11. NOISE AND VIBRATION

11.1 Introduction

11.1.1 Background & Objectives

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impacts associated with the proposed Coole Wind Farm (the 'Proposed Development'). The Proposed Development comprises up to 15 no. wind turbines with a tip height of up to 175 metres, an onsite electricity substation, construction compound and all ancillary infrastructure including the grid connection to the National Grid. A full description of the Proposed Development is provided in Chapter 4 of this EIAR.

There are 18 no. occupied dwellings located within one kilometre of the proposed turbine locations. The closest occupied dwelling H14 (i.e. dwelling not involved with the Proposed Development) is located at a distance of approx. 700 metres from the nearest proposed turbine T11. There are 2 no. dwellings, H18 & H24 which are located at distances of 638m and 679m from T15 respectively however these are individuals involved with the Proposed Development.

Noise impact assessments have been prepared for both the construction and operational phases of the Proposed Development to the nearest NSLs. To inform this assessment background noise levels have been measured at locations, representative of the nearest NSLs in the vicinity of the site to assess the potential impacts associated with the operation of the Proposed Development. The current *Wind Energy Development Guidelines for Planning Authorities*, published by the Department of the Environment, Heritage and Local Government in 2006, defines a noise sensitive location as any occupied dwelling house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational amenity importance.

There are no existing or permitted wind turbines located within 10 kilometres of the Proposed Development site, therefore it is not necessary to consider cumulative noise and/or vibration impacts in this assessment. Other developments that did not significantly contribute to cumulative noise levels surrounding the site were excluded from the assessment in line with guidance set out in the IOA Good Practice Guide. Further details on each of these developments is provided in Chapter 2 of this EIAR.

The cumulative impact of the different elements of the Proposed Development is considered in 11.5.7.

11.1.2 Statement of Authority

This chapter of the EIAR has been prepared by the following staff of AWN Consulting Ltd:

Mike Simms

Mike Simms (Senior Acoustic Consultant) holds a BE and MEngSc in Mechanical Engineering, and is a member of the Institute of Acoustics (MIOA) and of the Institution of Engineering and Technology (MIEI). Mike has worked in the field of acoustics for over 19 years. He has extensive experience in all aspects of environmental surveying, noise modelling and impact assessment for various sectors including, wind energy, industrial, commercial and residential.

Dermot Blunnie

Dermot Blunnie (Senior Acoustic Consultant) holds a BEng (Hons) in Sound Engineering, MSc in Applied Acoustics and has completed the Institute of Acoustics (IOA) Diploma in Acoustics and Noise

Control. He has been working in the field of acoustics since 2008 and is a member of the Institute of Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA). He has extensive knowledge and experience in relation to commissioning noise monitoring and impact assessment of wind farms as well as a detailed knowledge of acoustic standards and proprietary noise modelling software packages. He has commissioned noise surveys and completed noise impact assessments for numerous wind farm projects within Ireland.

11.2 Fundamentals of Acoustics

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. To take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels (SPL) is 0dB (for the threshold of hearing) to 120dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3 dB.

The frequency of sound is the rate at which a sound wave oscillates is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz. In order to rank the SPL of various noise sources, the measured level has to be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. The 'A-weighting' system defined in the international standard, BS ISO 226:2003 Acoustics. Normal Equal-loudness Level Contours has been found to provide the best correlations with human response to perceived loudness. SPL's measured using 'A-weighting' are expressed in terms of dB(A).

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 11-1.

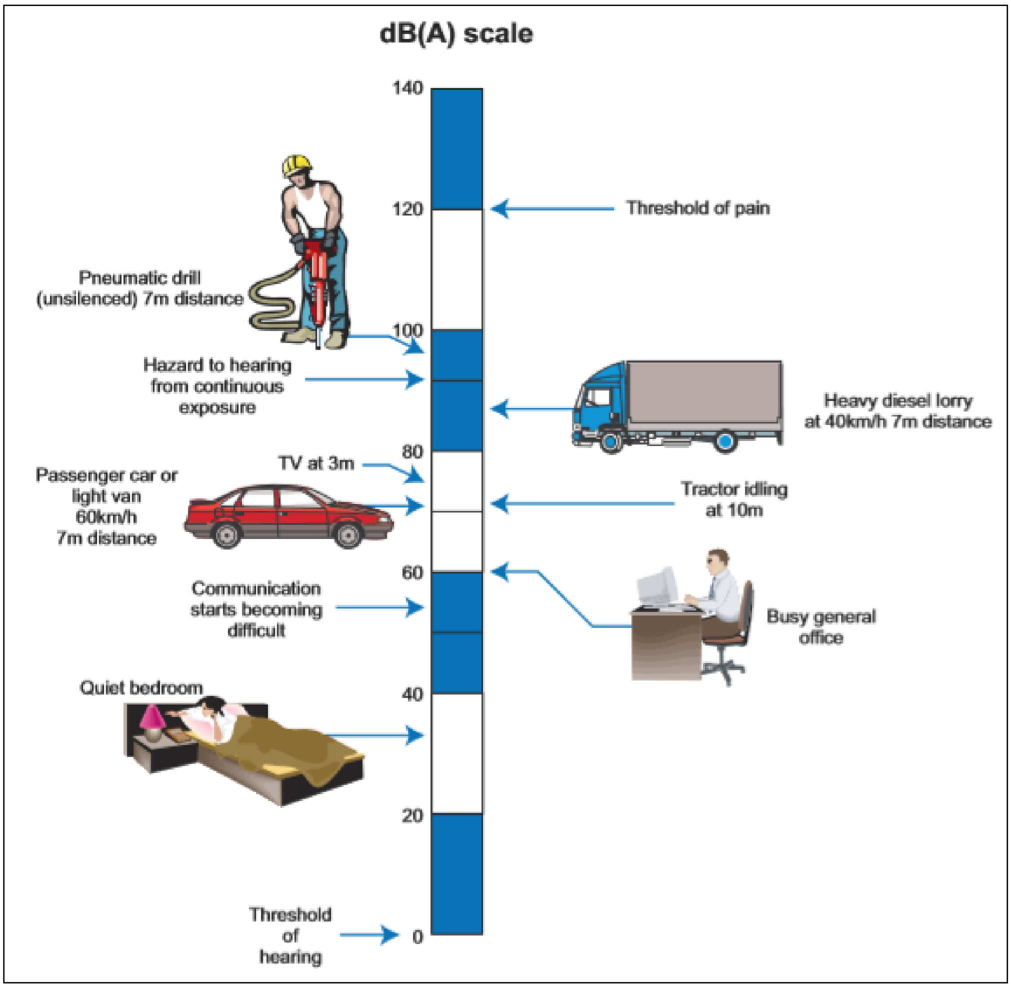


Figure 11-1 The level of typical common sounds on the dB(A) scale (NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2004)

For a glossary of terms used in this chapter please refer to Appendix 11-1.

