11 Noise & Vibration

11.1 Introduction

11.1.1 This chapter considers the likely significant noise effects associated with the construction, operation and decommissioning of the proposed Bloch Wind Farm (hereafter referred to as the proposed development) on residents of nearby properties. The specific objectives of the chapter are to:

- describe the current baseline;
- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the potential effects, including direct, indirect and cumulative effects;
- describe the mitigation measures proposed to address the likely significant effects; and
- assess the residual effects remaining following the implementation of mitigation measures.

11.1.2 This assessment has been undertaken by RES, with at least one in-house Member of the Institute of Acoustics involved in its production. RES has undertaken acoustic impact assessments in every single one of its UK wind farm development applications since 2000. RES has also carried out noise assessments and reported to several local planning authorities on operational wind energy projects, including taking measurements on newly constructed wind farms to ensure compliance with planning conditions.

11.1.3 The chapter author is Andrew Birchby, a Member of the Institute of Acoustics with 15 years of experience in wind farm development and 10 years of experience in performing acoustic assessments. The chapter reviewer is Jeremy Bass, a Member of the Institute of Acoustics with over 30 years of experience in wind farm development and acoustic assessments.

11.1.4 Additionally, RES has been project co-ordinator for several Joule[1] projects, leading European research into wind turbine noise, was involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms'[2] for the DTI in 1996, acted as peer reviewer for the 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'[3], and contributed to the RenewableUK work on Amplitude Modulation[4]. Selected publications include:

- 'Wind Turbine Measurements for Noise Source Identification', ETSU W/13/003914/00.REP, 1999, Dr P Dunbabin, RES et al;
- 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU W/13/00385/REP, 2000 Dr J Bass, RES;
- 'Aerodynamic Noise Reduction for Variable Speed Turbines', ETSU/W/45/00504/REP, 2000, Dr P Dunbabin, RES;
- 'Fundamental research in amplitude modulation - a project by RenewableUK', Dr J Bass et al, Fourth International Meeting on Wind Turbine Noise, Rome, April 2011;
- 'Investigation of the 'Den Brook' Amplitude Modulation methodology for wind turbine noise', Dr J Bass, Acoustics Bulletin Vol 36 No 6 November/December 2011;
- 'How does noise influence the design of a wind farm?', Dr M Cassidy, Fifth International Conference on Wind Turbine Noise, Denver, 2013;
- 'Propagation of Noise from Wind Farms According to the Good Practice Guide', A Birchby, Sixth International Conference on Wind Turbine Noise, Glasgow, 2015; and
- 'A Method for Rating Amplitude Modulation in Wind Turbine Noise', Institute of Acoustics Noise Working Group, August 2016.

11.1.5 The chapter is supported by:

- Figure 11.1 – Predicted Noise Footprint due to Proposed Development;
- Figure 11.2 – Predicted Cumulative Noise Footprint;
- Technical Appendix 11.1 - Assessment of Energy Storage Facility;
- Technical Appendix 11.2 – Issues Scoped Out of Wind Farm Noise Assessment;
- Technical Appendix 11.3 – Calculating Standardised Wind Speed;
- Technical Appendix 11.4 – Propagation Height & Valley Effect;
- Technical Appendix 11.5 – Background Noise Survey Photos;

[1] DGXII European Commission funded projects in the field of Research and Technological Development in non-nuclear energy

[2] 'The Assessment and Rating of Noise from Wind Farms', The Working Group on Noise from Wind Turbines, ETSU Report for the DTI, ETSU-R-97, September 1996. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49869/ETSU_Full_copy__Searchable_.pdf

[3] 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise', Institute of Acoustics, May 2013. Available at: https://www.ioa.org.uk/publications/wind-turbine-noise

[4] 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects', RenewableUK, December 2013. Available at: http://usir.salford.ac.uk/id/eprint/33475/

- Technical Appendix 11.6 – Instrumentation Records;
- Technical Appendix 11.7 – Charts;
- Technical Appendix 11.8 – Suggested Planning Conditions; and
- Glossary.

11.1.6 Figures and Technical Appendices are referenced in the text where relevant.

11.2 Legislation, Policy and Guidance

Construction Noise

11.2.1 In the web based Scottish Government technical advice on construction noise assessment in 'Appendix 1: Legislative Background, Technical Standards and Codes of Practice'[5] it is stated that:

"However, under Environmental Impact Assessments and for planning purposes i.e. not in regard to the Control of Pollution Act 1974, the 2009 version of BS 5228 is applicable."

11.2.2 Given that BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise'[6] is identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities, it is adopted herein.

11.2.3 The Control of Pollution Act 1974 provides information on the need for ensuring that the best practicable means are employed to minimise noise[7].

11.2.4 BS 5228-2:2009 'Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration'[8], provides a method for predicting vibration levels which has been adopted in this assessment.

11.2.5 BS 6472-2:2008 'Guide to evaluation of human exposure to vibration in buildings - Part 2: Blast-induced vibration'[9] has been used to set criteria for satisfactory magnitudes of vibration at nearby residential properties to ensure compliance with respect to human response.

Operational Noise

11.2.6 In the context of other sources of environmental noise, the noise levels produced by wind turbines are generally low and have greater dependence upon wind speed. The combination of these two factors implies that a degree of masking would often be provided by background noise.

11.2.7 As described by Scottish Government Planning Advice for Onshore Wind Turbines[10]:

"Technically, there are two quite distinct types of noise sources within a wind turbine - the mechanical noise produced by the gearbox, generator and other parts of the drive train; and the aerodynamic noise produced by the passage of the blades through the air. There has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design."

11.2.8 Within Scotland, noise is defined within the planning context by 'Planning Advice Note 1/2011: Planning and Noise'[11]. This Planning Advice Note provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The Planning Advice Note 1/2011 states that:

"Good acoustical design and siting of turbines is essential to minimise the potential to generate noise."

11.2.9 Planning Advice Note 1/2011 refers to the use of the Department of Trade and Industry's 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97), noting that further guidance is provided in the web-based planning advice on renewable technologies for onshore wind turbines[5]. In relation to noise from wind farms the web-based renewables advice states:

"The Report, '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."

11.2.10 It is therefore considered that the use of ETSU-R-97, as criteria for assessment of wind farm noise, fulfils the requirements of Planning Advice Note 1/2011.

[5] 'Assessment of noise: technical advice note', Scottish Government, March 2011. Available at: http://www.gov.scot/publications/technical-advice-note-assessment-noise/

[6] 'Code of Practice for Noise and vibration control on construction and open sites - Part 1: Noise', British Standards Institution, BS 5228-1:2009

[7] 'Control of Pollution Act', published by Her Majesty's Stationary Office, July 1974. Available at: https://www.legislation.gov.uk/ukpga/1974/40

[8] 'Code of Practice for Noise and vibration control on construction and open sites - Part 2: Vibration', British Standards Institution, BS 5228-2:2009

[9] 'Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration', BS 6472-2:2008

[10] 'Onshore wind turbines: planning advice', Scottish Government, May 2014. Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/

[11] 'Planning Advice Note 1/2011: Planning and Noise', Scottish Government, March 2011. Available at: https://www.gov.scot/publications/planning-advice-note-1-2011-planning-noise/

11.2.11 The methodology described in ETSU-R-97 was developed by a working group comprised of a cross-section of interested persons including, amongst others, environmental health officers, wind farm operators and independent acoustic experts.

11.2.12 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that arise through the development of renewable energy resources. The principle of balancing development needs against protection of amenity may be considered common to any type of noise control guidance.

11.2.13 The basic aim of ETSU-R-97, in arriving at the recommendations contained within the report, is the intention to provide:

"Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities."

11.2.14 An article published in the Institute of Acoustics (IoA) Bulletin Vol. 34 No. 2, March/April 2009[12], recommends a methodology for addressing issues not made explicit by, or outside the scope of, ETSU-R-97, such as in relation to wind shear or noise propagation modelling. Whilst this article does not represent formal legislation or guidance it was authored by a group of independent acousticians experienced in wind farm noise issues who have undertaken work on behalf of wind farm developers, local planning authorities and third parties and as such is a good indicator of best practice techniques. The assessment presented herein adopts the recommendations made within this article.

11.2.15 A Good Practice Guide (GPG) to the application of ETSU-R-97 for the assessment and rating of wind turbine noise[3], issued by the Institute of Acoustics in May 2013 and endorsed by the Northern Ireland Executive, along with the governments in England, Scotland and Wales, provides guidance on all aspects of the use of ETSU-R-97 and reaffirms the recommendations of the Acoustics Bulletin article with regard to propagation modelling and wind shear. The assessment presented herein adopts the recommendations of the GPG.

11.2.16 Supplementary guidance notes were published by the IoA in July and September 2014, and these provide further details on specific areas of the IoA GPG[13]. The assessment presented herein adopts the recommendations made within these supplementary guidance notes.

11.2.17 ETSU-R-97 has been applied at the vast majority of wind farms currently operating in the UK and provides a robust basis for assessing the noise impact of a wind farm when used in accordance with the IoA GPG. It is the only relevant guidance referenced in Scottish Planning Policy (2014) for rating and assessing operational wind farm noise. Based on planning policy and guidance, as outlined above, a wind farm which can operate within noise limits derived according to ETSU-R-97 shall be considered acceptable. This approach has been agreed with Dumfries and Galloway Council.

11.3 Consultation

11.3.1 Details of the consultation undertaken are outlined in Table 11.1.

Table 11.1: Acoustic Assessment Consultation

Consultees	Date of Consultation	Nature and Purpose of Consultation
Energy Consents Unit	06/04/22	Scoping opinion requested on: proposed methodology, use of previously measured baseline data, maximum scaling factor for use when scaling consented sites to conditioned limits, and proposed lower fixed limits.
Energy Consents Unit	13/06/22	Scoping response that noise assessment should be carried out in line with the legislation and standards outlined in the scoping report.
Dumfries and Galloway Council	20/04/22	RES report (04097-3764531-01) sent to Dumfries and Galloway Council for environmental health department to review. Report details proposed assessment methodology along with suggested background noise survey locations.
Dumfries and Galloway Council	29/04/22	Response from EHO confirming they have no objections or concerns in relation to the proposed methodology.
Dumfries and Galloway Council	25/05/22	Email to EHO informing them that LiDAR has been installed and permission granted to survey at three locations.
Dumfries and Galloway Council	27/05/22	Email to EHO informing them of intention to start survey the following week should they wish to attend.
Dumfries and Galloway Council	27/05/22	Response from EHO saying they are unable to attend survey setup.
Dumfries and Galloway Council	07/06/22	RES report (04097-4135146-01) sent to EHO providing details of installed survey locations.

[12] 'Prediction and Assessment of Wind Turbine Noise', Bowdler et al, Acoustics Bulletin Vol 34 No 2 March/April 2009

[13] 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise - Supplementary Guidance Notes', Institute of Acoustics, July & September 2014. Available at https://www.ioa.org.uk/publications/wind-turbine-noise

11.4 Methodology

Scope of Assessment

11.4.1 Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The effect of noise, both in the construction and operational phase, is therefore a material consideration in the determination of planning applications.

Construction Noise

11.4.2 The sources of construction noise, which are temporary, would vary both in location and duration as the different elements of the wind farm are constructed and would arise primarily through the operation of large items of plant. Noise would also arise due to the temporary increase in construction traffic near the proposed development. This level would also depend on the particular construction phase of the proposed development.

11.4.3 Noise due to construction activities and construction traffic is scoped into the assessment. The acoustic impact assessment of construction noise from the proposed development presented here is based on applicant's experience of constructing wind farms and calculated for the operation of the primary large items of construction equipment. Additionally, consideration is given to the increased noise levels due to increased traffic flows during the construction phase to and from the site.

11.4.4 Blasting is anticipated to be required in order to extract material from the proposed borrow pits. Vibration and air overpressure due to blasting could therefore arise at periods during construction. An assessment of the level of vibration at nearby properties due to blasting to release material from the proposed borrow pits is therefore scoped in. Air overpressure due to blasting cannot be reliably predicted so this is scoped out of the assessment although steps to limit any resulting impact through appropriate blast design shall be adopted.

11.4.5 To assess the potential impacts of construction noise from the proposed development the following steps have been taken:

- Baseline noise criteria are established from the appropriate guidance BS 5228-1:2009;
- Noise levels due to on-site construction activities are predicted at nearby residential properties in accordance with the BS 5228-1:2009 standard;
- Predicted noise levels due to construction traffic at the same residential properties are made using the BS 5228-1:2009 standard;
- The cumulative noise level due to on-site construction activities and construction traffic is compared with the threshold values specified by the ABC Method of BS 5228-1:2009. Significant effects would be identified if the predicted construction noise levels exceed the threshold values. The effects would not be deemed significant if the predicted construction noise levels are less than the threshold values; and
- Predictions of the level of vibration due to blasting are made using BS 5228-2:2009 and the significance evaluated based on whether the criteria specified by BS 6472-2:2008 are met or exceeded.

Operational Noise

11.4.6 To ensure adequate assessment of the potential impacts of the operational noise from the proposed development the following steps have been taken, in accordance with relevant guidance detailed above:

- The baseline noise conditions at each of the nearest residential properties to the proposed development are established by way of representative background noise surveys;
- The noise levels at the nearest residential properties from the operation of the proposed development are predicted using a sound propagation model considering: the locations of the wind turbines; the intervening terrain; and the likely noise emission characteristics of the wind turbines;
- The acoustic assessment criteria are derived appropriately; and
- The evaluation of the acoustic impact is undertaken by comparing the predicted noise levels with the assessment criteria. Significant effects would be identified if the predicted noise levels exceed limits derived in accordance with ETSU-R-97. Significant effects would not be expected should the predicted noise levels be less than the ETSU-R-97 limit.

11.4.7 Aerodynamic and mechanical noise are scoped into the operational noise assessment. The main focus of the assessment of operational noise presented here is based on the most relevant type of noise emission for modern wind turbines: aerodynamic noise, which is broadband in nature. Mechanical noise, which can be tonal in nature, is also considered albeit less relevant to modern wind turbines whose improved design has led to significant reductions in mechanical noise. Implicitly incorporated within this assessment is the normal character of the noise associated with wind turbines (commonly referred to as 'blade swish') and consideration of a range of noise frequencies, including low frequencies.

11.4.8 An acoustic assessment considering the operation of the proposed battery energy storage system (BESS), including consideration of the cumulative impact with the proposed wind turbines, is also scoped in and can be found in Technical Appendix 11.1.

11.4.9 Low frequency content of the noise from wind farms shall be considered through the use of octave band specific noise emission and propagation modelling, however it is considered that specific and targeted assessment on low frequency content of noise emissions from the proposed development is unjustified. Details for scoping out low frequency noise from the operational noise assessment, as well as infrasound, sleep disturbance, vibration, amplitude modulation and wind turbine syndrome can be found in Technical Appendix 11.2.

11.4.10 A summary of the findings of a comprehensive study into wind turbine noise and associated health effects can be found in Technical Appendix 11.2.

Decommissioning Noise

11.4.11 Whilst noise would also arise during decommissioning of the proposed development (through turbine deconstruction and breaking of the exposed part of the concrete bases) this is not discussed separately as noise levels resulting from it are expected to be lower than those during construction due to the number and type of activities involved. The impact of decommissioning can therefore be considered in light of the conclusions of the construction noise assessment.

Baseline Characterisation

11.4.12 Similar to other assessments of noise impacts (most notably BS 4142[14], which ETSU-R-97 identifies as forming the basis of its recommendations), the ETSU-R-97 methodology requires the comparison of predicted noise levels due to turbine emissions (which vary with hub height wind speed) with noise limits based upon the noise levels already existing under those same conditions (i.e. the baseline conditions).

11.4.13 Since background noise levels depend upon wind speed, as indeed do wind turbine noise emissions, it is important when making reference measurements to put them in that context. Thus, the assessment of background noise levels requires the measurement of not only noise levels, but concurrent wind conditions, covering a representative range of wind speeds. These wind measurements are made at the site rather than at the residential properties, since it is this wind speed that would subsequently govern the proposed development's noise generation. Often the residential properties themselves will be sheltered from the wind and may consequently have relatively low background noise levels.

11.4.14 To establish the baseline conditions, sound level meters and associated apparatus are set-up to record the required acoustic information at a selection of the nearest residential properties geographically spread around the proposed development and which are likely to be representative of other residential properties in the locale.

11.4.15 Wind speed and direction are recorded as 10-minute averages for the same period as for the noise measurements, and are synchronised with the acoustic data to allow correlations to be established. The wind speed that is adopted for use is the same wind speed as that which drives the turbine noise levels.

11.4.16 The adoption of this wind speed was recommended within the article published in the IoA Bulletin and the subsequent IoA GPG. The methodology used to calculate standardised 10m wind speed is described in Technical Appendix 11.3.

11.4.17 Prior to establishing the baseline conditions the acoustic data is filtered as follows:

- For each background noise measurement location, the measured noise data is divided into two sets, as specified by ETSU-R-97 and shown in Table 11.2:

Table 11.2: Definition of Time-of-Day Periods

Time of Day	Definition
Quiet daytime	08:00 - 23:00 every day 13:00 - 18:00 Saturday 07:00 - 18:00 Sunday
Night-time	23:00 - 07:00 every day

[14] 'Method for Rating Industrial Noise affecting Mixed Residential and Industrial Areas', British Standards Institution, 1997

- Rainfall affected data is systematically removed from the acoustic data set. To facilitate this, a rain gauge is deployed to record 10-minute rainfall data and identify potentially affected noise data. Both the 10-minute period containing the bucket tip and the preceding 10-minute period are removed from the dataset as recommended in the IoA GPG to account for the time it takes for the rain gauge tipping bucket to fill.
- Periods of measured background noise data thought to be affected by extraneous, i.e. non-typical, noise sources are identified and removed from the data set. Whilst some 'extraneous' data may actually be real, it tends to bias any trend lines upwards so its removal is adopted as a conservative measure.
- In practice this means close inspection of the measured background noise levels, comparison with concurrent data measured at nearby locations and consideration of both directional and temporal variation.

Modelling Noise Propagation

11.4.18 Whilst there are several sound propagation models available, the ISO 9613 Part 2 model has been used[15], this being identified as most appropriate for use in such rural sites[16]. The specific interpretation of the ISO 9613 Part 2 propagation methodology recommended in the aforementioned IoA Bulletin and the subsequent IoA GPG has been employed.

11.4.19 To make noise predictions it is assumed that:

- the wind turbines radiate noise at the power specified in this report;
- each wind turbine can be modelled as a point source at hub-height; and
- each residential property is assigned a reference height to simulate the presence of an observer.

