11 NOISE AND VIBRATION

11.1 INTRODUCTION

This chapter of the EIAR assesses the effects of the Development from noise impacts. The Development refers to all elements of the application for the proposed Wind Farm (**Chapter 2: Project Description**). The assessment considers the potential effects during the following phases of the Development:

- Construction of the Development
- Operation of the Development
- Decommissioning of the Development

Any effects arising as a result of the future decommissioning of the Development, are considered to be no greater than the effects arising during construction.

Common acronyms used throughout this EIAR can be found in **Appendix 1.2**. This chapter of the EIAR is supported by the Figures in Volume III and the following Appendices documents provided in Volume IV of this EIAR:

- **Appendix 11.1: Photos of noise monitors in-situ**
- **Appendix 11.2: Methodology for calculating wind shear, different hub heights and standardising hub height wind speed**
- **Appendix 11.3: Calibration certificates of noise instruments**
- **Appendix 11.4: Candidate turbine manufacturer's noise emission data**
- **Appendix 11.5: Predicted noise levels for 102.5m hub height**

11.1.1 Statement of Authority

This section of the EIAR has been prepared by Brendan O'Reilly of Noise and Vibration Consultants Ltd and Shane Carr of Irwin Carr Ltd. Brendan has a Master's degree in noise and vibration from Liverpool University and over 40 years' experience in noise and vibration control (many years' experience in preparation of noise impact statements) and have been a member of a number of professional organisations including the SFA, ISEE and IMQS. Brendan was a co-author and project partner (as a senior noise consultant) in 'Environmental Quality Objectives, Noise in Quiet Areas' administered by the EPA. Brendan has considerable experience in the assessment of noise impact and has compiled studies for more than 100 wind farm developments. Brendan carried out the baseline study and contributed to the report.

Irwin Carr Consulting is based in Northern Ireland. The company has a proven track record in noise impact assessments throughout the UK and Ireland, with extensive knowledge of the issues in relation to noise from wind energy developments.

Shane Carr carried out the noise modelling in this assessment and contributed to the report. Shane is a Director in Irwin Carr Consulting, primarily responsible for environmental noise and noise modelling. He has over 22 years' experience working in both the public and private sectors having previously obtained a BSc (Hons) Degree in Environmental Health and a Post-Graduate Diploma in Acoustics. Shane has been responsible for undertaking and reviewing noise impact assessments on numerous large scale wind farms throughout the UK and Ireland.

11.1.2 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria – a description of the methods used in baseline surveys and in the assessment of the significance of effects
- Baseline Description - a description of the noise baseline of the receiving environment based on the results of surveys, desk information and consultations, and a summary of any information required for the assessment that could not be obtained
- Assessment of Potential Effects - identifying the ways in which noise receptors could be affected by the Development, including a summary of the measures taken during design of the Development to minimise noise effects
- Mitigation Measures and Residual Effects - a description of measures recommended to off-set potential negative effects and a summary of the significance of the effects of the Development after mitigation measures have been implemented
- Cumulative Effects – identifying the potential for effects of the Development to combine with those from other wind farm developments
- Summary of Significant Effects
- Statement of Significance

11.1.3 Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment, is transitory, fluctuates, and is normally localised. Environmental noise is normally assessed in terms of A-weighted decibels, dB (A), when the 'A weighted' filter in the measuring device elicits a response which provides a good correlation with the human ear. The criteria for environmental noise control are of annoyance or nuisance rather than damage. In general, a noise level is liable to provoke a complaint whenever its level exceeds by a certain margin, the pre-existing noise level or when it attains an absolute level. A change in noise level of 3dB (A) is 'barely perceptible', while an increase in noise level of 10dB (A) is perceived as a twofold increase in loudness. A noise level in excess of 85dB (A) gives a significant risk of hearing damage. Construction and industrial noise sources are normally assessed and expressed using equivalent continuous levels, LAeq[1]. Wind turbine source noise is generally expressed in Leq dBA and in sound power levels (LWA).

Operational wind turbine noise is assessed using the LA90[2] descriptor, which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources. The LA90 should be used for assessing both the wind energy development noise and background noise. As discussed in ETSU-R-97[3] the LA90 is 1.5-2.5dBA less than the LAeq measured over the same period. In this assessment, the difference between LAeq and LA90 is assumed to be 2dBA, which is standard industry practice applied in wind farm assessments in Ireland. Wind turbine noise levels are given as sound power levels (LWA) in dB at integer wind speeds up to maximum LWA levels which are reached at between 5 to 9m/s wind speed at 10m height depending on turbine type chosen. The larger turbines reach maximum sound power level output at lower wind speeds. **Table 11.1** gives a comparison of noise levels in our everyday environment.

Table 11.1: Comparison of sound pressure level in our Environment[4]

Source/Activity	Indicative noise level dBA
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm at 350m	**35-45**
Busy road at 5km	35-45
Car at 65km/hr at 100m	55
Busy general office	60
Conversation	60

[1] L_{Aeq} is defined as being the A-weighted equivalent continuous steady sound level that has the same sound energy as the real fluctuating sound during the sample period and effectively represents a type of average value.
[2] LA90, or L90dBA is defined as the noise level equaled or exceeded for 90% of the measurement interval and with wind farm noise the interval used is 10 minutes.
[3] ETSU-R-97, The Assessment & Rating of Noise from Wind Farms, June 1996
[4] Fact sheet published by the Australian Government (Greenhouse Office) and the Australian Wind Energy Association

Source/Activity	Indicative noise level dBA
Truck at 50km/hr at 100m	65
Inside a typical shopping centre	70-75
Inside a modern car at around 90km/hr	75-80
Passenger cabin of jet aircraft	85
City Traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

11.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

11.2.1 Assessment Methodology

This assessment has involved the following elements, further details of which are provided in the following sections:

- Legislation and guidance review
- Desktop study, including review of available maps and published information
- Site walkover
- Evaluation of potential effects
- Evaluation of the significance of these effects
- Identification of measures to avoid and mitigate potential effects

11.2.2 Description of Effects

The significance of effects of the proposed development is described in accordance with the EPA guidance document '*Guidelines on the information to be contained in the Environmental Impact Assessment Reports (EIAR), EPA May 2022'*. The details of the methodology for describing the significance of effects are provided in Table 3.4: Section 3.7.3 of the aforementioned EPA 2022 document.

11.2.3 Relevant Legislation and Guidance

The noise assessment is carried out in accordance with the guidance and consideration of the following documents, with references given where relevant in the various Sections of the report:

- Wind Energy Development Guidelines[5] (the 2006 Guidelines)

[5] Department of Environment, Heritage and Local Government: Wind Energy Development Guidelines, Guidelines for Planning Authorities 2006 Energy

- ETSU-R-97[6]: The Assessment & Rating of Noise from Wind Farms (ETSU-R-97)
- Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including Supplementary Guidance Note 4: Wind Shear'[7] (the IOA Good Practice Guide)
- ISO 1996[8]Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures (ISO 1996)
- WHO 2018 Environmental Noise Guidelines for European Region (WHO 2018)
- Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG, 2019)
- National Roads Authority (NRA) Guidelines for Treatment of Noise and Vibration in National Road Schemes, 2004.

11.2.3.1 Wind Energy Development Guidelines 2006

The following are a number of key extracts from the 2006 Guidelines in relation to noise impact:

General Noise Impact

"*Noise impact should be assessed by reference to the nature and character of noise sensitive locations*."

"*Separate noise limits should apply for day-time and for night-time*".

"Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

Measurement Units

"The descriptor [LA90 10min] which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources, should be used for assessing both wind energy development noise and background noise."

Specific Noise Limits

"In general, a lower fixed limit of 45dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours.

However, in very quiet areas, the use of the margin of 5dB(A) above the background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection

[6] ETSU-R-97: Acoustics-The Assessment & Rating of Noise from Wind Farms: ETSU for the DTI, UK, 1996
[7] Institute of Acoustics (2013) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise
[8] ISO 1996/1- Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures

and may unduly restrict wind energy developments. Instead in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of LA90,10min of the wind energy development noise should be limited to an absolute level within the range 35-40dB(A)".

"During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) L90,10min will protect sleep inside properties during the night".

The 2006 Guidelines do not specify daytime or night-time hours. However, it is considered good practice to follow the framework given in ETSU-R-97 and IOA Good Practice Guide where daytime and night-time hours are specified. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ETSU-R-97 as:

- Quiet waking hours or quiet day-time periods are defined as:
- All evenings from 18:00 to 23:00hrs
- Saturday afternoon from 13:00 to 18:00hrs and all-day Sunday 07:00 to 18:00hrs
- Night-time is defined as 23:00 to 07:00hrs

11.2.3.2 WHO 2018

The most recent WHO 2018 Guidelines: 'Environmental Noise Guidelines for the European Region' gives a conditional recommendation requiring substantial debate with a limit of 45 dB Lden which is based on low quality evidence. This is an annual average noise level, based on wind speed and direction in the vicinity of the site with no specific limits for night.

11.2.3.3 DRWEDG 2019

Draft Revised Wind Energy Development December 2019 (DRWEDG 2019)

There have been a number of draft guidelines over the years with the latest one being the *Draft Revised Wind Energy Guidelines December 2019.* These guidelines, currently in draft format are subject to significant public and stakeholder consultation and liable to change. In line with best practice, this assessment is based on the current guidance outlined in Section 11.2.2..

11.2.4 Desktop Study

The Study Area has been defined such that the predicted noise results have been included for all the residential receptors within 2km of the wind farm. Where the noise levels meet the relevant noise limits at the nearest locations, it will also meet the relevant noise limits at more distant residential locations. On this basis five locations for noise monitoring were selected by inspection of site maps and by identifying the nearest receptors surrounding the wind turbines. The validation of selected locations was made with a visit to the Noise Study

Area. The five locations selected are considered representative of the local noise environment and are as shown in **Figure 11.1**.

11.2.5 Acquisition and Analysis of Background Noise Data

The 2006 Guidelines, ETSU-R-97 and the IOA Good Practice Guide recommend the measurement and use of wind speed data, against which background noise measurements are correlated. The IOA Good Practice Guide Supplementary Guidance Note 4[9] (**Appendix 11.2**) gives the methodology to account for wind shear, calculation to hub height and to standardise 10m height wind speed.

A Meteorological Mast (Met Mast) located within the Site during the noise survey was used for wind data measurements at heights of 80m and 61m with wind shear derived and used to calculate the hub height wind speed of 110.5m.

The 110.5m hub height wind speed was then standardised to 10m height wind speed with the wind speed plotted against the 10minute background noise data to derive a best fit polynomial curve.

The proposed turbine has a range of hub heights between 102.5m and 110.5m. A variation in hub height will not change the maximum sound power level of a turbine. The higher turbine hub height (110.5m) gives marginally higher noise levels at the lower wind speeds of 3 and 4m/s and thus lower hub heights will generate marginally lower noise levels. It should be noted that the marginally higher noise levels of 0.8dBA and 0.7dBA respectively at the 110.5m hub height will have a negligible effect on predicted noise levels.

11.2.6 Prediction of Wind Turbine Noise Levels

The predicted noise levels are based on the methodology given in the IOA Good Practice Guide. Noise level calculations are based on ISO 9613-2[10] which provides a prediction of noise levels likely to occur under worst-case down-wind conditions.

SoundPLAN version 8.2 software package, produced by Braunstein & Berndt GmbH was used to calculate the noise level at the receptors. The propagation model calculates the predicted sound pressure levels by taking the source sound power level for each turbine in their

[9] IOA, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise- Supplementary Guidance Note 4: Wind Shear

[10] ISO 9613-2 Acoustics -Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation

respective octave bands and subtracting a number of attenuation factors according to the following formula:

Predicted Octave Band Noise level = LW +D – (A_{geo} +A_{atm} +A_{gr} + A_{br} +A_{mis})

The predicted octaves from each of the turbines are summed to give the predicted noise level expressed as dBA.

It is not necessary to make an allowance for the character of noise emitted by the turbines as is normal practice for most sound sources, however in general the emissions from wind turbines are broadband in nature. In the unlikely event of a turbine exhibiting clearly tonal components as a result of a turbine malfunction at any receptor, the turbine would be turned down or stopped until such tonality is ameliorated. A guarantee will also be sought in the procurements of the turbine to be used in the Development, stating that there should be no clearly tonal or impulsive components audible at any noise sensitive receptor location.

A_{geo} –Geometric Spreading

Geometric (spherical) spreading from a simple free-field point source result in attenuation over distance according to:

Lp = Lw – (20 log R + 11)

Where:

Lp = sound pressure level

Lw = sound power level

R = distance from the turbine to receiver

D – Directivity Factor

The sound power levels are predicted as worstcase propagation conditions, i.e. all receptors are assumed to be in downwind conditions.

A_{gr} - Ground Effects

Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from the turbine to receiver. The prediction of ground effects is complex and depends on the source height, receiver height, propagation height between the source and receiver and the intervening ground conditions.

Ground conditions are described according to a variable defined as G, which varies between 0 for hard ground and 1 for soft ground. Although in reality the ground is predominately porous, it has been modelled as mixed 50% hard and 50% porous corresponding to a ground absorption coefficient of 0.5. Our predictions have been carried out using a source height corresponding to the proposed height of the turbine nacelle, a receiver height of 4m and an assumed ground factor of G=0.5 as recommended in the IOA Good Practice Guide. Using a receiver height of 4m equates to first floor height resulting in a higher predicted noise level.

A_{bar}- Barrier Attenuation

The effect of a barrier (including a natural barrier) between a noise source and receptor is that noise will be reduced according to the path difference (difference between the direct distance between source to receptor and distance between source and receptor over the barrier). The reduction is relative to the frequency spectrum of the sound and may be predicted according to the method given in ISO 9613. In practice, barriers can become less effective in downwind conditions. A barrier can be very effective when it lies within a few metres of the receptor. In the prediction model, zero attenuation is given for barrier effects, which is a worst-case scenario setting.

A_{atm} - Atmospheric Absorption

Sound energy through the atmosphere is attenuated by conversion of sound energy to heat. This energy is dependent on the temperature and relative humidity of the air, but only weakly on ambient pressure through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. The attenuation by atmospheric absorption A_{atm} in decibels during propagation through distance in metres is given by:

$A_{atm} = d \times \alpha$,

α = atmospheric absorption coefficient in dBm^{-1}

d = distance from turbine

Values of α from ISO 9613 Part 1, corresponding to a temperature of 10^0C and a relative humidity of 70% has been used for these predictions and are given in **Table 11.2** below. These values are recommended in the IOA Good Practice Guide.

Table 11.2: Frequency dependent atmospheric attenuation coefficients (dB/m)

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.0001	0.0004	0.001	0.0019	0.0037	0.0097	0.0328	0.117

A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

The ISO 9613-2 standard calculates under downwind propagation conditions and therefore predicts the average downwind sound pressure level at each dwelling. The model assumes that the wind is directly downwind from each turbine to each dwelling at the same time. The prediction model is thus calculated as a worst-case scenario.

11.2.7 Aerodynamic Modulation or Aerodynamic Noise

Aerodynamic noise originates from the flow of air over, under and around the blades and is generally broadband in character. It is directly linked to the movement of the rotors through the air and will occur to varying degrees whenever the turbine blades move. Aerodynamic noise is generally both broadband i.e., it does not contain a distinguishable note or tone, and of random character, although the level is not constant and fluctuates in time with the movement of the blades. The dominant character of such aerodynamic noise is therefore normally a 'swish' type of sound, which is familiar to most people who have stood near to a large wind turbine.

The sound level of aerodynamic noise from wind turbine blades is not completely steady, but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called "*blade swish*", typically occurring in step with the angle of rotation of the blades and so being periodic at the rotor's rotational speed – for typical commercial turbines, this is at a rate of around once or twice per second. This phenomenon is known as Amplitude Modulation of Aerodynamic Noise or more succinctly by the acronym AM.

In early wind turbine designs, where the rotor was positioned downwind of the tower, a pronounced 'beat' was audible as each blade passed through the turbulent wake shed from the tower. However, this effect does not exist for the upwind rotor designs found on the majority of modern wind farms including the proposed wind farm where the air flow to the blades is not interrupted by the tower structure. Instead, it seems that aerodynamic modulation is due to fluctuation of the primary mechanisms of aerodynamic noise generation i.e.. the blade swish mentioned above.

The Temple Group[11] undertook a review of Renewable UK's Research into Amplitude Modulation and concluded the following:

"*The distinction between normal AM i.e., blade swish (NAM) and other AM (OAM) is important as they are caused by different mechanisms and have separate impacts. Normal AM (NAM) is a commonly occurring typical characteristic of wind turbine noise that occurs persistently for long periods. NAM or "swish" usually disappears at around 3 to 4 rotor lengths from the turbines, except in crosswind conditions."*

Based on the evidence available, it was recognised that even at those wind farm sites where OAM has been reported to be an issue, its occurrence may be relatively infrequent.

The study reports that the occurrence and intensity of OAM is dependent on a number of interacting factors that are specific to a location and it is not feasible to reliably predict the occurrence of OAM at another location simply by cross checking whether similar conditions that arise at a location where OAM has occurred might arise at the new location.