11.3 Assessment Methodology

The assessment of impacts has been undertaken with reference to the most appropriate guidance documents relating to noise and vibration for both the operational and construction phases of the Proposed Development, which are set out within the relevant sections of this chapter.

In addition to the specific guidance documents outlined below, the Environmental Impact Assessment (EIA) guidelines listed in Section 1.7.2 of Chapter 1 were considered and consulted for the purposes of preparing this EIAR chapter.

The methodology adopted for this noise impact assessment is summarised as follows:

- Review of appropriate guidance to identify appropriate noise and vibration criteria for both the construction and operational phases;
- Characterise the receiving environment through baseline noise surveys at various NSLs surrounding the Proposed Development;
- Undertake predictive calculations to assess the potential impacts associated with the construction phase of the Proposed Development at NSLs;
- Undertake predictive calculations to assess the potential impacts associated with the operational of the Proposed Development at NSLs; evaluate the potential noise and vibration impacts and effects;

- Specify mitigation measures to reduce, where necessary, the identified potential outward impacts relating to noise and vibration from the Proposed Development; and
- Describe the significance of the residual noise and vibration effects associated with the Proposed Development.

11.3.1 EPA Description of Effects

The significance of effects of the Proposed Development shall be described in accordance with the EPA guidance document *Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR), Draft, August 2017*. Details of the methodology for describing the significant of the effects are provided in Chapter 1 – Introduction.

The effects associated with the Proposed Development are described with respect to the EPA guidance in the relevant sections of this chapter.

11.3.2 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

11.3.2.1 Construction and Decommissioning Phase

11.3.2.1.1 *Construction Noise*

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. Local authorities normally control construction activities by imposing limits on the hours of construction works and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the *British Standard 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*.

The approach adopted here calls for the designation of a NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded (construction noise only) at the façade of residential, noise sensitive locations, indicates a potential significant noise impact is associated with the construction activities.

Table 11-1 sets out the values which, when exceeded, potentially signify a significant effect at the facades of residential receptors as recommended by BS 5228 – 1. These levels relate to construction noise only.

Table 11-1 Example Threshold of Potential Significant Effect at Noise Sensitive Locations

Assessment category and threshold value period (T)	Threshold values, $L_{Aeq,T}$ dB		
	Category A Note A	Category B Note B	Category C Note C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends Note D	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The following assessment method is only valid for residential properties.

For the appropriate period (e.g. daytime) the ambient noise level is determined and rounded to the nearest 5 dB. In this instance, with the rural nature of the site, properties near the Proposed Development have daytime ambient noise levels that typically range from 45 to 55 dB $L_{Aeq,1hr}$. Therefore, as a precautionary approach, all properties will be afforded a Category A designation.

See Section 11.5.2 for the detailed assessment of construction noise in relation to the Proposed Development. If the specific construction noise level exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,T}$ during daytime periods) then a significant effect is deemed to have occurred.

11.3.2.1.2 Additional Vehicular Activity on Public Roads

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the Proposed Development will make use of existing roads already carrying traffic volumes, it is appropriate to assess the calculated increase in traffic noise levels that will arise because of vehicular movements associated with the Proposed Development. To assist with the interpretation of the noise associated with additional vehicular traffic on public roads, Table 11-2, adapted from *Design Manual for Roads and Bridges (DMRB*), Highways England Company Limited, Transport Scotland, The Welsh Government and The Department for Regional Development (Northern Ireland), 2019, offers guidance as to the likely impact in the long-term associated with any change in traffic noise level.

Table 11-2 Likely Impacts Associated with Change in Traffic Noise Level (Source DMRB, 2019)

Change in Sound Level dB(A)	Magnitude of Impact	EPA Significance of Effect
0	No Change	Imperceptible
0.1 – 0.9	Negligible	Not significant
1.0 – 2.9	Minor	Slight/Moderate
3.0 – 4.9	Moderate	Significant
5+	Major	Very Significant

The guidance outlined in Table 11-2 will be used to assess the predicted increases in traffic levels on public roads associated with the construction of the Proposed Development. Where an impact is identified due to the change in traffic noise level, reference will be made to the overall predicted noise level from construction traffic in the context of the construction noise criteria outlined in Section 11.3.2.1.

11.3.2.1.3 Construction Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to the Proposed Development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (1993); and
- BS 5228 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (2009+A1:2014).

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above.

BS 5228 recommends that, for soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above than 15 Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is generated the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (NRA, 2004) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 11-3.

Table 11-3 Allowable Transient Vibration at Properties

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

11.3.2.2 Operational Phase

11.3.2.2.1 *Noise*

The noise assessment summarised in the following sections has been based on guidance in relation to acceptable levels of noise from wind farms as contained in the document "*Wind Energy Development Guidelines*" published by the Department of the Environment, Heritage and Local Government in 2006. These guidelines are in turn based on detailed recommendations set out in the Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) publication "*The Assessment and Rating of Noise from Wind Farms*" (1996). The ETSU document has been used to supplement the guidance contained within the "Wind Energy Development Guidelines" publication where necessary.

11.3.2.2.2 *Wind Energy Development Guidelines*

Section 5.6 of the *Wind Energy Development Guidelines* published by the Department of the Environment, Heritage and Local Government (2006) addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

The following extracts from this document should be considered:

> *"An appropriate balance must be achieved between power generation and noise impact."*

While this comment is noted it should be stated that the Guidelines give no specific advice in relation to what constitutes an 'appropriate balance'. In the absence of this, guidance will be taken from alternative and appropriate publications.

> *"In the case of wind energy development, a noise sensitive location includes any occupied house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational importance. Noise limits should apply only to those areas frequently used for relaxation of activities for which a quiet environment is highly desirable. Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."*

As can be seen from the calculations presented later in this chapter the various issues identified in this extract have been incorporated into our assessment.

> *"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."*

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

> *"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 30dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development be limited to an absolute level within the range of 35 – 40dB(A)."*

In relation to night-time periods the following guidance is given:

> *"A fixed limit of 43dB(A) will protect sleep inside properties during the night."*

This limit is defined in terms of the $L_{A90,10min}$ parameter. This represents the commonly adopted night-time lower limit noise criterion curve in relation to wind farm developments.

Reviewing the baseline noise data contained in this assessment and in order to provide a robust approach it is proposed to adopt a lower daytime threshold of 40dB LA90,10mn in this instance. This considers the baseline noise levels measured in the area and ongoing developments in terms of Irish guidance on the issue of wind turbine noise.