11.4.20 The sound propagation model takes account of attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10˚C and 70% respectively, as recommended in the IoA Bulletin and IoA GPG. Ground effects are also taken into account by the propagation model with a ground factor of 0.5 and a receiver height of 4m used as recommended in the IoA Bulletin and IoA GPG.

11.4.21 The barrier attenuations predicted by ISO 9613 Part 2 have been shown to be significantly greater than those measured in practice under downwind conditions[16]. Therefore, barrier attenuation according to the ISO 9613 Part 2 method has been discounted. In lieu of this, where there is no direct line of sight between the residential property in question and any part of the wind turbine, 2dB attenuation has been assumed as recommended in the IoA Bulletin and the IoA GPG.

11.4.22 Additionally, verification studies have also shown that ISO 9613 Part 2 tends to slightly underestimate noise levels at nearby dwellings in certain exceptional cases, notably in a valley type environment where the ground drops off between source and receiver. In these instances, an addition of 3dB(A) has been applied to the resulting overall a weighted noise level as recommended by the IoA GPG. Further detail is provided in Technical Appendix 11.4.

11.4.23 To generate the ground cross sections between each turbine and each dwelling necessary for reliable propagation modelling, ground contours at 5m intervals for the area of interest have been generated from 50m grid resolution digital terrain data.

11.4.24 The predicted noise levels are calculated as L_{Aeq} noise levels and changed to the L_{A90} descriptor (to allow comparisons to be made) by subtraction of 2dB, as specified by ETSU-R-97.

11.4.25 It has been shown by measurement-based verification studies that the ISO 9613 Part 2 model tends to slightly overestimate noise levels at nearby dwellings[16]. Examples of additional conservative assumptions modelled are:

- properties are assumed to be downwind of all noise sources simultaneously and at all times. In reality, this is not the case and additional attenuation would be expected when a property is upwind or crosswind of the proposed wind turbines;
- although, in reality, the ground is predominantly porous (acoustically absorptive) it has been modelled as 'mixed', i.e. a combination of hard and porous, corresponding to a ground absorption coefficient of 0.5 as recommended by the IoA Bulletin and IoA GPG;
- receiver heights are modelled at 4m above local ground level, which equates roughly to first floor window level, as recommended by the IoA Bulletin and IoA GPG. This results in a predicted noise level anything up to 2dB(A) higher than at the typical human ear height of 1.2m – 1.8m;
- trees and other non-terrain shielding effects have not been considered;

[15] 'Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation', International Organisation for Standardisation, ISO 9613-2:1996

[16] 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU Report W/13/00385/REP, January 2000

- an allowance for measurement uncertainty has been included in the sound power levels for the presented candidate turbine.

Operational Noise Impact Criteria

11.4.26 Noise is measured in decibels (dB) which is a measure of the sound pressure level, i.e. the magnitude of the pressure variations in the air. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.

11.4.27 ETSU-R-97 seeks to protect the internal and external amenity of wind farm neighbours by defining acceptable limits for operational noise from wind turbines. The test applied to operational noise is whether or not the noise levels produced by the combined operation of the wind turbines lie below noise limits derived in accordance with ETSU-R-97 at nearby residential properties.

11.4.28 Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also provides a simplified methodology:

"if the noise is limited to an $L_{A90,10min}$ of 35dB(A) up to wind speeds of 10m/s at 10m height, then these conditions alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary".

11.4.29 In the detailed methodology, ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits, derived from the background noise levels measured during quiet daytime periods, are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The general principle is that the noise limits should be based on existing background noise levels, except for very low background noise levels, in which case a fixed limit may be applied. The suggested limits are given in Table 11.3 below, where L_B is the background $L_{A90,10min}$ and is a function of wind speed. During daytime periods and at low background noise levels, a lower fixed limit of 35-40dB(A) is applicable. The exact value is dependent upon a number of factors: the number of nearby dwellings, the effect of the noise limits on energy produced, and the duration and level of exposure.

Table 11.3: Permissible Noise Level Criteria

Time of Day	Definition
Quiet daytime	35-40 dB(A) for LB less than 30-35 dB(A) LB + 5 dB, for LB greater than 30-35 dB(A)
Night-time	43 dB(A) for LB less than 38 dB(A) LB + 5 dB, for LB greater than 38 dB(A)

11.4.30 Note that a higher noise level is permissible during the night than during the day as it is assumed that residents would be indoors. The night-time criterion is derived from sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB for attenuation through an open window.

11.4.31 The wind speeds at which the acoustic impact is considered are less than or equal to $12ms^{-1}$ at a height of 10m and are likely to be the acoustically critical wind speeds. Above these wind speeds, as stated in ETSU-R-97, reliable measurements of background and turbine noise are difficult to make. However, if a wind farm meets the noise criteria at the wind speeds presented, it is most unlikely that it would cause any greater loss of amenity at higher wind speeds due to increasing background noise levels masking wind farm generated noise.

11.4.32 It is important to note that, since reactions to noise are subjective, it is not possible to guarantee that a given development would not result in any adverse comment with regard to noise as the response to any given noise will vary from person to person. Consequently, standards and guidance that relate to environmental noise are typically presented in terms of criteria that would be expected to be considered acceptable by the majority of the population.

11.5 Baseline

Construction Noise

11.5.1 For the on-site construction noise assessment, Annex E of BS 5228-1:2009 provides guidance on setting environmental noise targets. Several methods of assessing the significance of noise levels are presented in Annex E and the most applicable to the construction of the proposed development is the ABC method. The ABC method sets threshold noise levels for specific periods based on the ambient noise levels.

Operational Noise

11.5.2 The proposed development is located approximately 5.5km[17] south-west of Langholm, Dumfries and Galloway. The surrounding area is predominantly rural in nature and used for grazing sheep and cattle with the A7 to the east. The general noise character is typical of a rural environment with noise from farm machinery, sheep, cattle, and birds, with the occasional overhead aircraft.

11.5.3 Background noise measurements were undertaken at three residential property locations (Bloch Farm, Kerr and Upper Caulfield) in accordance with ETSU-R-97. Existing data from the four locations (Allfornought, Bigholms Cottages, Kirtleton House and Pingle Farm) where measurements were made to assess the existing Solwaybank Wind Farm have also been included in the assessment. The seven locations are detailed in Table 11.4.

Table 11.4 - Background Noise Survey Details

House Name	Measurement Period		
	Start	End	Duration (days)
Allfornought	19/12/2005	18/01/2006	30
Bigholms Cottage	05/01/2006	18/01/2006	13
Kirtleton House	19/12/2005	18/01/2006	30
Pingle Farm	19/12/2005	18/01/2006	30
Bloch Farm	01/06/2022	13/07/2022	43
Kerr	01/06/2022	13/07/2022	43
Upper Caulfield	01/06/2022	13/07/2022	43

11.5.4 The background noise monitoring equipment was housed in weather-proof enclosures and powered by lead-acid batteries. The microphones were placed at a height of approximately 1.2 - 1.5m above ground and equipped with all-weather wind shields which also provide an element of water resistance.

11.5.5 The proprietary wind shields used are designed to reduce the effects of wind-generated noise at the microphone and accord with the recommendations of the IoA GPG in that they are the appropriate size and, in combination with the microphone, are certified by the manufacturer as meeting Type 1 / Class 1 precision standards.

11.5.6 Noise levels are monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. The relevant statistic measured is the $L_{A90,10min}$ (The A-weighted sound pressure level exceeded for 90% of the 10-minute interval).

11.5.7 The sound level meters were placed away from reflecting walls and vegetation. Photos of the equipment, in situ, may be seen in Technical Appendix 11.5. The apparatus were calibrated before and after the survey period and the maximum drift detected was 0.2dB, which is within the required range recommended in the IoA GPG. All instrumentation has been subject to laboratory calibration traceable to national standards within the last 24 months, as recommended in the IoA GPG. Details are provided in Technical Appendix 11.6.

11.5.8 Chart A11.1 (see Technical Appendix 11.7 for all charts) shows the measured wind rose over the 2022 background noise survey period, as measured by a LiDAR located on-site.

11.5.9 A LiDAR (Light Detection and Ranging) is a remote sensing device that measures conditions in the atmosphere by using pulses from a LASER by applying the principle of the Doppler Effect, detecting the movement of air in the atmospheric boundary layer to measure wind speed and direction. LiDAR provides measurements at several heights, and this enables wind speed data to be obtained that describe the wind profile across a range of heights.

11.5.10 LIDAR has been successfully tested, by independent third parties using suitable test sites, against conventional anemometry[18,19]. From the technical reports, these tests have demonstrated that, over a range of relevant heights, the accuracy of the LIDAR is comparable to that of the conventional anemometry.

11.5.11 For illustrative purposes, Chart A11.2 shows the measured wind rose over an extended period (21/03/03 – 15/01/08) by a meteorological mast located on the existing Solwaybank Wind Farm site. As previously discussed, the noise prediction model employed is likely to overestimate the real noise immission levels for locations not downwind of the turbines. Chart A11.2 therefore may aid the reader as to the likelihood of over-estimation due to this factor.

11.5.12 The equivalents of the photos, instrumentation details and charts mentioned in this section for the four Solwaybank Wind Farm survey locations can be found in the application for the existing Solwaybank wind farm[20].

[17] This distance is given to the approximate centre point of the site boundary.
[18] "Evaluation of WINDCUBE", Albers et al, Deutsche WindGuard Consulting GmbH, Report PP 08007, 16 March 2008
[19] "Verification test for three WindCubeTM WLS7 LiDARs at the Høvsøre test site", Gottschall et al, DTU Report Risø-R-1732, May 2010
[20] Solwaybank wind farm Environmental Statement 2011, Dumfries & Galloway Council Planning Reference 11/P/4/0354

11.5.13 The noise data has been cross-referenced with rainfall data measured at the site using a rain gauge. Any noise data identified as having been affected by rainfall has been removed from the analysis as shown in Charts A11.3 to A11.8.

11.5.14 Short-term periods of increased noise levels considered to be atypical have been removed from the datasets. The excluded data is shown in Charts A11.3 to A11.8.

11.5.15 Periods of raised noise levels were removed from the night-time datasets at Bloch Farm and Kerr due to the dawn chorus which may not be present to the same extent at other times of year.

11.5.16 The 2022 survey locations were selected to be sufficiently far from the existing Solwaybank Wind Farm so as not to have been significantly influenced by operational noise from this site. This was confirmed via directional analysis of the measured data which showed no significant directional trends i.e. increases in the noise levels when the survey locations were downwind of the existing Solwaybank Wind Farm.

11.5.17 Charts A11.3 to A11.5 show $L_{A90,10min}$ correlated against wind speed for quiet daytime periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added. The equation of the regression polynomial has been provided in the charts.

11.5.18 Charts A11.6 to A11.8 show $L_{A90,10min}$ correlated against the wind speed for night-time periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added. The equation of the regression polynomial has been provided in the charts.

11.5.19 Table 11.5 and Table 11.6 detail the $L_{A90,10min}$ background noise levels calculated from the derived 'best fit' lines, as described above. They are provided as sound pressure levels in dB referenced to 20 micro Pascals (see Glossary for further detail):

Table 11.5 - Quiet Daytime Noise Levels (dB(A) re 20μPa)

House Name	Standardised 10m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Allfornought	22.9	24.0	25.3	26.6	28.2	29.9	31.8	33.9	36.4	39.1	42.1	42.1
Bigholms Cottage	27.0	27.0	28.2	29.4	30.4	31.4	32.6	33.9	35.4	37.1	37.1	37.1
Kirtleton House	26.2	26.6	27.2	27.9	28.9	30.2	31.7	33.5	35.6	38.1	40.8	40.8
Pingle Farm	24.4	24.4	24.8	25.5	26.6	28.1	29.9	32.1	34.5	37.2	40.1	40.1
Bloch Farm	28.9	30.6	32.5	34.7	37.1	39.6	42.3	45.1	47.9	50.8	53.7	56.5
Kerr	29.3	29.3	29.5	30.2	31.5	33.3	35.6	38.2	41.2	44.4	47.9	51.6
Upper Caulfield	23.4	23.4	24.4	26.5	29.4	33.0	37.1	41.5	46.0	50.3	54.3	57.8

Table 11.6 - Night-time Noise Levels (dB(A) re 20 μPa)

House Name	Standardised 10m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Allfornought	22.4	22.6	23.4	24.7	26.6	28.8	31.5	34.5	37.7	41.2	41.2	41.2
Bigholms Cottage	25.9	25.9	27.3	28.3	29.2	30.1	30.9	31.9	33.1	34.8	34.8	34.8
Kirtleton House	24.0	24.5	25.4	26.6	28.1	29.8	31.9	34.3	36.9	39.8	42.9	46.2
Pingle Farm	22.4	22.7	23.4	24.6	26.1	28.0	30.2	32.7	35.5	38.5	41.8	45.4
Bloch Farm	19.8	19.8	21.0	23.3	26.5	30.2	34.4	38.9	43.3	47.4	47.4	47.4
Kerr	21.6	21.6	21.6	21.8	22.6	24.0	26.2	29.3	33.3	38.3	38.3	38.3
Upper Caulfield	21.2	21.2	21.7	22.8	24.6	27.2	30.6	35.0	40.4	46.8	46.8	46.8

Future Baseline

11.5.20 The baseline conditions would not be expected to change under the "do nothing" scenario i.e. in the event that the proposed development does not go ahead.

11.6 Assessment of Potential Effects

Construction Effects

Construction Noise Assessment

11.6.1 Primary activities creating noise during the construction period are from: the construction of the turbine bases; the erection of the turbines; the excavation of trenches for cables; the working of borrow pits; and the construction of associated hard standings, access tracks and construction compounds. Noise from vehicles on local roads and access tracks would also arise due to the delivery of turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

11.6.2 It should be noted that the exact methodology and timing of construction activities cannot be predicted at this time, this assessment is therefore based on assumptions representing a worst-case approach.

Construction Noise Predictions

11.6.3 The plant assumed for each construction activity is shown in Table 11.7. The number of items indicates how many of each plant are required for the specified activity, and the duration of activity is a percentage of a given 12-hour day period needed for that plant to operate. Overall sound power levels are based upon the data in Annex C of BS 5228-1:2009.

Table 11.7: Construction Phases and Sound Power Levels

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Construction Compound	Tracked excavator	113	2	100	119
	Dump truck	113	2	100	
	Tipper lorry	107	2	50	
	Vibratory roller	102	1	75	
	Lorry	108	1	75	
Construct Site Tracks	Tracked excavator	113	3	100	122
	Dump truck	113	2	75	
	Tipper lorry	107	4	50	
	Dozer	109	1	100	
	Vibratory roller	102	1	75	
	Excavator mounted rock breaker	121	1	33	
Construct Substations	Tracked excavator	113	1	100	117
	Concrete mixer truck	108	2	50	
	Lorry	108	1	50	
	Telescopic Handler	99	1	100	
	Piling rig	117	1	50	
Construct Crane Hardstands	Tracked excavator	113	3	100	120
	Dump truck	113	2	100	
	Tipper lorry	107	4	50	
	Vibratory roller	102	1	50	
Construct Wind Turbine Foundations	Tracked excavator	113	2	75	123
	Dump truck	113	2	75	
	Concrete mixer truck	108	4	50	
	Mobile telescopic crane	110	1	50	
	Concrete pump	106	2	50	
	Water pump	93	1	100	
	Hand-held pneumatic breaker	111	1	75	
	Compressor	103	3	50	
	Piling rig	117	1	100	
	Poker vibrator	106	3	50	
	Excavator mounted rock breaker	121	1	50	
Excavate and Lay Site Cables	Tracked excavator	113	2	100	122
	Dump truck	113	2	75	
	Tractor (Towing Equipment)	108	1	75	
	Tractor (Towing Trailer)	107	1	75	
	Vibratory plate	108	1	50	
	Excavator mounted rock breaker	121	1	50	
Erect Wind Turbine	Mobile telescopic crane	110	2	75	119
	Lorry	108	1	75	
	Diesel generator	102	1	100	
	Torque guns	111	4	100	
Reinstate Crane Bases	Tracked excavator	113	1	75	115
	Dump truck	113	1	75	
Lay Cable to Substations	Wheeled loader	108	1	100	117
	Saw	114	1	50	
	Hand-held pneumatic breaker	111	1	50	
	Dump truck	113	1	75	
	Tipper lorry	107	1	50	
	Vibratory plate	108	1	75	
	Tandem roller	102	1	75	
	Tractor (Towing Trailer)	107	1	50	
	Lorry	108	1	75	
Borrow Pits	Excavator mounted rock breaker	121	1	100	126
	Dump truck	113	2	75	
	Dozer	109	1	100	
	Tracked semi-mobile crusher	124	1	100	
	Tracked excavator	113	1	100	
Construct New Water Crossing	Tracked Excavator	113	1	100	120
	Dump Truck	113	1	100	
	Tipper lorry	107	4	50	
	Dozer	109	1	75	

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
	Vibratory Roller	102	1	75	
	Telescopic Handler	99	1	100	
	Piling Rig	117	1	50	
	Concrete Pump	106	1	50	
	Concrete mixer truck	108	3	50	
	Poker vibrator	106	2	50	
	Water pump	93	2	100	
Construct Batching Plant	Tracked excavator	113	1	67	116
	Dump truck	113	1	67	
	Tipper lorry	107	1	67	
	Vibratory roller	102	1	67	
	Lorry	108	1	67	
	Mobile telescopic crane	110	1	67	
Operational Batching Plant	Concrete Batching Plant	111	1	67	109
Construct Gas Pipeline Crossing	Tracked Excavator	113	1	100	119
	Dump Truck	113	1	100	
	Tipper lorry	107	4	50	
	Dozer	109	1	75	
	Vibratory Roller	102	1	75	
	Telescopic Handler	99	1	100	
	Concrete Pump	106	1	50	
	Concrete mixer truck	108	3	50	
	Poker vibrator	106	2	50	
	Mobile telescopic crane	110	1	75	

11.6.4 Predictions of construction noise levels have been carried out using the methods prescribed in Annex F of BS 5228-1:2009[21]. The worst-case scenario, where each construction activity takes place at the nearest proposed location to the residential property being assessed, is considered. The locations of the construction activities are taken from the infrastructure drawing. The results of these predictions, made at seven representative residential properties, are shown in Table 11.8.

11.6.5 In all cases average noise levels over the construction period would be lower as the worst case is presented for when the construction activities are closest to the residential property.