Normal Amplitude Modulation (NAM) is a fundamental component of wind turbine noise and can be heard in proximity to virtually all wind turbine installations. The 2007[12] Salford University Report found instances of "enhanced" AM which occurred at larger distances, but relatively infrequently and at only a small minority of sites. These characteristics are consistent with and can be explained by OAM.

As described previously, many risk factors have been considered for OAM. However, no single item or specific combination of items have been found to be the controlling factors whereby the occurrence, duration and intensity of OAM at a particular location can be reliably predicted in advance of a wind turbine or wind farm being installed. In the very unlikely event that OAM arises then appropriate mitigation measures will be put in place,

Salford University in 2007, found that out of 133 operational wind farms investigated, 27 were associated with noise complaints, but OAM was considered to be a factor in noise complaints at only four sites and a possible factor in a further eight locations. The research has shown that OAM is a rare and unlikely occurrence at operational wind farms.

[11] Report for Renewable UK by Temple Group (Dani Fliumicelli). *Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines*, Wind Turbine Amplitude Modulation: *Research to Improve Understanding as to the cause and Effec*t, Dec'2013.

[12] Research into Aerodynamic Modulation of Wind Turbine Noise. Report by University of Salford

11.2.8 Low Frequency Noise and Vibration

There is always low frequency (or infrasound) noise present in the ambient quiet background. It is generated by natural sources such as distant road traffic, wind effects through air and vegetation, wave motion, water flow in streams and rivers. There are also low frequency emissions from many sources found in modern life, such as household appliances (e.g. washing machines, air conditioners, fridges, heating systems, extraction systems, electric or battery clocks), water flowing through pipes within the home and in water flow from municipal water supply. Vibration of elements of structures (low frequency) is generated in one's home by way of normal routine activity, like climbing stairs and closing doors, etc. The frequency range of audible noise is in the range of 20 to 20,000Hz and low frequency noise is generally from about 2 to 200Hz with infrasound being the term for low frequency noise typically of frequencies below 20Hz. There appears to be little or no agreement about the biological effects of low frequency noise on human health and there is strong evidence to suggest that there are no serious consequences to people's health from infrasound exposure.

A study of low frequency noise (infrasound) and vibration around a modern wind farm was carried out for ETSU and reported in ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'[13]. The results showed levels of infrasound to be below accepted thresholds of perception even on the site. Furthermore, a document prepared for the World Health Organisation, states that *'there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects'.*

Significant research carried out on low frequency noise has been in the area of blasting (air overpressure) which falls into a very low frequency range (2-20Hz), although with a considerably higher magnitude – typically in a range of 110-125dB. Interestingly most microphones recording air-overpressure (low frequency sound) is linear down to 2Hz with a range that does not go below 88dB, as below that value trigger will occur by relatively low wind speeds (a gust of wind at 9m/s equates to an air overpressure of 133dB). Wind in the natural environment, along with streams and rivers, generates elevated levels of low frequency (infrasound) yet nobody complains from about these sources being the cause of sickness. Low frequency sound is generated from wind effects on vegetation close to receptors in the wind speed range that turbines operate in, yet nobody complains about wind (or rivers or streams) being the cause of sickness.

[13] ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'.

South Australian Environment Protection Authority (EPA) Infrasound Study

A report released in January 2013 by the South Australian EPA[14] found that the level of infrasound from wind turbines is insignificant and no different to any other sources of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people. The study included several houses in rural and urban areas, houses both adjacent to a wind farm, away from turbines and measured the levels of infrasound with the wind farms operating and also switched off. There were no noticeable differences in the level of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building. The South Australian study found: '*the contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment'*.

Massachusetts Institute of Technology (MIT)

A report by an Independent Expert Panel prepared for Massachusetts Department of Health (2012)[15] which consisted of a panel that included seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering, all considered independent experts from academic institutions. The report found that *'there is insufficient evidence that the noise from wind turbines is directly (i.e., independent from an effect on annoyance or sleep) causing health problems or disease'* and '*available evidence shows that infrasound levels near wind turbines cannot impact the vestibular system'*.

Technical Research Centre of Finland

A long-term study into so-called "wind turbine syndrome"[16] health problems supposedly caused by low-frequency sound from spinning blades has concluded that this "infrasound" has absolutely no physical impact on the human body.

The study conducted by the Technical Research Centre of Finland (VTT) and others, commissioned by the Finnish government, found that infrasound sound waves with frequencies below the range of human hearing cause no measurable changes in the human body, and cannot in any way be detected by the human ear.

[14] http://www.epa.sa.gov.au/environmental_info/noise/wind_farms
[15] A Wind Turbine Health Impact Study: Report of Independent Expert Panel in January 2012. Prepared for: the Massachusetts Department of Environmental Protection, Massachusetts Department of Public Health.
[16] Infrasound Does Not Explain Symptoms Related to Wind Turbines, Finnish Government, June 2020, https://www.vttresearch.com/en/news-and-ideas/vtt-studied-health-effects-infrasound-wind-turbine-noise-multidisciplinary.

Infrasound measurements were taken inside and outside local dwellings near two Finnish wind farms, as well as inside the facilities and beyond them, for 308 days.

"Infrasound samples representing the worst-case scenarios were picked out from the measurement data and used in the listening tests," said VTT.

"The participants in the listening tests were divided into two groups based on how they reported wind turbine infrasound related symptoms: people who suffered from those and people who never had symptoms.

"The participants were unable to make out infrasonic frequencies in wind turbine noise, and the presence of infrasound made no difference to how annoying the participants perceived the noise, and their autonomous nervous system did not respond to it. There were no differences between the results of the two groups". "No evidence of health effects of wind turbine infrasound was found."

11.2.9 Field Work

Baseline noise monitoring was undertaken at five locations between 6th August and 3rd September 2020. The continuous monitoring period coincided with the wind speed monitoring over the same period and at the same 10-minute intervals. Noise data was recorded for a representative range of wind speeds during this four week period.

11.2.10 Consultation

Consultation was initiated by the Developer's Community Liaison Officer with local residents to obtain permission to install noise monitors at five locations for baseline noise monitoring (see **Section 11.3** of this EIAR). Access to the nearest dwellings was carried out with permission from the householders and landowners.

11.2.11 Operational Noise Assessment Methodology

In summary, the assessment process comprises:

- Identification of potential receptors, i.e., houses and other potentially noise-sensitive locations
- Measurement of existing background noise levels at representative locations close to the Site
- Prediction of noise levels from construction and from wind turbines
- Comparison of the predicted levels with noise limits

- The 110kV substation is considered. However, it is discounted from the noise assessment as the noise emissions are very low compared to the wind turbines i.e., less than 30dBA at 150m and will have negligible impact at the nearest noise sensitive receptor H10 which is 325m away.

Potential receptors in the area around the Development Area were initially identified from Ordnance Survey maps, google maps, EPA maps, Site visits and Eircode's. Background measurements were carried out at five locations as shown in **Figure 11.1**.

The method of measuring background noise is described in ISO 1996 and ETSU-R-97. In practice, it means carrying out continuous monitoring of background noise levels at receptors for a period that includes a range of wind speeds which at minimum correspond to the maximum sound power of the candidate turbines being proposed which is usually 3 to 4 weeks duration. The candidate turbine assessed reaches maximum sound power level at 5m/s at standardised 10m height wind speed.

The method of predicting noise levels of wind turbines at receptors is discussed in **Section 11.2.3.2**. This method was applied to the calculations for both contour plots and individual receptor predictions.

It is standard practice to predict noise levels for a reference wind speed and to adjust these for other wind speeds, according to the variation in sound power level with wind speed.

There are a range of turbine options available for the Site, the final turbine choice will be made through a commercial tender process. For EIA purposes hypothetical candidate turbine, the Nordex N149 has been selected as it reflects a worst-case scenario for the technical assessment as it generates the highest sound power levels of all turbines within the proposed range.

All turbines to be used will have a best practice Serrations Trailing Edge (STE) fitted as standard, which reduces the sound power levels of each turbine. **Table 11.3** provides details of the candidate turbine used for the noise assessment.

A copy of the manufacturer's noise specification of all turbines used in the assessment are given in the **Appendix 11.4**.

Table 11.3: Candidate Turbine Assessed

Turbine Manufacturer	Model	Turbine Output (MW)	Sound Power Level at Source dB LWA
Nordex	149-Mode 0	5.X	105.2

The Nordex N149 turbine has a range of hub heights, however the proposed hub heights ranges between 102.5m and 110.5m. A wind farm noise assessment is based on a standardised noise level referenced to a wind speed at 10m height. The change in hub height does not therefore change the maximum sound power level of any specific turbine.

The maximum sound power level of the Nordex 149 in Mode 0 is similar for hub heights of 102.5m and 110.5m at 105.6dBA. At lower wind speeds there is a small variation in the sound power levels due to variation in hub height when it is standardised to a 10m wind speed. The manufacturer's data gives the sound power levels at hub height and at varying wind speeds. **Table 11.4** and **Table 11.5** give the sound power levels at varying wind speeds at standardised 10m height wind speed using the methodology in the IOA Good Practice Guide and given in **Appendix 11.2**.

The prediction modelling is based on all the turbines operating at full power (maximum sound power output) in standard Mode 0. The IOA Good Practice Guide recommends that an uncertainty value is required to be added to the turbine emission data prior to modelling. Depending on the type of manufacturer's data, the uncertainty value will range from 0 to 2dBA. However, for the Nordex N149 in Mode 0 an uncertainty value of 2dBA is added in line with guidance. **Table 11.4** gives the maximum sound power levels at varying wind speeds (presented at standardised 10m height) for the Nordex N149 with a hub height of 110.5m.

Table 11.4: Noise Emission Levels, Nordex N149 with STE in Mode 0

Standardised 10m height Wind Speed, ms^{-1}	3	4	5	6	7	8	9+
Sound Power Level, dB LWA, derived from 110.5m hub height	97.4	103.8	105.6	105.6	105.6	105.6	105.6
Uncertainty added and conversion of LAeq to LA90 made	97.4	103.8	105.6	105.6	105.6	105.6	105.6

Table 11.5 gives the maximum sound power levels at varying wind speeds presented at standardised 10m height for the Nordex N149 with a hub height of 102.5m.

Table 11.5: Noise Emission Levels, Nordex N149 with STE in Mode 0

Standardised 10m height Wind Speed, ms^{-1}	3	4	5	6	7	8	9+
Sound Power Level, dB LWA, derived from 102.5m hub height	96.6	103.1	105.6	105.6	105.6	105.6	105.6
Uncertainty added and conversion of LAeq to LA90 made	96.6	103.1	105.6	105.6	105.6	105.6	105.6

The standardised sound power level at the lowest hub height (102.5m) is 0.8dB lower at 3m/s and 0.7dB lower at 4m/s. At 5m/s and above there is no change in the overall sound power level in either turbine hub height (see **Table 11.4** and **Table 11.5**).

The octave band values at maximum sound power levels are given in **Table 11.6** with uncertainty values of 2dB added and conversion of LAeq to LA90 added as input to the prediction model.

Table 11.6: Octave Band Spectrum of Nordex N149 with STE in Mode 0

Octave Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level, dB LWA 8 ms^{-1}	86.5	93.1	96.8	98.9	100.2	98.3	88.7	80.8
Uncertainty added to octaves and conversion of LAeq to LA90	86.5	93.1	96.8	98.9	100.2	98.3	88.7	80.8

11.2.11.1 Cumulative Assessment

Cumulative effects from any existing, consented or application-stage wind farms within 3km of the wind farm have been taken into consideration as the potential for cumulative effects beyond this distance is considered negligible. On this basis, the cumulative effect of the operational Derragh Wind Farm located 1,095m south of the Development was assessed. The operational Derragh Wind Farm comprises six no. Nordex N100 each rated at 3.3MW. The maximum noise emission data at varying wind speeds (at standardised 10m height) is presented for the Nordex N100, 3.3MW wind turbines of 100m hub height with STE is given in **Table 11.7**.

Table 11.7: Noise Emission Levels of Nordex N100, 3.3MW with STE

Standardised 10m height Wind Speed, ms^{-1}	3	4	5	6	7	8	9+
Sound Power Level, dB LWA 8 ms^{-1} derived from 100m hub height	94.8	100.2	102.0	102.9	103.0	103.0	103.0
Uncertainty added and conversion of LAeq to LA90	94.8	100.2	102.0	102.9	103.0	103.0	103.0

The octave band values at maximum sound power output are given in **Table 11.8** with uncertainty values and conversion for LAeq to LA90 added as input to the prediction model.

Table 11.8: Octave Band Spectrum of Nordex N100, 3.3MW with STE

Octave Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level, dB LWA 9 ms^{-1}	84.4	90.8	94.9	94.9	95.8	95.9	95.7	88.4
Uncertainty added to octaves and conversion of LAeq to LA90	84.4	90.8	94.9	94.9	95.8	95.9	95.7	88.4

11.2.11.2 Noise Limits

The method of deriving operational noise limits is described in Section 11.2.2.1 based on the Wind Energy Development Guidelines 2006 and taking into account the cumulative effects and noise limits given for the Derragh Wind Farm. The noise limits for the Darragh Wins Farm is:

'Wind turbine noise arising from the proposed development, by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed the greater of:

- *5 dB(A) above the background noise levels. Or*
- *43 dB(A)'*

A noise limit of LA90 43dB for day and night to include cumulative effects is proposed for the Development.

11.2.12 Construction Assessment Methodology

11.2.12.1 Relevant Guidance

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. However, the National Roads Authority (NRA) give guideline limit values which are widely used (NRA Guidelines)[17]. Guidance to predict and control noise is also given in BS 5228:2009-1+A1:2014[18].

11.2.12.1.1 NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes

The NRA Guidelines provide noise maximum permissible noise levels at façade of dwellings during construction and where it is considered necessary to predict noise levels associated with construction noise that this can be done in accordance with BS 5228:2009-1+A1:2014.

11.2.12.1.2 BS 5228:2009-1+A1;2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites

Part 1 of BS 5228 deals with noise prediction and control. It recommends procedures for noise control in respect of construction operations. The standard stresses the importance of community relations, and states that early establishment and maintenance of the relations throughout the carrying out of Site operations will go some way towards allaying people's concerns. Some of the more relevant factors that are likely to affect the acceptability of construction noise are:

- The attitude of local receptors to the Development
- Site location relevant to noise sensitive receptors
- Duration of Site operations
- Hours of work
- The characteristics of the noise produced.

Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the activity. Measures to control noise are described including:

- Control of noise at source by, e.g.
- Substitution of plant or activities by less noisy ones
- Modification of plant or equipment by less noisy ones

[17] National Roads Authority, *2004, Guidelines for the Treatment of Noise and Vibration in National Road Schemes.*
[18] British Standard (BS) 5228-1: 2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites: *Code of Practice for Basic Information and Procedures for Noise Control*.

- Using noise control enclosures
- Siting of equipment and its method of use
- Maintenance of equipment
- Controlling the spread of noise by increasing distance between plant and receptors, or by the provision of acoustic screening

Example criteria for the assessment of the significance of noise effects are also given, although these are not mandatory.

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

11.2.12.2 Construction and Decommissioning Noise Assessment Methodology

The NRA guidelines for construction noise are given in **Table 11.9**.

Table 11.9: NRA Guidelines for Construction Noise

Day / Times	Guideline Limits
Monday to Friday 07:00 – 19:00hrs 19:00 – 22:00hrs	 70dB LAeq, (1h) and LAmax 80dB *60dB LAeq, (1h) and LAmax 65dB*
Saturday 08:00 – 16:30hrs	 65dB LAeq,1h and LAmax75dB
Sunday and Bank Holidays 08:00 – 16:00hrs	 *60dB LAeq,1h and LAmax 65dB*

*Construction at these times, other than required by an emergency works, will normally require explicit permission from the relevant local authority.

<u>Construction Times for Development</u>

The construction for this Development is:

Monday to Friday: 07.00 to 19.00hrs, Saturday 08.00 to 13.00hrs with no work on Sunday, or Bank Holidays.

Part 1 of BS 5228 provides several example criteria for assessment of the significance of noise effects from construction activities. Noise levels generated by construction activities are considered significant if:

- The LAeq, period level of construction noise exceeds lower threshold values of 65dB during daytime, 55dB during evenings and weekends or 45dB at night.

- The total noise level (pre-construction ambient noise plus construction noise) exceeds the pre-construction noise level by 5dB or more for a period of one month or more.

Construction noise from wind farm development, or decommissioning is not considered an intensive activity. The main noise sources will be associated with the excavation of the two borrow pits including blasting and crushing, construction of the turbine foundations and hardstands, while lower levels are generated by activity such as access roads, temporary construction compound and a 110kV substation (construction of a substation would generate no more noise than construction of a bungalow). Grid connection from the substation on site will involve cable being laid underground to connect to the Ballyvouskill 220kV Substation and this will include four crossings where horizontal drilling is required.

Road widening and other works are required for part of the Turbine Delivery Route. Road widening activity will be of short duration of less than a week with low level noise emissions at any receptor. A temporary bridge will be provided over the Sullane River with works expected to be no more than three months duration. Noise levels from this activity will give maximum hourly values at the nearest receptor (70m) ranging between 50 to 60dBA, with these maximum levels occurring for less than 50% of the work period..