A level of 40dB(A) has been adopted in relation to low noise areas. This is considered appropriate in light of the following:

- The EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' proposes a daytime noise criterion of 45dB(A) in 'areas of low background noise'. The proposed lower threshold here is 5dB more stringent than this level.
- It should be reiterated that the 2006 'Wind Energy Development Guidelines' calls for "An appropriate balance must be achieved between power generation and noise impact." Based on a review of other national guidance in relation to acceptable noise levels in areas of low background noise it is considered that the criteria adopted as part of this assessment are robust.

In summary, the proposed operational limits for the Proposed Development are:

- 40 dB $L_{A90,10min}$ for quiet daytime environments of less than 30 dB $L_{A90,10min}$;

- 45 dB $L_{A90,10min}$ for daytime environments with background noise levels of greater than 30 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), and;
- 43 dB $L_{A90,10min}$ or a maximum increase of 5dB above background noise (whichever is higher) for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála. Therefore, a night-time allowance for 5dB(A) above background has also been adopted for this assessment.

This set of criteria has been chosen as it is in line with the intent of the relevant Irish guidance. The proposed operational noise criteria curves for wind turbine noise at various noise sensitive locations are presented in Section 11.4.2.

11.3.2.2.3 *The Assessment and Rating of Noise from Wind Farms – ETSU-R-97*

As stated previously the core of the noise guidance contained within the Wind Energy Development Guidelines guidance document is based on the 1996 ETSU publication *The Assessment and Rating of Noise from Wind Farms (ETSU-R-97).*

ETSU-R-97 calls for the control of wind turbine noise by the application of noise limits at the nearest noise sensitive properties. ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind turbine developments and recommends that noise limits should be set relative to the existing background noise levels at noise sensitive locations. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site noise surveys.

ETSU-R-97 states on page 58, "*…absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question…".* Therefore, the noise contribution from all wind turbine developments in the area should be included in the assessment.

11.3.2.2.4 *Institute of Acoustics Good Practice Guide*

The guidance contained within the institute of Acoustics (IoA) document *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (2013) (IOA GPG) and Supplementary Guidance Notes are considered to represent best practice and have been adopted for this assessment. The IOA GPG states, that at a minimum continuous baseline noise monitoring should be carried out at the nearest noise sensitive locations for typically a two-week period and should capture a representative sample of wind speeds in the area (i.e. cut in speeds to wind speed of rated sound power of the proposed turbine). Background noise measurements (i.e. $L_{A90,10min}$) should be related to wind speed measurements that are collated at the site of the wind turbine development. Regression analysis is then conducted on the data sets to derive background noise levels at various wind speeds to establish the appropriate day and night-time noise criterion curves.

Noise emissions associated with the wind turbine can be predicted in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation* (1996). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

Where noise predictions indicate that reductions in noise emissions are required in order to satisfy any adopted criteria, consideration can be given to detailed downwind analysis and operating turbines in low noise mode, which is typically offered by modern wind turbine units.

Reference has been made to the IoA GPG for guidance on the methodology for the background noise survey and operation impact assessment for wind turbine noise.

11.3.2.2.5 World Health Organisation (WHO) Noise Guidelines for the European Region)

The WHO *Environmental Noise Guidelines for the European Region* (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'. A strong recommendation, "*can be adopted as policy in most situations*" whereas a conditional recommendation, "*requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply*".

The objective of the World Health Organisation (WHO) Environmental Noise Guidelines for the European Region that was published in October 2018 is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is potential for adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

> *"For average noise exposure, the GDG* ***conditionally*** *recommends reducing noise levels produced by wind turbines below 45 dB L_{den}, as wind turbine noise above this level is associated with adverse health effects.*
>
> *No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.*
>
> *To reduce health effects, the GDG* ***conditionally*** *recommends that policymakers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."*

The quality of evidence used for the WHO research is stated as being 'Low', the recommendations are therefore conditional.

The WHO Environmental Noise Guidelines aim to support the legislation and policy-making process on local, national and international level, thus shall be considered by Irish policy makers for any future revisions of Irish National Wind Energy Guidelines.

There is potential increased uncertainty due to the parameter used by the WHO for assessment of exposure (i.e. L_{den}), which it is acknowledged may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes, as stated below.

> *"Even though correlations between noise indicators tend to be high (especially between LAeq-like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in L_{den} is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at*

a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes...

...Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region."

Based upon the review set out above, it is concluded that the conditional WHO recommended average noise exposure level (i.e. 45dB L_{den}) should not currently be applied as target noise criteria for an existing or proposed wind turbine development in Ireland.

11.3.2.2.6 Future Potential Guidance Change

In December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG19) were published for consultation and therefore have yet to be finalised. It is important to note that as part of the public consultation a number of concerns in relation to the proposed approach have been expressed by various parties and it is the opinion of the authors' of this assessment that the DRWEDG19 document does not outline a best practice approach in terms of the assessment of wind turbine noise. Specific concerns expressed by a cross party group of interested professionals can be reviewed at:

https://www.ioa.org.uk/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community-and

The following statement is of note from the above submission:

"a number of acousticians working in the field have raised serious concerns over the significant amount of technical errors, ambiguities and inconsistencies in the content of the draft WEDG and these were highlighted during the consultation process by a group of acousticians"

Therefore, in line with best practice, which includes ETSU and IoA methodologies as described above the assessment presented in the EIAR is based on the current best practice guidance outlined in Section 5.6 of the Wind Energy Development Guidelines for Planning Authorities, 2006.

The original ETSU-R-97 concepts on which both the WEDG06 and DRWEDG19 are based underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics publication of the A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including 6 Supplementary Guidance Notes, all of which bring together the combined experience of acoustic consultants in the UK and Ireland in the application of these methods. Numerous improvements in the accuracy and robustness are described, in particular the treatment of wind shear and the general adaptation to larger wind turbines. The assessment in the EIAR is therefore in full accordance with the latest best-practice methods.

Should the Wind Energy Guidelines be finalised in advance of a decision on this application, any revised noise limits that are proposed could be complied with at this site. Where mitigation is required to comply to with any revised noise limits this could be implemented through the control system of the wind turbines by operating turbines

11.3.3 Special Characteristics of Turbine Noise

11.3.3.1 Infrasound/Low Frequency Noise

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200Hz whereas Infrasound is typically described as sound at frequencies below 20Hz. In relation to Infrasound, the following extract from the EPA document *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites* (NG3) (EPA, 2011) is noted here:

> *"There is similarly no significant infrasound from wind turbines. Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature."*

With respect to infrasonic noise levels below the hearing threshold, the World Health Organisation (WHO) document Community Noise (WHO, 1995) has stated that:

> *"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects."*

In 2010, the UK Health Protection Agency published a report entitled *Health Effects of Exposure to Ultrasound and Infrasound*, Report of the independent Advisory Group on Non-ionising Radiation. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

> *"Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects."*

The UK Institute of Acoustics Bulletin in March 2009 included a statement of agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments (IAO JS2009). The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. In relation to the issue of infrasound, the article states the following:

> *"Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.*

Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low-frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view."