Table 11.8: Predicted Sound Pressure Level due to Construction Noise (dB L_{Aeq})

Activity	H18	H19	H21	H22	H23	H29	H40
Temporary Construction Compound	42.9	44.6	35.4	39.3	45.0	41.8	34.1
Site Tracks	49.2	48.6	42.9	52.5	51.4	48.9	42.8
Substation Compound	41.4	43.5	33.5	36.8	42.3	39.2	31.9
Crane Hardstands	47.8	47.2	41.5	51.0	50.0	47.6	41.4
Turbine Foundations	50.7	50.1	44.4	53.9	52.9	50.5	44.3
Excavate and Lay Cables	49.0	48.4	42.7	52.2	51.2	48.8	42.6
Erect Turbine	46.1	45.5	39.8	49.3	48.3	45.9	39.7
Reinstate Crane Hardstands	42.1	41.5	35.8	45.3	44.3	41.9	35.7
Lay Cable to Substations	41.4	43.5	33.5	36.8	42.3	39.2	31.9
Borrow Pits	53.3	51.3	43.7	47.4	58.1	53.0	44.3
Water Crossing	43.9	44.3	38.2	48.5	48.2	44.8	38.2
Construct Batching Plant	42.1	39.5	31.0	36.6	40.1	37.6	30.1
Operate Batching Plant	35.1	32.5	24.0	29.6	33.1	30.6	23.1
Gas Pipeline Crossing	42.5	35.8	30.6	43.3	39.1	38.6	31.6

[21] A 50% mixed ground attenuation has been used throughout to conservatively account for the arable nature of ground conditions in the vicinity of the proposed development

Construction Traffic

11.6.6 Due to the delivery of construction material and wind farm components, vehicle movements either into or away from the proposed development shall increase levels of traffic flow on public roads in the area. Traffic regularly accessing the site is shown in Chapter 10: Transport and Traffic and is assumed to be characterised by the sound power levels of Dump Trucks, Lorries and Concrete Mixers as a worst case. It is estimated that a total of 210 vehicle movements per day would be required during the most intense period of construction activity although this would only be the case for a maximum of nine days during foundation pouring.

11.6.7 Construction traffic noise has been quantified using the method described in BS 5228:2009 Part 1. Calculated using the distances from residential properties to the centre of the relevant carriageway where site traffic would be, the noise levels predicted are presented in Table 11.9. The maximum sound pressure level due to traffic flows during the most intensive period of activity is predicted to be 63.4dB L_{Aeq}. The property where this occurs, H21, is adjacent to the proposed delivery route and, as such, corresponds to the worst case.

Table 11.9: Traffic Noise Predictions by Activity (dB L_{Aeq})

House ID	Dump Truck	Lorries	Concrete Mixer	Total Traffic Noise
H18	40.6	37.2	36.0	43.2
H19	45.8	42.4	41.1	48.3
H21	60.8	57.4	56.2	63.4
H22	42.1	38.7	37.4	44.6
H23	41.6	38.2	36.9	44.1
H29	40.5	37.1	35.8	43.0
H40	37.8	34.4	33.1	40.3

11.6.8 The increase in noise level due to the presence of construction traffic on nearby roads has been quantified using the methodology set out in CRTN[22]. The maximum predicted increase in daytime average traffic noise level, during the most intense period of construction, is 0.2dB(A). Given that a 3dB(A) change is commonly regarded as the smallest subjectively perceptible difference in noise level, the predicted short-term change in traffic noise levels are considered negligible and not significant.

General Construction Noise in Conjunction with Traffic Noise

11.6.9 Worst case construction noise levels may arise when work on the following activities occurs simultaneously: temporary compound, site tracks, substation, crane hardstands, wind turbine foundations, laying site cables and erecting turbines. Therefore, cumulative predictions of these construction activities and the additional noise contribution from construction traffic have been calculated and are shown in Table 11.10.

11.6.10 It should be noted that the predictions exclude the screening effects of local topography therefore actual levels of noise experienced at nearby residential properties could be lower.

Table 11.10: Predicted Noise Due to Combined Traffic Noise and Turbine Construction (dB L_{Aeq})

House ID	Construction Plant Noise	Traffic Noise	Combined Noise
H18	56.2	43.2	56.2
H19	55.8	48.3	56.5
H21	49.8	63.4	63.4
H22	59.1	44.6	59.1
H23	58.3	44.1	58.3
H29	55.9	43.0	55.9
H40	49.6	40.3	49.6

Assessment of Construction Noise

11.6.11 In accordance with the ABC method of Annex E of BS 5228-1:2009, due to the relatively low levels of ambient noise in the vicinity of the proposed development, a Category A assessment is appropriate. This category sets significant effect threshold L_{Aeq} criteria of: 65dB(A) during weekdays (07:00-19:00) and Saturdays (07:00-13:00); 55dB(A) for evenings (19:00-23:00), Saturdays (1300-2300) and Sundays; and 45dB(A) for night-time (23:00-07:00) periods.

11.6.12 Construction activities and Heavy Goods Vehicle (HGV) deliveries would be limited to 07:00-19:00 Monday to Saturday, except during wind turbine delivery/erection and commissioning or during periods of emergency work, so an assessment against the 65dB(A) and 55dB(A) criteria has been undertaken.

[22] Calculation of Road Traffic Noise (CRTN), HMSO Department of Transport, 1988.

11.6.13 Table 11.21 shows that predicted noise levels from the combined effect of increased traffic flows and activities associated with the peak of construction activities are below the 65dB(A) daytime threshold specified by BS 5228-1:2009 at all of the assessed residential properties.

11.6.14 Peak construction noise levels are predicted to exceed the 55dB(A) threshold for evenings and weekends at six of the assessed properties although, of the times when this criterion applies, construction is only scheduled to take place on Saturdays 1300-1900 with the exception of wind turbine delivery/erection and commissioning or periods of emergency work.

11.6.15 An assessment against the night-time threshold has not been undertaken as construction work is not scheduled to take place during the night with the exception of turbine delivery/erection and commissioning or periods of emergency work. Predicted noise levels of greater than 45dB(A) due to turbine erection imply that this activity should be avoided at night unless absolutely necessary.

11.6.16 The predictions made represent the worst-case combination of most intensive traffic activity with simultaneous construction activity at the nearest possible location to each residential property.

Assessment of Vibration due to Blasting

11.6.17 BS 5228-2:2009 provides guidance on the assessment of vibration due to blasting. A scaled distance graph is shown in Figure E.1 in Annex E of BS 5228.2:2009 which provides an indication of likely vibration magnitudes at various distances. This figure can be used to determine the level of vibration which would not be expected to be exceeded in 95% of blasts for a given distance and charge size.

11.6.18 BS 6472-2:2008 details the maximum satisfactory magnitudes for vibration measured on a firm surface outside buildings with respect to human response. For up to three blast vibration events per day the generally accepted maximum satisfactory magnitude at residential premises during daytime periods (0800-1800 Monday to Friday and 0800-1300 on Saturdays) is a peak particle velocity (ppv) of 6.0 to 10.0mms^{-1}. In practice, the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.

11.6.19 For a charge size of 1,000kg the estimated vibration magnitude is 5.74mms^{-1} at the nearest residential property to the borrow pit, H23 (Bloch Farm), which is approximately 688m away. This suggests that the probability of adverse comment is low according to the criteria outlined in BS 6472-2: 2008. No significant effects would therefore be anticipated.

Potential Operational Effects

Noise Propagation Modelling

11.6.20 The locations of the proposed turbines are provided in Table 11.11 and shown in Figure 11.1.

Table 11.11: Location of Proposed Turbines

Turbine	Co-ordinates		Turbine	Co-ordinates		Turbine	Co-ordinates	
	X (m)	Y (m)		X (m)	Y (m)		X (m)	Y (m)
T1	330671	579641	T8	332252	580610	T15	333809	580437
T2	331117	579442	T9	332213	580118	T16	333611	580986
T3	331233	579934	T10	332257	579636	T17	334128	580901
T4	330682	580233	T11	332750	580029	T18	333709	581477
T5	330260	580468	T12	332803	579565	T19	334307	581395
T6	331349	580426	T13	333272	579391	T20	334105	581903
T7	331843	580853	T14	333266	580464	T21	334665	581842

11.6.21 The locations of the nearest residential properties to the wind turbines have been determined by inspection of relevant maps and through site visits. More residential properties may have been identified but have not been considered critical to this acoustic assessment or may be adequately represented by another residential property. The locations considered are listed in Table 11.12 and are also shown in Figure 11.1.

11.6.22 The distances from each residential property to the nearest wind turbine are given in Table 11.8. It can be seen that the minimum house-to-turbine separation is 757m to H22 (Bigholms Cottage). This property, along with H23 (Bloch Farm), is treated as being occupied by a financial beneficiary of the proposed development. The nearest property without financial beneficiary status is H18 (Barnglieshead) at 1051m.

Table 11.12: Location of Residential Properties and Distances to Nearest Proposed Wind Turbine

House ID	House Name	Co-ordinates		Distance (m)	Nearest Turbine
		X (m)	Y (m)		
H1	SOLWAYBANK COTTAGE	330832	577322	2139	T2
H2	BARNGLIES COTTAGE	332770	577352	2100	T13
H3	BARNGLIES COTTAGE	332781	577360	2090	T13

House ID	House Name	Co-ordinates		Distance (m)	Nearest Turbine
		X (m)	Y (m)		
H4	SOLWAYBANK HOUSE	330757	577391	2082	T2
H5	WATTAMAN FARM	332137	577508	2131	T10
H6	BARNGLIES FARM	332856	577577	1861	T13
H7	WOODSIDE	331091	577580	1862	T2
H8	ALLFORNOUGHT	329294	577858	2253	T1
H9	TOMSHIELBURN	334491	577916	1914	T13
H10	SAUGHTREE COTTAGE	334779	577933	2097	T13
H11	SAUGHTREE COTTAGE	334796	577936	2107	T13
H12	SAUGHTREE COTTAGE	334850	577938	2146	T13
H13	MARCH COTTAGE	333887	578115	1416	T13
H14	PINGLE BRIDGE COTTAGE	332204	578349	1288	T10
H15	PINGLE FARM	332018	578373	1286	T10
H16	UPPER TOMSHIELBURN	334764	578390	1797	T13
H17	RYEHILLS	334576	578584	1534	T13
H18	BARNGLIESHEAD	332392	578594	1051	T10
H19	KERR	334390	579396	1118	T13
H20	MEGSFIELD	327603	580990	2708	T5
H21	OLD IRVINE COTTAGES	336483	581006	2001	T21
H22	BIGHOLMS COTTAGE	331145	581155	757	T6
H23	BLOCH FARM	332823	581273	839	T16
H24	COLLIN	330429	581507	1053	T5
H25	HOLMFOOT COTTAGE	330609	581523	1111	T5
H26	CALLISTERHALL	328925	581617	1761	T5
H27	HOUSE, FALCON FARM	330754	581685	1313	T5
H28	THE FLAT, FALCON FARM	330762	581685	1317	T5
H29	WAUCHOPE SCHOOL HOUSE	332510	581700	1078	T7
H30	WINTERHOPE	327254	582237	3488	T5
H31	WINTERHOPE FARMHOUSE	327187	582283	3569	T5
H32	FALCON FARM	330464	582286	1829	T5
H33	WINTERHOPE FILTER STATION	327247	582289	3521	T5
H34	WESTWATER FARM	330450	582298	1840	T5
H35	WESTWATER COTTAGE	330609	582317	1882	T5
H36	CLEUCHFOOT COTTAGE	331756	582394	1544	T7
H37	CLEUCHFOOT COTTAGE	331768	582395	1544	T7
H38	GREENCLEUCH	330396	582629	2165	T5
H39	CLEUCHFOOT FARM	331480	582822	2002	T7
H40	UPPER CAULFIELD	333704	583887	2024	T20
H41	HALLCROFTS	335066	583910	2107	T21
H42	BECKS KNOWE	335203	583920	2147	T21
H43	CAULFIELD PRIVATE	333905	583974	2080	T20
H44	CAULFIELD PRIVATE	333903	583987	2094	T20
H45	BECKS COTTAGE	334314	584092	2199	T20
H46	BECKS FARM	334354	584143	2254	T20
H47	PINGLE FARM	331972	578440	1229	T10
H48	KIRTLETON HOUSE	326899	580144	3377	T5

11.6.23 Although not finalised, the candidate wind turbine type used for the purposes of the acoustic assessment of the proposed development is the Vestas V150 6MW machine. This report uses the acoustic data from the manufacturer's performance specification for this machine for all analysis[23]. The manufacturer has identified these values as warranted although no independent test reports are available to indicate whether any margin has been incorporated. A 2dB allowance for uncertainty has therefore been added to the warranted levels as a conservative measure as recommended by the IoA GPG. Details used in this analysis are as follows:

- a mix of three hub heights (105m, 125m and 155m);
- a rotor diameter of 150m;
- sound power levels, L_{WA}, for standardised 10m height wind speeds (v_{10}) as shown in Table 11.13;
- octave band sound power level data, at the wind speeds where it is available, as shown in Table 11.14; and
- tonal emission characteristics such that no clearly audible tones are present at any wind speed.

[23] 'Performance Specification EnVentus V150 - 6.0 MW 50/60 Hz', Vestas, Document ID: 0098-0749 V01, 2020-10-13

Table 11.13 – A-Weighted Sound Power Levels (dB(A) re 1 pW) for the Vestas V150 6MW Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	105m Hub	125m Hub	155m Hub
1	94.8	95.0	95.2
2	94.8	95.0	95.2
3	94.8	95.0	95.2
4	98.2	98.6	99.1
5	102.5	103.0	103.5
6	106.0	106.3	106.6
7	106.8	106.8	106.9
8	106.9	106.9	106.9
9	106.9	106.9	106.9
10	106.9	106.9	106.9
11	106.9	106.9	106.9
12	106.9	106.9	106.9

Table 11.14 - Octave Band A-Weighted Sound Power Levels (dB(A) re 1 pW) at Standardised 10m Height Wind Speeds for the Vestas V150 6MW Wind Turbine

Octave Band (Hz)	$8ms^{-1}$
63	87.9
125	95.6
250	100.3
500	102.0
1000	100.9
2000	96.8
4000	89.8
8000	79.8
OVERALL	106.9

Predictions of Noise Levels at Residential Properties

11.6.24 Table 11.15 shows the predicted noise immission levels at the nearest residential properties at each wind speed considered, calculated from the operation of the proposed development. The property with the highest predicted noise immission level of 42.7dB(A) is H23 (Bloch Farm). The maximum at a property without financial involvement is 40.3dB(A) at H29 (Wauchope School House).

11.6.25 Figure 11.1 shows an isobel (i.e. noise contour) plot for the proposed development at a 10m height wind speed of $8ms^{-1}$. Such plots are useful for evaluating the noise 'footprint' of a given development.

Table 11.15: Predicted Noise Levels At Nearby Residential Properties, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	20.1	20.1	20.1	23.8	28.2	31.4	31.9	32.0	32.0	32.0	32.0	32.0
H2	20.8	20.8	20.8	24.6	29.0	32.2	32.6	32.7	32.7	32.7	32.7	32.7
H3	20.9	20.9	20.9	24.6	29.0	32.2	32.6	32.7	32.7	32.7	32.7	32.7
H4	20.3	20.3	20.3	24.0	28.4	31.6	32.1	32.2	32.2	32.2	32.2	32.2
H5	21.6	21.6	21.6	25.4	29.8	33.0	33.4	33.5	33.5	33.5	33.5	33.5
H6	21.8	21.8	21.8	25.6	30.0	33.2	33.6	33.6	33.6	33.6	33.6	33.6
H7	21.4	21.4	21.4	25.1	29.5	32.7	33.2	33.3	33.3	33.3	33.3	33.3
H8	19.0	19.0	19.0	22.6	27.0	30.3	30.8	30.9	30.9	30.9	30.9	30.9
H9	20.6	20.6	20.6	24.3	28.7	32.0	32.4	32.4	32.4	32.4	32.4	32.4
H10	19.9	19.9	19.9	23.7	28.1	31.3	31.7	31.8	31.8	31.8	31.8	31.8
H11	19.9	19.9	19.9	23.6	28.0	31.2	31.7	31.7	31.7	31.7	31.7	31.7
H12	19.8	19.8	19.8	23.5	27.9	31.1	31.5	31.6	31.6	31.6	31.6	31.6
H13	23.0	23.0	23.0	26.7	31.1	34.3	34.7	34.8	34.8	34.8	34.8	34.8
H14	25.9	25.9	25.9	29.7	34.1	37.3	37.7	37.8	37.8	37.8	37.8	37.8
H15	26.0	26.0	26.0	29.8	34.1	37.3	37.8	37.8	37.8	37.8	37.8	37.8
H16	21.5	21.5	21.5	25.2	29.6	32.8	33.2	33.3	33.3	33.3	33.3	33.3
H17	22.8	22.8	22.8	26.5	30.9	34.1	34.5	34.6	34.6	34.6	34.6	34.6
H18	27.6	27.6	27.6	31.4	35.8	39.0	39.4	39.4	39.4	39.4	39.4	39.4
H19	26.6	26.6	26.6	30.3	34.7	37.9	38.3	38.4	38.4	38.4	38.4	38.4
H20	16.2	16.2	16.2	19.9	24.3	27.5	28.0	28.1	28.1	28.1	28.1	28.1
H21	20.1	20.1	20.1	23.8	28.1	31.4	32.0	32.0	32.0	32.0	32.0	32.0
H22	30.1	30.1	30.1	33.8	38.2	41.4	41.8	41.9	41.9	41.9	41.9	41.9
H23	30.9	30.9	30.9	34.7	39.1	42.3	42.6	42.7	42.7	42.7	42.7	42.7

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H24	26.1	26.1	26.1	29.8	34.2	37.5	37.9	38.0	38.0	38.0	38.0	38.0
H25	26.4	26.4	26.4	30.2	34.6	37.8	38.2	38.3	38.3	38.3	38.3	38.3
H26	20.5	20.5	20.5	24.2	28.6	31.8	32.3	32.3	32.3	32.3	32.3	32.3
H27	25.8	25.8	25.8	29.6	34.0	37.2	37.6	37.7	37.7	37.7	37.7	37.7
H28	25.9	25.9	25.9	29.6	34.0	37.2	37.6	37.7	37.7	37.7	37.7	37.7
H29	28.5	28.5	28.5	32.2	36.6	39.8	40.2	40.3	40.3	40.3	40.3	40.3
H30	12.1	12.1	12.1	15.8	20.2	23.4	23.9	24.0	24.0	24.0	24.0	24.0
H31	12.2	12.2	12.2	15.9	20.3	23.5	24.0	24.1	24.1	24.1	24.1	24.1
H32	22.4	22.4	22.4	26.2	30.6	33.8	34.2	34.3	34.3	34.3	34.3	34.3
H33	12.4	12.4	12.4	16.1	20.4	23.7	24.2	24.2	24.2	24.2	24.2	24.2
H34	22.4	22.4	22.4	26.1	30.5	33.7	34.1	34.2	34.2	34.2	34.2	34.2
H35	22.6	22.6	22.6	26.3	30.7	33.9	34.4	34.5	34.5	34.5	34.5	34.5
H36	24.0	24.0	24.0	27.8	32.2	35.4	35.8	35.9	35.9	35.9	35.9	35.9
H37	24.1	24.1	24.1	27.8	32.2	35.4	35.8	35.9	35.9	35.9	35.9	35.9
H38	21.0	21.0	21.0	24.7	29.1	32.3	32.8	32.9	32.9	32.9	32.9	32.9
H39	22.2	22.2	22.2	25.9	30.3	33.5	34.0	34.0	34.0	34.0	34.0	34.0
H40	22.7	22.7	22.7	26.4	30.8	34.0	34.6	34.7	34.7	34.7	34.7	34.7
H41	18.6	18.6	18.6	22.2	26.6	29.9	30.5	30.5	30.5	30.5	30.5	30.5
H42	18.4	18.4	18.4	22.1	26.4	29.7	30.3	30.4	30.4	30.4	30.4	30.4
H43	21.5	21.5	21.5	25.1	29.4	32.7	33.3	33.4	33.4	33.4	33.4	33.4
H44	21.4	21.4	21.4	25.0	29.4	32.7	33.3	33.4	33.4	33.4	33.4	33.4
H45	19.3	19.3	19.3	23.0	27.3	30.6	31.2	31.3	31.3	31.3	31.3	31.3
H46	19.2	19.2	19.2	22.8	27.1	30.4	31.1	31.1	31.1	31.1	31.1	31.1
H47	26.4	26.4	26.4	30.1	34.5	37.7	38.2	38.2	38.2	38.2	38.2	38.2
H48	14.0	14.0	14.0	17.7	22.1	25.3	25.8	25.8	25.8	25.8	25.8	25.8

11.6.26 Noise levels at 34 of the 48 nearest residential properties are below 35dB(A), indicating that the noise immission levels would be regarded as acceptable and the resident's amenity as receiving 'sufficient protection' without further assessment requiring to be undertaken.