All workers associated with development will be subject to the Health and Safety Authority Guidance[19] which states that for noise exposure noise levels likely to exceed 80dBA (expressed as Lep,d 8 hour dBA) that there is the potential of risk of damage to hearing. All workers on site will be given guidance on how to comply with the 'First Action Level'

11.2.12.3 Blasting Vibration in Borrow Pits

Rock material for Development Infrastructure will be sourced from two borrow pit locations on Site which will require blasting. Over 80% of material to be excavated in the borrow pits will be used within the Site (refer to Chapter 2: Projection Description). The main use of excavated material will be for New Site Access Roads, Turbine Hardstands and Turbine Foundations. Most blasts will be of duration of less than 1 second with maximum duration less than 1.5 seconds.

Ground Vibration

Ground vibration is caused by the imperfect utilisation of the explosive energy released from the fragmentation of rock during blasting operations. The energy that is unused in the fragmentation of rock propagates as an elastic disturbance away from the shot area as seismic

[19] Noise - Frequently Asked Questions - Health and Safety Authority (hsa.ie)

waves. These waves, which radiate in a complex manner, diminish in strength with distance from the source. The theory relative to this motion is based on an idealised (sinusoidal) vibratory motion. When these waves come into contact with a free face, physical motion results as the energy induces oscillation in the ground surface. Blasting vibration is a surface wave type, which incorporates components of both body and surface motion.

Ground vibration itself is in-audible, however air vibrations (air overpressure) both audible and sub-audible usually accompany it. The resulting impacts of blasting vibration are often characterised as being impulsive and of short duration, usually less than 2 seconds. It is difficult for the average lay person to differentiate between the various types of vibrations (ground vibration and air overpressure) as humans commonly associate the level of vibration with the 'loudness' of a blast. Ground vibration from blasting at any receptor point is influenced in the main by:

- the maximum instantaneous charge of explosives usually referred to as MIC.
- the medium between blast source and receptor point and.
- the distance between the receptor point and the blast source.

Ground vibration control is based on reducing and controlling the weight of explosives detonated per delay. In any given situation large amounts of explosives can be detonated using time delay intervals (greater than 8 milliseconds) between specific charges within the overall blast. The level of ground vibration is directly related to the maximum instantaneous charge (MIC) weight per delay and numerous studies have shown that peak particle velocity (PPV) is directly related to the MIC. PPV is measured in mm/s in the 3 vectors (vertical, longitudinal, transverse).

Air Overpressure Noise

A blast causes a diverging shock-wave front that quickly reduces to the speed of sound, and an air blast is then propagated through the atmosphere as sound waves. Air blast or air overpressure is the term used to describe the low frequency high energy air vibrations generated by blasting detonation. Just as with ground vibration, these pressure waves can be described with time histories where the amplitude is air pressure instead of particle velocity. Air blasts are characterised by containing a larger proportion of its energy in the sub-audible spectrum, below 20 Hz. Because the waves associated with air blasts are essentially outside the audible spectrum (below 20 Hz), a separate unit of measure, pressure is reported.

Air overpressure (sound waves) can be reported in two distinct units of measurements, pressure (psi) or decibels (dB). A wind speed of 9m/s produces a pressure equal to 133.7 dB

(0.014 psi). Although such wind is comparable in amplitude to a strong air-blast, its effects are not as noticeable because of the relatively slow rate of wind speed change and the corresponding minor or non-existent rattling, compared with the rapid rise time (impulsive) of an air blast transient. The principal factors governing the level of air blasts generated are:

(a) the type and quantity of explosives (lowering the MIC)

(b) the degree and type of confinement (for stemming use chippings, no dust)

(c) the method of initiation (non-use of exposed detonating cord etc.)

(d) local geology, topography and distance (distance is large at

(e) atmospheric conditions (blasting in mid-day reduces frequency of temperature inversions).

Lowering the MIC, use of chipping as stemming, not using exposed detonating cord (which is now best practice) and large distance from blasts to receptors (in excess of 925m) are factors which reduces ground vibration and air-overpressure levels

11.2.12.3.1 Ground Vibration and Air Overpressure Guidelines

There are many different standards and recommendations being used internationally, however, most of these standards and recommendations are derived from the considerable work carried by the U. S Bureau of Mines (USBM)[20]. The USBM Report of Investigation 8507 gives practical safe criteria for blasts that generate low frequency ground vibrations (<40Hz). These are 19mm/sec for modern houses and 12.7mm/sec for older houses. Since 1993 British Standards Institute have adopted BS 7385 Part 2: 1993[21] this is based predominately on a literature review of the considerable work of the USBM. BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15mm/s at low frequencies rising to 20mm/s at 15Hz and 50mm/s at 40Hz and above. The guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings (residential buildings do not constitute critical buildings in this context)'. The NRA published guidelines contains information on permissible construction ground vibration levels and are given in **Table 11.10**.

Table 11.10: Allowable Vibration during Road Construction in order to Minimise the Risk of Building Damage

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz+
8mm/s	12.5mm/s	20mm/s

[20] Siskind, D. E, Stagg, M. S., Kopp, and Dowding, C. H. (1980) '*Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting*' U .S Bureau of Mines RI 8507

The guidance does not give limits for air overpressure, however limits are given by the EPA[21] which states:

'The air overpressure arising from the blasts shall not exceed 125dB (lin) max peak with a 95% confidence limit when measured outside the nearest house to the blast'.

11.2.13 Evaluation of Potential Effects

The potential impacts of construction are evaluated by comparing the predicted noise and vibration levels against the guideline limits given in **Table 11.9**, **Table 11.10**.

The potential operational impacts are evaluated by comparing the predicted noise levels against the day and night-time noise limits given in **Table 11.13**. The predicted noise levels are carried out according to the IOA Good Practice Guide as detailed in **Section 11.2.3.2** and potential impacts are assessed against the noise limits at the nearest receptors.

11.2.13.1 Sensitivity

The sensitivity of the Development during construction is based on the guideline values in **Table 11.9, Table 11.10** and sample criteria in Part 1 of BS 5228. The sensitivity of the Development during operation is based on the guideline values in **Section 11.3.6**.

11.2.13.2 Magnitude

The magnitude of potential impacts of construction is based on the values in **Table 11.15.** and compliance with the values given in **Table 11.9**. The magnitude of the Development during operation is based on the values in **Table 11.16 and 11.18.**

11.2.13.3 Significance Criteria

The significance of construction is based on the potential impacts based on the predicted values and compliance with the guideline limits in **Table 11.9, Table 11.10** and sample criteria of in Part 1 of BS 5228.

The significance of the potential impacts of the Development have been assessed by taking into account the noise limits at receptors and the degree to which compliance has been met.

[21] EPA 2006, Environmental Management Guidelines-Environmental Management in the Extractive Industry (Non-Scheduled Industry)

11.3 BASELINE DESCRIPTION

11.3.1 Identification of Potential Receptors

A number of predictions were prepared for layout of the 14 turbine Development. Based on layout, potential noise-sensitive receptors including occupied and un-occupied were identified from maps. Receptor locations were verified through visits to the area surrounding the Development and are shown in **Figure 11.1**.

11.3.2 Selection of Baseline Noise Survey Locations

Five baseline noise survey locations were selected on the basis of their location relative to the turbine layout, their location with respect to large trees, streams, rivers and access to properties as outlined in **Table 11.11** and shown in **Figure 11.1**.

11.3.3 Baseline Noise Survey

Baseline noise measurements were carried out from 6th August to 3rd September 2020 at locations given in **Table 11.11.** The baseline survey monitoring locations were carried out at receptor houses H2, H3, H5, H15 and H36 (photos of monitors in-situ in **Appendix 11.1**).

Table 11.11: Baseline Noise Survey Locations

Location	ITM Reference	Description of Location
H1	517410, 571864	Microphone 1.2-1.5m height, side of dwelling facing towards the Development
H2	517402, 573794	Microphone 1.2-1.5m height, front garden facing towards the Development
H4	515736, 571186	Microphone 1.2-1.5m height, 40m from dwelling facing towards the Development
H37	514777, 570545	Microphone 1.2-1.5m height, at side of dwelling facing towards the Development
H21	518556, 572363	Microphone 1.2-1.5m height, at side of dwelling facing towards the Development

The survey was carried out in accordance with ISO 1996, ETSU-R-97 and the IOA Good Practice Guide with the following implemented:

- Measurement of background noise levels at 10-minute intervals was undertaken using Type 1 instruments.
- Concurrent measurements of 10-minute interval mean wind speed / direction were recorded from the Met Mast located on Site. The methodology is given in Section 11.2.3.1.

- The background noise measurement recorded continuously included 10-minute intervals, as LA90, 10min along with a series of other parameters including LAeq,10min.
- Noise measurements were recorded at a height of 1.2-1.5m above ground level and more than 5m from any reflective surface.
- An electronic rain gauge was installed onsite at receptor H21 to monitor rainfall at 10-minute intervals over the duration of the noise survey. Rain data (including effects of small streams) which impacted on noise levels were removed from the noise data set prior to analysis.
- The standardised 10m height wind speed was plotted against the background noise levels using a best-fit polynomial line.

11.3.3.1 Instrumentation Used

The following instrumentation was used in the baseline survey measurements:

- Five Larson Davis Precision Integrating Sound Level Analyser/Data logger with 1/2" Condenser Microphones. All microphones were fitted with double skin windscreens based on that specified in W/31/00386/REP[22]
- Calibration Type: Larson Davis Precision Acoustic Calibrator
- Rain Gauge Type: Davis Instruments Vantage Pro2 weather station.

All acoustic instrumentation was calibrated before and after each survey and the drift of calibration was less than 0.3dB. Survey measurement data and calibration certificates of the acoustic instruments are included in **Appendix 11.3**.

11.3.4 Prevailing Background Noise Levels

Table 11.12 gives the background noise levels obtained from quiet daytime and night-time measurement periods at the five baseline measurement locations The WEDG06 states:

In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).

[22] W/31/00386/REP 'Noise Measurements in Windy Conditions'

In order to screen out the requirements to assess the site as a low noise environment, a 16hr daytime noise level was calculated for each day with the average level for each location presented below:

H1 – 33.4 dB LA90

H2 – 37.1 dB LA90

H4 – 39.5 dB LA90

H37 – 40.4 dB LA90

H21 – 32.6 dB LA90

The daytime background noise levels are above LA30dB as per the requirements of the WEDG06, therefore the site was not considered a low noise environment.

Table 11.12: Prevailing Background Noise Levels

Monitoring Location	Prevailing Background (B/G) noise levels LA90dB, 10min Standardised Mean 10m Height Wind Speed, (m/s)										
		3	4	5	6	7	8	9	10	11	12
H1	Day	27.6	28.2	29.3	30.7	32.5	34.6	36.9	39.2	41.7	44.2
	B/G+5	32.6	33.2	34.3	35.7	37.5	39.6	41.9	44.2	46.7	49.2
H1	Night	26.6	27.0	27.9	29.2	30.9	33.0	35.2	37.6	40.2	42.7
	B/G+5	31.6	32.0	32.9	34.2	35.9	38.0	40.2	42.6	45.2	47.7
H2	Day	25.1	26.9	29.1	31.8	34.6	37.5	40.3	42.8	44.9	46.5
	B/G+5	30.1	31.9	34.1	36.8	39.6	42.5	45.3	47.8	49.9	51.5
H2	Night	19.8	20.8	22.5	24.7	27.3	30.1	33.0	35.9	38.6	41.0
	B/G+5	24.8	25.8	27.5	29.7	32.3	35.1	38.0	40.9	43.6	46.0
H4	Day	34.8	35.6	36.6	37.9	39.4	41.0	42.8	44.6	46.5	48.4
	B/G+5	39.8	40.6	41.6	42.9	44.4	46.0	47.8	49.6	51.5	53.4
H4	Night	34.7	34.8	35.6	36.9	38.5	40.5	42.7	45.1	47.4	49.7
	B/G+5	39.7	39.8	40.6	41.9	43.5	45.5	47.7	50.1	52.4	54.7
H21	Day	27.5	28.4	29.4	30.5	31.8	33.2	34.9	36.7	38.8	41.1
	B/G+5	32.5	33.4	34.4	35.5	36.8	38.2	39.9	41.7	43.8	46.1
H21	Night	21.6	22.5	23.8	25.4	27.2	29.3	31.5	33.8	36.1	38.5
	B/G+5	26.6	27.5	28.8	30.4	32.2	34.3	36.5	38.8	41.1	43.5
H37	Day	27.8	28.6	30.3	32.6	35.4	38.7	42.3	46.1	49.9	53.7
	B/G+5	32.8	33.6	35.3	37.6	40.4	43.7	47.3	51.1	54.9	58.7
H37	Night	25.0	25.1	26.4	28.8	32.0	35.8	40.2	44.8	49.5	54.1
	B/G+5	30.0	30.1	31.4	33.8	37.0	40.8	45.2	49.8	54.5	59.1

Location H1

The house is located on the side of a steep slope close to the local road. The noise monitor was located at the side of the house facing towards the Development. The main source of noise was from domestic activity, wind effects on vegetation and small streams.

Location H2

The house is located in low elevation area on the side of a steep hill. The noise monitor was located in the front garden with lots of very tall trees on the slope. Noise sources were farming activity and wind effects on vegetation. During the survey period a large section of nearby trees were felled, however the noise from this source was filtered from the data prior to analysis.

Location H4

The house is located on the side of a steep slope not far from two local roads. The noise monitor was located approximately 40m from the house facing towards the Development. The main source of noise is from a waterfall approximately 120m away.

Location H21

The house is located on the side of a slope in a large field with little vegetation close by. The noise monitor was located at the side of the house facing towards the Development. The main source of noise is from local domestic activity and low traffic flow on the local road with small stream barely audible.

Location H37

The house is located on the side of a slope with little vegetation close by. The noise monitor was located at the side of the house facing towards the Development. The main source of noise is from local domestic activity, low traffic flow on the local road, wind effects on vegetation and local small streams.

11.3.5 Noise Assessment Locations

The nearest receptors to the Development were selected for assessment and represent the properties most likely to be affected by potential effects. Measured background noise levels are representative of the background noise environments surrounding the development.

Should the predicted noise levels from the Development comply with the requirements of the WEDG06 at the closest receptors, it may be assumed that the predicted noise levels at receptors further away from the Development will also comply, due to the attenuation of turbine noise levels with distance. The locations of all receptors assessed are given in **Figure 11.1**.

11.3.6 Noise Limits

The noise limits for the Development are based on the limits contained within the Wind Energy Development Guidelines 2006 and on the background levels obtained in **Table 11.13.** A lower fixed limit of 45dBA for day time could be applied, however a more stringent limit is applied with the lowest background noise levels obtained at location H2 used as the basis for the assessment at all receptors with a limit of 43dBA being applied for day and night.

Table 11.13: Derived Background Night Noise Levels Used in Assessment (H3)

Monitoring Location		Prevailing Background (B/G) noise levels LA90dB, 10min Standardised Mean 10m Height Wind Speed, (m/s)								
		4	5	6	7	8	9	10	11	12
H2	Day	26.9	29.1	31.8	34.6	37.5	40.3	42.8	44.9	46.5
	B/G+5	31.9	34.1	36.8	39.6	42.5	45.3	47.8	49.9	51.5
Noise Limit		43	43	43	43	43	43	43	43	43
H2	Night	20.8	22.5	24.7	27.3	30.1	33.0	35.9	38.6	41.0
	B/G+5	25.8	27.5	29.7	32.3	35.1	38.0	40.9	43.6	46.0
Noise Limit		43	43	43	43	43	43	43	43	43

11.3.7 Development Design Mitigation

The preferred turbine model, yet to be decided will be fitted with STE. A serrated extension of the trailing edge to the rotor blades mitigates noise emission by effectively breaking up the turbulence on the tooth flanks into smaller eddies. The intensity of the pressure fluctuations is reduced which mitigates the noise emissions. Since the intensity of the noise emissions is largely dependent on the flow speed, STE is only installed on the outer rotor blade area where the rotary speed is highest. Typically, STE reduces the noise levels by 2 to 3dBA without reducing the energy output.

11.4 ASSESSMENT OF POTENTIAL EFFECTS

11.4.1 Construction Noise and Decommissioning Noise Levels

As has been previously stated, the construction process associated with wind farms is not considered intensive and is temporary works most of which is carried out a considerable distance from receptors. The main noise sources will be associated with the construction of the turbine foundations, turbine hardstands, grid connection, processing in the borrow pit locations, with lesser sources being site access roads and construction of a 110kV substation. Accessing stone material from the two borrow pits will significantly reduce road traffic flow on local roads. The main construction traffic to Site will be due to a very short period where ready-mix trucks deliver concrete for the turbine bases. The delivery of turbines by large trucks travelling at very low speed will generate very low levels of noise.

It is not possible to specify the precise noise levels of emissions from the construction equipment until such time as a contractor is chosen and construction plant has been selected, however **Table 11.14** indicates typical construction range of noise levels for this type of activity (levels from author's database and BS 5228). Predictions are made for receptors nearest to the borrow pit processing, turbine bases / hardstands activity and for receptors at varying distance from the grid connection route. The construction of a substation is considerably less intensive than the construction of a small bungalow.

Decommissioning noise levels are expected to be similar to construction levels, but for a shorter period.