The article concludes that:

"from examination of reports of the studies referred to above, and other reports widely available on internet sites, we conclude that there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, generally has adverse effects on wind farm neighbours".

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[1] found that the level of infrasound from wind turbines is insignificant and no different to any other source 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, both adjacent to and away from a wind farm, and measured the levels of infrasound with the wind farms operating and switched off.

There were no noticeable differences in the levels 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 EPA's study concluded that the level of infrasound at houses near wind turbines was no greater than in other urban and rural environments, and stated that:

"The contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."

A German report[2], titled "*Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources*" presents the details of a measurement project which ran from 2013. The report was published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016 and concluded the following in relation to infrasound from wind turbines:

"The measured infrasound levels (G levels) at a distance of approx. 150 m from the turbine were between 55 and 80 dB(G) with the turbine running. With the turbine switched off, they were between 50 and 75 dB(G). At distances of 650 to 700 m, the G levels were between 55 and 75 dB(G) with the turbine switched on as well as off."

"For the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013 Draft) [3]"

"The results of this measurement project comply with the results of similar investigations on a national and international level."

[1] EPA South Australia, 2013, Wind farms https://www.epa.sa.gov.au/files/477912_infrasound.pdf
[2] Report available at https://www4.lubw.baden-wuerttemberg.de/servlet/is/262445/low-frequency_noise_incl_infrasound.pdf?command=downloadContent&filename=low-frequency_noise_incl_infrasound.pdf
[3] DIN 45680:2013-09 – Draft "Measurement and Assessment of Low-frequency Noise Emissions" November 2013

In June 2020, a report was released by the Finnish Government[4] presenting results of a project that investigated the infrasound produced by wind turbines and its effects through surveys, long-term measurements and exposure tests.

The surveys identified symptoms subjectively associated with infrasound from wind turbines were commonly within 2.5 km of the closest wind turbine and the range of symptoms experienced were broad. One third of residents with symptoms associated with infrasound subjectively were more likely to attribute their symptoms to wind farms and consider wind turbines disruptive health risks.

Long-term measurements were conducted collecting 308 days of data in two areas within 1.5 km of wind turbines operating between 3 to 3.3 MW. In measurements, infrasound levels were similar to the levels occurring typically in urban environments. The infrasound samples representing the worst-case scenarios were picked out from the measurement data and used in the exposure (listening) tests.

Double-blind listening tests were conducted in controlled laboratory conditions to examine how two groups (those who reported infrasound symptoms and those who did not) compared when examining whether the presence of infrasound affected participants' ability to detect the noise from wind turbines, their perception of the disturbance it caused and their physiological responses.

The findings of the report were that there was no difference between the two groups and:

> *"The participants could not detect the presence of infrasound in the noise from the wind turbines, it did not affect their perception of the disturbance caused by the noise, and it did not cause an involuntary nervous system response indicating stress."*

In summary, considering the modernisation of wind turbines and the conclusions of the studies quoted above, infrasound associated with wind turbines is insignificant in comparison to typical prevailing levels of infrasound and is below the threshold of hearing for humans even in proximity to turbines before setback distances of hundreds of meters are taken into account.

11.3.3.2 Amplitude Modulation

In the context of this assessment, amplitude modulation (AM) is defined in the IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document A Method for Rating Amplitude Modulation in Wind Turbine Noise (IOA, 2016) as:

> *"Periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency (BPF) of the turbine rotor(s)."*

It is now generally accepted that there are two mechanisms which can cause amplitude modulation:

- 'Normal' AM, and;
- 'Other' AM (sometimes referred to 'Excessive' AM).

In both cases, the result is a regular fluctuation in amplitude at the Blade Passing Frequency (BPF) of the wind turbine blades (the rate at which the blades of the turbine pass a fixed point). For a three-bladed turbine rotating at 20 rpm, this equates to a modulation frequency of 1 Hz.

'Normal' AM — An observer at ground level close to a wind turbine will experience 'blade swish' because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from the observer.

[4] Report available at: http://urn.fi/URN:ISBN:978-952-287-907-3

This effect is reduced for an observer on or close to the turbine axis, and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

The RenewableUK AM project (RenewableUK, 2013) has coined the term 'normal' AM (NAM) for this inherent characteristic of wind turbine noise, which has long been recognised and was discussed in ETSU-R-97 in 1996.

'Other' AM — In some cases AM is observed at large distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' at relatively low frequencies.

On sites where it has been reported, occurrences appear to be occasional, although they can persist for several hours under some conditions, dependent on atmospheric factors, including wind speed and direction.

It was proposed in the RenewableUK 2013 study that the fundamental cause of this type of AM is transient stall conditions occurring as the blades rotate, giving rise to the periodic thumping at the blade passing frequency.

Transient stall represents a fundamentally different mechanism from blade swish and can be heard at relatively large distances, primarily downwind of the rotor blade.

The RenewableUK AM project report adopted the term 'Other AM' (OAM) for this characteristic. The terms 'enhanced' or 'excess' AM (EAM) have been used by others, although such definitions do not distinguish between the source mechanisms and presuppose a 'normal' level of AM, presumably relating back to blade swish as described in ETSU-R-97.

Research and Guidance in the area is ongoing with recent publications being issued by the Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *A Method for Rating Amplitude Modulation in Wind Turbine Noise* (August 2016) (The Reference Method). The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation.

The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work and is currently the subject of a separate UK Government funded study. In the absence of published guidance to date, it is considered best practice to adopt the penalty rating and assessment scheme contained in an article published in the Institute of Acoustics publication Acoustics Bulletin (Vol. 42 No. 2 March/April 2017) titled, *Perception and Control of Amplitude Modulation in Wind Turbines Noise*.