11.6.27 There are 14 properties that have predicted noise levels greater than this simplified noise criteria as indicated in Table 11.15. Therefore the 'full' acoustic assessment need only be considered at these properties.

Acoustic Acceptance Criteria

11.6.28 As stated previously, during daytime periods and at low background noise levels, a lower fixed limit of 35-40dB(A) is applicable with the exact value dependent upon a number of factors: the number of noise affected residential properties; the potential impact on the power output of the proposed development and the likely duration and level of exposure. Through consideration of these factors, along with consultation with Dumfries and Galloway Council, RES have adopted a 37.5dB(A) level as per the existing Solwaybank Wind Farm. The justification being:

- Number of noise affected residential properties: 14 of the considered residential properties are predicted to experience noise levels of greater than 35dB(A). This is a small number of properties in relation to the scale of the proposed development which would generate significant social, economic and environmental benefits suggesting a limit towards the middle of the range would be appropriate;
- Potential impact on the power output of the proposed development: The rated power would be 126MW should the wind turbine type considered in the acoustic assessment be installed, large in comparison with other wind farm developments in Scotland, suggesting that a lower limit towards the middle, or upper end, of the range would be appropriate. A lower limit towards the lower end of the range would limit the power output of the proposed development; and
- The likely duration and level of exposure: The amount of the time that noise levels of greater than 35dB(A) are predicted is limited to periods of sufficiently high wind speed. Noise levels would also be reduced when properties are not located downwind of the wind turbines. Again, this does not suggest a high impact such that a lower limit in the middle of the range would be appropriate.

11.6.29 A 43dB(A) lower limit has been adopted at night in accordance with ETSU-R-97. The resulting criteria are shown in Table 11.16.

Table 11.16: Permissible Noise Level Criteria

Time of Day	Permissible Noise Level
Daytime	37.5dB(A) for L_B less than 32.5dB(A) L_B + 5dB, for L_B greater than 32.5dB(A)
Night-time	43dB(A) for L_B less than 38dB(A) L_B + 5dB, for L_B greater than 38dB(A)

Calculation of Acceptable Noise Limits from Baseline Conditions

11.6.30 The 'best-fit' lines of Technical Appendix 11.7 Charts A11.3-A11.8 have been used to calculate the acceptable noise limits at the background noise measurement locations in line with the permissible noise level criteria set out in Table 11.16. Table 11.17 shows the proposed daytime noise limits and Table 11.18 the night-time noise limits.

Table 11.17 - Recommended Daytime Noise Limits (dB(A) re 20 μPa)

House Name	Standardised 10m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Allfornought	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.9	41.4	44.1	47.1	47.1
Bigholms Cottage	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.4	42.1	42.1	42.1
Kirtleton House	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.5	40.6	43.1	45.8	45.8
Pingle Farm	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.5	42.2	45.1	45.1
Bloch Farm	37.5	37.5	37.5	39.7	42.1	44.6	47.3	50.1	52.9	55.8	58.7	61.5
Kerr	37.5	37.5	37.5	37.5	37.5	38.3	40.6	43.2	46.2	49.4	52.9	56.6
Upper Caulfield	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8

Table 11.18 - Recommended Night-time Noise Limits (dB(A) re 20 μPa)

House Name	Standardised 10m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
Allfornought	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.2	46.2	46.2
Bigholms Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Kirtleton House	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2
Pingle Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
Bloch Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	48.3	52.4	52.4	52.4
Kerr	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
Upper Caulfield	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8

11.6.31 The recommendations of ETSU-R-97 state that where there are groups of properties that are likely to have a similar background noise environment, it is appropriate to use data from one representative location as the basis for assessment at the other properties. The survey results inferred to be representative for each property are shown in Table 11.19.

11.6.32 The specific choice of noise survey chosen has been made considering the distance to the nearest survey location and the likelihood of experiencing a broadly similar exposure as the survey. Baseline data measured at Bloch Farm has not been inferred elsewhere as a conservative measure as raised background noise levels, potentially due to location-specific noise sources, occurred at this property.

Table 11.19 - Assumed Representative Background Noise Survey Locations

House ID	House Name	Survey Location
H1	SOLWAYBANK COTTAGE	Allfornought
H2	BARNGLIES COTTAGE	Pingle Farm
H3	BARNGLIES COTTAGE	Pingle Farm
H4	SOLWAYBANK HOUSE	Allfornought
H5	WATTAMAN FARM	Pingle Farm
H6	BARNGLIES FARM	Pingle Farm
H7	WOODSIDE	Allfornought
H8	ALLFORNOUGHT	Allfornought
H9	TOMSHIELBURN	Kerr
H10	SAUGHTREE COTTAGE	Kerr
H11	SAUGHTREE COTTAGE	Kerr
H12	SAUGHTREE COTTAGE	Kerr
H13	MARCH COTTAGE	Kerr
H14	PINGLE BRIDGE COTTAGE	Pingle Farm
H15	PINGLE FARM	Pingle Farm
H16	UPPER TOMSHIELBURN	Kerr
H17	RYEHILLS	Kerr
H18	BARNGLIESHEAD	Pingle Farm
H19	KERR	Kerr
H20	MEGSFIELD	Kirtleton House
H21	OLD IRVINE COTTAGES	Kerr
H22	BIGHOLMS COTTAGE	Bigholms Cottage
H23	BLOCH FARM	Bloch Farm
H24	COLLIN	Bigholms Cottage
H25	HOLMFOOT COTTAGE	Bigholms Cottage
H26	CALLISTERHALL	Bigholms Cottage
H27	HOUSE, FALCON FARM	Bigholms Cottage
H28	THE FLAT, FALCON FARM	Bigholms Cottage
H29	WAUCHOPE SCHOOL HOUSE	Bigholms Cottage

House ID	House Name	Survey Location
H30	WINTERHOPE	Kirtleton House
H31	WINTERHOPE FARM HOUSE	Kirtleton House
H32	FALCON FARM	Bigholms Cottage
H33	WINTERHOPE FILTER STATION	Kirtleton House
H34	WESTWATER FARM	Bigholms Cottage
H35	WESTWATER COTTAGE	Bigholms Cottage
H36	CLEUCHFOOT COTTAGE	Bigholms Cottage
H37	CLEUCHFOOT COTTAGE	Bigholms Cottage
H38	GREENCLEUCH	Bigholms Cottage
H39	CLEUCHFOOT FARM	Bigholms Cottage
H40	UPPER CAULFIELD	Upper Caulfield
H41	HALLCROFTS	Upper Caulfield
H42	BECKS KNOWE	Upper Caulfield
H43	CAULFIELD PRIVATE	Upper Caulfield
H44	CAULFIELD PRIVATE	Upper Caulfield
H45	BECKS COTTAGE	Upper Caulfield
H46	BECKS FARM	Upper Caulfield
H47	PINGLE FARM	Pingle Farm
H48	KIRTLETON HOUSE	Kirtleton House

11.6.33 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45dB(A) if the occupant has a financial involvement in the proposed development. These limits have therefore been adopted at H22 (Bigholms Cottage) and H23 (Bloch Farm).

Acoustic Assessment

11.6.34 Table 11.20 shows a comparison of the predicted noise levels with the proposed daytime noise limits for each residential property where the full assessment procedure is being applied. The predicted noise levels at $1ms^{-1}$ and $2ms^{-1}$ have been assumed as equal to $3ms^{-1}$ as a conservative measure as noise levels at these wind speeds would typically be less. The term ΔL is used to denote the difference between the predicted wind farm noise level and the proposed limit. A negative value indicates that the predicted noise level is within the limit. Table 11.21 shows a comparison with the proposed night-time noise limits.

11.6.35 Noise levels at all locations are within the night-time noise limits at all wind speeds considered with a minimum margin of -2.3dB(A). The daytime limit is predicted to be exceeded at nine properties by a maximum of 2.6dB(A). A noise management strategy is proposed in order to reduce the daytime noise levels to meet the limit. Further detail is provided in the cumulative assessment section as the strategy also needs to account for the presence of the existing Solwaybank Wind Farm.

Table 11.20 - Comparison of Predicted Noise Levels and Daytime Noise Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})																																			
	1			2			3			4			5			6			7			8			9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H14	25.9	37.5	-11.6	25.9	37.5	-11.6	25.9	37.5	-11.6	29.7	37.5	-7.8	34.1	37.5	-3.4	37.3	37.5	-0.2	37.7	37.5	0.2	37.8	37.5	0.3	37.8	39.5	-1.7	37.8	42.2	-4.4	37.8	45.1	-7.3	37.8	45.1	-7.3
H15	26.0	37.5	-11.5	26.0	37.5	-11.5	26.0	37.5	-11.5	29.8	37.5	-7.7	34.1	37.5	-3.4	37.3	37.5	-0.2	37.8	37.5	0.3	37.8	37.5	0.3	37.8	39.5	-1.7	37.8	42.2	-4.4	37.8	45.1	-7.3	37.8	45.1	-7.3
H18	27.6	37.5	-9.9	27.6	37.5	-9.9	27.6	37.5	-9.9	31.4	37.5	-6.1	35.8	37.5	-1.7	39.0	37.5	1.5	39.4	37.5	1.9	39.4	37.5	1.9	39.4	39.5	-0.1	39.4	42.2	-2.8	39.4	45.1	-5.7	39.4	45.1	-5.7
H19	26.6	37.5	-10.9	26.6	37.5	-10.9	26.6	37.5	-10.9	30.3	37.5	-7.2	34.7	37.5	-2.8	37.9	38.3	-0.4	38.3	40.6	-2.3	38.4	43.2	-4.8	38.4	46.2	-7.8	38.4	49.4	-11.0	38.4	52.9	-14.5	38.4	56.6	-18.2
H22	30.1	45.0	-14.9	30.1	45.0	-14.9	30.1	45.0	-14.9	33.8	45.0	-11.2	38.2	45.0	-6.8	41.4	45.0	-3.6	41.8	45.0	-3.2	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1
H23	30.9	45.0	-14.1	30.9	45.0	-14.1	30.9	45.0	-14.1	34.7	45.0	-10.3	39.1	45.0	-5.9	42.3	45.0	-2.7	42.6	47.3	-4.7	42.7	50.1	-7.4	42.7	52.9	-10.2	42.7	55.8	-13.1	42.7	58.7	-16.0	42.7	61.5	-18.8
H24	26.1	37.5	-11.4	26.1	37.5	-11.4	26.1	37.5	-11.4	29.8	37.5	-7.7	34.2	37.5	-3.3	37.5	37.5	0.0	37.9	37.6	0.3	38.0	38.9	-0.9	38.0	40.4	-2.4	38.0	42.1	-4.1	38.0	42.1	-4.1	38.0	42.1	-4.1
H25	26.4	37.5	-11.1	26.4	37.5	-11.1	26.4	37.5	-11.1	30.2	37.5	-7.3	34.6	37.5	-2.9	37.8	37.5	0.3	38.2	37.6	0.6	38.3	38.9	-0.6	38.3	40.4	-2.1	38.3	42.1	-3.8	38.3	42.1	-3.8	38.3	42.1	-3.8
H27	25.8	37.5	-11.7	25.8	37.5	-11.7	25.8	37.5	-11.7	29.6	37.5	-7.9	34.0	37.5	-3.5	37.2	37.5	-0.3	37.6	37.6	0.0	37.7	38.9	-1.2	37.7	40.4	-2.7	37.7	42.1	-4.4	37.7	42.1	-4.4	37.7	42.1	-4.4
H28	25.9	37.5	-11.6	25.9	37.5	-11.6	25.9	37.5	-11.6	29.6	37.5	-7.9	34.0	37.5	-3.5	37.2	37.5	-0.3	37.6	37.6	0.0	37.7	38.9	-1.2	37.7	40.4	-2.7	37.7	42.1	-4.4	37.7	42.1	-4.4	37.7	42.1	-4.4
H29	28.5	37.5	-9.0	28.5	37.5	-9.0	28.5	37.5	-9.0	32.2	37.5	-5.3	36.6	37.5	-0.9	39.8	37.5	2.3	40.2	37.6	2.6	40.3	38.9	1.4	40.3	40.4	-0.1	40.3	42.1	-1.8	40.3	42.1	-1.8	40.3	42.1	-1.8
H36	24.0	37.5	-13.5	24.0	37.5	-13.5	24.0	37.5	-13.5	27.8	37.5	-9.7	32.2	37.5	-5.3	35.4	37.5	-2.1	35.8	37.6	-1.8	35.9	38.9	-3.0	35.9	40.4	-4.5	35.9	42.1	-6.2	35.9	42.1	-6.2	35.9	42.1	-6.2
H37	24.1	37.5	-13.4	24.1	37.5	-13.4	24.1	37.5	-13.4	27.8	37.5	-9.7	32.2	37.5	-5.3	35.4	37.5	-2.1	35.8	37.6	-1.8	35.9	38.9	-3.0	35.9	40.4	-4.5	35.9	42.1	-6.2	35.9	42.1	-6.2	35.9	42.1	-6.2
H47	26.4	37.5	-11.1	26.4	37.5	-11.1	26.4	37.5	-11.1	30.1	37.5	-7.4	34.5	37.5	-3.0	37.7	37.5	0.2	38.2	37.5	0.7	38.2	37.5	0.7	38.2	39.5	-1.3	38.2	42.2	-4.0	38.2	45.1	-6.9	38.2	45.1	-6.9

Table 11.21 - Comparison of Predicted Noise Levels and Night Time Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})																																			
	1			2			3			4			5			6			7			8			9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H14	25.9	43.0	-17.1	25.9	43.0	-17.1	25.9	43.0	-17.1	29.7	43.0	-13.3	34.1	43.0	-8.9	37.3	43.0	-5.7	37.7	43.0	-5.3	37.8	43.0	-5.2	37.8	43.0	-5.2	37.8	43.5	-5.7	37.8	46.8	-9.0	37.8	50.4	-12.6
H15	26.0	43.0	-17.0	26.0	43.0	-17.0	26.0	43.0	-17.0	29.8	43.0	-13.2	34.1	43.0	-8.9	37.3	43.0	-5.7	37.8	43.0	-5.2	37.8	43.0	-5.2	37.8	43.0	-5.2	37.8	43.5	-5.7	37.8	46.8	-9.0	37.8	50.4	-12.6
H18	27.6	43.0	-15.4	27.6	43.0	-15.4	27.6	43.0	-15.4	31.4	43.0	-11.6	35.8	43.0	-7.2	39.0	43.0	-4.0	39.4	43.0	-3.6	39.4	43.0	-3.6	39.4	43.0	-3.6	39.4	43.5	-4.1	39.4	46.8	-7.4	39.4	50.4	-11.0
H19	26.6	43.0	-16.4	26.6	43.0	-16.4	26.6	43.0	-16.4	30.3	43.0	-12.7	34.7	43.0	-8.3	37.9	43.0	-5.1	38.3	43.0	-4.7	38.4	43.0	-4.6	38.4	43.0	-4.6	38.4	43.3	-4.9	38.4	43.3	-4.9	38.4	43.3	-4.9
H22	30.1	45.0	-14.9	30.1	45.0	-14.9	30.1	45.0	-14.9	33.8	45.0	-11.2	38.2	45.0	-6.8	41.4	45.0	-3.6	41.8	45.0	-3.2	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1	41.9	45.0	-3.1
H23	30.9	45.0	-14.1	30.9	45.0	-14.1	30.9	45.0	-14.1	34.7	45.0	-10.3	39.1	45.0	-5.9	42.3	45.0	-2.7	42.6	45.0	-2.4	42.7	45.0	-2.3	42.7	48.3	-5.6	42.7	52.4	-9.7	42.7	52.4	-9.7	42.7	52.4	-9.7
H24	26.1	43.0	-16.9	26.1	43.0	-16.9	26.1	43.0	-16.9	29.8	43.0	-13.2	34.2	43.0	-8.8	37.5	43.0	-5.5	37.9	43.0	-5.1	38.0	43.0	-5.0	38.0	43.0	-5.0	38.0	43.0	-5.0	38.0	43.0	-5.0	38.0	43.0	-5.0
H25	26.4	43.0	-16.6	26.4	43.0	-16.6	26.4	43.0	-16.6	30.2	43.0	-12.8	34.6	43.0	-8.4	37.8	43.0	-5.2	38.2	43.0	-4.8	38.3	43.0	-4.7	38.3	43.0	-4.7	38.3	43.0	-4.7	38.3	43.0	-4.7	38.3	43.0	-4.7
H27	25.8	43.0	-17.2	25.8	43.0	-17.2	25.8	43.0	-17.2	29.6	43.0	-13.4	34.0	43.0	-9.0	37.2	43.0	-5.8	37.6	43.0	-5.4	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3
H28	25.9	43.0	-17.1	25.9	43.0	-17.1	25.9	43.0	-17.1	29.6	43.0	-13.4	34.0	43.0	-9.0	37.2	43.0	-5.8	37.6	43.0	-5.4	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3	37.7	43.0	-5.3
H29	28.5	43.0	-14.5	28.5	43.0	-14.5	28.5	43.0	-14.5	32.2	43.0	-10.8	36.6	43.0	-6.4	39.8	43.0	-3.2	40.2	43.0	-2.8	40.3	43.0	-2.7	40.3	43.0	-2.7	40.3	43.0	-2.7	40.3	43.0	-2.7	40.3	43.0	-2.7
H36	24.0	43.0	-19.0	24.0	43.0	-19.0	24.0	43.0	-19.0	27.8	43.0	-15.2	32.2	43.0	-10.8	35.4	43.0	-7.6	35.8	43.0	-7.2	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1
H37	24.1	43.0	-18.9	24.1	43.0	-18.9	24.1	43.0	-18.9	27.8	43.0	-15.2	32.2	43.0	-10.8	35.4	43.0	-7.6	35.8	43.0	-7.2	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1	35.9	43.0	-7.1
H47	26.4	43.0	-16.6	26.4	43.0	-16.6	26.4	43.0	-16.6	30.1	43.0	-12.9	34.5	43.0	-8.5	37.7	43.0	-5.3	38.2	43.0	-4.8	38.2	43.0	-4.8	38.2	43.0	-4.8	38.2	43.5	-5.3	38.2	46.8	-8.6	38.2	50.4	-12.2

The term L_p is used to denote the predicted noise level due to the operation of the proposed development

The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit

11.7 Mitigation

Construction Noise

11.7.1 For all activities, measures would be taken to reduce noise levels with due regard to practicality and cost as per the concept of 'best practicable means' as defined in Section 72 of the Control of Pollution Act 1974.

