

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

⁴ Onshore Wind Turbines, Scottish Government [online], Available from: <http://www.gov.scot/Resource/0045/00451413.pdf> [Accessed: 13/02/2020]

⁵ Planning Advice Note 1/2011: Planning and Noise, The Scottish Government, March 2011.

⁶ ETSU-R-97 (1996) The Assessment and Rating of Noise from Wind Farms, ETSU: DTI.

⁷ East Renfrewshire Council: 'Local Development Plan: Supplementary Planning Guidance – Renewable Energy', January 2017

⁸ A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind turbine Noise, IOA, 2013.

Both background noise and noise from wind turbines 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 specifies the use of the $L_{A90, 10min}$ descriptor for both background and wind turbine noise. Therefore, unless otherwise specified, all references to noise levels within this chapter relate to this descriptor. Similarly, all wind speeds referred to relate to a height of 10 metres (m) above ground level (AGL) at the location of the Development, standardised in accordance with current good practice guidance or BS:EN (IEC) 61400 11:2003⁹ as appropriate, unless otherwise stated.

The document recommends the application of external noise limits at the nearest noise sensitive properties, to protect outside amenity and prevent sleep disturbance inside dwellings. These limits take the form of a 5 decibel (dB) margin above the prevailing background noise level, except where background noise levels are lower than certain thresholds, where fixed lower limits apply. Separate limits apply for quiet daytime and night-time periods, as outlined below.

During daytime, the guidance specifies limits designed to protect the amenity of residents whilst within the external amenity areas of their properties. The limits are based on the **prevailing background noise level for 'quiet daytime' periods, defined in ETSU-R-97 as:**

- 18:00 – 23:00 every day; plus
- 13:00 – 18:00 on Saturday; and
- 07:00 – 18:00 on Sundays.

ETSU-R-97 recommends that the fixed lower noise limit for daytime should be set within the range 35 to 40 dB, $L_{A90, 10min}$, with choice of value dependent on the following factors:

- The number of dwellings in the neighbourhood of the Development;
- The effect of the noise limits on the number of kilo Watt hours (kWh) generated; and
- The duration and level of exposure.

Different standards apply at night, where potential 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 at night at wind speeds or locations where the prevailing wind speed-related night-time background noise level is lower than 38 dB (A). At other times, the limit of 5 dB above the prevailing wind speed-related background noise level applies. The value of night-time fixed lower limit was selected in order to ensure that internal noise levels remained below those considered to have the potential to cause sleep disturbance, taking account of the attenuation of noise when passing from outdoors to indoors, and making allowance for the presence of open windows.

Where the occupier of the property has a financial interest in the Development, ETSU-R-97 states that the fixed lower noise limit for both daytime and night-time can be increased to 45 dB(A) and that *"...consideration should be given to increasing the permissible margin above background"*.

2.3 A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise

The Good Practice Guide (GPG) was published by the IOA in May 2013 and has been endorsed by the Scottish Government as current industry good practice. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind

⁹ BS EN (IEC). 61400-11:2003 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques

turbine developments at the various stages of the assessment process. The recommendations provided in the GPG been followed throughout this assessment.

In addition, the IOA published a suite of six Supplementary Guidance Notes (SGNs) in 2014, intended to support the GPG and provide additional clarification where considered necessary. The recommendations of the SGNs have been followed where relevant in this assessment.

The GPG provides advice on the assessment of cumulative noise impact, detailing a number of possible cumulative scenarios and recommended approaches. Advice is also provided with regard to the geographical scope of a cumulative noise assessment, to determine the area within which a cumulative noise assessment is necessary.

Where a new noise source is introduced to a given scenario with a noise level which is predicted to be 10 dB or more below the existing level, the increase in the total noise level is considered to be negligible. On this basis, the necessary extents of a cumulative noise assessment can be determined. Paragraph 5.1.4 of the GPG states... ***"If the proposed wind farm produces noise levels within 10 dB of any existing wind farm(s) at the same receptor location, then a cumulative noise impact assessment is necessary"***.

As noted in ETSU-R-97, noise from existing wind turbines should not form part of the background noise level from which noise limits for new wind energy developments are derived.

2.4 Local Planning Policies

Scottish Planning Policy (2014) states that development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets, giving due regard to relevant environmental, community and cumulative impact considerations.

The East Renfrewshire Council Local Development Plan **states:** *'The council will support renewable energy infrastructure developments, including micro-renewable energy technologies on individual properties, wind turbine developments, hydro-electric, biomass and energy from waste technologies in appropriate locations. The assessment of applications for such developments will be based on the principles set out in Scottish Planning Policy (2014), in particular, the considerations set out at paragraph 169 and additionally, for onshore wind developments, the terms of Table 1: Spatial Frameworks. Where appropriate, the applicant will be required to submit satisfactory mitigation measures to alleviate any adverse environmental impacts.'*¹⁰

The local development plan policy also **states that** *'the visual and noise impact of proposals located within 500m of a residential property will be considered on a case by case basis.'*

Policy E2 of the emerging LDP states that all proposals for renewable energy projects will be assessed against criteria including:

"Impacts on communities and individual dwellings, including visual impact, residential amenity, noise and shadow flicker."

2.5 Alternative Noise Conditions from Soame Appeal

During the Appeal into the proposed Soame Wind Farm (PPA-220-2048), part of which was on the same land as the Development, agreed was reached between the proposers of Soame and ScottishPower Renewables (SPR) on a set of planning conditions to control noise from Soame to a level which would both ensure that cumulative noise effects with neighbouring wind farms (principally Whitelee and its Extensions) were within the limits defined in ETSU-R-97, and that SPR would not be disadvantaged by any noise

¹⁰ East Renfrewshire Council: *'Local Development Plan; Supplementary Planning Guidance – Renewable Energy'*, January 2017

investigations required of Soame. The agreed conditions are provided in Annexe C to this Report, and a comparison between predicted noise from the Development and the limits incorporated into those conditions is presented in Section 0. Assessment methodology

2.6 Construction Noise

Due to the significant separation distance between the Development and nearby noise receptors (approximately 1.2 km from the closest proposed turbine to the closest non-financially involved receptor), rather than assessing the effects of construction noise in terms of noise level, the mitigation measures outlined in Section 6.1 are to be adopted, which are considered to be Best Practice, as advocated in BS 5228.

Construction noise will be limited in duration and confined to working hours specified by the Council which can be adequately controlled through planning condition. On this basis, no further assessment of construction noise is considered necessary.

Noise produced during decommissioning of the Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with.

2.7 Vibration (Construction)

Occupants of residential properties near construction sites sometimes express concerns about vibration resulting from construction activities.

BS 5228-2 states... "In general, the longer the duration of activities on a site, the more likely it is that vibration from the site will prove to be an issue. In this context, good public relations and communication are important. Local residents might be willing to accept higher levels of vibration if they know that such levels will only last for a short time".

Given the large separation distance of 1.2 km to the closest receptor, no significant vibration effects are anticipated and this has not been considered further in this appendix.

2.8 Operational Noise Assessment Methodology

In summary, the assessment process comprises:

- Identification of potential receptors, i.e. residential properties and other potentially noise-sensitive locations;
- Establishment of limits for acceptable levels of wind turbine noise, based on the measured background noise levels (if applicable) and appropriate fixed lower limits as specified in ETSU-R-97;
- Prediction of the likely levels of wind turbine noise received at each receptor; and
- Comparison of the predicted levels with the noise limits.