Where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements during the operational phase of the Proposed Development. The 'Reference Method' for measuring AM outlined in the IoA AMWG document will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

11.3.4 Comments on Human Health Impacts

11.3.4.1 The National Health & Medical Research Council

The relevant Australian authority on health issues, the National Health and Medical Research Council (NHMRC), conducted a comprehensive independent assessment of the scientific evidence on wind farms and human health, the findings are contained in the NHMRC Information Paper: *Evidence on Wind Farms and Human Health* 2015, this report concluded:

> *"After careful consideration and deliberation, NHMRC concluded that there is no consistent evidence that wind farms cause adverse health effects in humans. This finding reflects the results and limitations of the direct evidence and also takes into account the relevant available parallel evidence on whether or not similar noise exposure from sources other than wind farms causes health effects"*

11.3.4.2 Health Canada

Health Canada, Canada's national health organisation, released preliminary results of a study into the effect of wind farms on human health in 2014[5]. The study was initiated in 2012 specifically to gather new data on wind farms and health. The study considered physical health measures that assessed stress levels using hair cortisol, blood pressure and resting heart rate, as well as measures of sleep quality. More than 4,000 hours of wind turbine noise measurements were collected and a total of 1,238 households participated.

No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses. Additionally, the study's results did not support a link between wind turbine noise and stress, or sleep quality (self-reported or measured). However, an association was found between increased levels of wind turbine noise and individuals reporting of being annoyed.

11.3.4.3 New South Wales Health Department

In 2012, the New South Wales (NSW) Health Department provided written advice to the NSW Government that stated existing studies on wind farms and health issues had been examined and no known causal link could be established.

NSW Health officials stated that fears that wind turbines make people sick are 'not scientifically valid'. The officials wrote that there was no evidence for 'wind turbine syndrome', a collection of ailments including sleeplessness, headaches and high blood pressure that some people believe are caused by the noise of spinning blades.

11.3.4.4 The Australian Medical Association

The Australian Medical Association put out a position statement, Wind Farms and Health 2014[6]. The statement said:

> *"The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well*

[5] *Health Canada 2014, Wind Turbine Noise and Health Study: Summary of Results. Available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html*
[6] *Australian Medical Association, 2014, Wind farms and health. Available at https://ama.com.au/position-statement/wind-farms-and-health-2014*

> *below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."*

11.3.4.5 Journal of Occupational and Environmental Medicine

The review titled, Wind Turbines and Health: A Critical Review of the Scientific Literature was published in the Journal of Occupational and Environmental Medicine, 2014. An independent review of the literature was undertaken by the Department of Biological Engineering of the Massachusetts Institute of Technology (MIT). The review took into consideration health effects such as stress, annoyance and sleep disturbance, as well as other effects that have been raised in association with living close to wind turbines. The study found that:

> *"No clear or consistent association is seen between noise from wind turbines and any reported disease or other indicator of harm to human health."*

The report concluded that living near wind farms does not result in the worsening of the quality of life in that region.

11.3.4.6 Health and Safety Executive

Health Service Executive (HSE) Public Health Medicine Environment and Health Group

In Ireland the HSE Public Health Medicine Environment and Health Group drafted a position paper in 2017 titled Position Paper on Wind Turbines and Public Health. The group identified that there is no published scientific evidence to support adverse effects of wind turbines on health and concluded that:

> *"Published scientific evidence is inconsistent and does not support adverse effects of wind turbines on health. However, adequate setback distances and meaningful engagement with local communities are recommended in order to address public concern."*

11.3.4.7 Summary

The peer reviewed research outlined in the preceding sections supports that there are no negative health effects on people with long term exposure to wind turbine noise. Please refer to Chapter 5 of the EIAR for further details of potential health impacts associated with the Proposed Development.

11.3.5 Vibration

A recent report published in Germany by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016, "*Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources*", Conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

11.3.6 Background Noise Assessment

This section presents the background noise survey carried out in support of the noise assessment of the proposed turbines at Coole Wind Farm. A supplemental noise survey was carried out to inform the assessment of the construction of the grid connection route. For details of this additional background noise survey see Section 11.4.3.

An environmental noise survey was undertaken to determine typical background noise levels at representative NSLs surrounding the Proposed Development site. The background noise survey was conducted through installing unattended sound level meters at four representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with the Institute to Acoustic's Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IoA GPG, 2013) and accompanying, Supplementary Guidance Note 1: Data Collection (2014) discussed in the following Section.

The NSLs are spread over a large area and the noise monitoring locations were selected to obtain background noise levels representative of the noise environments at NSLs surrounding the Proposed Development site. Consideration was also given to the potential for noise from existing turbines effecting the survey when selecting the locations.

11.3.6.1 Choice of Measurement Locations

The background noise data measured as part of the permitted Coole Wind Farm, as detailed in Section 2.5.1 in Chapter 2 of this EIAR, in January to February 2017 remain relevant and as the surrounding environment has remained largely unchanged, the same data is used here. The guidance on the collection of background noise data remains the same today as it was during the survey period. The noise monitoring locations were identified by preparing a preliminary noise model contour. Any locations that fell inside the predicted 35 dB L_{A90} noise contour were considered for noise monitoring in line with current best practice guidance outlined in the IoA GPG. The selection of the noise monitoring locations was informed by site visits, discussions with locals and supplemented by reviewing of aerial images of the study area and other online sources of information (e.g. Google Earth).