11.7.2 BS 5228-1:2009 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authority is recommended along with steps to inform residents of intended activity. Non-acoustic factors, which influence the overall level of complaints such as mud on roads and dust generation, would also be controlled through construction practices adopted on-site.

11.7.3 Furthermore, the following noise mitigation options could be implemented where appropriate:

- Consideration would be given to noise emissions when selecting plant and equipment to be used on-site;
- All equipment should be maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;
- Stationary noise sources would be sited as far away as reasonably possible from residential properties and where necessary and appropriate, acoustic barriers could be used to screen them; and
- The movement of vehicles to and from the proposed development would be controlled and employees instructed to ensure compliance with the noise control measures adopted.

11.7.4 Site operations would be limited to 07:00-19:00 Monday to Saturday except during turbine delivery/erection and commissioning or during periods of emergency work. Should it be considered necessary to reduce noise levels from the conservative predicted levels to adhere to the 55dB(A) target level for Saturdays 13:00-19:00, the following mitigation measures would be considered:

- Reduce the number of construction activities occurring simultaneously;
- Restrict the distance of construction activity from nearby properties during these times; &
- Reduce construction traffic as appropriate.

11.7.5 There are many strategies to reduce construction noise by the limitation of activities that would result in predicted noise levels being lower than the specified target. Any such measures should be considered adequate and the mitigation adopted should not be limited to the measures proposed.

11.7.6 With specific regard to blasting, it is proposed that the following mitigation measures are implemented:

- Good practice on blasting, as recommended by Planning Advice Note (PAN) 50 'Controlling the environmental effects of surface mineral workings'[24] shall be followed;
- The vibration and air overpressure reduction methods outlined in Section 8.6.9.2 of BS 5228-2:2009 shall be adhered to where appropriate;
- Advance warning shall be given to nearby residents;
- Blasting should only occur between the hours of 08:00-18:00 on Mondays-Fridays or between the hours of 08:00-13:00 on Saturdays; and
- No more than three blasts per day should occur.

11.7.7 Depending upon the charge sizes required it may be prudent to perform trial blasts with smaller amounts of explosive and measure vibration magnitudes at various distances to more accurately determine how vibration propagates at the proposed development.

Operational Noise

11.7.8 One of the key constraints and considerations in designing the layout of the turbines was the minimisation of potential noise impacts at the nearest residential receptors. As such the turbine layout was designed to ensure that there is an adequate separation distance between any of the proposed turbines and the nearest residential property.

11.7.9 Due to this consideration of the noise impacts in the design of the proposed development, embedding mitigation measures in the turbine layout, when a conservative candidate machine is modelled a limited amount of noise management is required to meet noise limits derived in accordance with ETSU-R-97.

11.7.10 Noise management involves altering the operational mode of the turbines in certain conditions by changing the pitch of the blades, resulting in a trade-off between power production and noise reduction. This provides a potential mechanism for further reducing the level of noise experienced at nearby residential properties although the acoustic assessment demonstrates that this is not required.

[24] 'Planning Advice Note 50: Controlling the environmental effects of surface mineral workings', Scottish Government, October 1996. Available at: https://www.gov.scot/publications/planning-advice-note-pan-50-controlling-environmental-effects-surface-mineral/

11.7.11 If planning permission is granted for the proposed development, planning conditions can be proposed to provide a degree of protection to nearby residents in the form of limits relating to noise level and tonality.

11.7.12 Technical Appendix 11.8 contains a set of draft planning conditions relating to noise that RES considers appropriate.

11.8 Assessment of Residual Effects

Construction

11.8.1 Construction noise levels above the criteria noise level for Saturdays between 13:00-19:00 are predicted although this can be mitigated by restricting the activities that are allowed to take place as necessary. At all other locations predicted noise from the worst-case combination of increased traffic and site construction noise would not exceed relevant criteria and therefore no significant impacts are expected.

Operational

11.8.2 The acoustic assessment demonstrates that predicted noise levels at residential properties do not exceed the derived noise limits with an appropriate noise management strategy in place. This should not be interpreted to mean that wind farm operational noise would be inaudible (or masked by background noise) under all conditions, but that the levels of noise are acceptable under ETSU-R-97 and associated guidance.

11.9 Assessment of Cumulative Effects

Cumulative Construction Noise Assessment

11.9.1 Any noise due to the construction of the other wind farms considered in the cumulative operational noise assessment would not be ongoing at the same time as the construction of the proposed development as Solwaybank wind farm is already built.

Cumulative Operational Noise Assessment

11.9.2 An assessment of the cumulative acoustic impact of the proposed development in conjunction with the existing Solwaybank Wind Farm has been undertaken in accordance with the guidance on wind farm noise assessment; ETSU-R-97 and the IoA GPG. No other wind farm sites are considered as they are far enough away that there is no cumulative impact i.e. the noise levels from other sites would be insignificant compared to those from the Proposed Development in combination with the existing Solwaybank Wind Farm.

11.9.3 ETSU-R-97 states:

"It is clearly unreasonable to suggest that, because a wind farm has been constructed in the vicinity in the past which resulted in increased noise levels at some properties, the residents of those properties are now able to tolerate higher noise levels still. The existing wind farm should not be considered as part of the prevailing background noise."

11.9.4 The locations of the 21 wind turbines making up the proposed development, along with the other turbines considered in the cumulative assessment, are shown in Figure 11.2. Those prefixed "T" make up the proposed development whereas those prefixed "S" belong to the existing Solwaybank Wind Farm.

11.9.5 The residential properties considered in the cumulative assessment are those detailed in Table 11.22. The distances to the nearest turbine included in the cumulative assessment are also given in Table 11.22.

Table 11.22: Distances from Residential Properties to Nearest Cumulative Turbine

House ID	House Name	Distance (m)	Nearest Turbine
H1	SOLWAYBANK COTTAGE	S10	1726
H2	BARNGLIES COTTAGE	T13	2100
H3	BARNGLIES COTTAGE	T13	2090
H4	SOLWAYBANK HOUSE	S10	1629
H5	WATTAMAN FARM	T10	2131
H6	BARNGLIES FARM	T13	1861
H7	WOODSIDE	S10	1674
H8	ALLFORNOUGHT	S14	955
H9	TOMSHIELBURN	T13	1914
H10	SAUGHTREE COTTAGE	T13	2097

House ID	House Name	Distance (m)	Nearest Turbine
H11	SAUGHTREE COTTAGE	T13	2107
H12	SAUGHTREE COTTAGE	T13	2146
H13	MARCH COTTAGE	T13	1416
H14	PINGLE BRIDGE COTTAGE	T10	1288
H15	PINGLE FARM	T10	1286
H16	UPPER TOMSHIELBURN	T13	1797
H17	RYEHILLS	T13	1534
H18	BARNGLIESHEAD	T10	1051
H19	KERR	T13	1118
H20	MEGSFIELD	S15	1402
H21	OLD IRVINE COTTAGES	T21	2001
H22	BIGHOLMS COTTAGE	T6	757
H23	BLOCH FARM	T16	839
H24	COLLIN	T5	1053
H25	HOLMFOOT COTTAGE	T5	1111
H26	CALLISTERHALL	S1	1411
H27	HOUSE, FALCON FARM	T5	1313
H28	THE FLAT, FALCON FARM	T5	1317
H29	WAUCHOPE SCHOOL HOUSE	T7	1078
H30	WINTERHOPE	S6	2647
H31	WINTERHOPE FARM HOUSE	S6	2723
H32	FALCON FARM	T5	1829
H33	WINTERHOPE FILTER STATION	S6	2694
H34	WESTWATER FARM	T5	1840
H35	WESTWATER COTTAGE	T5	1882
H36	CLEUCHFOOT COTTAGE	T7	1544
H37	CLEUCHFOOT COTTAGE	T7	1544
H38	GREENCLEUCH	T5	2165
H39	CLEUCHFOOT FARM	T7	2002
H40	UPPER CAULFIELD	T20	2024
H41	HALLCROFTS	T21	2107
H42	BECKS KNOWE	T21	2147
H43	CAULFIELD PRIVATE	T20	2080
H44	CAULFIELD PRIVATE	T20	2094
H45	BECKS COTTAGE	T20	2199
H46	BECKS FARM	T20	2254
H47	PINGLE FARM	T10	1229
H48	KIRTLETON HOUSE	S15	1461

Cumulative Assessment Methodology

11.9.6 ETSU-R-97 recommends that the derived noise limits applicable at nearby residential properties shall relate to the cumulative effects of noise from all wind turbines that may affect a particular location.

11.9.7 The methodology is therefore to:

- Predict the level of noise resulting from the operation of the turbines being considered in the cumulative assessment without the proposed development;
- Identify appropriate overall ETSU-R-97 noise limits for each receptor;
- Subtract the predicted noise levels calculated in step 1 from the ETSU-R-97 limits identified in step 2. Such a calculation shall provide a maximum total noise limit at each house identified which the proposed development should not exceed; and
- Compare the predicted noise levels due to the proposed development to the limit calculated in step 3 to determine compliance with ETSU-R-97.

11.9.8 The methodology outlined above is in accordance with the appropriate guidance on cumulative wind farm noise assessment as described in ETSU-R-97 and the IoA GPG.

Predictions of Noise Levels at Residential Properties

11.9.9 The noise limits contained in the Decision Notice[25] are used to calculate the worst case predicted noise levels from the existing Solwaybank Wind Farm using the 'Controlling Property' method outlined in the IoA GPG as follows:

- Predictions are made using appropriate turbine noise data;
- Comparison is made between the predictions and the limits from the planning conditions in order to identify the controlling property; and
- The predictions are scaled by the margin between the predictions and the conditioned noise limits at the controlling property.

[25] Scottish Government, Appeal Decision Notice, Reference PPA-170-2091, 23 September 2014.

11.9.10 The above process would yield predicted noise levels which are equal to the conditioned noise limit at the controlling property which in this case is Allfornought. However, at wind speeds where significant headroom exists between the predicted noise levels and the limits this would be an unrealistic assumption and the scaling factor has been limited to 3dB.

11.9.11 The wind turbine installed at Solwaybank Wind Farm is the Vestas V100 turbine. Warranted acoustic data for this machine is taken from the manufacturer's performance specification[26] and an uncertainty of 1dB has been added as independent test reports indicate that some allowance for uncertainty has already been included. Details used in this analysis are as follows:

- a mix of rated powers (T1 & T5 at 2.2MW, others at 2MW);
- a hub height of 76.5m;
- a rotor diameter of 100m;
- sound power levels, L_{WA}, for standardised 10m height wind speeds (v_{10}) as shown in Table 11.23; and
- octave band sound power level data, at the wind speeds where it is available, as shown in Table 11.24.

Table 11.23: A-Weighted Sound Power Levels (dB(A) re 1pW) for the Vestas V100 Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	2 MW	2.2 MW
1	95.2	95.2
2	95.2	95.2
3	95.2	95.2
4	97.9	98.0
5	101.5	101.6
6	104.8	104.9
7	106.0	106.0
8	106.0	106.0
9	106.0	106.0
10	106.0	106.0
11	106.0	106.0
12	106.0	106.0

Table 11.24: Octave Band A-Weighted Sound Power Levels (dB(A) re 1pW) at 10m Standardised Wind Speeds for the Vestas V100 Wind Turbine

Octave Band (Hz)	2MW			2.2MW		
	$6ms^{-1}$	$7ms^{-1}$	$8ms^{-1}$	$6ms^{-1}$	$7ms^{-1}$	$8ms^{-1}$
63	83.7	85.2	85.6	83.9	85.0	85.5
125	91.4	92.6	92.3	91.6	92.6	92.4
250	97.2	98.0	96.6	97.4	98.2	97.1
500	99.5	100.5	99.6	99.6	100.6	99.9
1000	99.3	100.7	101.1	99.4	100.6	101.0
2000	96.9	98.7	99.7	97.1	98.5	99.4
4000	89.3	91.2	92.7	89.4	90.9	92.2
8000	78.3	79.5	79.0	78.5	79.5	79.2
OVERALL	104.8	106.0	106.0	104.9	106.0	106.0

11.9.12 The predicted noise levels at nearby residential properties due to the operation of the existing Solwaybank Wind Farm, scaled to its conditioned daytime limits, are detailed in Table 11.25. The predicted night-time noise levels due to the existing Solwaybank Wind Farm, scaled to its conditioned night-time limits, are shown in Table 11.26. The day and night-time predictions differ in some instances due to the different limits that apply for day and night-time periods.

Table 11.25: Predicted Daytime Noise Levels due to Existing Solwaybank Wind Farm, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	24.7	24.7	24.7	27.4	31.0	31.7	31.6	32.9	34.7	34.7	34.7	34.7
H2	19.4	19.4	19.4	22.1	25.7	26.4	26.4	27.6	29.4	29.4	29.4	29.4
H3	19.4	19.4	19.4	22.1	25.7	26.4	26.3	27.6	29.4	29.4	29.4	29.4
H4	25.2	25.2	25.2	27.9	31.5	32.2	32.2	33.5	35.3	35.3	35.3	35.3
H5	21.7	21.7	21.7	24.4	28.0	28.7	28.7	29.9	31.7	31.7	31.7	31.7
H6	19.6	19.6	19.6	22.3	25.9	26.6	26.5	27.7	29.5	29.5	29.5	29.5
H7	24.8	24.8	24.8	27.6	31.2	31.9	31.8	33.1	34.9	34.9	34.9	34.9
H8	30.5	30.5	30.5	33.2	36.8	37.5	37.5	38.9	40.7	40.7	40.7	40.7
H9	15.8	15.8	15.8	18.6	22.2	22.9	22.8	24.0	25.8	25.8	25.8	25.8
H10	15.1	15.1	15.1	17.9	21.5	22.2	22.1	23.3	25.1	25.1	25.1	25.1

[26] "Vestas V100-2.0 MW Mk10 Performance specification", 0051-0207_V01, 2015-12-04

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H11	15.1	15.1	15.1	17.8	21.4	22.1	22.1	23.3	25.1	25.1	25.1	25.1
H12	15.0	15.0	15.0	17.7	21.3	22.0	21.9	23.2	24.9	24.9	24.9	24.9
H13	16.4	16.4	16.4	19.1	22.7	23.4	23.3	24.5	26.3	26.3	26.3	26.3
H14	22.3	22.3	22.3	25.0	28.6	29.3	29.2	30.5	32.3	32.3	32.3	32.3
H15	23.1	23.1	23.1	25.8	29.4	30.1	30.1	31.3	33.1	33.1	33.1	33.1
H16	14.3	14.3	14.3	17.0	20.6	21.3	21.3	22.5	24.3	24.3	24.3	24.3
H17	14.9	14.9	14.9	17.6	21.2	21.9	21.9	23.1	24.9	24.9	24.9	24.9
H18	22.1	22.1	22.1	24.8	28.4	29.1	29.0	30.3	32.1	32.1	32.1	32.1
H19	15.6	15.6	15.6	18.3	21.9	22.6	22.5	23.8	25.5	25.5	25.5	25.5
H20	26.9	26.9	26.9	29.6	33.2	33.9	33.9	35.2	37.0	37.0	37.0	37.0
H21	9.1	9.1	9.1	11.8	15.4	16.1	16.1	17.4	19.2	19.2	19.2	19.2
H22	23.6	23.6	23.6	26.4	30.0	30.7	30.6	31.9	33.7	33.7	33.7	33.7
H23	17.3	17.3	17.3	20.1	23.7	24.4	24.3	25.5	27.3	27.3	27.3	27.3
H24	25.4	25.4	25.4	28.1	31.7	32.4	32.4	33.7	35.4	35.4	35.4	35.4
H25	24.7	24.7	24.7	27.5	31.1	31.8	31.7	33.0	34.8	34.8	34.8	34.8
H26	26.8	26.8	26.8	29.5	33.1	33.8	33.8	35.1	36.9	36.9	36.9	36.9
H27	24.3	24.3	24.3	27.0	30.6	31.3	31.3	32.6	34.3	34.3	34.3	34.3
H28	24.3	24.3	24.3	27.0	30.6	31.3	31.3	32.5	34.3	34.3	34.3	34.3
H29	19.0	19.0	19.0	21.7	25.3	26.0	26.0	27.2	29.0	29.0	29.0	29.0
H30	19.0	19.0	19.0	21.7	25.3	26.0	26.0	27.2	29.0	29.0	29.0	29.0
H31	18.7	18.7	18.7	21.4	25.0	25.7	25.7	26.9	28.7	28.7	28.7	28.7
H32	22.5	22.5	22.5	25.3	28.9	29.6	29.5	30.7	32.5	32.5	32.5	32.5
H33	18.8	18.8	18.8	21.5	25.1	25.8	25.8	27.0	28.8	28.8	28.8	28.8
H34	22.5	22.5	22.5	25.2	28.8	29.5	29.5	30.7	32.5	32.5	32.5	32.5
H35	22.2	22.2	22.2	24.9	28.5	29.2	29.1	30.4	32.2	32.2	32.2	32.2
H36	17.3	17.3	17.3	20.0	23.6	24.3	24.2	25.4	27.2	27.2	27.2	27.2
H37	17.2	17.2	17.2	20.0	23.6	24.2	24.2	25.4	27.2	27.2	27.2	27.2
H38	20.4	20.4	20.4	23.1	26.7	27.4	27.3	28.5	30.3	30.3	30.3	30.3
H39	17.7	17.7	17.7	20.4	24.0	24.7	24.6	25.8	27.6	27.6	27.6	27.6
H40	15.1	15.1	15.1	17.8	21.4	22.1	22.0	23.3	25.1	25.1	25.1	25.1
H41	9.6	9.6	9.6	12.3	15.9	16.6	16.6	17.9	19.7	19.7	19.7	19.7
H42	9.6	9.6	9.6	12.3	15.9	16.6	16.6	17.9	19.7	19.7	19.7	19.7
H43	12.9	12.9	12.9	15.6	19.2	19.9	19.9	21.1	22.9	22.9	22.9	22.9
H44	12.9	12.9	12.9	15.6	19.2	19.9	19.8	21.1	22.9	22.9	22.9	22.9
H45	11.2	11.2	11.2	13.9	17.5	18.2	18.2	19.5	21.3	21.3	21.3	21.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H46	11.1	11.1	11.1	13.8	17.4	18.1	18.1	19.4	21.1	21.1	21.1	21.1
H47	23.3	23.3	23.3	26.0	29.6	30.3	30.2	31.5	33.3	33.3	33.3	33.3
H48	25.7	25.7	25.7	28.4	32.0	32.7	32.7	34.0	35.7	35.7	35.7	35.7