2.8.1 Receptor Identification

Potential noise sensitive receptors in the area around the Development were identified from Ordnance Survey (OS) 1:25,000 scale digital mapping, online aerial imagery and OS AddressBase data; a database which combines Royal Mail address data with buildings identified on large-scale Ordnance Survey mapping and provides addresses, descriptions and grid references.

2.8.2 Baseline Measurements

The method of measuring background noise is described in Chapter 7 of ETSU-R-97. In brief, it involves continuous measurement of both background noise levels at the receptors, and wind speeds at the location of the turbines for a period of at least one week. The

resulting data is then sorted into quiet daytime and night-time periods and the relationship between wind speed and background noise established for each location.

In this case, the measurement of background noise in accordance with ETSU-R-97 is complicated by the presence of the operational Whitelee Wind Farm. As ETSU-R-97 stipulates that noise from existing wind turbines should not be considered a component of background noise, rather than carrying out measurements, baseline noise levels have been obtained from a noise report¹¹ carried out in relation to the noise planning conditions associated with Whitelee Windfarm.

2.8.3 Noise Limits

The noise limits described in ETSU-R-97 are a combination of a 5 dB margin above the prevailing wind speed-dependent background noise level and fixed lower limits, applicable where background noise levels are low. These limits apply to cumulative effects.

For night-time periods (23:00 – 07:00), a fixed lower limit of 43 dB, $L_{A90, 10min}$ has been applied, in accordance with ETSU-R-97.

For daytime periods, the fixed lower portion of the noise limit is defined in ETSU-R-97 as a value within the range 35 to 40 dB, $L_{A90, 10min}$. This has been previously set at 40 dB for Whitelee and therefore the same value has been adopted for the cumulative assessment.

The sum of noise levels 10 dB or more apart is equal (to within 1 dB) to the larger of the values. Therefore, where noise levels from the Development are predicted to be less than 30 dB, i.e. 10 dB below the minimum cumulative noise limit, the Development could not cause the cumulative limits to be exceeded. Taking this into account, together with the fact that noise levels below 30 dB would be very difficult to measure accurately, no noise limit is considered to be necessary in such cases.

Figure 1 includes the predicted 30 dB, $L_{A90, 10min}$ contour for the Development.

Figure 2 shows the cumulative noise contours and highlights which receptors have a financial interest in the Development, and as such these are subject to the increased fixed lower limit, as stated in ETSU-R-97. In the case of such receptors, the increased fixed lower limit of 45 dB has been applied in the derivation of cumulative noise limits. The calculated contribution from Whitelee has then been logarithmically subtracted from this cumulative limit to derive an apportioned noise limit, which can be applied to the Development alone.

2.8.4 Noise Predictions

Noise predictions have been made using the ISO 9613-2 noise model, taking account of the specific data and parameters recommended in the GPG, as summarised below:

- The turbine sound power levels should be stated and these should include an appropriate allowance for measurement uncertainty. If the data provided contains no allowance for measurement uncertainty, or uncertainties are not stated, an additional 2 dB should be included;
- Atmospheric absorption should be calculated based on conditions of 10°C and 70% relative humidity;
- The ground factor assumed should be $G=0.5$ (mixed ground) except in urban areas or where noise propagates across large bodies of water, where $G=0$ (hard ground) should be assumed;
- A receiver height of 4.0 m should be assumed;
- Barrier attenuation should not be included, unless there is no line of sight from the receptor, in which case a 2 dB barrier effect may be included;

¹¹ Hoare Lea Acoustics 'Whitelee Windfarm – Background Noise Assessment' 2006.

- An additional 3 dB should be added to noise immission levels at properties located across a valley or with heavily concave ground between the receptor location and the wind turbine(s)¹²; and
- The predicted noise levels ($L_{Aeq,t}$) should be converted to the required $L_{A90,10min}$ by subtracting 2 dB.

ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e., down-wind or under a moderate, ground-based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the GPG have been shown to provide good correlation with levels of wind turbine noise measured at operational wind farms^{13,14}.

2.8.5 Candidate Turbine

The GPG notes that most sites at planning stage will not have selected a preferred turbine, therefore a candidate turbine representative of a range of turbines should be selected to provide appropriate noise levels. Once noise levels have been predicted at the potentially affected properties, compliance with noise limits can be assessed and design advice provided if compliance with the limits is considered unlikely.

The Vestas V136 4.2 MW, with a hub height of 82 m, has been used as the candidate turbine for the assessment. It is assumed that the turbines are fitted with the serrated trailing edge (STE) blades, and operate at full power (Mode 0) at all times. Table 1 details the noise emissions (sound power levels) for this turbine.

Table 1: Noise Emissions, Candidate Turbine

Turbine Type	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Manufacturer's Sound Power Level + 2 dB for uncertainty as per GPG								
Vestas V136 4.2MW	96.6	101.5	105.2	105.9	105.9	105.9	105.9	105.9	105.9

The octave-band frequency spectrum at the wind speed for which the maximum sound power level is achieved (7 ms⁻¹), which has been used as the source for modelling purposes, is detailed in Table 2.

Table 2: Octave-band Spectra

	Octave-band Centre Frequency, f, Hz							
	63	125	250	500	1000	2000	4000	8000
	Octave-band Sound Power Level, dB, $L_{WA,f}$							
Sound Power Level, dB, LWA, Scaled to 105.9 dB(A)	86.3	94.2	99.1	101.1	100.0	95.8	88.8	78.5

¹² Equation to determine concave ground as presented in Section 4.3.9 of the GPG.

¹³ Bullmore et al. (2009). Wind Farm Noise Predictions and Comparison with Measurements, Third International Meeting on Wind Turbine Noise, Aalborg, Denmark 17 – 19 June 2009.

¹⁴ Cooper & Evans (2013). Effects of different meteorological conditions on wind turbine noise.

2.8.6 Cumulative Noise Assessment

ETSU-R-97 states that the assessment should take account of the effect of noise from all wind turbines that may affect a particular receptor. In order to facilitate this, a screening exercise was conducted to identify any wind turbines either operational, consented, or part of a current planning application, considered to have the potential to result in cumulative noise effects when assessed in conjunction with the Development.

The following cumulative developments were identified:

- Whitelee Wind Farm and Extensions 1 & 2 (operational);
- Middleton Wind Farm (operational); and
- Over Enoch Wind Farm (operational).

Details of the noise emission data for each cumulative development has been derived from the respective turbine specifications including turbine make, model, capacity hub height and rotor diameter. The sound power levels and envelope were taken from turbine manufacturers data for the respective cumulative developments, and is presented in Annex A in the interest of completeness.

In order to identify the area (and thereby the noise-sensitive receptors) requiring a cumulative assessment, a screening tool has been developed. This involves calculating noise grids for both the Development and the cumulative sites under consideration, based on the maximum sound power levels for the turbines from each development. The difference between the grid values is then calculated to identify the area in which the difference in noise levels is less than 10 dB, in line with the requirements of the GPG.

This 'difference map' is then overlaid with the cumulative noise contours. The area where the cumulative level is greater than 35 dB(A) and the difference between the Development and the cumulative sites is less than 10 dB defines the area with the potential for cumulative effects.