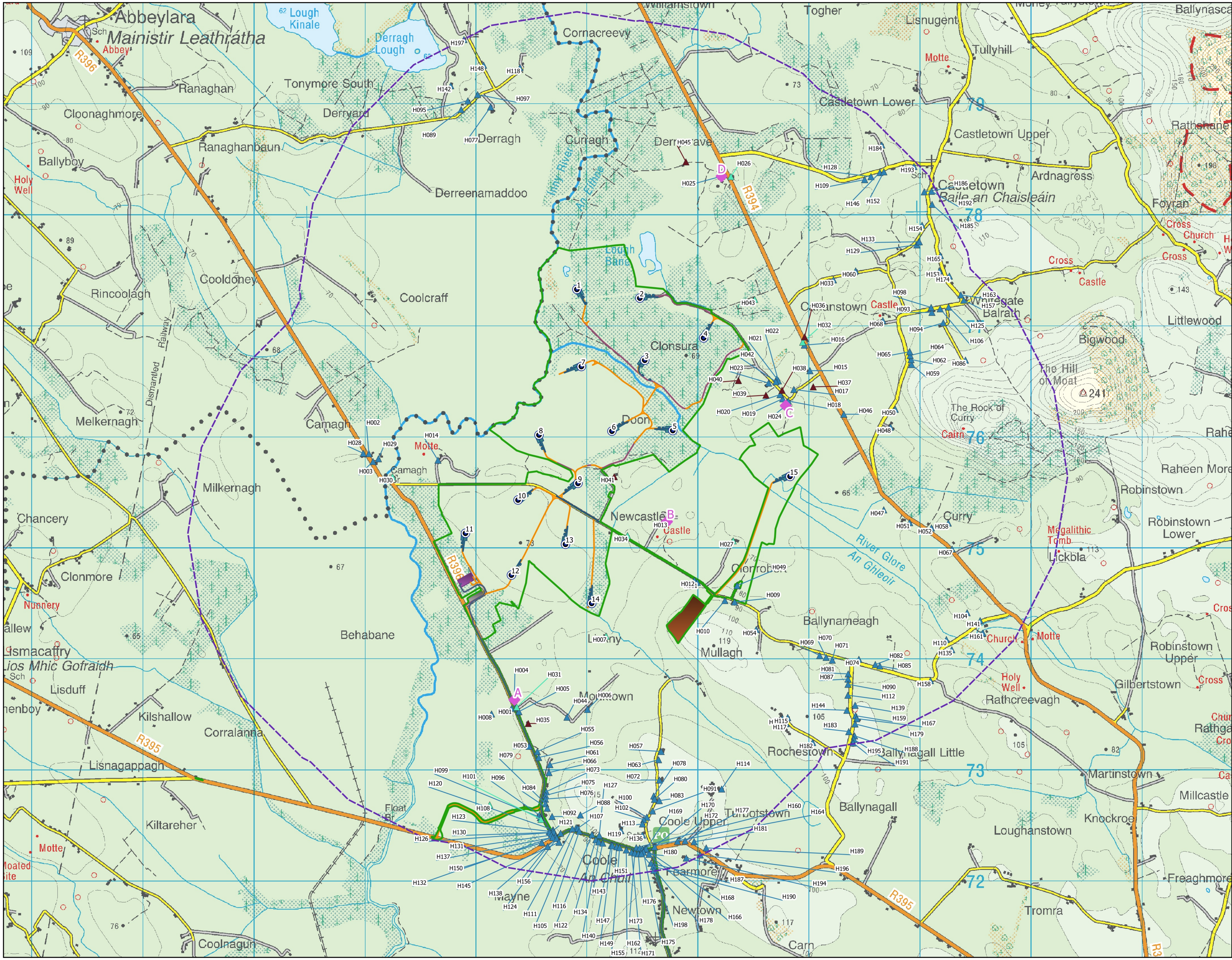
The selected locations for the noise monitoring are outlined in the following sections. Coordinates for the noise monitoring locations are detailed in Table 11-4.

Table 11-4 Measurement Location Coordinates

Location	Coordinates – Irish Transverse Mercator (ITM)	
	Easting	Northing
A (H004)	640,304	773,677
B (H013)	641,712	775,309
C (H024)	642,720	776,284
D (H025)	642,161	778,353

Noise sources were noted to be traffic noise on adjacent roads and in the distance, foliage noise, livestock noise, and intermittent farm machinery. At Location C, distant commercial /construction activities were discernible.

There were no perceptible sources of vibration noted at any of the survey locations. Indicative measurement locations A, B, C and D are shown in Figure 11-2 and photographs of the measurement locations are presented in Appendix 11-2.



Map Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Turbine Buffer 2500m
- Noise Monitoring Locations

Properties

- Dwelling
- Derelict
- Commercial / Agricultural
- Proposed Hardstand
- Internal Roads (new)
- Internal Roads (Upgrades to existing)
- External Roads (Upgrades to Existing)
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Onsite Substation
- Proposed Grid Connection Route

Drawing Title: Noise Monitoring Locations

Project Title: Coole Wind Farm, Co. Westmeath

Drawn By	Checked By
EC	MW
Project No. 200445	Drawing No. Figure 11-2
Scale 1:30000	Date 11.02.2021

MKO
Planning and Environmental Consultants
Tuam Road, Galway
Ireland, H91 VW84
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email:info@mkoireland.ie
Website: www.mkoireland.ie

11.3.6.2 Measurement Periods

Noise measurements were conducted at each of the monitoring locations over the periods outlined in Table 11-5.

Table 11-5 Measurement Periods

Location	Start Date	End Date
A (H004)	17th January 2017	14th February 2017
B (H013)	20th January 2017	14th February 2017
C (H024)	17th January 2017	8th February 2017
D (H025)	17th January 2017	14th February 2017

A variety of wind speed and weather conditions were encountered over the survey periods in question. Figure 11-3 illustrates the distributions of wind speed and wind direction standardised to 10 metre height over the survey period detailed in Table 11-5.

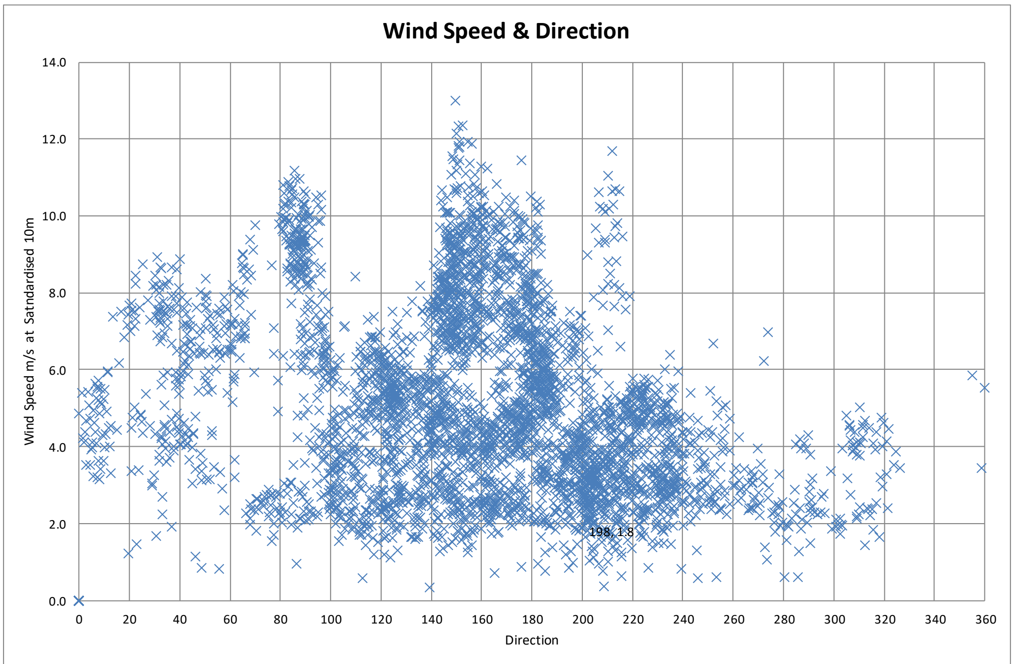

Figure 11-3 Distributions of Wind Speeds and Directions Over the Survey Period

11.3.6.3 Personnel and Instrumentation

AWN Consulting installed and removed the noise monitors at all locations. Battery checks and meter calibrations were carried out part-way through the survey periods. The following instrumentation was used at the various locations:

Table 11-6 Instrumentation Details

Location	Equipment	Serial Number
A (H004)	Larson Davis 812	801
B (H013)	RION NL-52	164427

Location	Equipment	Serial Number
C (H024)	Brüel & Kjær Type 2238	2684495
D (H025)	RION NL-52	164426
Calibrator	Brüel & Kjær Type 4231	2394086

Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator where appropriate. Instruments were calibrated on each interim visit and any drift noted. Relevant calibration certificates are presented in Appendix 11-3.