Table 11.14: Typical Noise Levels from Construction Works

Activity	L_{Aeq} at 10m
Pile driving, ready-mix trucks pouring concrete).	70-84dBA
Large tracked excavator removing topsoil, subsoil for foundation.	80- 87dBA
Rock breaker, vibrating rollers, trucks loading and tipping material	76-89dBA
Grid Connection: Trenching, Tracked excavator 14t, pneumatic breaker, vibratory roller 71t. Horizontal Drilling: Rig HPU* (diesel), mud pump, diesel generator /tractor/dumper.	70-74dBA 70-86dBA
Borrow Pit Processing (Portable crusher, screener, truck loading by excavator, front end loader, dump truck)	78-86dBA

* Hydraulic power unit (for horizontal drilling)

The difference in noise levels between two locations can be calculated as:

$$\mathbf{L}_{p2} - \mathbf{L}_{p1} = 10 \log (R_2 / R_1)^2 - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$

$$= 20 \log (R_2 / R_1) - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$

where:

L_{p1} = sound pressure level at location 1

L_{p2} = sound pressure level at location 2

R_1 = distance from source to location 1

R_2 = distance from source to location 2

and where:

A_{atm} = Attenuation due to air absorption

A_{gr} = Attenuation due to ground absorption

A_{br} = Attenuation provided by a barrier

A_{mis} = Attenuation provided by miscellaneous other effects

In the calculation attenuation by A_{atm}, A_{gr} and A_{mis} is assumed as 3dBA.

Table 11.15 gives the noise levels predicted from construction activity at the nearest receptor to the two borrow excavation and at varying distances due to the development of the Grid connection. The maximum construction noise levels will be at the receptor listed in **Table 11.15.** At receptor locations further away, noise levels will be less than that predicted.

Table 11.15: Predicted Construction Noise Levels

Receptor	Activity	Distance of Activity (m)	LAeq dB 1hr range
H1	Foundation works: trucks pouring concrete, large tracked excavator moving topsoil/subsoil	753	29-43
H1	Rock breaking, vibratory roller, trucks loading/tipping	753	34-47
H4 H1	Borrow Pit A Borrow Pit B	925 997	36-44 35-43
Grid connection Receptors at varying distances	Excavator removing material, Pneumatic breaker, truck loading	20 40 80	58-65 52-59 46-53
Horizontal drilling Na Doiri N22 crossing	Rig HPU* (diesel), Mud Pump, Diesel generator, tractor, dumper	210 540	41-57 25-49

Receptor	Activity	Distance of Activity (m)	LAeq dB 1hr range
Droichead Ui Mhathuna Droichead Barr Duinse		145 85	44-60 49-65

* Hydraulic power unit (for horizontal drilling).

NB: Predicted noise levels assumes that there are no barrier/berm attenuation effects

Construction Traffic

The delivery of turbines to the site will generate low level traffic noise as the vehicles carrying the turbines will move slowly along the local roads where impact is expected to be greatest. The main construction noise generated by traffic to the Site will be due to ready-mix trucks delivering concrete. The concrete pour for each individual turbine will be required to be completed in a short a period as possible (usually within 10 hours).

Each turbine will require 590m^3 of concrete while each ready-mix truck has a capacity of 8m^3. This results in 74 loads of concrete and 148 truck movements for each turbine. For delivery of concrete the timeframe envisaged for each turbine concrete pour is taken as 10 hrs. This equates to an average of 14.8 movements per hour.

The general expression for predicting the 1 hr LAeq alongside a haul road used by single engine items of mobile plant is:

$$L_{Aeq} = L_{WA} - 33 + 10\log_{10}Q - 10\log_{10}V - 10\log_{10}d$$

where:

L_{WA} is the sound power level of the truck, in decibels (dB);

Q is 15 the number of vehicles per hour;

V is 30, the average vehicle speed, in kilometres per hour (km/h);

d is the distance of receiving position from the centre of haul road, in metres (m).

LAeq = 105-33 + 10log 15 – 10log30 – 10log20 = 54.8 LAeq 1hr.

At 10m from the roadside the noise levels equates to 57.8 LAeq 1hr. The concrete pour trucking will extend for a total of 15 days (1 day for each turbine). In practice the levels generated by truck movement should be lower than predicted due to the smooth surface on the local roads.

Grid Connection-Cable laying in fields and along road by trenching

Cable laying and trenching will move along the grid route from the substation on site to the Ballyvouskill 220kV Substation which means maximum levels will pertain to no more than one day equivalent (8 hours) at any single receptor except where horizontal drilling is required.

Construction noise levels are based on continuous operation. In practice most plant will operate at a maximum level for short intervals. Where works are required at distances within 20m of a receptor an acoustic barrier will be provided which can be placed close to the source giving maximum attenuation (refer to BS 5228 for guidance on screening / barrier effects). There are two receptors H15 and H31 located between 15 and 20m from the grid route. An acoustic barrier will be installed at both these locations to provide a minimum 10dBA attenuation. When a noise source is completely obscured from a receptor by an acoustic barrier a 10dBA reduction is obtained.

Grid Connection- Horizontal Drilling

Horizontal or directional drilling is required at seven locations where the grid connection requires undergrounding. The nearest receptor to horizontal drilling activity is 540m from the N22 crossing, 210m from Na Doiri crossing, 145m from Droichead Ui crossing and 85m from Droichead Barr crossing. The noise levels predicted at all locations is within the NRA construction guidelines without any amelioration required. The activity works associated with this activity is temporary but expected to continue for a number of weeks. All drilling activity will be carried out during daytime.

The predicted construction noise levels are within the NRA guidelines for daytime for all activity and within the lower threshold of 65 dBA, as defined in BS 5228-1:2009, the noise levels are therefore considered as not significant**.**

11.4.1.1 Assessment of Construction Noise

The maximum predicted noise levels from construction of the turbine foundations and hardstands will be at H1 while lower levels will be experienced at all other receptors which are located further away. Most of the activity close to turbine bases will be invisible to the nearest inhabited houses thereby providing significant additional attenuation (in excess of 10dBA above that predicted) due to topographic screening effects. All activity is predicted without additional mufflers, or without topographic screening. The level of ground vibration generated by truck movement along roadways at receptors will be below the threshold of sensitivity to humans, at less than 0.2mm/s peak particle velocity[23] at all receptors. The maximum road traffic noise which is generated by readymix trucks will be short term and of

[23] Wiss, J. F., and Parmelee, R. A.. (1974) Human Perception of Transient Vibrations, "*Journal of Structural Division*", ASCE, Vol 100, No. S74, PP. 773-787

duration of 15 days with noise levels within NRA guidelines and is therefore considered not significant.

11.4.1.2 Description of Effects

The criteria for description of effects for all construction noise activity and the potential worst-case effects, at the nearest receptors is given below.

Quality	Significance	Duration
Negative	Slight	Temporary

11.4.1.3 Assessment of Ground Vibration and Air Overpressure

Blasting in the two Borrow Pit locations are in excess of 924m from the nearest receptor. Ground vibration levels are controlled by the maximum charge weight of explosives per delay used in a blast and will easily be kept below the lower guideline values of 8mm/sec peak particle velocity given in **Table 11.10.** Blasting, including design is only carried out by suitable qualified certified personnel. The levels of air overpressure will be kept within the EPA's guidance value of 125dB (lin).

The effects of blasting vibration and air overpressure from the Development is at a distance greater than 870m and is therefore considered not significant and will be kept well within the recommended guidelines described in **Section 11.2.8.3.1**.

The criteria for description of effects for vibration (blasting) and the potential worst-case effects, at the nearest receptors is given below.

Quality	Significance	Duration
Negative	Not significant	Momentary

11.4.1.4 Decommissioning

Noise effects during decommissioning of the Development are likely to be of a similar nature to that during construction but of shorter duration. There will be no blasting during decommissioning. Turbine bases (excluding plinths) will be left in place and revegetated. It is proposed to leave roadways and drainage in place. It is likely that the duration of decommissioning will be less intensive and of shorter duration than that during construction. Any legislation, guidance or best practice relevant at the time of decommissioning will be complied with.

11.4.2 Predicted Operational Noise Levels

Table 11.16 gives the predicted noise levels at the nearest receptors to the Development at varying wind speeds for the turbine with 110.5m hub height. The predicted noise levels for the turbine in the lowest hub height range (102.5m) possible that may be used is given in **Appendix 11.5.**

A noise contour map of the 14 no. turbine Development at maximum sound power output at a wind speed of 8m/s at 10m height is presented in **Figure 11.1**. The contour map in **Figure 11.1** assumes that all turbines are simultaneously downwind at the same time to each location which results in an overprediction of the noise levels.

Table 11.16: Predicted Noise Levels from the Development as LA90 at Varying Wind Speeds (110.5m hub height)

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H1	517410	571864	32.7	39.1	40.9	40.9	40.9	40.9	40.9
H2	517402	573794	32.5	38.9	40.7	40.7	40.7	40.7	40.7
H3	517734	572119	32.0	38.4	40.2	40.2	40.2	40.2	40.2
H4	515736	571186	32.9	39.3	41.1	41.1	41.1	41.1	41.1
H5	515395	574092	30.9	37.3	39.1	39.1	39.1	39.1	39.1
H6	517462	571790	32.0	38.4	40.2	40.2	40.2	40.2	40.2
H7	517467	571806	32.1	38.5	40.3	40.3	40.3	40.3	40.3
H8	515487	574211	30.2	36.6	38.4	38.4	38.4	38.4	38.4
H9	516372	574046	31.9	38.3	40.1	40.1	40.1	40.1	40.1
H10	517533	571990	32.5	38.9	40.7	40.7	40.7	40.7	40.7
H11	515143	574094	29.7	36.1	37.9	37.9	37.9	37.9	37.9
H12	515896	574342	29.7	36.1	37.9	37.9	37.9	37.9	37.9
H13	517811	571946	30.6	37.0	38.8	38.8	38.8	38.8	38.8
H14	514534	572878	31.6	38.0	39.8	39.8	39.8	39.8	39.8
H15	516142	574318	29.9	36.3	38.1	38.1	38.1	38.1	38.1
H16	514510	572872	31.4	37.8	39.6	39.6	39.6	39.6	39.6
H17	516223	574321	29.8	36.2	38	38	38	38	38
H18	514997	574130	28.8	35.2	37	37	37	37	37
H19	515702	570880	30.3	36.7	38.5	38.5	38.5	38.5	38.5
H20	514411	572890	30.7	37.1	38.9	38.9	38.9	38.9	38.9
H21	518556	572363	27.5	33.9	35.7	35.7	35.7	35.7	35.7
H22	517923	573934	28.8	35.2	37	37	37	37	37
H23	517883	573984	28.7	35.1	36.9	36.9	36.9	36.9	36.9
H24	514830	574098	28.2	34.6	36.4	36.4	36.4	36.4	36.4

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H25	517613	571154	28.0	34.4	36.2	36.2	36.2	36.2	36.2
H26	514887	574194	27.9	34.3	36.1	36.1	36.1	36.1	36.1
H27	514265	570703	26.3	32.7	34.5	34.5	34.5	34.5	34.5
H28	518705	572403	26.5	32.9	34.7	34.7	34.7	34.7	34.7
H29	514728	570617	27.1	33.5	35.3	35.3	35.3	35.3	35.3
H30	517670	571142	27.7	34.1	35.9	35.9	35.9	35.9	35.9
H31	514223	570697	26.1	32.5	34.3	34.3	34.3	34.3	34.3
H32	518774	572454	26.2	32.6	34.4	34.4	34.4	34.4	34.4
H33	518384	573830	26.8	33.2	35	35	35	35	35
H34	514633	570556	26.5	32.9	34.7	34.7	34.7	34.7	34.7
H35	514379	570581	26.0	32.4	34.2	34.2	34.2	34.2	34.2
H36	514814	570551	26.9	33.3	35.1	35.1	35.1	35.1	35.1
H37	514777	570545	26.8	33.2	35	35	35	35	35
H38	515088	570586	27.6	34.0	35.8	35.8	35.8	35.8	35.8
H39	514187	570609	25.5	31.9	33.7	33.7	33.7	33.7	33.7
H40	514433	570535	25.9	32.3	34.1	34.1	34.1	34.1	34.1
H41	517124	574610	27.1	33.5	35.3	35.3	35.3	35.3	35.3
H42	518824	572353	25.7	32.1	33.9	33.9	33.9	33.9	33.9
H43	518107	574098	27.0	33.4	35.2	35.2	35.2	35.2	35.2
H44	516773	574652	27.3	33.7	35.5	35.5	35.5	35.5	35.5
H45	517869	574232	27.3	33.7	35.5	35.5	35.5	35.5	35.5
H46	514750	570477	26.3	32.7	34.5	34.5	34.5	34.5	34.5
H47	518434	573927	26.2	32.6	34.4	34.4	34.4	34.4	34.4
H48	517605	574420	27.1	33.5	35.3	35.3	35.3	35.3	35.3
H49	516256	574698	27.2	33.6	35.4	35.4	35.4	35.4	35.4
H50	517850	571155	26.9	33.3	35.1	35.1	35.1	35.1	35.1
H51	517890	571229	27.0	33.4	35.2	35.2	35.2	35.2	35.2
H52	514698	570464	26.1	32.5	34.3	34.3	34.3	34.3	34.3
H53	517210	574625	26.8	33.2	35	35	35	35	35
H54	514485	570469	25.7	32.1	33.9	33.9	33.9	33.9	33.9
H55	514590	570438	25.7	32.1	33.9	33.9	33.9	33.9	33.9
H56	518528	573917	25.7	32.1	33.9	33.9	33.9	33.9	33.9
H57	515290	570548	27.6	34.0	35.8	35.8	35.8	35.8	35.8
H58	514512	570431	25.5	31.9	33.7	33.7	33.7	33.7	33.7
H59	518930	572410	25.1	31.5	33.3	33.3	33.3	33.3	33.3
H60	516878	574725	26.7	33.1	34.9	34.9	34.9	34.9	34.9
H61	517955	571250	26.8	33.2	35	35	35	35	35

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H62	514394	573903	27.0	33.4	35.2	35.2	35.2	35.2	35.2
H63	514059	570556	24.8	31.2	33	33	33	33	33
H64	518941	572403	25.1	31.5	33.3	33.3	33.3	33.3	33.3
H65	518321	574087	26.0	32.4	34.2	34.2	34.2	34.2	34.2
H66	518957	572447	25.0	31.4	33.2	33.2	33.2	33.2	33.2
H67	518976	572514	25.0	31.4	33.2	33.2	33.2	33.2	33.2
H68	518097	574217	26.4	32.8	34.6	34.6	34.6	34.6	34.6
H69	518989	572432	24.8	31.2	33	33	33	33	33
H70	519003	572456	24.8	31.2	33	33	33	33	33
H71	518987	572390	24.8	31.2	33	33	33	33	33
H72	519042	572577	24.6	31.0	32.8	32.8	32.8	32.8	32.8
H73	519032	572454	24.6	31.0	32.8	32.8	32.8	32.8	32.8
H74	518159	574273	25.9	32.3	34.1	34.1	34.1	34.1	34.1
H75	517248	574791	25.8	32.2	34	34	34	34	34
H76	514292	570334	24.4	30.8	32.6	32.6	32.6	32.6	32.6
H77	519031	572269	24.4	30.8	32.6	32.6	32.6	32.6	32.6
H78	514600	574467	25.4	31.8	33.6	33.6	33.6	33.6	33.6
H79	519083	573399	24.0	30.4	32.2	32.2	32.2	32.2	32.2
H80	518088	574393	25.6	32.0	33.8	33.8	33.8	33.8	33.8
H81	514828	574738	24.9	31.3	33.1	33.1	33.1	33.1	33.1
H82	515800	575045	25.0	31.4	33.2	33.2	33.2	33.2	33.2
H83	514232	574023	25.8	32.2	34	34	34	34	34
H84	516832	574974	25.3	31.7	33.5	33.5	33.5	33.5	33.5
H85	515011	570183	25.1	31.5	33.3	33.3	33.3	33.3	33.3
H86	516572	574987	25.4	31.8	33.6	33.6	33.6	33.6	33.6
H87	514991	574930	24.4	30.8	32.6	32.6	32.6	32.6	32.6
H88	516684	575011	25.2	31.6	33.4	33.4	33.4	33.4	33.4
H89	518743	574118	24.0	30.4	32.2	32.2	32.2	32.2	32.2
H90	514914	574938	24.1	30.5	32.3	32.3	32.3	32.3	32.3
H91	514204	570162	23.4	29.8	31.6	31.6	31.6	31.6	31.6
H92	514308	574396	24.6	31.0	32.8	32.8	32.8	32.8	32.8
H93	515847	575193	24.3	30.7	32.5	32.5	32.5	32.5	32.5
H94	517147	575057	24.5	30.9	32.7	32.7	32.7	32.7	32.7
H95	514310	574440	24.5	30.9	32.7	32.7	32.7	32.7	32.7
H96	516360	570045	24.9	31.3	33.1	33.1	33.1	33.1	33.1
H97	515285	570118	25.1	31.5	33.3	33.3	33.3	33.3	33.3
H98	517237	575083	24.3	30.7	32.5	32.5	32.5	32.5	32.5

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H99	518853	574198	23.3	29.7	31.5	31.5	31.5	31.5	31.5
H100	514172	569993	22.6	29.0	30.8	30.8	30.8	30.8	30.8
H101	514126	574409	23.9	30.3	32.1	32.1	32.1	32.1	32.1
H102	519337	573772	22.1	28.5	30.3	30.3	30.3	30.3	30.3
H103	515882	575406	23.2	29.6	31.4	31.4	31.4	31.4	31.4
H104	519423	572097	22.2	28.6	30.4	30.4	30.4	30.4	30.4
H105	515128	575313	22.8	29.2	31	31	31	31	31
H106	519384	571987	22.2	28.6	30.4	30.4	30.4	30.4	30.4

11.4.3 Operational Noise Assessment

The assessment was made with predicted operational noise levels from the Development against noise limits in the Wind Energy Development Guidelines 2006. **Table 11.17** gives the difference between the predicted noise levels in **Table 11.16** and noise limits for each receptor. A negative margin indicates that the predicted noise levels are within the lower fixed 43dBA limit which means the levels are also within the day and night limits.