Figure 2 presents the results of this screening figure. The receptors (residential dwellings) with the potential to experience a cumulative noise effect are those located within both the orange area and the cumulative 35 dB(A) contour.

As stated above, where the predicted level from the Development is less than 30 dB, no cumulative effects would occur. Figure 2 also shows the predicted contour for this level; receptors out with this area have been scoped out of the assessment.

Modelling of the effects of Whitelee in isolation found that without the use of low-noise operational modes predicted levels at Greenfield Farm could exceed the daytime limits at a small range of wind speeds. Greenfield Farm is therefore a controlling property for noise from Whitelee, as described in the GPG. As details of the operating modes applied are not available, it has been assumed as a worse-case scenario in the assessment that all Whitelee turbines operate on standard operating modes. As this is a worse-case assumption, no addition to the sound power level data for Whitelee is considered necessary to make allowance for the noise limits applicable to Whitelee.

2.8.7 Apportioned Noise Limits

Cumulative noise effects have been addressed through the derivation of apportioned noise limits. Apportioned noise limits are created by logarithmically subtracting the cumulative noise levels (excluding noise due to the Development), from the cumulative noise limits (Section 4.3). The result is the remaining noise budget available to the Development. Should no additional noise budget be available at a given property, limits at that property for noise due to the Development are set 10 dB below the cumulative noise limit, ensuring that any contribution to operational noise due to the Development is negligible.

3 BASELINE CONDITIONS

3.1 Assessed Receptors

Table 3 details the receptors considered in the assessment.

Table 3: Noise Sensitive Receptors

Name	Eastings	Northings
Shieldhill (FI)	251201	649221
Moor Farm	250866	648041
Highfield Farm	250372	649631

The noise sensitive receptors above are situated within the 30 dB contour of the Development as seen in Figure 1. Receptors outwith the contour extent are predicted to be more than 10 dB lower than the Whitelee operational noise limits and as such will not be unacceptably affected by noise from the Development.

3.2 Background Noise Levels

Table 4 below details the baseline noise levels for Greenfield and Moor Farm taken from Whitelee report.

Table 4: Representative Baseline Noise Levels

Baseline Monitoring Location	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Prevailing Background Noise Level, LA90,10min								
Quiet Daytime Background									
Greenfield Farm ¹⁵	26.8	29.3	32.6	36.2	40.1	44.1	47.7	51.0	53.6
Moor Farm ¹⁶	32.7	33.7	35.0	36.5	38.1	39.9	41.7	43.4	44.9
Night-time Background									
Greenfield Farm	23.0	26.1	30.1	34.6	39.4	44.0	48.1	51.5	53.7
Moor Farm	28.1	29.3	31.0	33.1	35.5	38.1	40.6	43.0	45.1

These locations are closest to Moorshield Wind Turbines and are considered likely to be representative of the background noise at the closest receptors (stated in Table 3).

Figure 1 illustrates the assessment locations and Whitelee baseline monitoring locations as shown in Tables 3 and 4.

3.3 Cumulative Noise Limits

Moor Farm background levels are taken as representative for all three receptors for the Development; considering the receptors context, location and background environment. Background noise levels at Moor Farm are also lower than Greenfield Farm for higher wind speeds, (Table 4 above); as such, taking Moor Farm background level is considered a conservative approach.

Table 5 below shows the derived day and night cumulative noise limits for the receptors

¹⁵ Greenfield Farm background level derived from; $y = -0.0366x^3 + 0.8798x^2 - 3.1103x + 27.464$ for day, and $y = -0.0549x^3 + 1.2553x^2 - 4.818x + 25.667$ for night, taken from Whitelee baseline monitoring report

¹⁶ Moor Farm background level derived from; $y = -0.0128x^3 + 0.3507x^2 - 1.4239x + 33.647$ for day, and $y = -0.0244x^3 + 0.6531x^2 - 3.2573x + 32.29$ for night, taken from Whitelee baseline monitoring report

Table 5: Cumulative Noise Limits for Receptors

Receptors	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Cumulative Noise Limit, dB, L _{A90,10min}								
Daytime Derived Noise Limits									
Shieldhill (FI)	45.0	45.0	45.0	45.0	45.0	45.0	46.7	48.4	49.9
Moor Farm	40.0	40.0	40.0	41.5	43.1	44.9	46.7	48.4	49.9
Highfield	40.0	40.0	40.0	41.5	43.1	44.9	46.7	48.4	49.9
Night-time Derived Noise Limits									
Shieldhill (FI)	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.0	48.0
Moor Farm	43.0	43.0	43.0	43.0	43.0	43.1	45.6	48.0	50.1
Highfield	43.0	43.0	43.0	43.0	43.0	43.1	45.6	48.0	50.1

These levels are used to derive apportioned limits for Moorshield Wind Turbines based on as described at 3.3.7.

3.4 Apportioned Noise Limits

Table 6 below details the apportioned limits for the receptors. Table 6 indicates that apportioned limit is calculated by subtracting 10 dB from the cumulative limit. Italic text indicates that the limits have been adjusted so that they are no higher than those at greater wind speeds.

Table 6: Apportioned Noise Limits

Receptors	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Apportioned Noise Limit, dB, L _{A90,10min}								
Daytime Derived Noise Limits									
Shieldhill (FI)	<i>43.3</i>	<i>43.3</i>	<i>43.3</i>	43.3	43.3	43.3	45.7	47.7	49.4
Moor Farm	<i>31.5</i>	<i>31.5</i>	<i>31.5</i>	31.5	38.4	42.4	45.2	47.5	49.3
Highfield Farm	<i>38.7</i>	<i>38.7</i>	38.7	40.0	42.1	44.3	46.3	48.1	49.7
Night-time Derived Noise Limits									
Shieldhill (FI)	<i>44.1</i>	<i>44.1</i>	44.1	43.3	43.3	43.3	44.2	47.3	49.7
Moor Farm	<i>38.1</i>	<i>38.1</i>	<i>38.1</i>	38.1	38.1	38.4	43.6	47.0	49.5
Highfield Farm	<i>42.0</i>	<i>42.0</i>	<i>42.0</i>	42.0	42.0	42.1	45.1	47.7	49.9

4 ASSESSMENT OF POTENTIAL EFFECTS

4.1 Predicted Noise Levels from Development

Table 7 below provides the predicted noise levels from the Development in isolation.

Table 7: Predicted Noise Levels from Development

Receptors	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Predicted Noise Level, dB, L _{A90,10min}								
Shieldhill (FI)	34.0	38.9	42.6	43.3	43.3	43.3	43.3	43.3	43.3
Moor Farm	21.5	26.4	30.1	30.8	30.8	30.8	30.8	30.8	30.8
Highfield Farm	23.5	28.4	32.1	32.8	32.8	32.8	32.8	32.8	32.8

4.2 Comparison with Apportioned Limits

The predicted noise level from the Development in isolation are compared against the apportioned noise limits for the respective receptor, results are shown in Table 8 below. A negative value indicates that the predicted noise levels is above the corresponding limit. As can be seen the predicted levels are no greater than the apportioned limits in all cases.