Rain fall was monitored and logged using a Texas Instruments TR-525T console and a data logger that was installed at Location D (H025) for the duration of the surveys. This allows for the identification of periods of rain fall to allow for the removal sample periods affect by rainfall from the noise monitoring data sets in line with best practice when calculating the prevailing background noise levels.

Wind data was measured at a meteorological mast located within the site of the Proposed Development and was supplied to AWN for data analysis.

Table 11-7 Met Mast Details

Description	Coordinates (ITM)	
	Easting	Northing
Met Mast	640665	774342

11.3.6.4 Procedure

Measurements were conducted at four locations over the survey periods outlined in Table 11-5. Data samples for all measurements (noise, rainfall and wind) were logged continuously at 10-minute interval periods for the duration of the survey.

Survey personnel noted potential primary noise sources contributing to noise build-up during the installation and removal of the sound level meters from site. Description of the observed noise environment at each of the monitoring locations is presented below. $L_{Aeq,10min}$ and $L_{A90,10min}$ parameters were measured in this instance.

11.3.6.5 Analysis of Background Noise Data

The data sets have been filtered to remove issues such as the dawn chorus and the influence of other atypical noise sources. An example of atypical sources would be short isolated periods of raised noise levels attributable to local sources, agricultural activity, boiler flues, operation of gardening equipment etc. In addition, sample periods affected by rainfall or when rainfall resulted in prolonged periods of atypical noise levels have also been screened from the data sets. The assessment methods outlined above are in line with the guidance contained in the IoA *GPG*.

There are no proposed or permitted wind turbines within 10 kilometres of the Proposed Development and so, there was no requirement to remove contributing noise from any existing wind turbines from the measured noise data.

The results presented in the following sections refer to the noise data collated during 'quiet periods' of the day and night as defined in the IoA *GPG*. These periods are defined as follows:

- Daytime Amenity hours are:
  - all evenings from 18:00 to 23:00hrs;
  - Saturday afternoons from 13:00 to 18:00hrs, and;
  - all day Sunday from 07:00 to 18:00hrs.
- Night-time hours are 23:00 to 07:00hrs.

11.3.6.5.1 *Consideration of Wind Shear*

Wind shear is defined as the increase of wind speed with height above ground. As part of a robust wind farm noise assessment due consideration should be given to the issue of wind shear. The issue of wind shear has been considered in this assessment and followed relevant guidance as outlined in the IoA GPG. It is standard procedure to reference noise data to standardised 10 metre height wind speed.

Wind speed measurements at 80m and 60m heights have been corrected to a height of 100.5m (the hub height assumed for the purposes of this noise assessment) in accordance with Method B of Section 2.6 of the IOA GPG. The calculated hub height wind speeds were then corrected to standardised 10 metre height wind speed in accordance with same guidance.

Any reference to wind speed in this chapter should be understood to be the standardised 10m height wind speed reference unless otherwise stated.

11.3.7 Turbine Noise Calculations

A series of computer-based prediction models have been prepared to quantify the noise level associated with the operation of the Proposed Development. This section discusses the methodology for the noise modelling process.

11.3.7.1 Noise Modelling Software

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software, DGMR iNoise Enterprise, calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 1996).

iNoise is a proprietary noise calculation package for computing noise levels and propagation of noise sources. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated considering a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (L_{WA});
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

11.3.7.2 Input Data and Assumptions

The calculation settings, input data and any assumptions made in the assessment are described in the following sections. Additional information relating to the noise model inputs and calculation settings is provided in Appendix 11-4.

11.3.7.2.1 Turbine Details

The coordinates of the 15 turbines that are considered in this assessment are presented in Section 4.3 in Chapter 4 of this EIAR. For the purposes of this assessment, the turbine type assessed is the Nordex N149. The turbine is a pitch regulated upwind turbine with a three-blade rotor. For the purposes of this assessment predictions have assumed the source of noise at the hub height of 100.5 m. Each wind turbine is secured to a circular-shaped reinforced concrete foundation.

While the noise profiles of the Nordex N149 wind turbine have been used for the purposes of this assessment, the actual turbine to be installed on the site will be the subject of a competitive tender process and could include turbines not amongst the turbine models currently available. Regardless of the make or model of the turbine eventually selected for installation on site, the noise it will give rise to will be of no greater significance than that used for the purposes of this assessment, to ensure the findings of this assessment remain valid. Any references to the Nordex turbine in this assessment must be considered in the context of the above, and should not be construed as meaning it is the only make or model of wind turbine that could be used on the site.

Table 11-8 details the noise spectra used for noise modelling purposes for the proposed Coole Wind Farm.

Table 11-8 Sound Power Level Spectra Used for Prediction Model – Coole Wind Farm

Wind Speed (m/s)	Octave Band Centre Frequency (Hz)								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
3	77.1	83.7	86.6	87.6	88	86.2	80.5	71.3	94.0
4	78.3	84.9	87.8	88.8	89.2	87.4	81.7	72.5	95.2
5	81.0	87.6	91.3	93.4	94.7	92.8	83.2	75.3	99.7
6	85.3	91.9	95.6	97.7	99.0	97.1	87.5	79.6	104.0
7	86.9	93.4	97.1	99.2	100.5	98.7	89.1	81.2	105.5
≥8	87.3	93.5	97.2	99.8	100.5	98.0	90.4	82.4	105.6

The manufacturer's turbine sound power levels in Table 11-8 are based on measurements in terms of the L_{Aeq} acoustic parameter[7]. In accordance with best practice guidance contained within the Institute of Acoustics Good Practice Guide (IoA GPG), an allowance for uncertainty in the measurement of turbine source levels of +2dB is added to all turbine sound power levels presented in the tables above.

Moreover, as explained in Section 11.3.2.2, appropriate guidance is couched in terms of a L_{A90} criterion. Best practice guidance in the IoA GPG states that "*L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB*". Therefore, a 2dB reduction has been applied to the noise model output. All predicted noise levels in this chapter are presented in terms of L_{A90}, i.e. this reduction of 2dB is included the values presented. In the interest of clarity, the levels presented in Table 11-8 are the corrected levels following the adding and subtracting of 2dB. This approach is the same as that followed in the noise assessment conducted for the permitted Coole Wind Farm.