Table 11.26: Predicted Night Noise Levels due to Existing Solwaybank Wind Farm, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	24.7	24.7	24.7	27.4	31.0	34.3	35.3	34.7	34.7	34.7	34.7	34.7
H2	19.4	19.4	19.4	22.1	25.7	29.0	30.1	29.4	29.4	29.4	29.4	29.4
H3	19.4	19.4	19.4	22.1	25.7	29.0	30.0	29.4	29.4	29.4	29.4	29.4
H4	25.2	25.2	25.2	27.9	31.5	34.8	35.9	35.3	35.3	35.3	35.3	35.3
H5	21.7	21.7	21.7	24.4	28.0	31.3	32.3	31.7	31.7	31.7	31.7	31.7
H6	19.6	19.6	19.6	22.3	25.9	29.2	30.2	29.5	29.5	29.5	29.5	29.5
H7	24.8	24.8	24.8	27.6	31.2	34.5	35.5	34.9	34.9	34.9	34.9	34.9
H8	30.5	30.5	30.5	33.2	36.8	40.1	41.2	40.7	40.7	40.7	40.7	40.7
H9	15.8	15.8	15.8	18.6	22.2	25.5	26.5	25.8	25.8	25.8	25.8	25.8
H10	15.1	15.1	15.1	17.9	21.5	24.8	25.8	25.1	25.1	25.1	25.1	25.1
H11	15.1	15.1	15.1	17.8	21.4	24.7	25.7	25.1	25.1	25.1	25.1	25.1
H12	15.0	15.0	15.0	17.7	21.3	24.6	25.6	24.9	24.9	24.9	24.9	24.9
H13	16.4	16.4	16.4	19.1	22.7	26.0	27.0	26.3	26.3	26.3	26.3	26.3
H14	22.3	22.3	22.3	25.0	28.6	31.9	32.9	32.3	32.3	32.3	32.3	32.3
H15	23.1	23.1	23.1	25.8	29.4	32.7	33.7	33.1	33.1	33.1	33.1	33.1
H16	14.3	14.3	14.3	17.0	20.6	23.9	25.0	24.3	24.3	24.3	24.3	24.3
H17	14.9	14.9	14.9	17.6	21.2	24.5	25.6	24.9	24.9	24.9	24.9	24.9
H18	22.1	22.1	22.1	24.8	28.4	31.7	32.7	32.1	32.1	32.1	32.1	32.1
H19	15.6	15.6	15.6	18.3	21.9	25.2	26.2	25.5	25.5	25.5	25.5	25.5
H20	26.9	26.9	26.9	29.6	33.2	36.5	37.6	37.0	37.0	37.0	37.0	37.0
H21	9.1	9.1	9.1	11.8	15.4	18.7	19.7	19.2	19.2	19.2	19.2	19.2
H22	23.6	23.6	23.6	26.4	30.0	33.3	34.3	33.7	33.7	33.7	33.7	33.7
H23	17.3	17.3	17.3	20.1	23.7	27.0	28.0	27.3	27.3	27.3	27.3	27.3
H24	25.4	25.4	25.4	28.1	31.7	35.0	36.0	35.4	35.4	35.4	35.4	35.4
H25	24.7	24.7	24.7	27.5	31.1	34.4	35.4	34.8	34.8	34.8	34.8	34.8
H26	26.8	26.8	26.8	29.5	33.1	36.4	37.5	36.9	36.9	36.9	36.9	36.9
H27	24.3	24.3	24.3	27.0	30.6	33.9	35.0	34.3	34.3	34.3	34.3	34.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H28	24.3	24.3	24.3	27.0	30.6	33.9	34.9	34.3	34.3	34.3	34.3	34.3
H29	19.0	19.0	19.0	21.7	25.3	28.6	29.7	29.0	29.0	29.0	29.0	29.0
H30	19.0	19.0	19.0	21.7	25.3	28.6	29.6	29.0	29.0	29.0	29.0	29.0
H31	18.7	18.7	18.7	21.4	25.0	28.3	29.4	28.7	28.7	28.7	28.7	28.7
H32	22.5	22.5	22.5	25.3	28.9	32.2	33.2	32.5	32.5	32.5	32.5	32.5
H33	18.8	18.8	18.8	21.5	25.1	28.4	29.5	28.8	28.8	28.8	28.8	28.8
H34	22.5	22.5	22.5	25.2	28.8	32.1	33.2	32.5	32.5	32.5	32.5	32.5
H35	22.2	22.2	22.2	24.9	28.5	31.8	32.8	32.2	32.2	32.2	32.2	32.2
H36	17.3	17.3	17.3	20.0	23.6	26.9	27.9	27.2	27.2	27.2	27.2	27.2
H37	17.2	17.2	17.2	20.0	23.6	26.9	27.9	27.2	27.2	27.2	27.2	27.2
H38	20.4	20.4	20.4	23.1	26.7	30.0	31.0	30.3	30.3	30.3	30.3	30.3
H39	17.7	17.7	17.7	20.4	24.0	27.3	28.3	27.6	27.6	27.6	27.6	27.6
H40	15.1	15.1	15.1	17.8	21.4	24.7	25.7	25.1	25.1	25.1	25.1	25.1
H41	9.6	9.6	9.6	12.3	15.9	19.2	20.3	19.7	19.7	19.7	19.7	19.7
H42	9.6	9.6	9.6	12.3	15.9	19.2	20.3	19.7	19.7	19.7	19.7	19.7
H43	12.9	12.9	12.9	15.6	19.2	22.5	23.5	22.9	22.9	22.9	22.9	22.9
H44	12.9	12.9	12.9	15.6	19.2	22.5	23.5	22.9	22.9	22.9	22.9	22.9
H45	11.2	11.2	11.2	13.9	17.5	20.8	21.9	21.3	21.3	21.3	21.3	21.3
H46	11.1	11.1	11.1	13.8	17.4	20.7	21.7	21.1	21.1	21.1	21.1	21.1
H47	23.3	23.3	23.3	26.0	29.6	32.9	33.9	33.3	33.3	33.3	33.3	33.3
H48	25.7	25.7	25.7	28.4	32.0	35.3	36.3	35.7	35.7	35.7	35.7	35.7

Derived Acoustic Acceptance Criteria

11.9.13 Due to the greater generation capacity and therefore increased planning merit of the cumulative development, and in accordance with the guidance provided by ETSU-R-97 and the IoA GPG, a 40dB(A) daytime lower limit has been adopted. Justification for this limit is as follows:

- Number of noise affected residential properties: 24 of the considered residential properties are predicted to experience cumulative noise levels of greater than 35dB(A), although this increases to 30 when the predicted noise levels due to Solwaybank Wind Farm are scaled to their conditioned limits. This is a small number of properties in relation to the scale of the cumulative development which would generate significant social, economic and environmental benefits, suggesting a limit towards the upper end of the range would be appropriate;
- Potential impact on the power output of the proposed development: The rated power of the cumulative developments would be 156MW should the wind turbine types considered in the acoustic assessment be installed, large in comparison with other wind farm developments in Scotland, suggesting that a lower limit towards the upper end of the range would be appropriate. A lower limit towards the lower or middle of the range could limit the number and size of wind turbine installed, or result in additional noise management being required, thereby impacting the amount of energy generated; and
- The likely duration and level of exposure: The amount of the time that noise levels of greater than 35dB(A) are predicted is limited to periods of sufficiently high wind speed. Furthermore, it has been assumed that properties can be downwind of all wind turbines simultaneously such that the noise levels experienced would be less at properties where this would not occur in practice. Again, this does not suggest a high impact such that a lower limit at the upper end of the range would be appropriate.

11.9.14 A 43dB(A) night-time lower limit has been adopted for the cumulative assessment as recommended by ETSU-R-97. The chosen lower limits also account for the existing Solwaybank wind farm being consented with lower fixed limits of 37.5dB(A) during the day and 43dB(A) at night.

11.9.15 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45dB(A) if the occupant has a financial involvement in the wind farm. Such limits have been adopted at H22 (Bigholms Cottage) and H23 (Bloch Farm).

11.9.16 The total ETSU-R-97 noise limits for daytime and night-time periods, for each residential property, can be found in Table 11.27 and Table 11.28.

Table 11.27: Total ETSU-R-97 Daytime Noise Limit, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	44.1	47.1	47.1
H2	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	44.1	47.1	47.1
H5	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H6	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H7	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	44.1	47.1	47.1
H8	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	44.1	47.1	47.1

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H9	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H10	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H11	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H12	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H13	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H14	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H15	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H16	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H17	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H18	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H19	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H20	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.1	45.8	45.8
H21	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.2	46.2	49.4	52.9	56.6
H22	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
H23	45.0	45.0	45.0	45.0	45.0	45.0	47.3	50.1	52.9	55.8	58.7	61.5
H24	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H25	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H26	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H27	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H28	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H29	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H30	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.1	45.8	45.8
H31	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.1	45.8	45.8
H32	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H33	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.1	45.8	45.8
H34	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H35	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H36	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H37	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H38	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H39	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.1	42.1	42.1
H40	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H41	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H42	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H43	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H44	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H45	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H46	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.5	51.0	55.3	59.3	62.8
H47	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.2	45.1	45.1
H48	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.6	43.1	45.8	45.8

Table 11.28: Total ETSU-R-97 Night-time Noise Limit, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.2	46.2	46.2
H2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H3	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H4	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.2	46.2	46.2
H5	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H6	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H7	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.2	46.2	46.2
H8	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.2	46.2	46.2
H9	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H10	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H11	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H12	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H13	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H14	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H15	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H16	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H17	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H18	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H19	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H20	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2
H21	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H22	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
H23	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	48.3	52.4	52.4	52.4
H24	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H25	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H26	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H27	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H28	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H29	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H30	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2
H31	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2
H32	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H33	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2
H34	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H35	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H36	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H37	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H38	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H39	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
H40	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H41	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H42	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H43	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H44	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H45	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H46	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H47	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	46.8	50.4
H48	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.9	51.2

11.9.17 The noise limit remaining for the proposed development can now be calculated by subtracting the predicted noise levels due to the existing Solwaybank Wind Farm from the total noise limit. The limit remaining during daytime periods, calculated by subtracting the predicted noise levels in Table 11.25 from the limits in Table 11.27, is shown in Table 11.29. The resulting limits are restricted from being greater than those identified as being appropriate for the proposed development alone i.e. a daytime lower limit of 37.5dB(A). The limit remaining during the night, calculated by subtracting the predicted noise levels in Table 11.26 from the limits in Table 11.28, is shown in Table 11.30.

Table 11.29: Daytime Noise Limit Remaining for Proposed Development, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.9	40.4	43.6	46.8	46.8
H2	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.5	42.0	45.0	45.0
H3	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.5	42.0	45.0	45.0
H4	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.9	40.2	43.5	46.8	46.8
H5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.3	41.8	44.9	44.9
H6	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.5	42.0	45.0	45.0
H7	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.9	40.3	43.5	46.8	46.8
H8	37.5	37.5	37.5	37.5	37.2	36.4	36.4	33.5	33.2	41.5	46.0	46.0
H9	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.1	46.2	49.4	52.9	56.6
H10	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H11	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H12	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H13	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.1	46.2	49.4	52.9	56.6
H14	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.2	41.7	44.9	44.9
H15	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.0	41.6	44.8	44.8
H16	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H17	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H18	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.2	41.8	44.9	44.9
H19	37.5	37.5	37.5	37.5	37.5	38.3	40.5	43.2	46.2	49.4	52.9	56.6
H20	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.2	38.1	41.9	45.2	45.2
H21	37.5	37.5	37.5	37.5	37.5	38.3	40.6	43.2	46.2	49.4	52.9	56.6
H22	45.0	45.0	45.0	44.9	44.9	44.8	44.8	44.8	44.7	44.7	44.7	44.7
H23	45.0	45.0	45.0	45.0	45.0	45.0	47.3	50.1	52.9	55.8	58.7	61.5
H24	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	38.7	41.0	41.0	41.0
H25	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.0	41.2	41.2	41.2
H26	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.3	37.8	40.5	40.5	40.5
H27	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.2	41.3	41.3	41.3
H28	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.2	41.3	41.3	41.3
H29	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.1	41.9	41.9	41.9
H30	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.5	40.3	42.9	45.7	45.7
H31	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.5	40.3	42.9	45.7	45.7
H32	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.6	41.6	41.6	41.6
H33	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.5	40.3	42.9	45.7	45.7

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H34	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.6	41.6	41.6	41.6
H35	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	39.7	41.6	41.6	41.6
H36	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.2	42.0	42.0	42.0
H37	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.2	42.0	42.0	42.0
H38	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.0	41.8	41.8	41.8
H39	37.5	37.5	37.5	37.5	37.5	37.5	37.6	38.9	40.2	41.9	41.9	41.9
H40	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H41	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H42	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H43	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H44	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H45	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H46	37.5	37.5	37.5	37.5	37.5	38.0	42.1	46.5	51.0	55.3	59.3	62.8
H47	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.0	41.6	44.8	44.8
H48	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.5	38.9	42.2	45.3	45.3

Table 11.30: Night Noise Limit Remaining for Proposed Development, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	42.9	42.9	42.9	42.9	42.7	42.4	42.2	42.3	42.3	45.9	45.9	45.9
H2	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	43.3	46.7	50.4
H3	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	43.3	46.7	50.4
H4	42.9	42.9	42.9	42.9	42.7	42.3	42.1	42.2	42.2	45.8	45.8	45.8
H5	43.0	43.0	43.0	42.9	42.9	42.7	42.6	42.7	42.7	43.2	46.7	50.3
H6	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	43.3	46.7	50.4
H7	42.9	42.9	42.9	42.9	42.7	42.3	42.1	42.3	42.3	45.9	45.9	45.9
H8	42.7	42.7	42.7	42.5	41.8	39.9	38.3	39.2	39.2	44.8	44.8	44.8
H9	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H10	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H11	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H12	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H13	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H14	43.0	43.0	43.0	42.9	42.8	42.6	42.6	42.6	42.6	43.2	46.6	50.3
H15	43.0	43.0	43.0	42.9	42.8	42.6	42.5	42.5	42.5	43.1	46.6	50.3
H16	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H17	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H18	43.0	43.0	43.0	42.9	42.8	42.7	42.6	42.6	42.6	43.2	46.7	50.3
H19	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	43.2	43.2	43.2
H20	42.9	42.9	42.9	42.8	42.5	41.9	41.5	41.7	41.7	44.0	47.5	51.0
H21	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	43.3	43.3
H22	45.0	45.0	45.0	44.9	44.9	44.7	44.6	44.7	44.7	44.7	44.7	44.7
H23	45.0	45.0	45.0	45.0	45.0	44.9	44.9	44.9	48.3	52.4	52.4	52.4
H24	42.9	42.9	42.9	42.9	42.7	42.2	42.0	42.2	42.2	42.2	42.2	42.2
H25	42.9	42.9	42.9	42.9	42.7	42.4	42.2	42.3	42.3	42.3	42.3	42.3
H26	42.9	42.9	42.9	42.8	42.5	41.9	41.6	41.8	41.8	41.8	41.8	41.8
H27	42.9	42.9	42.9	42.9	42.7	42.4	42.3	42.4	42.4	42.4	42.4	42.4
H28	42.9	42.9	42.9	42.9	42.7	42.4	42.3	42.4	42.4	42.4	42.4	42.4
H29	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	42.8	42.8	42.8
H30	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	44.7	47.8	51.2
H31	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	44.7	47.8	51.2
H32	43.0	43.0	43.0	42.9	42.8	42.6	42.5	42.6	42.6	42.6	42.6	42.6
H33	43.0	43.0	43.0	43.0	42.9	42.8	42.8	42.8	42.8	44.7	47.8	51.2
H34	43.0	43.0	43.0	42.9	42.8	42.6	42.5	42.6	42.6	42.6	42.6	42.6
H35	43.0	43.0	43.0	42.9	42.8	42.7	42.6	42.6	42.6	42.6	42.6	42.6
H36	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	42.9	42.9	42.9
H37	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	42.9	42.9	42.9
H38	43.0	43.0	43.0	43.0	42.9	42.8	42.7	42.8	42.8	42.8	42.8	42.8
H39	43.0	43.0	43.0	43.0	42.9	42.9	42.9	42.9	42.9	42.9	42.9	42.9
H40	43.0	43.0	43.0	43.0	43.0	42.9	42.9	42.9	45.4	51.8	51.8	51.8
H41	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H42	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H43	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H44	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H45	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H46	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	51.8	51.8	51.8
H47	43.0	43.0	43.0	42.9	42.8	42.6	42.4	42.5	42.5	43.1	46.6	50.3
H48	42.9	42.9	42.9	42.8	42.6	42.2	41.9	42.1	42.1	44.2	47.6	51.1

Cumulative Acoustic Assessment

11.9.18 A comparison of the predicted noise levels for the proposed development with the daytime noise limits is shown in Table 11.31 and Table 11.32 shows a comparison with the night-time noise limits. A negative value indicates that the predicted noise level is within the limit.