As can be seen from **Table 11.17** the predicted noise levels at all receptors are lower than the noise limits in all cases are therefore compliant with the noise limits and are not significant in terms of EIAR Regulations.

The predicted noise levels assume that all 14 No. Turbines are directly down-wind. The potential for negative impacts is negligible.

Table 11.17: Margin between Predicted Noise Levels and Lower Fixed Limit of 43dBA

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H1	517410	571864	-10.3	-3.9	-2.1	-2.1	-2.1	-2.1	-2.1
H2	517402	573794	-10.5	-4.1	-2.3	-2.3	-2.3	-2.3	-2.3
H3	517734	572119	-11.0	-4.6	-2.8	-2.8	-2.8	-2.8	-2.8
H4	515736	571186	-10.1	-3.7	-1.9	-1.9	-1.9	-1.9	-1.9
H5	515395	574092	-12.1	-5.7	-3.9	-3.9	-3.9	-3.9	-3.9
H6	517462	571790	-11.0	-4.6	-2.8	-2.8	-2.8	-2.8	-2.8
H7	517467	571806	-10.9	-4.5	-2.7	-2.7	-2.7	-2.7	-2.7
H8	515487	574211	-12.8	-6.4	-4.6	-4.6	-4.6	-4.6	-4.6
H9	516372	574046	-11.1	-4.7	-2.9	-2.9	-2.9	-2.9	-2.9

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H10	517533	571990	-10.5	-4.1	-2.3	-2.3	-2.3	-2.3	-2.3
H11	515143	574094	-13.3	-6.9	-5.1	-5.1	-5.1	-5.1	-5.1
H12	515896	574342	-13.3	-6.9	-5.1	-5.1	-5.1	-5.1	-5.1
H13	517811	571946	-12.4	-6.0	-4.2	-4.2	-4.2	-4.2	-4.2
H14	514534	572878	-11.4	-5.0	-3.2	-3.2	-3.2	-3.2	-3.2
H15	516142	574318	-13.1	-6.7	-4.9	-4.9	-4.9	-4.9	-4.9
H16	514510	572872	-11.6	-5.2	-3.4	-3.4	-3.4	-3.4	-3.4
H17	516223	574321	-13.2	-6.8	-5.0	-5.0	-5.0	-5.0	-5.0
H18	514997	574130	-14.2	-7.8	-6.0	-6.0	-6.0	-6.0	-6.0
H19	515702	570880	-12.7	-6.3	-4.5	-4.5	-4.5	-4.5	-4.5
H20	514411	572890	-12.3	-5.9	-4.1	-4.1	-4.1	-4.1	-4.1
H21	518556	572363	-15.5	-9.1	-7.3	-7.3	-7.3	-7.3	-7.3
H22	517923	573934	-14.2	-7.8	-6.0	-6.0	-6.0	-6.0	-6.0
H23	517883	573984	-14.3	-7.9	-6.1	-6.1	-6.1	-6.1	-6.1
H24	514830	574098	-14.8	-8.4	-6.6	-6.6	-6.6	-6.6	-6.6
H25	517613	571154	-15.0	-8.6	-6.8	-6.8	-6.8	-6.8	-6.8
H26	514887	574194	-15.1	-8.7	-6.9	-6.9	-6.9	-6.9	-6.9
H27	514265	570703	-16.7	-10.3	-8.5	-8.5	-8.5	-8.5	-8.5
H28	518705	572403	-16.5	-10.1	-8.3	-8.3	-8.3	-8.3	-8.3
H29	514728	570617	-15.9	-9.5	-7.7	-7.7	-7.7	-7.7	-7.7
H30	517670	571142	-15.3	-8.9	-7.1	-7.1	-7.1	-7.1	-7.1
H31	514223	570697	-16.9	-10.5	-8.7	-8.7	-8.7	-8.7	-8.7
H32	518774	572454	-16.8	-10.4	-8.6	-8.6	-8.6	-8.6	-8.6
H33	518384	573830	-16.2	-9.8	-8.0	-8.0	-8.0	-8.0	-8.0
H34	514633	570556	-16.5	-10.1	-8.3	-8.3	-8.3	-8.3	-8.3
H35	514379	570581	-17.0	-10.6	-8.8	-8.8	-8.8	-8.8	-8.8
H36	514814	570551	-16.1	-9.7	-7.9	-7.9	-7.9	-7.9	-7.9
H37	514777	570545	-16.2	-9.8	-8.0	-8.0	-8.0	-8.0	-8.0
H38	515088	570586	-15.4	-9.0	-7.2	-7.2	-7.2	-7.2	-7.2
H39	514187	570609	-17.5	-11.1	-9.3	-9.3	-9.3	-9.3	-9.3
H40	514433	570535	-17.1	-10.7	-8.9	-8.9	-8.9	-8.9	-8.9
H41	517124	574610	-15.9	-9.5	-7.7	-7.7	-7.7	-7.7	-7.7
H42	518824	572353	-17.3	-10.9	-9.1	-9.1	-9.1	-9.1	-9.1
H43	518107	574098	-16.0	-9.6	-7.8	-7.8	-7.8	-7.8	-7.8
H44	516773	574652	-15.7	-9.3	-7.5	-7.5	-7.5	-7.5	-7.5
H45	517869	574232	-15.7	-9.3	-7.5	-7.5	-7.5	-7.5	-7.5
H46	514750	570477	-16.7	-10.3	-8.5	-8.5	-8.5	-8.5	-8.5

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H47	518434	573927	-16.8	-10.4	-8.6	-8.6	-8.6	-8.6	-8.6
H48	517605	574420	-15.9	-9.5	-7.7	-7.7	-7.7	-7.7	-7.7
H49	516256	574698	-15.8	-9.4	-7.6	-7.6	-7.6	-7.6	-7.6
H50	517850	571155	-16.1	-9.7	-7.9	-7.9	-7.9	-7.9	-7.9
H51	517890	571229	-16.0	-9.6	-7.8	-7.8	-7.8	-7.8	-7.8
H52	514698	570464	-16.9	-10.5	-8.7	-8.7	-8.7	-8.7	-8.7
H53	517210	574625	-16.2	-9.8	-8.0	-8.0	-8.0	-8.0	-8.0
H54	514485	570469	-17.3	-10.9	-9.1	-9.1	-9.1	-9.1	-9.1
H55	514590	570438	-17.3	-10.9	-9.1	-9.1	-9.1	-9.1	-9.1
H56	518528	573917	-17.3	-10.9	-9.1	-9.1	-9.1	-9.1	-9.1
H57	515290	570548	-15.4	-9.0	-7.2	-7.2	-7.2	-7.2	-7.2
H58	514512	570431	-17.5	-11.1	-9.3	-9.3	-9.3	-9.3	-9.3
H59	518930	572410	-17.9	-11.5	-9.7	-9.7	-9.7	-9.7	-9.7
H60	516878	574725	-16.3	-9.9	-8.1	-8.1	-8.1	-8.1	-8.1
H61	517955	571250	-16.2	-9.8	-8.0	-8.0	-8.0	-8.0	-8.0
H62	514394	573903	-16.0	-9.6	-7.8	-7.8	-7.8	-7.8	-7.8
H63	514059	570556	-18.2	-11.8	-10.0	-10.0	-10.0	-10.0	-10.0
H64	518941	572403	-17.9	-11.5	-9.7	-9.7	-9.7	-9.7	-9.7
H65	518321	574087	-17.0	-10.6	-8.8	-8.8	-8.8	-8.8	-8.8
H66	518957	572447	-18.0	-11.6	-9.8	-9.8	-9.8	-9.8	-9.8
H67	518976	572514	-18.0	-11.6	-9.8	-9.8	-9.8	-9.8	-9.8
H68	518097	574217	-16.6	-10.2	-8.4	-8.4	-8.4	-8.4	-8.4
H69	518989	572432	-18.2	-11.8	-10.0	-10.0	-10.0	-10.0	-10.0
H70	519003	572456	-18.2	-11.8	-10.0	-10.0	-10.0	-10.0	-10.0
H71	518987	572390	-18.2	-11.8	-10.0	-10.0	-10.0	-10.0	-10.0
H72	519042	572577	-18.4	-12.0	-10.2	-10.2	-10.2	-10.2	-10.2
H73	519032	572454	-18.4	-12.0	-10.2	-10.2	-10.2	-10.2	-10.2
H74	518159	574273	-17.1	-10.7	-8.9	-8.9	-8.9	-8.9	-8.9
H75	517248	574791	-17.2	-10.8	-9.0	-9.0	-9.0	-9.0	-9.0
H76	514292	570334	-18.6	-12.2	-10.4	-10.4	-10.4	-10.4	-10.4
H77	519031	572269	-18.6	-12.2	-10.4	-10.4	-10.4	-10.4	-10.4
H78	514600	574467	-17.6	-11.2	-9.4	-9.4	-9.4	-9.4	-9.4
H79	519083	573399	-19.0	-12.6	-10.8	-10.8	-10.8	-10.8	-10.8
H80	518088	574393	-17.4	-11.0	-9.2	-9.2	-9.2	-9.2	-9.2
H81	514828	574738	-18.1	-11.7	-9.9	-9.9	-9.9	-9.9	-9.9
H82	515800	575045	-18.0	-11.6	-9.8	-9.8	-9.8	-9.8	-9.8
H83	514232	574023	-17.2	-10.8	-9.0	-9.0	-9.0	-9.0	-9.0

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H84	516832	574974	-17.7	-11.3	-9.5	-9.5	-9.5	-9.5	-9.5
H85	515011	570183	-17.9	-11.5	-9.7	-9.7	-9.7	-9.7	-9.7
H86	516572	574987	-17.6	-11.2	-9.4	-9.4	-9.4	-9.4	-9.4
H87	514991	574930	-18.6	-12.2	-10.4	-10.4	-10.4	-10.4	-10.4
H88	516684	575011	-17.8	-11.4	-9.6	-9.6	-9.6	-9.6	-9.6
H89	518743	574118	-19.0	-12.6	-10.8	-10.8	-10.8	-10.8	-10.8
H90	514914	574938	-18.9	-12.5	-10.7	-10.7	-10.7	-10.7	-10.7
H91	514204	570162	-19.6	-13.2	-11.4	-11.4	-11.4	-11.4	-11.4
H92	514308	574396	-18.4	-12.0	-10.2	-10.2	-10.2	-10.2	-10.2
H93	515847	575193	-18.7	-12.3	-10.5	-10.5	-10.5	-10.5	-10.5
H94	517147	575057	-18.5	-12.1	-10.3	-10.3	-10.3	-10.3	-10.3
H95	514310	574440	-18.5	-12.1	-10.3	-10.3	-10.3	-10.3	-10.3
H96	516360	570045	-18.1	-11.7	-9.9	-9.9	-9.9	-9.9	-9.9
H97	515285	570118	-17.9	-11.5	-9.7	-9.7	-9.7	-9.7	-9.7
H98	517237	575083	-18.7	-12.3	-10.5	-10.5	-10.5	-10.5	-10.5
H99	518853	574198	-19.7	-13.3	-11.5	-11.5	-11.5	-11.5	-11.5
H100	514172	569993	-20.4	-14.0	-12.2	-12.2	-12.2	-12.2	-12.2
H101	514126	574409	-19.1	-12.7	-10.9	-10.9	-10.9	-10.9	-10.9
H102	519337	573772	-20.9	-14.5	-12.7	-12.7	-12.7	-12.7	-12.7
H103	515882	575406	-19.8	-13.4	-11.6	-11.6	-11.6	-11.6	-11.6
H104	519423	572097	-20.8	-14.4	-12.6	-12.6	-12.6	-12.6	-12.6
H105	515128	575313	-20.2	-13.8	-12.0	-12.0	-12.0	-12.0	-12.0
H106	519384	571987	-20.8	-14.4	-12.6	-12.6	-12.6	-12.6	-12.6

Substation 110kV

The on-site substation will operate during the life of the turbines. Noise levels taken outside an existing 110kV substation was measured at less than 32dBA at 150m and inaudible , thus it has no potential for impact on the nearest receptor H10 which is 325m away.

Charts 11.1 to **11.10** (outlined below) of this section plots the derived background noise levels at the five receptors where monitoring was carried out, with the predicted noise levels for that location and a lower fixed limit of 43 dBA.