Table 8: Comparison of Predicted Noise levels to Apportioned Limits

Receptors	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Headroom, dB								
Daytime									
Shieldhill (FI)	9.3	4.4	0.7	0.0	0.0	0.0	2.4	4.4	6.1
Moor Farm	10.0	5.1	1.4	0.7	7.6	11.6	14.4	16.7	18.5
Highfield Farm	15.2	10.3	6.6	7.2	9.3	11.5	13.5	15.3	16.9
Night-time									
Shieldhill (FI)	10.1	5.2	1.5	0.0	0.0	0.0	0.9	4.0	6.4
Moor Farm	16.6	11.7	8.0	7.3	7.3	7.6	12.8	16.2	18.7
Highfield Farm	18.5	13.6	9.9	9.2	9.2	9.3	12.3	14.9	17.1

4.3 Comparison with Soame Limits

Table 9 presents the noise limits from the conditions agreed with SPR during the Soame Appeal. It should be noted that Arcus has no information on how these noise limits were calculated and that in some cases they are higher than the apportioned limits calculated by Arcus (Table 8).

Table 9: Soame Noise Limits

Receptors	Standardised 10 m Wind Speed, ms ⁻¹									
	4	5	6	7	8	9	10	11	12	
	Apportioned Noise Limit, dB, L _{A90,10min}									
Daytime Noise Limits										
Shieldhill	44.8	44.5	45.5	47.4	49.7	52.1	54.4	56.5	58.6	
Moor Farm	30.0	30.0	30.0	31.5	33.1	34.9	36.7	38.4	39.9	
Highfield Farm	46.9	48.0	49.1	50.2	51.1	52.1	53.0	53.8	54.6	
Night-time Noise Limits										
Shieldhill	44.8	44.5	44.2	43.8	43.7	43.9	47.0	49.6	51.9	
Moor Farm	33.0	33.0	33.0	33.0	33.0	33.1	35.6	38.0	40.1	
Highfield Farm	42.9	42.7	42.5	42.3	44.3	46.3	48.2	50.2	52.0	

Table 10 shows the difference between the Soame noise limits (Table 9) and the predicted noise levels for the Development (Table 7). With the exception of a single daytime wind speed at Moor Farm, the predicted noise levels are no greater than the limits. The 0.1dB exceedance at Moor Farm is acoustically insignificant as it would be neither perceptible nor measurable.

Table 10: Comparison of Predicted Noise levels to Soame Limits

Receptors	Standardised 10 m Wind Speed, ms ⁻¹									
	4	5	6	7	8	9	10	11	12	
	Headroom, dB									
Daytime										
Shieldhill (FI)	10.8	5.6	2.9	4.1	6.4	8.8	11.1	13.2	15.3	
Moor Farm	8.5	3.6	-0.1	0.7	2.3	4.1	5.9	7.6	9.1	
Highfield Farm	23.4	19.6	-17.0	17.4	18.3	19.3	20.2	21.0	21.8	
Night-time										
Shieldhill (FI)	10.8	5.6	1.6	0.5	0.4	0.6	3.7	6.3	8.6	
Moor Farm	11.5	6.6	2.9	2.2	2.2	2.3	4.8	7.2	9.3	
Highfield Farm	19.4	14.3	10.4	9.5	11.5	13.5	15.4	17.4	19.2	

5 MITIGATION

5.1 Construction and Decommissioning Noise

The good practice measures detailed below will be implemented to manage the effects of noise during construction operations, and will be required of all contractors:

- Operations shall be limited to times agreed with the Council;
- Deliveries of turbine components, plant and materials by HGV to site shall only take place by designated routes and within times agreed with the Council;
- The site contractors shall be required to employ the best practicable means of reducing noise emissions from plant, machinery and construction activities, as advocated in BS 5228;
- Where practicable, the work programme will be phased, which would help to reduce the combined effects arising from several noisy operations;
- Where necessary and practicable, noise from fixed plant and equipment will be contained within suitable acoustic enclosures or behind acoustic screens;
- All sub-contractors appointed by the main contractor will be formally and legally obliged, and required through contract, to comply with all environmental noise conditions;
- Where practicable, night-time working will not be carried out. Local residents shall be notified in advance of any night-time construction activities likely to generate significant noise levels, e.g., turbine erection; and
- Any plant and equipment normally required for operation at night (23:00 - 07:00), e.g., generators or dewatering pumps, shall be silenced or suitably shielded to ensure that the night-time lower threshold of 45 dB, $L_{Aeq, night}$ shall not be exceeded at the nearest noise-sensitive receptors.

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.

Noise produced during decommissioning of the Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with.

5.2 Operational Noise

During the development of the layout of the wind turbines, the distance between the turbines and neighbouring non-financially properties was maximised as far as practicable, in order to minimise the effects of noise.

The control systems of all modern wind turbine models are capable of controlling the noise emissions from the turbines through management of factors such as rotational speed and blade pitch. It will therefore be possible to manage the noise emissions of the Development to ensure compliance with appropriate noise limits.

It is recommended that planning conditions are applied to permission that include the wording of conditions agreed between the proposers of Soame Wind Farm and SPR, as detailed in Appendix C. However, it is recommended that the tables included with these conditions are replaced with Tables A and B provided below. The limits detailed in Tables A and B comprise the lower value of the limits calculated by Arcus and those in the Alternative Noise Condition from the Soame Appeal. This ensures the protection both of residential amenity and the interests of the operator of the neighbouring wind farm.

In addition, it is recommended that a condition is attached, requiring the submission for the approval of the planning authority of details of the turbine model to be installed,

including its noise emissions and details of any noise-management measures required to ensure compliance with the conditioned noise limits.

Table A: Recommended Noise Limits for Conditions

Receptors	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Noise Limit, dB, LA90,10min								
Daytime (0700 to 2300)									
Shieldhill	43.3	43.3	43.3	43.3	43.3	43.3	45.7	47.7	49.4
Moor Farm	30.0	30.0	30.0	31.5	33.1	34.9	36.7	38.4	39.9
Highfield Farm	38.7	38.7	38.7	40.0	42.1	44.3	46.3	48.1	49.7
Night-time (2300 to 0700)									
Shieldhill	44.1	44.1	44.1	43.3	43.3	43.3	44.2	47.3	49.7
Moor Farm	33.0	33.0	33.0	33.0	33.0	33.1	35.6	38.0	40.1
Highfield Farm	42.0	42.0	42.0	42.0	42.0	42.1	45.1	47.7	49.9

Table B: Grid References of Receptors Listed in Table A

Name	Eastings	Northings
Shieldhill (F1)	251201	649221
Moor Farm	250866	648041
Highfield Farm	250372	649631

6 SUMMARY

An assessment of potential noise effects associated with the Development has been carried out.

Construction noise will be limited in duration and confined to working hours as specified by the Council and therefore can be adequately controlled through the application of good practice measures and secured by planning condition. This will ensure that any noise from the Development site during construction will be adequately controlled.

Operational noise has been assessed in accordance with ETSU-R-97 and in line with current best practice. It has been shown that the Development would comply with the requirements of ETSU-R-97 at all receptor locations.

The cumulative effects of the Development in conjunction with nearby wind energy developments either operational, consented or the subject of a current planning application were taken into consideration in the above assessment, in accordance with ETSU-R-97 and the GPG.

Noise during decommissioning will be of a similar nature to that of construction and will be managed through best practice or other guidance or legislation relevant at the time.