11.9.19 The predicted noise levels meet the night-time noise limits at all of the considered properties with a minimum margin of -2.2dB(A). The daytime limit is predicted to be exceeded at nine properties by a maximum of 2.6dB(A).

Table 11.31: Comparison of Predicted Noise Levels and Daytime Noise Limits, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-17.4	-17.4	-17.4	-13.7	-9.3	-6.1	-5.6	-6.9	-8.4	-11.6	-14.9	-14.9
H2	-16.7	-16.7	-16.7	-12.9	-8.5	-5.3	-4.9	-4.8	-6.8	-9.3	-12.3	-12.3
H3	-16.6	-16.6	-16.6	-12.9	-8.5	-5.3	-4.9	-4.8	-6.8	-9.3	-12.3	-12.3
H4	-17.2	-17.2	-17.2	-13.5	-9.1	-5.9	-5.4	-6.7	-8.0	-11.3	-14.6	-14.6
H5	-15.9	-15.9	-15.9	-12.1	-7.7	-4.5	-4.1	-4.0	-5.8	-8.3	-11.4	-11.4
H6	-15.7	-15.7	-15.7	-11.9	-7.5	-4.3	-3.9	-3.9	-5.9	-8.3	-11.3	-11.3
H7	-16.1	-16.1	-16.1	-12.4	-8.0	-4.8	-4.3	-5.6	-7.0	-10.2	-13.5	-13.5
H8	-18.5	-18.5	-18.5	-14.9	-10.2	-6.1	-5.6	-2.6	-2.4	-10.6	-15.1	-15.1
H9	-16.9	-16.9	-16.9	-13.2	-8.8	-6.3	-8.2	-10.7	-13.7	-16.9	-20.5	-24.2
H10	-17.6	-17.6	-17.6	-13.8	-9.4	-7.0	-8.8	-11.4	-14.4	-17.6	-21.1	-24.8
H11	-17.6	-17.6	-17.6	-13.9	-9.5	-7.1	-8.9	-11.4	-14.4	-17.6	-21.2	-24.9
H12	-17.7	-17.7	-17.7	-14.0	-9.6	-7.2	-9.0	-11.6	-14.6	-17.8	-21.3	-25.0
H13	-14.5	-14.5	-14.5	-10.8	-6.4	-4.0	-5.8	-8.3	-11.4	-14.6	-18.1	-21.8
H14	-11.6	-11.6	-11.6	-7.8	-3.4	-0.2	0.2	0.3	-1.4	-4.0	-7.1	-7.1
H15	-11.5	-11.5	-11.5	-7.7	-3.4	-0.2	0.3	0.3	-1.2	-3.8	-7.0	-7.0
H16	-16.0	-16.0	-16.0	-12.3	-7.9	-5.5	-7.3	-9.9	-12.9	-16.1	-19.6	-23.3
H17	-14.7	-14.7	-14.7	-11.0	-6.6	-4.2	-6.0	-8.5	-11.6	-14.8	-18.3	-22.0
H18	-9.9	-9.9	-9.9	-6.1	-1.7	1.5	1.9	1.9	0.2	-2.3	-5.5	-5.5
H19	-10.9	-10.9	-10.9	-7.2	-2.8	-0.4	-2.2	-4.8	-7.8	-11.0	-14.5	-18.2
H20	-21.3	-21.3	-21.3	-17.6	-13.2	-10.0	-9.5	-10.2	-10.0	-13.8	-17.1	-17.1
H21	-17.4	-17.4	-17.4	-13.7	-9.4	-6.9	-8.6	-11.2	-14.2	-17.4	-20.9	-24.6
H22	-14.9	-14.9	-14.9	-11.1	-6.6	-3.4	-3.0	-2.9	-2.8	-2.8	-2.8	-2.8
H23	-14.1	-14.1	-14.1	-10.3	-5.9	-2.7	-4.6	-7.4	-10.2	-13.1	-16.0	-18.8
H24	-11.4	-11.4	-11.4	-7.7	-3.3	0.0	0.3	-0.9	-0.8	-3.1	-3.1	-3.1
H25	-11.1	-11.1	-11.1	-7.3	-2.9	0.3	0.6	-0.6	-0.8	-3.0	-3.0	-3.0
H26	-17.0	-17.0	-17.0	-13.3	-8.9	-5.7	-5.3	-6.0	-5.5	-8.2	-8.2	-8.2
H27	-11.7	-11.7	-11.7	-7.9	-3.5	-0.3	0.0	-1.2	-1.5	-3.6	-3.6	-3.6
H28	-11.6	-11.6	-11.6	-7.9	-3.5	-0.3	0.0	-1.2	-1.5	-3.6	-3.6	-3.6
H29	-9.0	-9.0	-9.0	-5.3	-0.9	2.3	2.6	1.4	0.2	-1.6	-1.6	-1.6
H30	-25.4	-25.4	-25.4	-21.7	-17.3	-14.1	-13.6	-14.5	-16.3	-19.0	-21.8	-21.8
H31	-25.3	-25.3	-25.3	-21.6	-17.2	-14.0	-13.5	-14.4	-16.2	-18.8	-21.6	-21.6
H32	-15.1	-15.1	-15.1	-11.3	-6.9	-3.7	-3.4	-4.6	-5.3	-7.3	-7.3	-7.3
H33	-25.1	-25.1	-25.1	-21.4	-17.1	-13.8	-13.3	-14.3	-16.1	-18.7	-21.5	-21.5
H34	-15.1	-15.1	-15.1	-11.4	-7.0	-3.8	-3.5	-4.7	-5.4	-7.4	-7.4	-7.4
H35	-14.9	-14.9	-14.9	-11.2	-6.8	-3.6	-3.2	-4.4	-5.2	-7.2	-7.2	-7.2
H36	-13.5	-13.5	-13.5	-9.7	-5.3	-2.1	-1.8	-3.0	-4.3	-6.1	-6.1	-6.1
H37	-13.4	-13.4	-13.4	-9.7	-5.3	-2.1	-1.8	-3.0	-4.3	-6.0	-6.0	-6.0
H38	-16.5	-16.5	-16.5	-12.8	-8.4	-5.2	-4.8	-6.0	-7.1	-8.9	-8.9	-8.9
H39	-15.3	-15.3	-15.3	-11.6	-7.2	-4.0	-3.6	-4.9	-6.1	-7.9	-7.9	-7.9
H40	-14.8	-14.8	-14.8	-11.1	-6.7	-4.0	-7.5	-11.8	-16.3	-20.6	-24.6	-28.1
H41	-18.9	-18.9	-18.9	-15.3	-10.9	-8.1	-11.6	-16.0	-20.5	-24.8	-28.8	-32.3
H42	-19.1	-19.1	-19.1	-15.4	-11.1	-8.3	-11.8	-16.1	-20.6	-24.9	-28.9	-32.4
H43	-16.0	-16.0	-16.0	-12.4	-8.1	-5.3	-8.7	-13.1	-17.6	-21.9	-25.9	-29.4
H44	-16.1	-16.1	-16.1	-12.5	-8.1	-5.3	-8.8	-13.1	-17.6	-21.9	-25.9	-29.4
H45	-18.2	-18.2	-18.2	-14.5	-10.2	-7.4	-10.8	-15.2	-19.7	-24.0	-28.0	-31.5
H46	-18.3	-18.3	-18.3	-14.7	-10.4	-7.6	-11.0	-15.4	-19.9	-24.2	-28.2	-31.7
H47	-11.1	-11.1	-11.1	-7.4	-3.0	0.2	0.7	0.7	-0.7	-3.4	-6.6	-6.6
H48	-23.5	-23.5	-23.5	-19.8	-15.4	-12.2	-11.7	-12.7	-13.0	-16.4	-19.5	-19.5

Table 11.32: Comparison of Predicted Noise Levels and Night Noise Limits, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-22.9	-22.9	-22.9	-19.1	-14.6	-11.0	-10.3	-10.3	-10.3	-13.9	-13.9	-13.9
H2	-22.1	-22.1	-22.1	-18.4	-13.9	-10.6	-10.2	-10.1	-10.1	-10.7	-14.1	-17.7
H3	-22.1	-22.1	-22.1	-18.3	-13.9	-10.6	-10.1	-10.1	-10.1	-10.6	-14.0	-17.7
H4	-22.6	-22.6	-22.6	-18.8	-14.3	-10.6	-9.9	-10.0	-10.0	-13.6	-13.6	-13.6
H5	-21.3	-21.3	-21.3	-17.6	-13.1	-9.7	-9.2	-9.2	-9.2	-9.7	-13.2	-16.9
H6	-21.2	-21.2	-21.2	-17.4	-13.0	-9.7	-9.2	-9.2	-9.2	-9.7	-13.1	-16.7
H7	-21.5	-21.5	-21.5	-17.8	-13.2	-9.6	-8.9	-9.0	-9.0	-12.6	-12.6	-12.6

H8	-23.8	-23.8	-23.8	-19.9	-14.8	-9.6	-7.5	-8.3	-8.3	-13.9	-13.9	-13.9
H9	-22.4	-22.4	-22.4	-18.6	-14.2	-11.0	-10.5	-10.5	-10.5	-10.8	-10.8	-10.8
H10	-23.1	-23.1	-23.1	-19.3	-14.9	-11.7	-11.2	-11.2	-11.2	-11.5	-11.5	-11.5
H11	-23.1	-23.1	-23.1	-19.3	-14.9	-11.7	-11.3	-11.2	-11.2	-11.5	-11.5	-11.5
H12	-23.2	-23.2	-23.2	-19.5	-15.1	-11.8	-11.4	-11.3	-11.3	-11.6	-11.6	-11.6
H13	-20.0	-20.0	-20.0	-16.3	-11.8	-8.6	-8.2	-8.1	-8.1	-8.4	-8.4	-8.4
H14	-17.0	-17.0	-17.0	-13.2	-8.7	-5.4	-4.9	-4.9	-4.9	-5.4	-8.9	-12.6
H15	-17.0	-17.0	-17.0	-13.2	-8.7	-5.2	-4.7	-4.7	-4.7	-5.2	-8.8	-12.5
H16	-21.5	-21.5	-21.5	-17.8	-13.4	-10.1	-9.7	-9.6	-9.6	-9.9	-9.9	-9.9
H17	-20.2	-20.2	-20.2	-16.5	-12.1	-8.8	-8.4	-8.3	-8.3	-8.6	-8.6	-8.6
H18	-15.4	-15.4	-15.4	-11.5	-7.0	-3.7	-3.2	-3.2	-3.2	-3.8	-7.2	-10.9
H19	-16.4	-16.4	-16.4	-12.7	-8.3	-5.0	-4.6	-4.5	-4.5	-4.8	-4.8	-4.8
H20	-26.7	-26.7	-26.7	-22.9	-18.2	-14.4	-13.5	-13.7	-13.7	-15.9	-19.4	-22.9
H21	-22.9	-22.9	-22.9	-19.2	-14.9	-11.6	-11.0	-11.0	-11.0	-11.3	-11.3	-11.3
H22	-14.9	-14.9	-14.9	-11.1	-6.6	-3.3	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
H23	-14.1	-14.1	-14.1	-10.3	-5.9	-2.7	-2.3	-2.2	-5.6	-9.7	-9.7	-9.7
H24	-16.8	-16.8	-16.8	-13.0	-8.4	-4.8	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2
H25	-16.5	-16.5	-16.5	-12.7	-8.2	-4.6	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0
H26	-22.4	-22.4	-22.4	-18.6	-14.0	-10.1	-9.3	-9.4	-9.4	-9.4	-9.4	-9.4
H27	-17.1	-17.1	-17.1	-13.3	-8.8	-5.2	-4.6	-4.7	-4.7	-4.7	-4.7	-4.7
H28	-17.1	-17.1	-17.1	-13.3	-8.7	-5.2	-4.6	-4.7	-4.7	-4.7	-4.7	-4.7
H29	-14.5	-14.5	-14.5	-10.7	-6.3	-3.0	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
H30	-30.9	-30.9	-30.9	-27.2	-22.8	-19.4	-18.9	-18.9	-18.9	-20.7	-23.9	-27.2
H31	-30.8	-30.8	-30.8	-27.1	-22.6	-19.3	-18.8	-18.7	-18.7	-20.6	-23.8	-27.1
H32	-20.5	-20.5	-20.5	-16.8	-12.3	-8.9	-8.3	-8.3	-8.3	-8.3	-8.3	-8.3
H33	-30.6	-30.6	-30.6	-26.9	-22.5	-19.2	-18.6	-18.6	-18.6	-20.5	-23.6	-26.9
H34	-20.6	-20.6	-20.6	-16.8	-12.4	-8.9	-8.4	-8.4	-8.4	-8.4	-8.4	-8.4
H35	-20.4	-20.4	-20.4	-16.6	-12.1	-8.7	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2
H36	-19.0	-19.0	-19.0	-15.2	-10.8	-7.5	-7.1	-7.0	-7.0	-7.0	-7.0	-7.0
H37	-18.9	-18.9	-18.9	-15.2	-10.7	-7.5	-7.0	-7.0	-7.0	-7.0	-7.0	-7.0
H38	-22.0	-22.0	-22.0	-18.2	-13.8	-10.4	-9.9	-9.9	-9.9	-9.9	-9.9	-9.9
H39	-20.8	-20.8	-20.8	-17.1	-12.7	-9.4	-8.9	-8.8	-8.8	-8.8	-8.8	-8.8
H40	-20.2	-20.2	-20.2	-16.6	-12.2	-8.9	-8.3	-8.3	-10.7	-17.1	-17.1	-17.1
H41	-24.4	-24.4	-24.4	-20.8	-16.4	-13.1	-12.5	-12.4	-14.9	-21.3	-21.3	-21.3
H42	-24.6	-24.6	-24.6	-20.9	-16.6	-13.3	-12.7	-12.6	-15.0	-21.4	-21.4	-21.4
H43	-21.5	-21.5	-21.5	-17.9	-13.6	-10.2	-9.6	-9.5	-12.0	-18.4	-18.4	-18.4
H44	-21.6	-21.6	-21.6	-18.0	-13.6	-10.3	-9.7	-9.6	-12.0	-18.4	-18.4	-18.4
H45	-23.6	-23.6	-23.6	-20.0	-15.7	-12.4	-11.7	-11.7	-14.1	-20.5	-20.5	-20.5
H46	-23.8	-23.8	-23.8	-20.2	-15.8	-12.5	-11.9	-11.8	-14.2	-20.7	-20.7	-20.7
H47	-16.6	-16.6	-16.6	-12.8	-8.3	-4.8	-4.3	-4.3	-4.3	-4.8	-8.4	-12.1
H48	-28.9	-28.9	-28.9	-25.2	-20.6	-16.9	-16.2	-16.2	-16.2	-18.4	-21.8	-25.2

11.9.20 A noise management strategy can be implemented to reduce the predicted noise levels so that they meet the daytime noise limit. Such a strategy involves operating certain wind turbines in reduced noise mode under specific conditions. The available reduced noise modes for the Vestas V150 6MW machine, referenced to a 155m hub height and including a 2dB(A) allowance for measurement uncertainty, are outlined in Table 11.33.

Table 11.33 – Reduced Noise Modes for the Vestas V150 6MW Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	SO0	SO2	SO3	SO4	SO5	SO6
1	95.1	94.8	94.8	94.8	94.8	94.8
2	95.1	94.8	94.8	94.8	94.8	94.8
3	95.1	94.8	94.8	94.8	94.8	94.8
4	99.1	99.1	99.1	99.1	99.0	99.0
5	103.5	103.0	102.5	101.8	100.9	99.9
6	105.7	104.0	103.0	102.0	101.0	100.0
7	106.0	104.0	103.0	102.0	101.0	100.0
8	106.0	104.0	103.0	102.0	101.0	100.0
9	106.0	104.0	103.0	102.0	101.0	100.0
10	106.0	104.0	103.0	102.0	101.0	100.0
11	106.0	104.0	103.0	102.0	101.0	100.0
12	106.0	104.0	103.0	102.0	101.0	100.0

11.9.21 An example of a noise management strategy which would allow the daytime noise limit to be met is provided in Table 11.34. The strategy is only shown for standardised 10m wind speeds of 6-9ms^{-1} where the limit is predicted to be exceeded. The wind turbines would operate in their standard mode of operation ('M0') at all other wind speeds. There are many different combinations of wind turbines operating in different modes which would result in the limit being met and this is just one example to demonstrate the principle rather than being optimised from an energy capture perspective.

Table 11.34 – Daytime Noise Management Strategy

Wind Turbine ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})			
	6	7	8	9
T1	SO0	SO0	M0	M0
T2	SO2	SO2	SO2	M0
T3	SO0	SO0	M0	M0
T4	SO0	M0	M0	M0
T5	SO0	SO0	M0	M0
T6	SO2	SO0	M0	M0
T7	SO4	SO4	SO4	SO4
T8	SO3	SO4	SO3	SO3
T9	SO2	SO2	SO2	M0
T10	SO2	SO3	SO4	SO0
T11	SO0	SO0	M0	M0
T12	SO2	SO2	SO4	M0
T13	SO2	SO2	SO4	SO0
T14	SO2	SO2	SO0	M0
T15	SO2	SO2	M0	M0
T16	SO2	SO2	SO2	M0
T17	SO0	SO0	M0	M0
T18	SO2	SO3	SO3	M0
T19	SO2	SO2	M0	M0
T20	SO3	SO3	SO2	M0
T21	SO0	SO0	M0	M0

11.9.22 The predicted noise levels with the above noise management strategy in place are provided in Table 11.35. The margin between these mitigated predicted noise levels and the limit remaining for the proposed development during daytime periods is shown in Table 11.36 and there are no longer any exceedances.