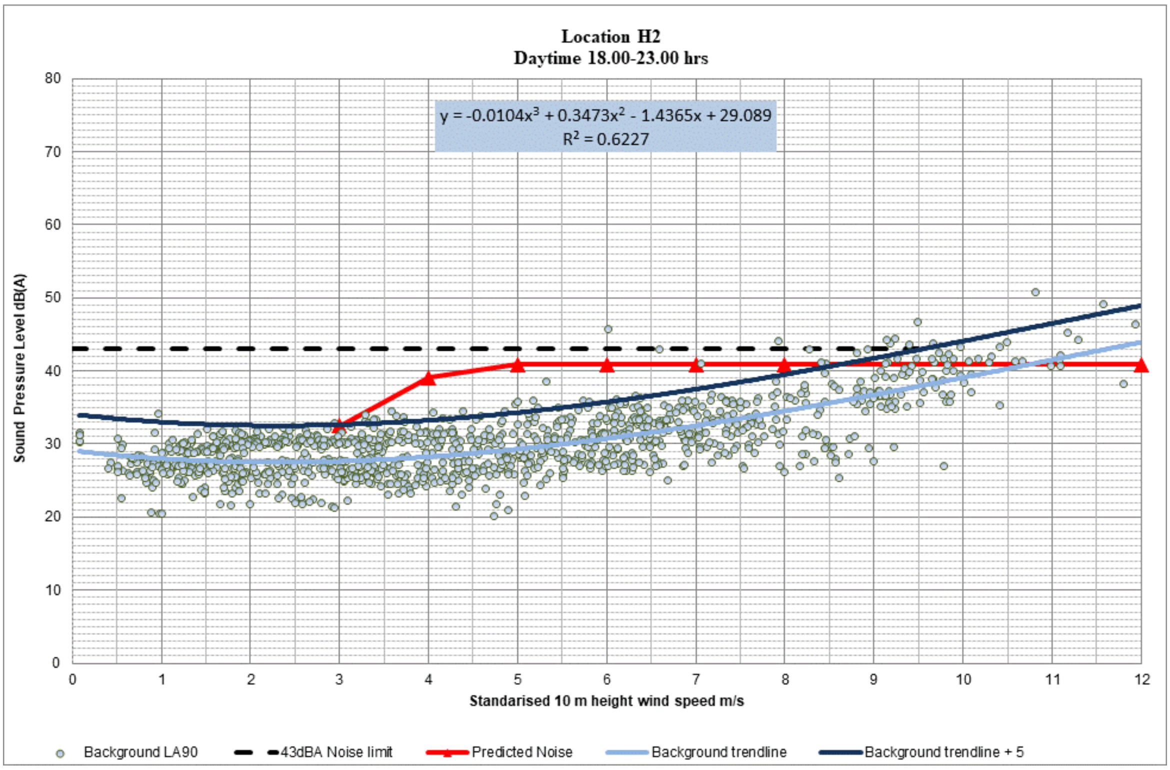

Chart 11.1: Quiet Daytime Background and Predicted Noise Levels at House H1

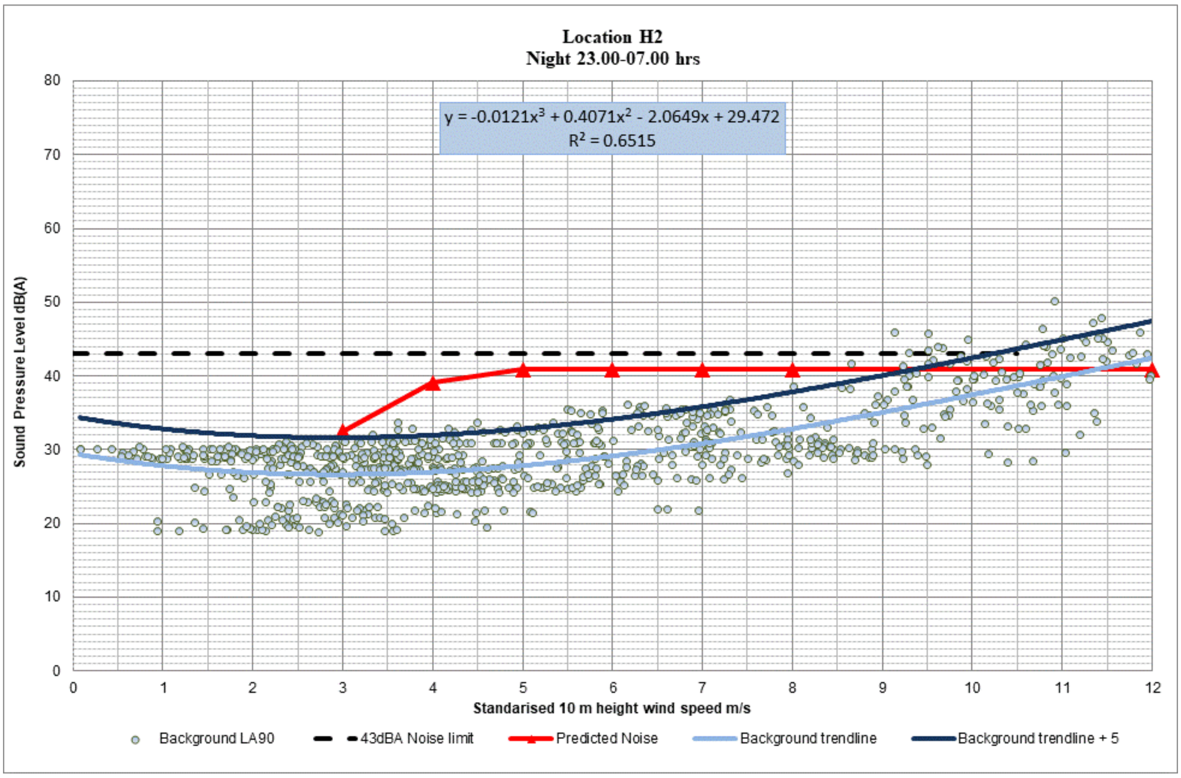

Chart 11.2: Night-time Background and Predicted Noise Levels at House H1

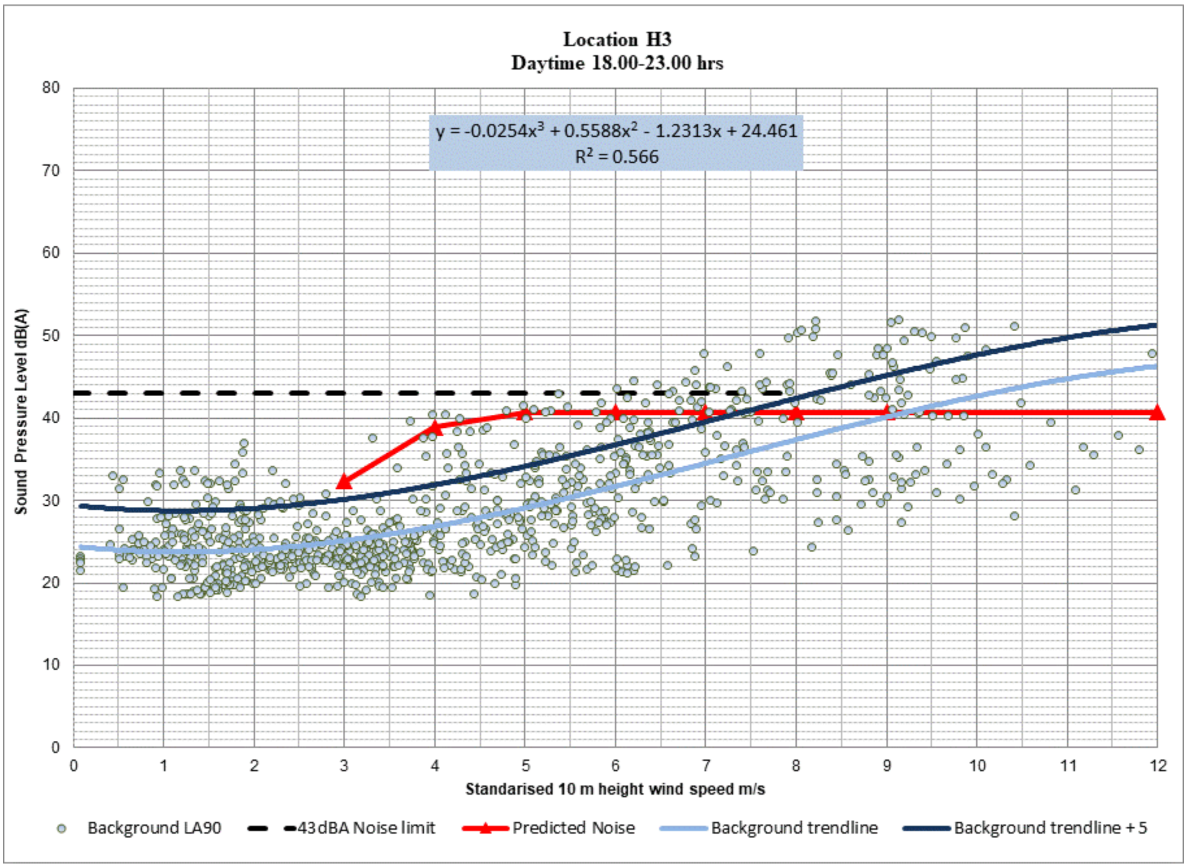

Chart 11.3: Quiet Daytime Background and Predicted Noise Levels at House H2

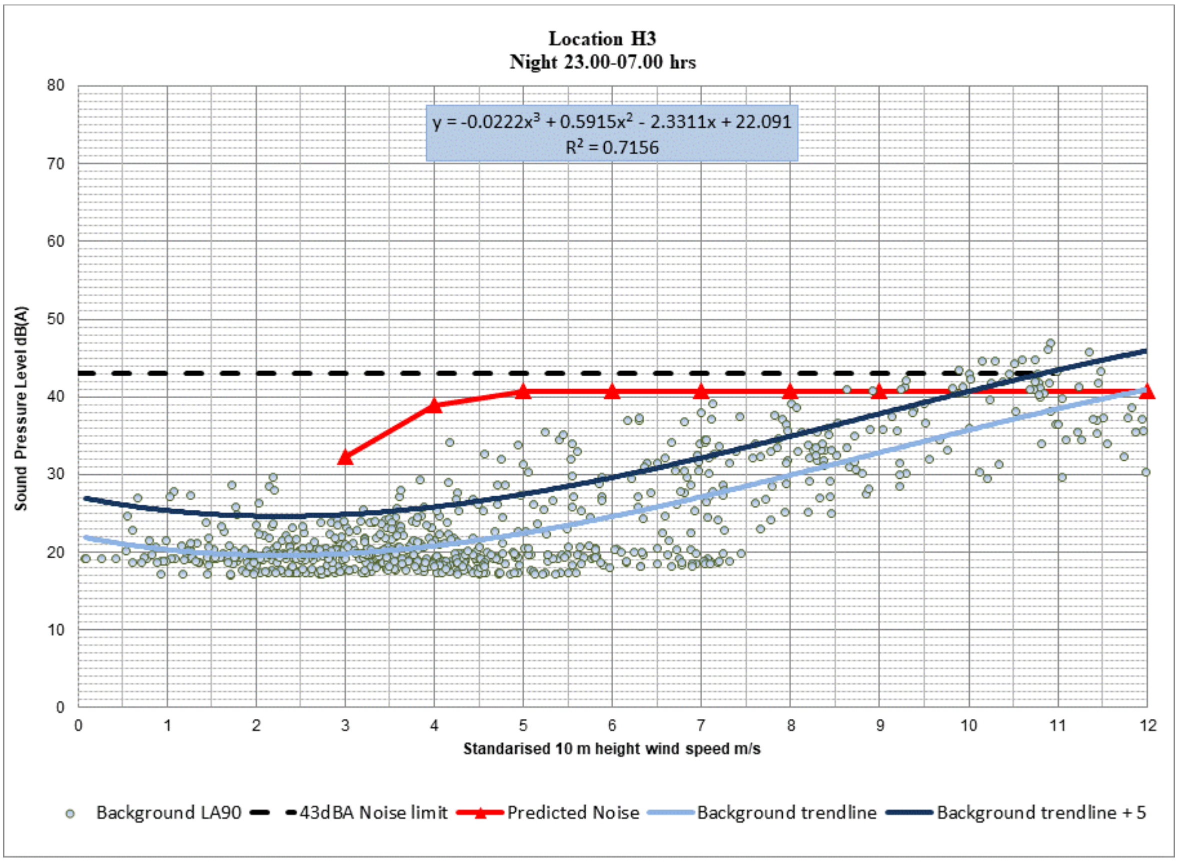

Chart 11.4: Night-time Background and Predicted Noise Levels at House H2

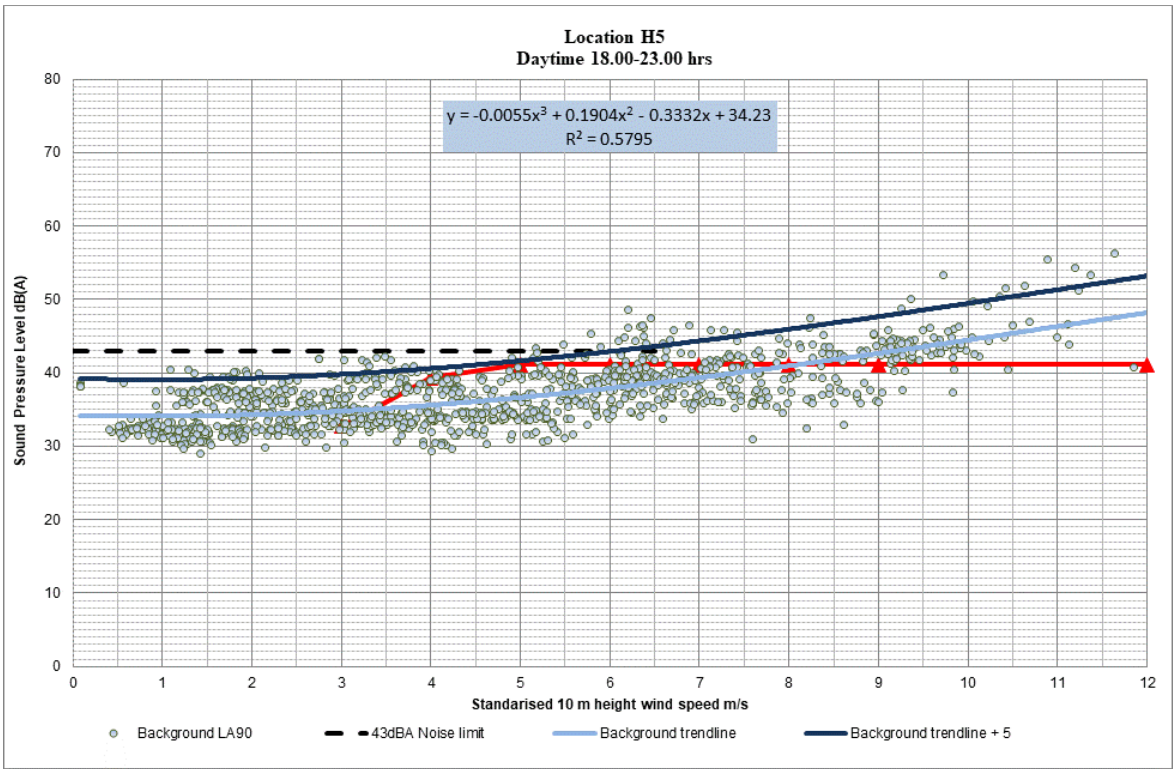

Chart 11.5: Quiet Daytime Background and Predicted Noise Levels at House H4

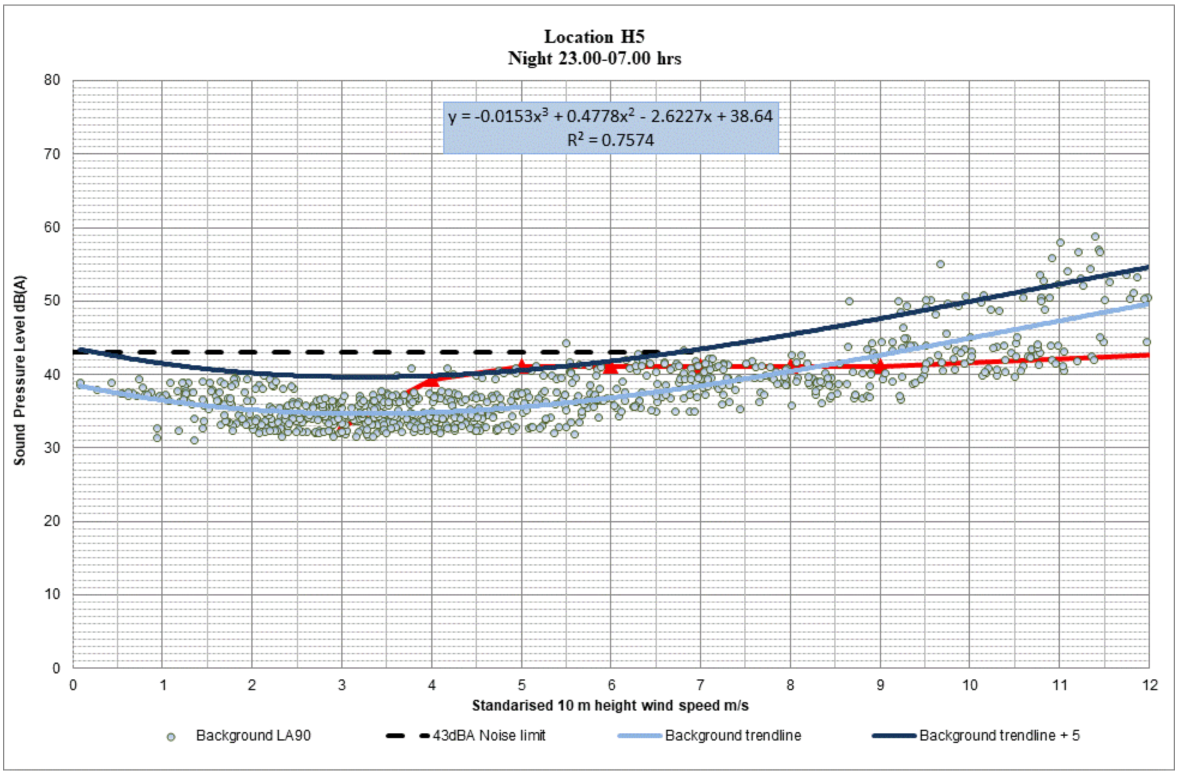

Chart 11.6: Night-time Background and Predicted Noise Levels at House H4

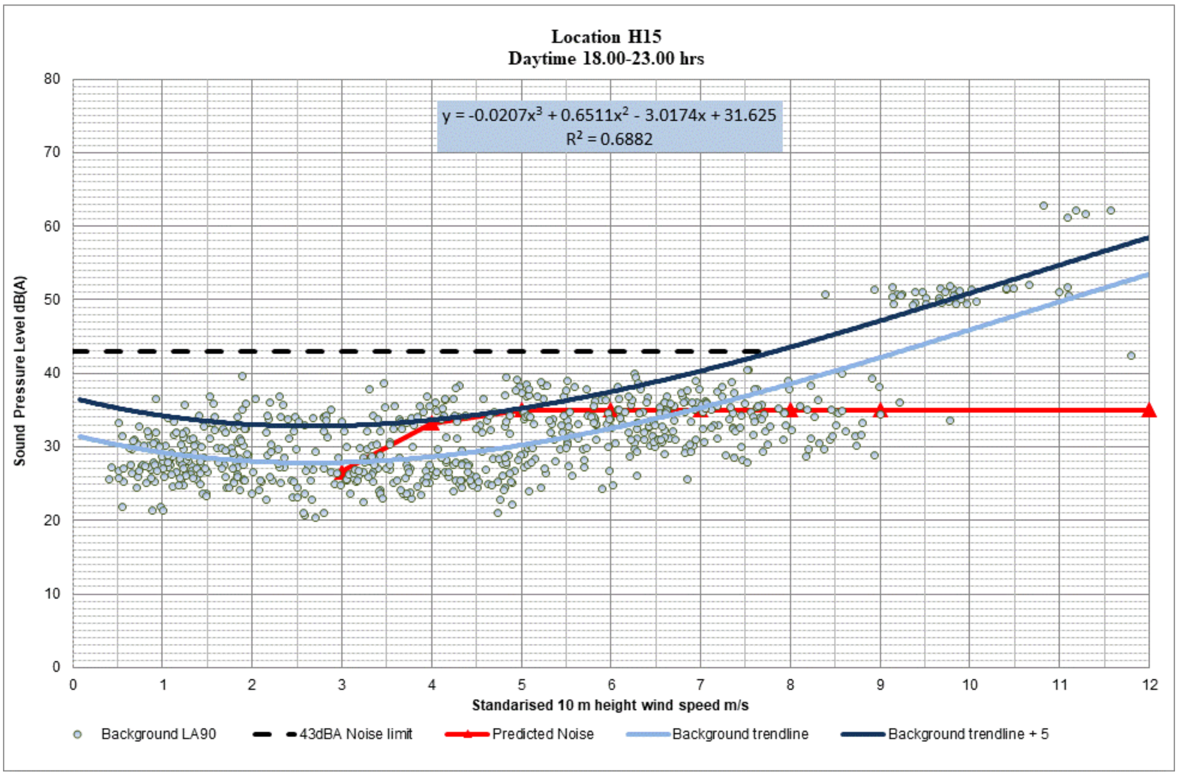

Chart 11.7: Quiet Daytime Background and Predicted Noise Levels at House H37

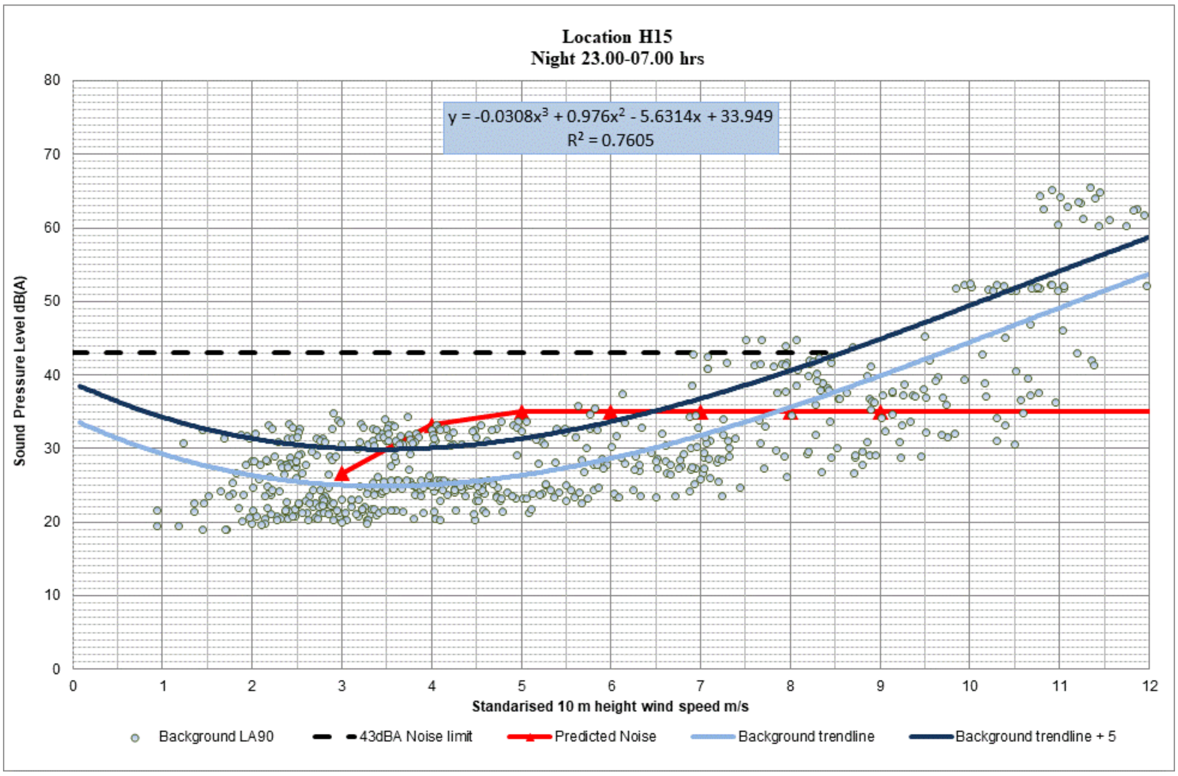

Chart 11.8: Night-time Background and Predicted Noise Levels at House H37

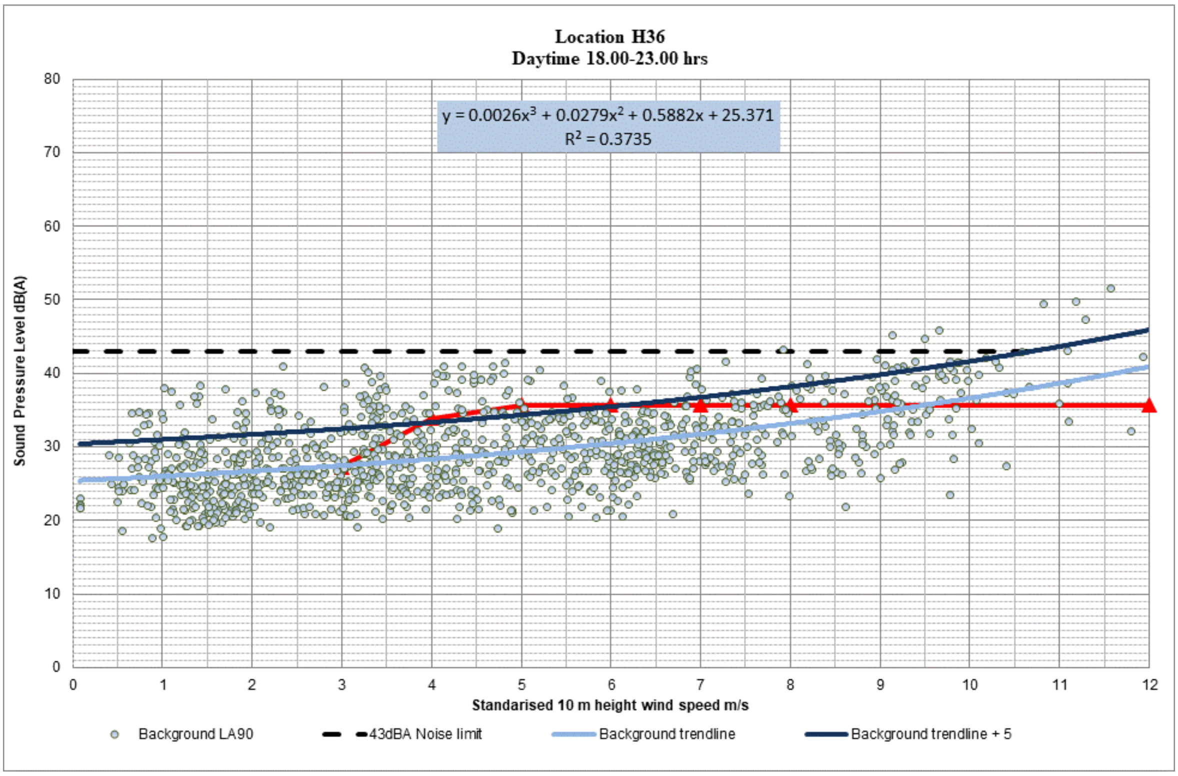

Chart 11.9: Quiet Daytime Background and Predicted Noise Levels at House H21

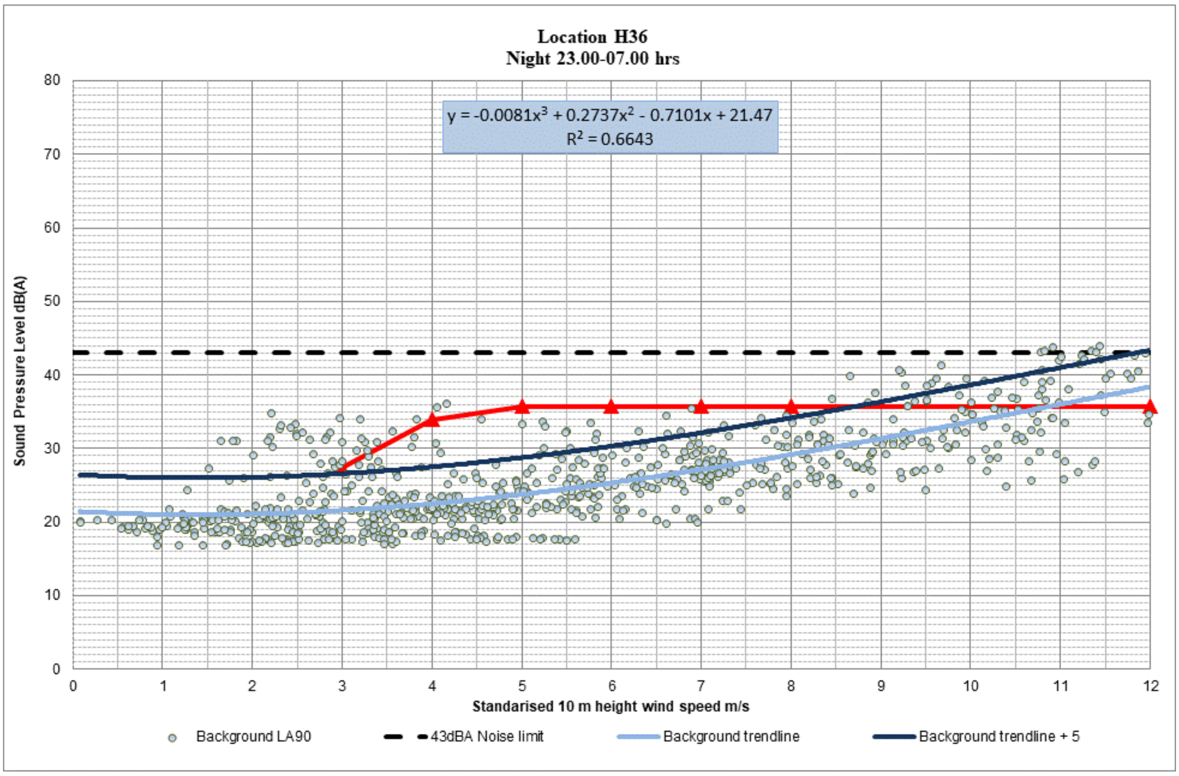

Chart 11.10: Night-time Background and Predicted Noise Levels at House H21

11.4.4 Cumulative Effects Assessment

An assessment of the cumulative effects of noise from the Development together with the nearby six turbines operational Derragh Wind Farm, located south of the Development has been undertaken.

11.4.4.1 Cumulative Assessment locations

The same receptor locations used for the Development are also used in the cumulative assessment. The assessment is a worst-case scenario with the assumption made that the predicted noise levels to receptors are downwind from both wind farms and individual turbines at the same time, a scenario that cannot occur in practice.

11.4.4.2 Noise Limits

The noise limits are the same as that used in **Table 11.13**, a limit of LA90 43dB for day and night.

11.4.4.3 Cumulative Noise levels

Table 11.18 gives details of the predicted cumulative noise levels for the nearest receptors to the Development.

Table 11.18: Predicted Cumulative Noise Levels for each Receptor

	ITM	ITM	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H1	517410	571864	33.1	39.4	41.2	41.2	41.3	41.3	41.3
H3	517734	572119	32.3	38.6	40.4	40.4	40.5	40.5	40.5
H4	515736	571186	34.5	40.6	42.2	42.4	42.6	42.7	42.7
H5	515395	574092	31.0	37.3	39.1	39.1	39.2	39.2	39.2
H6	517462	571790	32.5	38.8	40.6	40.6	40.7	40.7	40.7
H7	517467	571806	32.6	38.9	40.6	40.7	40.8	40.8	40.8
H8	515487	574211	30.3	36.7	38.4	38.4	38.5	38.5	38.5
H9	516372	574046	32.0	38.3	40.1	40.1	40.2	40.2	40.2
H10	517533	571990	32.8	39.2	40.9	41.0	41.0	41.0	41.0
H11	515143	574094	29.8	36.2	37.9	38.0	38.0	38.0	38.0
H12	515896	574342	29.8	36.2	37.9	38.0	38.0	38.0	38.0
H13	517811	571946	31.1	37.4	39.1	39.2	39.2	39.3	39.3
H14	514534	572878	31.7	38.1	39.9	39.9	39.9	39.9	39.9
H15	516142	574318	30.0	36.4	38.1	38.2	38.2	38.2	38.2
H16	514510	572872	31.5	37.9	39.7	39.7	39.7	39.7	39.7
H17	516223	574321	29.9	36.3	38.0	38.1	38.1	38.1	38.1

	ITM	ITM	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H18	514997	574130	28.9	35.3	37.1	37.1	37.1	37.1	37.1
H19	515702	570880	34.5	40.3	41.7	42.0	42.5	42.7	42.7
H20	514411	572890	30.8	37.2	39.0	39.0	39.0	39.0	39.0
H21	518556	572363	27.9	34.2	36.0	36.0	36.0	36.1	36.1
H22	517923	573934	28.9	35.3	37.1	37.1	37.1	37.1	37.1
H23	517883	573984	28.8	35.2	37.0	37.0	37.0	37.0	37.0
H24	514830	574098	28.3	34.7	36.5	36.5	36.5	36.5	36.5
H25	517613	571154	30.8	36.8	38.3	38.5	38.9	39.0	39.0