7 GLOSSARY

AGL: Above Ground Level

Background Noise: The background noise level is the underlying 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 cyclical changes in air pressure created by the sound (Sound Pressure Level) and operates on a logarithmic scale, ranging upwards from 0 dB. 0 dB is equivalent to the normal threshold of human hearing at a frequency of 1000 Hz. Each increase of 3 dB on the scale represents a doubling in the Sound Pressure Level, 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 level, 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 1000-3000 Hertz (Hz)), 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.

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.

Noise Emission: The sound power level emitted from a given source.

Noise Immission: The sound pressure level detected at a given location (e.g. nearest dwelling).

$L_{A90,t}$: This term is used to represent the A-weighted sound pressure level that is exceeded for 90% of a period of time, t. This is used as a measure of the background noise level.

$L_{Aeq,t}$: 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 steady, continuous noise which has the same energy as the actual measured noise.

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

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-sensitive receptors: Locations that may potentially be adversely affected by the addition of a new source of noise (typically residential dwellings).

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_0) 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.

ANNEX A: CUMULATIVE NOISE EMISSION DATA

Tables A1.1 and A1.2 below detail the Sound Power Level and Octave Band Data used in the Cumulative Assessment respectively.

Table A1.1 – Sound Power Level Data Used in Cumulative Assessment

Wind Farm	Standardised 10 m Wind Speed, ms ⁻¹								
	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)								
Middleton Windfarm	97.1	101.9	104.8	105.1	105.1	105.1	105.1	105.1	105.1
Over Enoch Windfarm	98.3	105.2	107.4	107.4	107.4	107.4	107.4	107.4	107.4
Whitelee Windfarm	98.3	105.2	107.4	107.4	107.4	107.4	107.4	107.4	107.4

Table A1.2 – Octave Band Data Used in Cumulative Assessment

Wind Farm	Octave Band Centre Frequency, Hz								
	63	125	250	500	1k	2k	4k	8k	SUM
	Sound Power Level, dB(A)								
Middleton Windfarm	87.8	94.5	98.5	99.7	98.7	96.0	89.9	80.4	105.1
Over Enoch Windfarm	85.6	95.6	102.3	102.7	99.8	96.3	91.0	87.3	107.4
Whitelee Windfarm	85.6	95.6	102.3	102.7	99.8	96.3	91.0	87.3	107.4

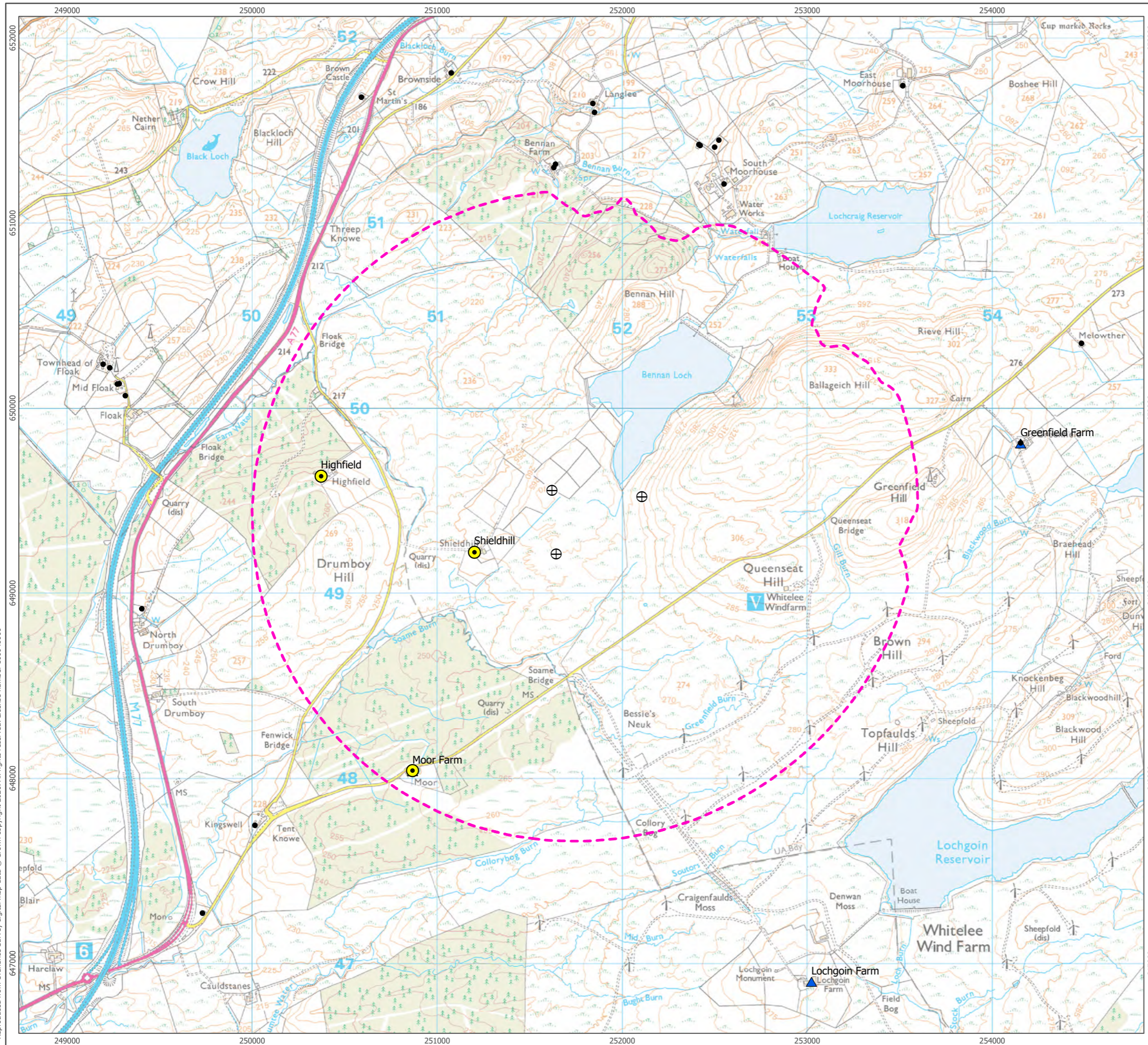
Sound power levels includes +2dB uncertainty correction

The Noise Emission Data above were taken from turbine manufacturers data for respective makes and models used in the cumulative wind farms, modelled with the existing rotor diameter and hub heights. The following wind turbine specifications were modelled¹⁷:

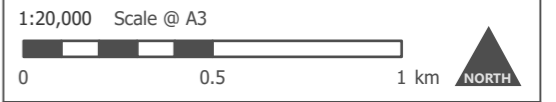
- Whitelee Windfarm: Siemens - 2.3MW turbine at hub height of 63 m and 93 m rotor diameter (Tip height of 110 m);
- Middleton Windfarm: Gamesa G80 – 2MW turbine at Hub height of 60 m and 80 m rotor diameter (Tip height of 100 m); and
- Over Enoch Windfarm: Siemens SWT – 2.3MW turbine at hub height of 63 m and 93 m rotor diameter (Tip height of 110 m).