Table 11.35: Mitigated Daytime Noise Levels, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	20.1	20.1	20.1	23.8	28.2	29.6	29.9	30.4	31.7	32.0	32.0	32.0
H2	20.8	20.8	20.8	24.6	29.0	30.1	30.3	30.6	32.3	32.7	32.7	32.7
H3	20.9	20.9	20.9	24.6	29.0	30.2	30.3	30.6	32.3	32.7	32.7	32.7
H4	20.3	20.3	20.3	24.0	28.4	29.9	30.2	30.7	31.9	32.2	32.2	32.2
H5	21.6	21.6	21.6	25.4	29.8	31.0	31.1	31.5	33.1	33.5	33.5	33.5
H6	21.8	21.8	21.8	25.6	30.0	31.1	31.2	31.4	33.2	33.6	33.6	33.6
H7	21.4	21.4	21.4	25.1	29.5	31.0	31.2	31.7	33.0	33.3	33.3	33.3
H8	19.0	19.0	19.0	22.6	27.0	28.7	29.1	29.7	30.6	30.9	30.9	30.9
H9	20.6	20.6	20.6	24.3	28.7	29.8	29.9	30.4	32.1	32.4	32.4	32.4
H10	19.9	19.9	19.9	23.7	28.1	29.2	29.3	29.8	31.4	31.8	31.8	31.8
H11	19.9	19.9	19.9	23.6	28.0	29.2	29.3	29.8	31.4	31.7	31.7	31.7
H12	19.8	19.8	19.8	23.5	27.9	29.0	29.1	29.7	31.3	31.6	31.6	31.6
H13	23.0	23.0	23.0	26.7	31.1	32.2	32.2	32.5	34.4	34.8	34.8	34.8
H14	25.9	25.9	25.9	29.7	34.1	35.2	35.3	35.5	37.4	37.8	37.8	37.8
H15	26.0	26.0	26.0	29.8	34.1	35.3	35.4	35.7	37.5	37.8	37.8	37.8
H16	21.5	21.5	21.5	25.2	29.6	30.7	30.8	31.4	33.0	33.3	33.3	33.3
H17	22.8	22.8	22.8	26.5	30.9	32.0	32.1	32.6	34.3	34.6	34.6	34.6
H18	27.6	27.6	27.6	31.4	35.8	36.8	36.8	36.8	39.0	39.4	39.4	39.4
H19	26.6	26.6	26.6	30.3	34.7	35.8	35.9	36.7	38.1	38.4	38.4	38.4
H20	16.2	16.2	16.2	19.9	24.3	26.0	26.5	27.2	27.8	28.1	28.1	28.1
H21	20.1	20.1	20.1	23.8	28.1	29.6	29.8	31.0	31.9	32.0	32.0	32.0
H22	30.1	30.1	30.1	33.8	38.2	39.2	39.9	40.6	41.0	41.9	41.9	41.9
H23	30.9	30.9	30.9	34.7	39.1	39.8	39.8	40.6	42.1	42.7	42.7	42.7
H24	26.1	26.1	26.1	29.8	34.2	35.8	36.4	37.1	37.5	38.0	38.0	38.0
H25	26.4	26.4	26.4	30.2	34.6	36.0	36.6	37.3	37.7	38.3	38.3	38.3
H26	20.5	20.5	20.5	24.2	28.6	30.3	30.8	31.5	32.1	32.3	32.3	32.3
H27	25.8	25.8	25.8	29.6	34.0	35.2	35.8	36.5	37.0	37.7	37.7	37.7
H28	25.9	25.9	25.9	29.6	34.0	35.3	35.8	36.5	37.1	37.7	37.7	37.7
H29	28.5	28.5	28.5	32.2	36.6	37.3	37.3	38.1	39.5	40.3	40.3	40.3
H30	12.1	12.1	12.1	15.8	20.2	21.7	22.2	22.9	23.6	24.0	24.0	24.0
H31	12.2	12.2	12.2	15.9	20.3	21.9	22.4	23.1	23.8	24.1	24.1	24.1
H32	22.4	22.4	22.4	26.2	30.6	31.9	32.3	33.1	33.7	34.3	34.3	34.3
H33	12.4	12.4	12.4	16.1	20.4	22.1	22.5	23.3	23.9	24.2	24.2	24.2
H34	22.4	22.4	22.4	26.1	30.5	31.8	32.3	33.0	33.7	34.2	34.2	34.2
H35	22.6	22.6	22.6	26.3	30.7	32.0	32.4	33.2	33.9	34.5	34.5	34.5
H36	24.0	24.0	24.0	27.8	32.2	33.0	33.2	34.0	35.1	35.9	35.9	35.9
H37	24.1	24.1	24.1	27.8	32.2	33.1	33.3	34.1	35.1	35.9	35.9	35.9

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H38	21.0	21.0	21.0	24.7	29.1	30.4	30.8	31.6	32.3	32.9	32.9	32.9
H39	22.2	22.2	22.2	25.9	30.3	31.3	31.6	32.5	33.4	34.0	34.0	34.0
H40	22.7	22.7	22.7	26.4	30.8	32.0	32.0	33.1	34.4	34.7	34.7	34.7
H41	18.6	18.6	18.6	22.2	26.6	28.0	28.1	29.3	30.4	30.5	30.5	30.5
H42	18.4	18.4	18.4	22.1	26.4	27.9	28.0	29.1	30.2	30.4	30.4	30.4
H43	21.5	21.5	21.5	25.1	29.4	30.8	30.8	31.9	33.3	33.4	33.4	33.4
H44	21.4	21.4	21.4	25.0	29.4	30.7	30.7	31.9	33.2	33.4	33.4	33.4
H45	19.3	19.3	19.3	23.0	27.3	28.6	28.6	29.7	31.2	31.3	31.3	31.3
H46	19.2	19.2	19.2	22.8	27.1	28.4	28.5	29.6	31.0	31.1	31.1	31.1
H47	26.4	26.4	26.4	30.1	34.5	35.7	35.8	36.0	37.8	38.2	38.2	38.2
H48	14.0	14.0	14.0	17.7	22.1	23.8	24.2	24.9	25.5	25.8	25.8	25.8

Table 11.36: Comparison of Mitigated Daytime Noise Levels with Limits, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-17.4	-17.4	-17.4	-13.7	-9.3	-7.9	-7.6	-8.5	-8.7	-11.6	-14.9	-14.9
H2	-16.7	-16.7	-16.7	-12.9	-8.5	-7.4	-7.2	-6.9	-7.2	-9.3	-12.3	-12.3
H3	-16.6	-16.6	-16.6	-12.9	-8.5	-7.3	-7.2	-6.9	-7.2	-9.3	-12.3	-12.3
H4	-17.2	-17.2	-17.2	-13.5	-9.1	-7.6	-7.3	-8.2	-8.3	-11.3	-14.6	-14.6
H5	-15.9	-15.9	-15.9	-12.1	-7.7	-6.5	-6.4	-6.0	-6.2	-8.3	-11.4	-11.4
H6	-15.7	-15.7	-15.7	-11.9	-7.5	-6.4	-6.3	-6.1	-6.3	-8.3	-11.3	-11.3
H7	-16.1	-16.1	-16.1	-12.4	-8.0	-6.5	-6.3	-7.2	-7.3	-10.2	-13.5	-13.5
H8	-18.5	-18.5	-18.5	-14.9	-10.2	-7.7	-7.3	-3.8	-2.6	-10.6	-15.1	-15.1
H9	-16.9	-16.9	-16.9	-13.2	-8.8	-8.5	-10.6	-12.7	-14.1	-16.9	-20.5	-24.2
H10	-17.6	-17.6	-17.6	-13.8	-9.4	-9.1	-11.2	-13.3	-14.7	-17.6	-21.1	-24.8
H11	-17.6	-17.6	-17.6	-13.9	-9.5	-9.1	-11.3	-13.3	-14.8	-17.6	-21.2	-24.9
H12	-17.7	-17.7	-17.7	-14.0	-9.6	-9.3	-11.4	-13.5	-14.9	-17.8	-21.3	-25.0
H13	-14.5	-14.5	-14.5	-10.8	-6.4	-6.1	-8.3	-10.7	-11.8	-14.6	-18.1	-21.8
H14	-11.6	-11.6	-11.6	-7.8	-3.4	-2.3	-2.2	-2.0	-1.8	-4.0	-7.1	-7.1
H15	-11.5	-11.5	-11.5	-7.7	-3.4	-2.2	-2.1	-1.8	-1.5	-3.8	-7.0	-7.0
H16	-16.0	-16.0	-16.0	-12.3	-7.9	-7.6	-9.7	-11.8	-13.2	-16.1	-19.6	-23.3
H17	-14.7	-14.7	-14.7	-11.0	-6.6	-6.3	-8.5	-10.5	-11.9	-14.8	-18.3	-22.0
H18	-9.9	-9.9	-9.9	-6.1	-1.7	-0.7	-0.7	-0.7	-0.2	-2.3	-5.5	-5.5
H19	-10.9	-10.9	-10.9	-7.2	-2.8	-2.5	-4.7	-6.5	-8.1	-11.0	-14.5	-18.2
H20	-21.3	-21.3	-21.3	-17.6	-13.2	-11.5	-11.0	-11.1	-10.3	-13.8	-17.1	-17.1
H21	-17.4	-17.4	-17.4	-13.7	-9.4	-8.7	-10.8	-12.2	-14.3	-17.4	-20.9	-24.6
H22	-14.9	-14.9	-14.9	-11.1	-6.6	-5.7	-5.0	-4.2	-3.7	-2.8	-2.8	-2.8
H23	-14.1	-14.1	-14.1	-10.3	-5.9	-5.2	-7.5	-9.4	-10.8	-13.1	-16.0	-18.8
H24	-11.4	-11.4	-11.4	-7.7	-3.3	-1.7	-1.2	-1.7	-1.2	-3.1	-3.1	-3.1
H25	-11.1	-11.1	-11.1	-7.3	-2.9	-1.5	-1.0	-1.6	-1.3	-3.0	-3.0	-3.0
H26	-17.0	-17.0	-17.0	-13.3	-8.9	-7.2	-6.8	-6.8	-5.8	-8.2	-8.2	-8.2
H27	-11.7	-11.7	-11.7	-7.9	-3.5	-2.3	-1.8	-2.4	-2.1	-3.6	-3.6	-3.6
H28	-11.6	-11.6	-11.6	-7.9	-3.5	-2.2	-1.8	-2.4	-2.1	-3.6	-3.6	-3.6
H29	-9.0	-9.0	-9.0	-5.3	-0.9	-0.2	-0.3	-0.8	-0.6	-1.6	-1.6	-1.6
H30	-25.4	-25.4	-25.4	-21.7	-17.3	-15.8	-15.3	-15.6	-16.7	-19.0	-21.8	-21.8
H31	-25.3	-25.3	-25.3	-21.6	-17.2	-15.6	-15.1	-15.4	-16.5	-18.8	-21.6	-21.6
H32	-15.1	-15.1	-15.1	-11.3	-6.9	-5.6	-5.3	-5.8	-5.9	-7.3	-7.3	-7.3
H33	-25.1	-25.1	-25.1	-21.4	-17.1	-15.4	-15.0	-15.2	-16.4	-18.7	-21.5	-21.5
H34	-15.1	-15.1	-15.1	-11.4	-7.0	-5.7	-5.3	-5.9	-6.0	-7.4	-7.4	-7.4
H35	-14.9	-14.9	-14.9	-11.2	-6.8	-5.5	-5.2	-5.7	-5.8	-7.2	-7.2	-7.2
H36	-13.5	-13.5	-13.5	-9.7	-5.3	-4.5	-4.4	-4.9	-5.1	-6.1	-6.1	-6.1
H37	-13.4	-13.4	-13.4	-9.7	-5.3	-4.4	-4.3	-4.8	-5.1	-6.0	-6.0	-6.0
H38	-16.5	-16.5	-16.5	-12.8	-8.4	-7.1	-6.8	-7.3	-7.6	-8.9	-8.9	-8.9
H39	-15.3	-15.3	-15.3	-11.6	-7.2	-6.2	-6.0	-6.4	-6.7	-7.9	-7.9	-7.9
H40	-14.8	-14.8	-14.8	-11.1	-6.7	-6.0	-10.0	-13.4	-16.6	-20.6	-24.6	-28.1
H41	-18.9	-18.9	-18.9	-15.3	-10.9	-10.0	-13.9	-17.2	-20.6	-24.8	-28.8	-32.3
H42	-19.1	-19.1	-19.1	-15.4	-11.1	-10.1	-14.1	-17.4	-20.8	-24.9	-28.9	-32.4
H43	-16.0	-16.0	-16.0	-12.4	-8.1	-7.2	-11.3	-14.6	-17.7	-21.9	-25.9	-29.4
H44	-16.1	-16.1	-16.1	-12.5	-8.1	-7.3	-11.3	-14.6	-17.8	-21.9	-25.9	-29.4
H45	-18.2	-18.2	-18.2	-14.5	-10.2	-9.4	-13.4	-16.7	-19.8	-24.0	-28.0	-31.5
H46	-18.3	-18.3	-18.3	-14.7	-10.4	-9.6	-13.6	-16.9	-20.0	-24.2	-28.2	-31.7
H47	-11.1	-11.1	-11.1	-7.4	-3.0	-1.8	-1.7	-1.5	-1.1	-3.4	-6.6	-6.6
H48	-23.6	-23.6	-23.7	-19.9	-16.0	-13.7	-13.3	-13.6	-13.3	-16.4	-19.5	-19.5

11.9.23 The presented noise management strategy is designed such that the limit would be met assuming the properties in question are downwind of the proposed development at all times. The amount of noise management required is likely to reduce for certain wind directions should an assessment considering the attenuation applicable when properties are located crosswind or upwind of the proposed development be undertaken.

11.9.24 Figure 11.2 shows a cumulative noise contour plot for the proposed development and the other projects considered in the cumulative assessment calculated using the ISO 9613 Part 2 propagation model. The plot is provided to illustrate the cumulative noise 'footprint' and should be considered indicative only. Where properties are located such that they cannot be downwind of all wind turbines simultaneously, the predictions made using a downwind propagation model such as ISO 9613-2 are conservative given that reductions in noise would be expected when a property is crosswind or upwind of a noise source. The footprint shows the proposed development without noise management and with no scaling applied to the predicted noise levels for the other sites considered.

11.10 Summary

11.10.1 The acoustic impact for the operation of the proposed development on nearby residential properties has been assessed in accordance with the guidance on wind farm noise as issued in the DTI publication 'The Assessment and Rating of Noise from Wind Farms', otherwise known as ETSU-R-97, and Institute of Acoustics Good Practice Guide (IoA GPG), as recommended for use by relevant planning policy.

11.10.2 To establish baseline conditions, background noise surveys were carried out at seven nearby properties and the measured background noise levels used to determine appropriate noise limits, as specified by ETSU-R-97 and the IoA GPG.

11.10.3 Operational noise levels were predicted using the recommended noise propagation model. The limit remaining for the proposed development was determined by subtracting the predicted noise levels due to the existing Solwaybank Wind Farm from the total noise limit. The predicted noise levels for the proposed development are within the derived noise limits at all considered wind speeds assuming an appropriate noise management strategy in place. The proposed development therefore complies with the relevant guidance on wind farm noise and the impact on the amenity of all nearby residential properties would be regarded as acceptable.

11.10.4 A construction noise assessment carried out in accordance with BS 5228-1:2009 "Noise control on construction and open sites Part 1 Noise" found that construction noise levels are predicted to temporarily exceed construction noise criteria at nearby properties although appropriate mitigation measures have been identified.

11.10.5 Vibration and air overpressure due to blasting are not expected to have a significant impact on nearby residents should the mitigation measures described within the chapter be adopted.

11.10.6 The potential impact of the proposed development, along with the mitigation proposed and any residual impact, is summarised in Table 11.37.

Table 11.37: Summary of Potential Impacts, Mitigation and Residual Impacts

Potential Impact	Mitigation Proposed	Means of Implementation	Outcome/ Residual Impact
Construction			
Potential for noise and vibration to be created during general construction activities and by construction traffic	Due regard for 'best practicable means' (defined by Section 72 of the Control of Pollution Act 1974). A range of noise mitigation measures are proposed for the construction phase in accordance with measures outlined in BS 5228-1:2009. Site operations to be limited to 0700-1900 Monday to Saturday (except during wind turbine delivery/erection and commissioning/periods of emergency work). Good practice on blasting shall be followed along with guidance on blast frequency and timing.	Noise mitigation measures would be implemented as part of the Construction and Environmental Management Plan which would be required to be agreed as a condition of consent.	Not significant
Operation			
Potential impact on residential amenity due to operational noise	Impact is deemed to be acceptable as proposed development meets noise limits specified by relevant guidance both alone and in the cumulative scenario with an appropriate noise management strategy in place. No additional mitigation measures are required due to absence of identified significant effect.	Not applicable	Not significant
Decommissioning			
Potential noise from proposed development decommissioning activities	General best practice measures of reducing noise, employed during the construction phase, would be adopted as precaution.	A Decommissioning and Restoration Plan would be submitted for approval no later than twelve months prior to the final decommissioning of the proposed development.	Not significant

Glossary

Word	Definition
A-weighting	A frequency-response function providing good correlation with the sensitivity of the human ear.
Broadband Noise	Noise which covers a wide range of frequencies (see Frequency).
Decibel dB(A)	The decibel (dB) is a logarithmic unit used in acoustics to quantify sound levels relative to a 0dB reference (e.g. a sound pressure level of $2*10^{-5}$ Pa). The 'A' signifies A-weighting.
Equivalent Continuous Sound Level (L_{eq})	The equivalent continuous sound level is a notional steady noise level, which over a given time would provide the same energy as the intermittent noise.
Frequency	Refers to how quickly the air vibrates, or how close the sound waves are to each other and is measured in cycles per second, or Hertz (Hz). The lowest frequency audible to humans is 20Hz and the highest is 20,000Hz. The human ear is most sensitive to the 1kHz, 2kHz and 4kHz octave bands and much less sensitive at lower audible frequencies.
Frequency Spectrum	Description of the sound pressure level of a source as a function of frequency.
Percentile Sound Level (L_{90})	Sound pressure level exceeded for 90% of the time for any given time interval. For example, $L_{(A)90,10min}$ means the A-weighted level that is exceeded for 90% of a ten-minute interval. This indicates the noise levels during quieter periods, or the background noise level. It represents the lower estimate of the prevailing noise level and is useful for excluding such effects as aircraft or dogs barking on background noise levels.
Noise Emission	The noise energy emitted by a source (e.g. a wind turbine).
Noise Immission	The sound pressure level detected at a given location (e.g. nearest dwelling).
Octave Band	Range of frequencies between one frequency ($f_0*2^{-1/2}$) and a second frequency ($f_0*2^{+1/2}$). The quoted centre frequency of the octave band is f_0.
Sound Power Level	Sound power level is the acoustic power radiated from a sound source and is independent of the surroundings. It is a logarithmic measure in comparison to a reference level (10^{-12} watts).
Sound Pressure Level	A logarithmic measure of the effective sound pressure of a sound relative to a reference value which is for minimum audible field conditions ($20*10^{-6}$Pa).
Third Octave Band	The range of frequencies between one frequency ($f_0*2^{-1/6}$) and a second frequency equal to ($f_0*2^{+1/6}$). The quoted centre frequency of the third octave band is f_0.
Tonal Noise	A noise that contains a noticeable or discrete, continuous note and includes noises such as hums, hisses, screeches.