H26	514887	574194	28.0	34.4	36.2	36.2	36.2	36.2	36.2
H27	514265	570703	26.9	33.2	34.9	35.0	35.1	35.1	35.1
H28	518705	572403	26.9	33.2	35.0	35.0	35.1	35.1	35.1
H29	514728	570617	28.0	34.3	36.0	36.0	36.2	36.2	36.2
H30	517670	571142	30.6	36.6	38.1	38.3	38.7	38.8	38.8
H31	514223	570697	26.7	33.0	34.7	34.8	34.9	34.9	34.9
H32	518774	572454	26.6	32.9	34.7	34.7	34.8	34.8	34.8
H33	518384	573830	27.0	33.3	35.1	35.1	35.2	35.2	35.2
H34	514633	570556	27.4	33.6	35.3	35.4	35.6	35.6	35.6
H35	514379	570581	26.7	33.0	34.7	34.8	34.9	34.9	34.9
H36	514814	570551	28.0	34.2	35.9	36.0	36.1	36.2	36.2
H37	514777	570545	27.9	34.1	35.7	35.8	36.0	36.1	36.1
H38	515088	570586	29.1	35.2	36.9	37.0	37.2	37.3	37.3
H39	514187	570609	26.2	32.4	34.2	34.2	34.3	34.4	34.4
H40	514433	570535	26.7	33.0	34.7	34.7	34.9	34.9	34.9
H41	517124	574610	27.2	33.6	35.4	35.4	35.4	35.4	35.4
H42	518824	572353	26.2	32.5	34.2	34.3	34.3	34.4	34.4
H43	518107	574098	27.1	33.5	35.3	35.3	35.3	35.3	35.3
H44	516773	574652	27.4	33.8	35.6	35.6	35.6	35.6	35.6
H45	517869	574232	27.4	33.8	35.6	35.6	35.6	35.6	35.6
H46	514750	570477	27.4	33.6	35.3	35.4	35.5	35.6	35.6
H47	518434	573927	26.4	32.7	34.5	34.5	34.6	34.6	34.6
H48	517605	574420	27.2	33.6	35.4	35.4	35.4	35.4	35.4
H49	516256	574698	27.3	33.7	35.5	35.5	35.5	35.5	35.5
H50	517850	571155	29.6	35.6	37.1	37.3	37.7	37.8	37.8
H51	517890	571229	29.3	35.3	36.9	37.1	37.4	37.5	37.5
H52	514698	570464	27.2	33.4	35.1	35.2	35.3	35.4	35.4
H53	517210	574625	26.9	33.3	35.1	35.1	35.1	35.1	35.1

	ITM	ITM	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H54	514485	570469	26.6	32.8	34.5	34.6	34.7	34.8	34.8
H55	514590	570438	26.7	32.9	34.6	34.7	34.9	34.9	34.9
H56	518528	573917	25.9	32.2	34.0	34.0	34.1	34.1	34.1
H57	515290	570548	29.8	35.8	37.4	37.6	37.8	38.0	38.0
H58	514512	570431	26.5	32.7	34.4	34.5	34.6	34.7	34.7
H59	518930	572410	25.6	31.9	33.6	33.7	33.8	33.8	33.8
H60	516878	574725	26.8	33.2	35.0	35.0	35.0	35.0	35.0
H61	517955	571250	29.0	35.0	36.6	36.8	37.0	37.2	37.2
H62	514394	573903	27.1	33.5	35.3	35.3	35.3	35.3	35.3
H63	514059	570556	25.5	31.7	33.5	33.5	33.6	33.7	33.7
H64	518941	572403	25.6	31.9	33.6	33.7	33.8	33.8	33.8
H65	518321	574087	26.2	32.5	34.3	34.3	34.4	34.4	34.4
H66	518957	572447	25.5	31.8	33.5	33.6	33.6	33.7	33.7
H67	518976	572514	25.4	31.8	33.5	33.5	33.6	33.6	33.6
H68	518097	574217	26.5	32.9	34.7	34.7	34.7	34.7	34.7
H69	518989	572432	25.3	31.6	33.3	33.4	33.5	33.5	33.5
H70	519003	572456	25.3	31.6	33.3	33.4	33.4	33.5	33.5
H71	518987	572390	25.3	31.6	33.3	33.4	33.5	33.5	33.5
H72	519042	572577	25.1	31.4	33.1	33.2	33.2	33.3	33.3
H73	519032	572454	25.1	31.4	33.1	33.2	33.3	33.3	33.3
H74	518159	574273	26.1	32.4	34.2	34.2	34.2	34.3	34.3
H75	517248	574791	25.9	32.3	34.1	34.1	34.1	34.1	34.1
H76	514292	570334	25.3	31.5	33.2	33.3	33.4	33.5	33.5
H77	519031	572269	25.0	31.3	33.0	33.1	33.1	33.2	33.2
H78	514600	574467	25.5	31.9	33.7	33.7	33.7	33.7	33.7
H79	519083	573399	24.3	30.6	32.4	32.4	32.5	32.5	32.5
H80	518088	574393	25.8	32.1	33.9	33.9	33.9	34.0	34.0
H81	514828	574738	25.0	31.4	33.2	33.2	33.2	33.2	33.2
H82	515800	575045	25.1	31.5	33.3	33.3	33.3	33.3	33.3
H83	514232	574023	25.9	32.3	34.1	34.1	34.1	34.1	34.1
H84	516832	574974	25.4	31.8	33.6	33.6	33.6	33.6	33.6
H85	515011	570183	26.9	33.0	34.6	34.8	35.0	35.1	35.1
H86	516572	574987	25.5	31.9	33.7	33.7	33.7	33.7	33.7
H87	514991	574930	24.5	30.9	32.7	32.7	32.7	32.7	32.7
H88	516684	575011	25.3	31.7	33.5	33.5	33.5	33.5	33.5
H89	518743	574118	24.2	30.6	32.4	32.4	32.4	32.4	32.4
H90	514914	574938	24.2	30.6	32.4	32.4	32.4	32.4	32.4