¹⁷ Sources: Arcus Internal Database, UK Renewables Database, and Online database from: thewindpower.net

ANNEX B: FIGURES



- ⊕ Proposed Turbines
- ▲ Whitelee Baseline Monitoring Locations
- Assessment Receptors
- Noise Sensitive Receptor Within 5km
- - - Development 35 dB, LA90,10min Contour

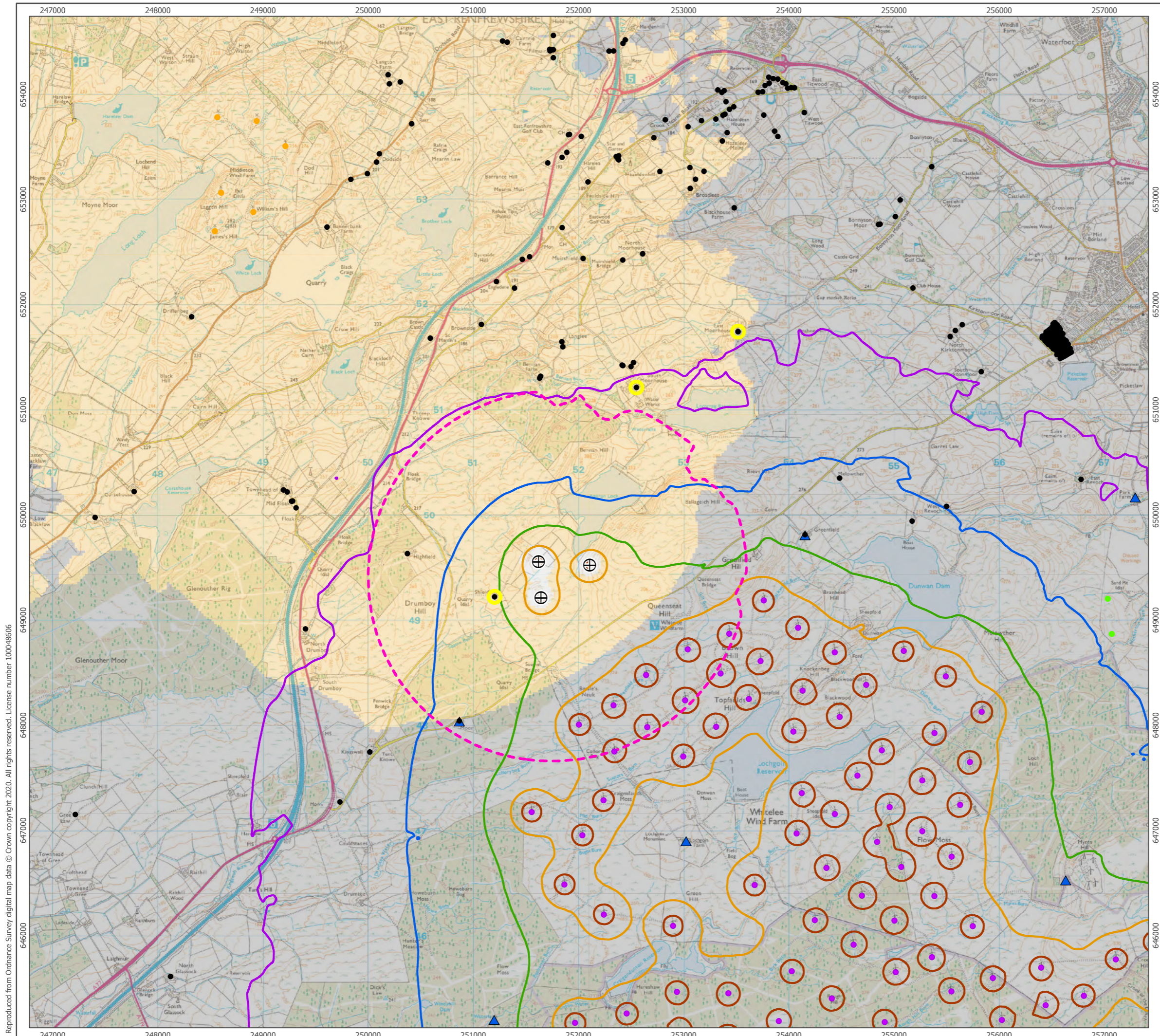


Produced By: BA	Ref: 3520-REP-027
Checked By: MR	Date: 25/11/2019

Assessed Receptors
Figure 1

**Moorshield Wind Turbines
Noise Assessment**

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- ⊕ Proposed Turbines
- Noise Sensitive Receptor Within 5km
- Financially Involved Receptor
- Over Enoch Windfarm
- Middleton Windfarm
- Whitelee Windfarm
- ▲ Whitelee Baseline Monitoring Locations
- 35 dB, LA90,10min
- 40 dB, LA90,10min
- 45 dB, LA90,10min
- 50 dB, LA90,10min
- 55 dB, LA90,10min
- Development 10 dB or More Above Others
- Development Within 10 dB of Others
- Development 10 dB Below Others
- - - Development 35 dB, LA90,10min Contour

1:35,000 Scale @ A3
 0 0.5 1 km
 NORTH

Produced By: BA	Ref: 3520-REP-028
Checked By: MR	Date: 25/11/2019

Predicted Cumulative Noise Contours
Figure 2

Moorshield Wind Turbines Noise Assessment

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ANNEX C: ALTERNATIVE SOAME NOISE CONDITION WORDING

Alternative Soame Noise Condition Wording

The rating level of noise immissions from the combined effects of the wind turbines approved by this permission ("Soame wind turbines") (including the application of any tonal penalty) when determined in accordance with the attached Guidance Notes (to this condition), shall not exceed the values for the relevant integer wind speed set out in, or derived from, the tables attached to this condition (Appendix 1) at any dwelling which is lawfully existing or has planning permission at the date of this permission and:

a) The wind farm operator shall continuously log power production, wind speed and wind direction, all in accordance with Guidance Note 1(d). These data shall be retained for a period of not less than 24 months. The wind farm operator shall provide this information in the format set out in Guidance Note 1(e) to the Planning Authority on its request, within 14 days of receipt in writing of such a request.

b) No electricity shall be exported until the wind farm operator has submitted to the Planning Authority for written approval a list of proposed independent consultants who may undertake compliance measurements in accordance with this condition. Amendments to the list of approved consultants shall be made only with the prior written approval of the Planning Authority.

c) Within 21 days from receipt of a written request from the Planning Authority following a complaint to it from an occupant of a dwelling alleging noise disturbance at that dwelling, the wind farm operator shall, at its expense, employ a consultant approved by the Planning Authority to assess the level of noise immissions from the wind farm at the complainant's property in accordance with the procedures described in the attached Guidance Notes. The written request from the Planning Authority shall set out at least the date, time and location that the complaint relates to and any identified atmospheric conditions, including wind direction, and include a statement as to whether, in the opinion of the Planning Authority, the noise giving rise to the complaint contains or is likely to contain a tonal component. Where in the opinion of the Planning Authority such a complaint relates to noise from the combined effects of the Soame wind turbines and those on Whitelee Adjacent Wind Energy Development, responsibility for assessment of compliance with the noise limits contained in the tables attached to this condition (including any associated requirement to stop the Soame wind turbines to undertake this assessment) shall firstly be undertaken for noise from the Soame wind turbines by the operator of the Soame wind turbines. "Whitelee Adjacent Wind Energy Development" shall mean the Whitelee Windfarm (the Section 36 consent and deemed planning permission granted by the Scottish Ministers in April 2006), Whitelee Windfarm Extension Phase 1 (the Section 36 consent and deemed planning permission granted by the Scottish Ministers for an extension to Whitelee Windfarm in May 2009) and Whitelee Windfarm Extension Phase 2 (the Section 36 consent and deemed planning permission granted by the Scottish Ministers for an extension to Whitelee Windfarm in December 2009). The wind farm operator shall stop all turbines on The Development in circumstances where they have received a notice from the Council that a valid complaint about noise from the Whitelee Adjacent Wind Energy Development has been received and that this requires assessment of the compliance by the operator of the Whitelee Adjacent Wind Energy Development with the noise limits applicable to the Whitelee Adjacent Wind Energy Development and where in the opinion of the Planning Authority there may be an acoustically relevant contribution from the operation of the wind turbines hereby approved which may influence that assessment. Any such notice served by the Planning Authority shall specify the duration of the monitoring and the particular wind speeds and directions in which the turbines will require to be turned off.

d) The assessment of the rating level of noise immissions shall be undertaken in accordance with an assessment protocol that shall previously have been submitted to and approved in writing by the Planning Authority. The protocol shall include the proposed measurement location identified in accordance with the Guidance Notes where measurements for compliance checking purposes shall be undertaken, whether noise giving rise to the complaint is anticipated to contain or is likely to contain a tonal component, and also the range of meteorological and operational conditions (which shall include the range of wind speeds, wind directions, power generation and times of day) to determine the assessment of rating level of noise immissions. The proposed range of conditions shall be those which prevailed during times when the complainant alleges there was disturbance due to noise, having regard to the written request of the Planning Authority under paragraph (c), and such others as the independent consultant considers likely to result in a breach of the noise limits.

e) Where a dwelling to which a complaint is related is not listed in the tables attached to this condition, the wind farm operator shall submit to the Planning Authority for written approval proposed noise limits selected from those listed in the Tables to be adopted at the complainant's dwelling for compliance checking purposes. The proposed noise limits are to be those limits selected from the Tables specified for a listed location which the independent consultant considers as being most appropriate, with justification provided in the consultant's assessment. The rating level of noise immissions resulting from the combined effects of the wind turbines approved by this permission when determined in accordance with the attached Guidance Notes shall not exceed the noise limits approved in writing by the Planning Authority for the complainant's dwelling.

f) The wind farm operator shall provide to the Planning Authority the independent consultant's assessment of the rating level of noise immissions undertaken in accordance with the Guidance Notes within 2 months of the date of the written request of the Planning Authority for compliance measurements to be made under paragraph (c), unless the time limit is extended in writing by the Planning Authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements, such data to be provided in the format set out in Guidance Note 1(e) of the Guidance Notes. The instrumentation used to undertake the measurements shall be calibrated in accordance with Guidance Note 1(a) and certificates of calibration shall be submitted to the Planning Authority with the independent consultant's assessment of the rating level of noise immissions.

g) Where a further assessment of the rating level of noise immissions from the wind farm is required pursuant to Guidance Note 4(c), the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's assessment pursuant to paragraph (d) above unless the time limit has been extended in writing by the Planning Authority.

Appendix 1 Tables

Table 1 – Between 07:00 and 23:00 – Noise limits expressed in dB LA90,10-minute as a function of the standardised wind speed (m/s) at 10 metre height as determined within the site averaged over 10-minute periods.

Location	Standardised wind speed at 10 meter height (m/s) within the site averaged over 10-minute periods									
	3	4	5	6	7	8	9	10	11	12
<i>Limit Where Financial Involvement Applies</i>										
Shieldhill	44.9	44.9	44.6	45.2	47.2	49.6	52.0	54.3	56.5	58.5
South Moorhouse	45.0	45.0	45.4	46.9	48.5	50.2	51.8	53.4	54.9	56.4
<i>Limit Where No Financial Involvement Applies</i>										
Moor Cottage	30.0	30.0	30.0	30.0	31.5	33.1	34.9	36.7	38.4	39.9
Greenfield	30.0	30.0	30.0	30.0	31.2	35.1	39.1	42.7	46.0	48.6
Highfield	45.7	46.9	48.0	49.0	50.1	51.1	52.1	53.0	53.8	54.6
Bennan Farm	42.7	43.9	45.2	46.6	48.2	50.0	51.9	53.8	55.9	58.2
Swan Cottages	39.9	39.9	40.2	41.5	43.2	44.9	46.6	48.2	49.8	51.4

Table 2 – Between 23:00 and 07:00 – Noise limits expressed in dB LA90,10-minute as a function of the standardised wind speed (m/s) at 10 metre height as determined within the site averaged over 10-minute periods.

Location	Standardised wind speed at 10 meter height (m/s) within the site averaged over 10-minute periods									
	3	4	5	6	7	8	9	10	11	12
<i>Limit Where Financial Involvement Applies</i>										
Shieldhill	44.9	44.9	44.6	43.8	43.1	43.1	43.1	46.6	49.5	51.8
South Moorhouse	45.0	45.0	44.9	44.7	44.5	46.4	48.4	50.3	52.2	54.0
<i>Limit Where No Financial Involvement Applies</i>										
Moor Cottage	33.0	33.0	33.0	33.0	33.0	33.0	33.1	35.6	38.0	40.1

<i>Greenfield</i>	33.0	33.0	33.0	33.0	33.0	34.4	39.0	43.1	46.5	48.7
<i>Highfield</i>	42.9	42.9	42.8	42.3	41.9	43.0	45.4	47.9	50.6	53.6
<i>Bennan Farm</i>	43.0	42.9	42.9	42.6	42.4	44.7	47.7	51.1	54.9	59.2
<i>Swan Cottages</i>	43.0	42.9	42.8	42.5	42.3	44.3	46.3	48.2	50.1	52.0

Table 3: Coordinate locations of the properties listed in Tables 1 and 2.

Property	Easting	Northing
<i>Moor Cottage</i>	250850	648050
<i>Greenfield</i>	254147	649810
<i>Shieldhill</i>	251233	649238
<i>Highfield</i>	250408	649634
<i>Bennan Farm</i>	251633	651306
<i>Swan Cottages</i>	252424	651417
<i>South Moorhouse</i>	252569	651217

Guidance Notes for Noise Condition

These notes are to be read with and form part of the noise condition. They further explain the condition and specify the methods to be employed in the assessment of complaints about noise immissions from the wind farm. The rating level at each integer wind speed is the arithmetic sum of the wind farm noise level as determined from the bin-average described in Guidance Note 2 of these Guidance Notes and any tonal penalty applied in accordance with Guidance Note 3. Reference to ETSU-R-97 refers to the publication entitled “The Assessment and Rating of Noise from Wind Farms” (1997) published by the Energy Technology Support Unit (ETSU) for the Department of Trade and Industry (DTI).

Guidance Note 1

(a) Values of the $L_{A90,10\text{-minute}}$ noise statistic should be measured at the complainant’s property, using a sound level meter of EN 60651/BS EN 60804 Type 1, or BS EN 61672 Class 1 quality (or the equivalent UK adopted standard in force at the time of the measurements) set to measure using the fast time weighted response as specified in BS EN 60651/BS EN 60804 or BS EN 61672-1 (or the equivalent UK adopted standard in force at the time of the measurements). This should be calibrated in accordance with the procedure specified in BS 4142: 1997 (or the equivalent UK adopted standard in force at the time of the measurements). Measurements shall be undertaken in such a manner to enable a tonal penalty to be applied in accordance with Guidance Note 3.