	ITM	ITM	3m/s	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H91	514204	570162	24.4	30.6	32.3	32.4	32.5	32.6	32.6
H92	514308	574396	24.7	31.1	32.9	32.9	32.9	32.9	32.9
H93	515847	575193	24.4	30.8	32.6	32.6	32.6	32.6	32.6
H94	517147	575057	24.6	31.0	32.8	32.8	32.8	32.8	32.8
H95	514310	574440	24.6	31.0	32.8	32.8	32.8	32.8	32.8
H96	516360	570045	32.0	37.6	38.8	39.3	39.9	40.2	40.2
H97	515285	570118	27.6	33.6	35.2	35.4	35.7	35.8	35.8
H98	517237	575083	24.4	30.8	32.6	32.6	32.6	32.6	32.6
H99	518853	574198	23.5	29.9	31.7	31.7	31.7	31.7	31.7
H100	514172	569993	23.7	29.9	31.6	31.7	31.8	31.9	31.9
H101	514126	574409	24.0	30.4	32.2	32.2	32.2	32.2	32.2
H102	519337	573772	22.4	28.8	30.5	30.6	30.6	30.6	30.6
H103	515882	575406	23.3	29.7	31.4	31.5	31.5	31.5	31.5
H104	519423	572097	23.0	29.2	30.9	31.0	31.1	31.2	31.2
H105	515128	575313	22.9	29.3	31.0	31.1	31.1	31.1	31.1
H106	519384	571987	23.0	29.3	31.0	31.1	31.2	31.2	31.2

A noise contour map of the cumulative effects of all turbines is presented with a maximum sound power output at a wind speed of 8m/s at 10m height in **Figure 11.2**. The contour map assumes that all turbines are simultaneously downwind at the same time to each location which results in an overprediction of the noise levels.

11.4.4.4 Cumulative Noise Assessment

The assessment was made with predicted operational noise levels from the Development against noise limits in the Wind Energy Development Guidelines 2006. All predicted noise levels are within the noise limits. **Table 11.19** gives the difference between the predicted cumulative noise levels in **Table 11.18** and noise limits for each receptor. A negative margin indicates that the predicted noise levels are within the lower fixed 43dBA limit which means the levels are within the day and night limits.

Table 11.19: Margin between Predicted Cumulative Noise Levels and Lower Fixed Limit of 43dBA

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H1	517410	571864	-9.9	-3.6	-1.8	-1.7	-1.7	-1.7	-1.7
H2	517402	573794	-10.4	-4.1	-2.3	-2.2	-2.2	-2.2	-2.2
H3	517734	572119	-10.7	-4.4	-2.6	-2.5	-2.5	-2.5	-2.5
H4	515736	571186	-8.5	-2.4	-0.6	-0.3	-0.3	-0.3	-0.3
H6	517462	571790	-10.5	-4.2	-2.4	-2.3	-2.3	-2.3	-2.3
H7	517467	571806	-10.4	-4.1	-2.3	-2.2	-2.2	-2.2	-2.2
H8	515487	574211	-12.7	-6.3	-4.5	-4.5	-4.5	-4.5	-4.5
H9	516372	574046	-11.0	-4.7	-2.9	-2.8	-2.8	-2.8	-2.8
H10	517533	571990	-10.2	-3.8	-2.0	-2.0	-2.0	-2.0	-2.0
H11	515143	574094	-13.2	-6.8	-5.0	-5.0	-5.0	-5.0	-5.0
H12	515896	574342	-13.2	-6.8	-5.0	-5.0	-5.0	-5.0	-5.0
H13	517811	571946	-11.9	-5.6	-3.8	-3.7	-3.7	-3.7	-3.7
H14	514534	572878	-11.3	-4.9	-3.1	-3.1	-3.1	-3.1	-3.1
H15	516142	574318	-13.0	-6.6	-4.8	-4.8	-4.8	-4.8	-4.8
H16	514510	572872	-11.5	-5.1	-3.3	-3.3	-3.3	-3.3	-3.3
H17	516223	574321	-13.1	-6.7	-4.9	-4.9	-4.9	-4.9	-4.9
H18	514997	574130	-14.1	-7.7	-5.9	-5.9	-5.9	-5.9	-5.9
H19	515702	570880	-8.5	-2.7	-0.9	-0.3	-0.3	-0.3	-0.3
H20	514411	572890	-12.2	-5.8	-4.0	-4.0	-4.0	-4.0	-4.0
H21	518556	572363	-15.1	-8.8	-7.0	-6.9	-6.9	-6.9	-6.9
H22	517923	573934	-14.1	-7.7	-5.9	-5.9	-5.9	-5.9	-5.9
H23	517883	573984	-14.2	-7.8	-6.0	-6.0	-6.0	-6.0	-6.0
H24	514830	574098	-14.7	-8.3	-6.5	-6.5	-6.5	-6.5	-6.5
H25	517613	571154	-12.2	-6.2	-4.4	-4.0	-4.0	-4.0	-4.0
H26	514887	574194	-15.0	-8.6	-6.8	-6.8	-6.8	-6.8	-6.8
H27	514265	570703	-16.1	-9.8	-8.0	-7.9	-7.9	-7.9	-7.9
H28	518705	572403	-16.1	-9.8	-8.0	-7.9	-7.9	-7.9	-7.9
H29	514728	570617	-15.0	-8.7	-6.9	-6.8	-6.8	-6.8	-6.8
H30	517670	571142	-12.4	-6.4	-4.6	-4.2	-4.2	-4.2	-4.2
H31	514223	570697	-16.3	-10.0	-8.2	-8.1	-8.1	-8.1	-8.1
H32	518774	572454	-16.4	-10.1	-8.3	-8.2	-8.2	-8.2	-8.2
H33	518384	573830	-16.0	-9.7	-7.9	-7.8	-7.8	-7.8	-7.8
H34	514633	570556	-15.6	-9.4	-7.6	-7.4	-7.4	-7.4	-7.4
H35	514379	570581	-16.3	-10.0	-8.2	-8.1	-8.1	-8.1	-8.1

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H36	514814	570551	-15.0	-8.8	-7.0	-6.8	-6.8	-6.8	-6.8
H37	514777	570545	-15.1	-8.9	-7.1	-6.9	-6.9	-6.9	-6.9
H38	515088	570586	-13.9	-7.8	-6.0	-5.7	-5.7	-5.7	-5.7
H39	514187	570609	-16.8	-10.6	-8.8	-8.6	-8.6	-8.6	-8.6
H40	514433	570535	-16.3	-10.0	-8.2	-8.1	-8.1	-8.1	-8.1
H41	517124	574610	-15.8	-9.4	-7.6	-7.6	-7.6	-7.6	-7.6
H42	518824	572353	-16.8	-10.5	-8.7	-8.6	-8.6	-8.6	-8.6
H43	518107	574098	-15.9	-9.5	-7.7	-7.7	-7.7	-7.7	-7.7
H44	516773	574652	-15.6	-9.2	-7.4	-7.4	-7.4	-7.4	-7.4
H45	517869	574232	-15.6	-9.2	-7.4	-7.4	-7.4	-7.4	-7.4
H46	514750	570477	-15.6	-9.4	-7.6	-7.4	-7.4	-7.4	-7.4
H47	518434	573927	-16.6	-10.3	-8.5	-8.4	-8.4	-8.4	-8.4
H48	517605	574420	-15.8	-9.4	-7.6	-7.6	-7.6	-7.6	-7.6
H49	516256	574698	-15.7	-9.3	-7.5	-7.5	-7.5	-7.5	-7.5
H50	517850	571155	-13.4	-7.4	-5.6	-5.2	-5.2	-5.2	-5.2
H51	517890	571229	-13.7	-7.7	-5.9	-5.5	-5.5	-5.5	-5.5
H52	514698	570464	-15.8	-9.6	-7.8	-7.6	-7.6	-7.6	-7.6
H53	517210	574625	-16.1	-9.7	-7.9	-7.9	-7.9	-7.9	-7.9
H54	514485	570469	-16.4	-10.2	-8.4	-8.2	-8.2	-8.2	-8.2
H55	514590	570438	-16.3	-10.1	-8.3	-8.1	-8.1	-8.1	-8.1
H56	518528	573917	-17.1	-10.8	-9.0	-8.9	-8.9	-8.9	-8.9
H57	515290	570548	-13.2	-7.2	-5.4	-5.0	-5.0	-5.0	-5.0
H58	514512	570431	-16.5	-10.3	-8.5	-8.3	-8.3	-8.3	-8.3
H59	518930	572410	-17.4	-11.1	-9.3	-9.2	-9.2	-9.2	-9.2
H60	516878	574725	-16.2	-9.8	-8.0	-8.0	-8.0	-8.0	-8.0
H61	517955	571250	-14.0	-8.0	-6.2	-5.8	-5.8	-5.8	-5.8
H62	514394	573903	-15.9	-9.5	-7.7	-7.7	-7.7	-7.7	-7.7
H63	514059	570556	-17.5	-11.3	-9.5	-9.3	-9.3	-9.3	-9.3
H64	518941	572403	-17.4	-11.1	-9.3	-9.2	-9.2	-9.2	-9.2
H65	518321	574087	-16.8	-10.5	-8.7	-8.6	-8.6	-8.6	-8.6
H66	518957	572447	-17.5	-11.2	-9.4	-9.3	-9.3	-9.3	-9.3
H67	518976	572514	-17.6	-11.2	-9.4	-9.4	-9.4	-9.4	-9.4
H68	518097	574217	-16.5	-10.1	-8.3	-8.3	-8.3	-8.3	-8.3
H69	518989	572432	-17.7	-11.4	-9.6	-9.5	-9.5	-9.5	-9.5
H70	519003	572456	-17.7	-11.4	-9.6	-9.5	-9.5	-9.5	-9.5
H71	518987	572390	-17.7	-11.4	-9.6	-9.5	-9.5	-9.5	-9.5

House ID	ITM Easting	ITM Northing	3m/s dBA	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H72	519042	572577	-17.9	-11.6	-9.8	-9.7	-9.7	-9.7	-9.7
H73	519032	572454	-17.9	-11.6	-9.8	-9.7	-9.7	-9.7	-9.7
H74	518159	574273	-16.9	-10.6	-8.8	-8.7	-8.7	-8.7	-8.7
H78	514600	574467	-17.5	-11.1	-9.3	-9.3	-9.3	-9.3	-9.3
H79	519083	573399	-18.7	-12.4	-10.6	-10.5	-10.5	-10.5	-10.5
H80	518088	574393	-17.2	-10.9	-9.1	-9.0	-9.0	-9.0	-9.0
H81	514828	574738	-18.0	-11.6	-9.8	-9.8	-9.8	-9.8	-9.8
H82	515800	575045	-17.9	-11.5	-9.7	-9.7	-9.7	-9.7	-9.7
H83	514232	574023	-17.1	-10.7	-8.9	-8.9	-8.9	-8.9	-8.9
H84	516832	574974	-17.6	-11.2	-9.4	-9.4	-9.4	-9.4	-9.4
H85	515011	570183	-16.1	-10.0	-8.2	-7.9	-7.9	-7.9	-7.9
H86	516572	574987	-17.5	-11.1	-9.3	-9.3	-9.3	-9.3	-9.3
H87	514991	574930	-18.5	-12.1	-10.3	-10.3	-10.3	-10.3	-10.3
H88	516684	575011	-17.7	-11.3	-9.5	-9.5	-9.5	-9.5	-9.5
H89	518743	574118	-18.8	-12.4	-10.6	-10.6	-10.6	-10.6	-10.6
H90	514914	574938	-18.8	-12.4	-10.6	-10.6	-10.6	-10.6	-10.6
H91	514204	570162	-18.6	-12.4	-10.6	-10.4	-10.4	-10.4	-10.4
H92	514308	574396	-18.3	-11.9	-10.1	-10.1	-10.1	-10.1	-10.1
H93	515847	575193	-18.6	-12.2	-10.4	-10.4	-10.4	-10.4	-10.4
H94	517147	575057	-18.4	-12.0	-10.2	-10.2	-10.2	-10.2	-10.2
H95	514310	574440	-18.4	-12.0	-10.2	-10.2	-10.2	-10.2	-10.2
H96	516360	570045	-11.0	-5.4	-3.6	-2.8	-2.8	-2.8	-2.8
H97	515285	570118	-15.4	-9.4	-7.6	-7.2	-7.2	-7.2	-7.2
H98	517237	575083	-18.6	-12.2	-10.4	-10.4	-10.4	-10.4	-10.4
H99	518853	574198	-19.5	-13.1	-11.3	-11.3	-11.3	-11.3	-11.3
H100	514172	569993	-19.3	-13.1	-11.3	-11.1	-11.1	-11.1	-11.1
H101	514126	574409	-19.0	-12.6	-10.8	-10.8	-10.8	-10.8	-10.8
H102	519337	573772	-20.6	-14.2	-12.4	-12.4	-12.4	-12.4	-12.4
H103	515882	575406	-19.7	-13.3	-11.5	-11.5	-11.5	-11.5	-11.5
H104	519423	572097	-20.0	-13.8	-12.0	-11.8	-11.8	-11.8	-11.8
H105	515128	575313	-20.1	-13.7	-11.9	-11.9	-11.9	-11.9	-11.9
H106	519384	571987	-20.0	-13.7	-11.9	-11.8	-11.8	-11.8	-11.8

11.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

11.5.1 Construction Noise Mitigation

No significant construction noise effects have been identified. However, where the grid route is closer than 20m to a receptor, mitigation measures will be put in place (refer to **Section 11.4.1**). General guidance for controlling construction noise through the use of good practice given in BS 5228 will be followed, including the placement of an acoustic barrier between the works and receptor where activity is being carried out within 20m. During construction of the Development, activity shall be limited to daytime given in the NRA guidelines, except where delivery of large transport loads such as the turbines, where it may be necessary to transport outside of daytime hours.

During decommissioning of the Development, noise levels are likely to be no more than predicted in **Table 11.15** as similar plant will be utilised. Any legislation, guidance or best practice relevant at the time of decommissioning will be complied with.

11.5.1.1 Residual Construction and Decommissioning Effects

The residual effects are the same as the construction and decommissioning effects identified in this assessment.

11.5.2 Operational Noise Mitigation

The Development has been designed to comply with best practice guidelines, the Wind Energy Development Guidelines 2006 and the noise limits given in the planning conditions for the adjoining wind farm which is dealt with in cumulative impacts. All 14 No. turbines in the Development will have as standard STE to reduce noise levels so no mitigation is required.

A warranty will be provided by the manufacturer of the turbine selected for the Development in order to ensure that the turbine selected does not require a tonal noise correction under best practice.

11.5.2.1 Residual Operational Effects

The residual effects are the same as the operational effects identified in this assessment.

11.5.3 Cumulative Effects

The cumulative effects of the permitted Derragh Wind Farm, located within 3km have been predicted and assessed and found to be in compliance with the noise limits set in the Wind Energy Development Guidelines 2006.

11.6 SUMMARY OF EFFECTS

Table 11.20 below summarises the effects.

Table 11.20: Summary of Effects

	Quality	Significance	Duration
Construction noise	Negative	Slight	Temporary
Blasting Vibration	Negative	Not Significant	Momentary
Operational Noise	Negative	Not Significant	Long Term

11.7 STATEMENT OF SIGNIFICANCE

This Section has assessed the significance of the potential effects of the Development during construction, operation and decommissioning.

The effects of noise from the operation of the Development has been assessed using the methodology in the 2006 Guidelines, the methodology described in ETSU-R-97 and the IOA Good Practice Guide. Noise levels during operation of the Development have been predicted using the best practice calculation technique, compared with the noise limits in the 2006 Guidelines.

There has been a consultation process in relation to the revision of the 2019 Wind Energy Development Guidelines. This document provided the basis for a discussion on amendments of the noise limits applicable to wind turbine developments. It is understood that there could be revisions to the draft consultation documents, however a mitigation strategy to incorporate a reduction in sound power level outputs with respect to directionality can be put in place to comply with any specific variation in noise limit levels if new guidelines are adopted. All turbines have software control incorporated so that the sound power levels can be reduced by direction and energy output.

Noise during construction, operation and decommissioning of the wind farm will be managed to comply with best practice, legislation and guidelines current at that time so that effects are not significant.