(b) The microphone should be mounted at 1.2 – 1.5 metres above ground level, fitted with a two-layer windshield or suitable equivalent approved in writing by the Local Planning Authority, and placed outside the complainant’s dwelling. Measurements should be made in “free field” conditions. To achieve this, the microphone should be placed at least 3.5 metres away from the building facade or any reflecting surface except the ground at the approved measurement location. In the event that the consent of the complainant for access to his or her dwelling to undertake compliance measurements is withheld, the wind farm operator shall submit for the written approval of the Local Planning Authority details of the proposed alternative representative measurement location prior to the commencement of measurements and the measurements shall be undertaken at the approved alternative representative measurement location.

(c) The $L_{A90,10\text{-minute}}$ measurements should be synchronised with measurements of the 10-minute arithmetic mean wind and operational data logged in accordance with Guidance Note 1(d), including the power generation data from the turbine control systems of the wind farm.

(d) To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second and wind direction in degrees from north at hub height for each turbine, and at any on site meteorological mast(s), if available, together with the arithmetic mean power generated by each turbine, all in successive 10-minute periods. All 10-minute arithmetic average mean wind speed data measured at hub height shall be ‘standardised’ to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres . It is this standardised 10 metre height wind speed data, as determined from whichever source is agreed in writing with the Local Planning Authority as being most appropriate to the noise compliance measurements being undertaken, which is correlated with the noise measurements determined as valid in accordance with Guidance Note 2, such correlation to be undertaken in the manner described in Guidance Note 2. All 10-minute periods shall commence on the hour and in 10-minute increments thereafter.

(e) Data provided to the Local Planning Authority in accordance with the noise condition shall be provided in comma separated values in electronic format.

(f) A data logging rain gauge shall be installed in the course of the assessment of the levels of noise immissions. The gauge shall record over successive 10-minute periods synchronised with the periods of data recorded in accordance with Note 1(d).

Guidance Note 2

(a) The noise measurements shall be made so as to provide not less than 20 valid data points as defined in Guidance Note 2 (b)

(b) Valid data points are those measured in the conditions specified in the agreed written protocol under paragraph (d) of the noise condition, but excluding any periods of rainfall measured in the vicinity of the sound level meter. Rainfall shall be assessed by use of a rain gauge that shall log the occurrence of rainfall in each 10-minute period concurrent with the measurement periods set out in Guidance Note 1.

(c) For those data points considered valid in accordance with Guidance Note 2(b), values of the $L_{A90,10\text{-minute}}$ noise measurements and corresponding values of the 10-minute standardised ten metre height wind speed, as derived from the site measured wind speed source(s) agreed in writing with the Local Planning Authority in accordance with Guidance Note 1(d), shall be plotted on an XY chart with noise level on the Y-axis and the standardised mean wind speed on the X-axis. Data shall be divided into 1 m/s wide 'bins', each bin being 1 metre per second wide and centred on integer wind speeds, with at least 5 data-points contained within each bin. An arithmetic mean of the data-points in each bin shall be calculated at each integer speed and define the measured noise level for each wind speed bin.

Guidance Note 3

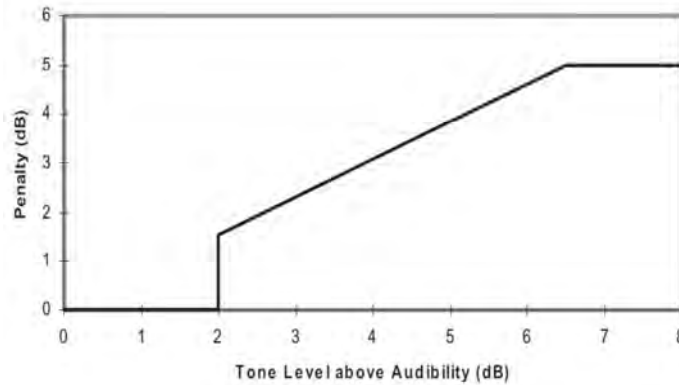
(a) Where, in accordance with the approved assessment protocol under paragraph (d) of the noise condition, noise immissions at the location or locations where compliance measurements are being undertaken contain or are likely to contain a tonal component, a tonal penalty is to be calculated and applied using the following rating procedure.

(b) For each 10-minute interval for which $L_{A90,10\text{-minute}}$ data have been determined as valid in accordance with Guidance Note 2 a tonal assessment shall be performed on noise immissions during 2 minutes of each 10-minute period. The 2 minute periods should be spaced at 10-minute intervals provided that uninterrupted uncorrupted data are available ("the standard procedure"). Where uncorrupted data are not available, the first available uninterrupted clean 2 minute period out of the affected overall 10-minute period shall be selected. Any such deviations from the standard procedure, as described in Section 2.1 on pages 104-109 of ETSU-R-97, shall be reported.

(c) For each of the 2-minute samples the tone level above or below audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104-109 of ETSU-R-97.

(d) The average tone level above audibility shall be calculated for each wind speed bin, each bin being 1 metre per second wide and centred on integer wind speeds. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted for that bin.

(e) The tonal penalty for each wind speed bin is derived from the margin above audibility of the tone according to the figure below.



Guidance Note 4

(a) If a tonal penalty is to be applied in accordance with Guidance Note 3 the rating level of the turbine noise at each wind speed is the arithmetic sum of the measured noise level as determined from the average for that wind speed bin described in Guidance Note 2 and the penalty for tonal noise as derived in accordance with Guidance Note 3 at each integer wind speed within the range specified by the Local Planning Authority in its written protocol under paragraph (d) of the noise condition.

(b) If no tonal penalty is to be applied then the rating level of the turbine noise at each wind speed is equal to the measured noise level as determined from the average for that wind speed bin described in Guidance Note 2.

(c) In the event that the rating level is above the limit(s) set out in the Tables attached to the noise conditions or the noise limits for a complainant's dwelling approved in accordance with paragraph (e) of the noise condition, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise immission only.

(d) The wind farm operator shall ensure that all necessary wind turbines in the development are turned off for such period as the independent consultant requires to undertake any further noise measurements required under Guidance Note 4(c). If the number of turbines to be turned off are less than the total number of turbines on the site then this shall be agreed in advance with the Local Planning Authority.

(e) To this end, the steps in Guidance Note 2 shall be repeated with the required number of turbines shut-down in accordance with Guidance Note 4(d) in order to determine the background noise (L_3) at each integer wind speed within the range requested by the Local Planning Authority in its written request under paragraph (c) and the approved protocol under paragraph (d) of the noise condition.

(f) The wind farm noise (L_1) at this speed shall then be calculated as follows where L_2 is the measured level with turbines running but without the addition of any tonal penalty:

$$L_1 = 10 \log \left[10^{L_2/10} - 10^{L_3/10} \right]$$

(g) The rating level shall be re-calculated by adding arithmetically the tonal penalty (if any is applied in accordance with Note 3) to the derived wind farm noise L_1 at that integer wind speed.

(h) If the rating level after adjustment for background noise contribution and adjustment for tonal penalty (if required in accordance with Guidance Note 3 above) at any integer wind speed lies at or

below the values set out in the Tables attached to the conditions or at or below the noise limits approved by the Local Planning Authority for a complainant's dwelling in accordance with paragraph (e) of the noise condition then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Tables attached to the conditions or the noise limits approved by the Local Planning Authority for a complainant's dwelling in accordance with paragraph (e) of the noise condition then the development fails to comply with the conditions.