[7] *For details, see IEC 61400 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques.*

11.3.8 Assessments of Construction Impacts

The potential impacts of the construction phase noise and vibration in addition to the potential impacts from additional vehicular activity on public roads will be assessed in accordance with best practice guidance as outlined in Section 11.3.2.1.

11.4 Receiving Environment

This stage of the assessment was to determine typical background noise levels at representative NSLs surrounding the Proposed Development site. The background noise survey was conducted through installing unattended sound level meters at four locations in the surrounding area.

11.4.1 Background Noise Levels

The following sections present an overview and results of the noise monitoring data obtained from the background noise survey in accordance with the methodology discussed above. Observations made on site during installation, interim visits and collection are presented below for each monitoring location. Site visits were carried out during the morning and afternoon time and therefore no observations were made during night-time periods.

Prevailing background noise levels are expressed in dB L_{A90} at standardised 10 m height, as discussed in the previous section. The survey data has been corrected to a standardised 10m height above ground wind speed with an assumed hub height of 100.5m for the purposes of this assessment.

11.4.1.1 Location A (H004)

11.4.1.1.1 *Daytime Periods*

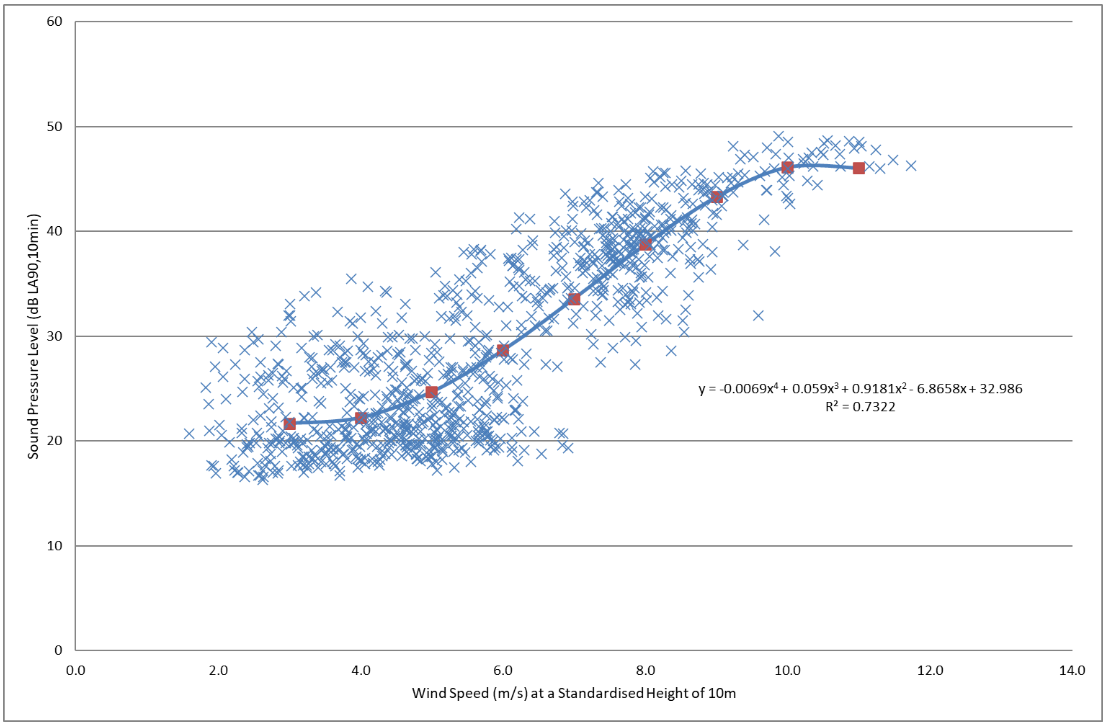

Figure 11-4 Location A (H004) Daytime Regression Analysis

11.4.1.1.2 Night-time Periods

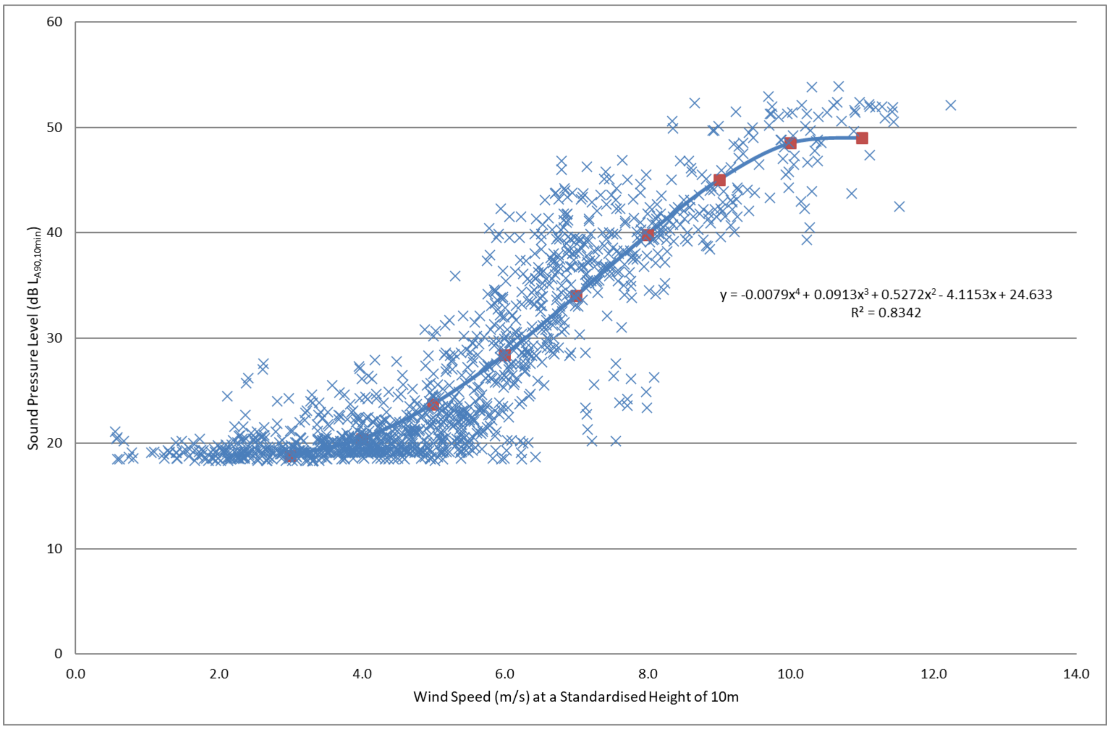

Figure 11-5 Location A (H004) Night-time Regression Analysis

11.4.1.2 Location B (H013)

11.4.1.2.1 Daytime Periods

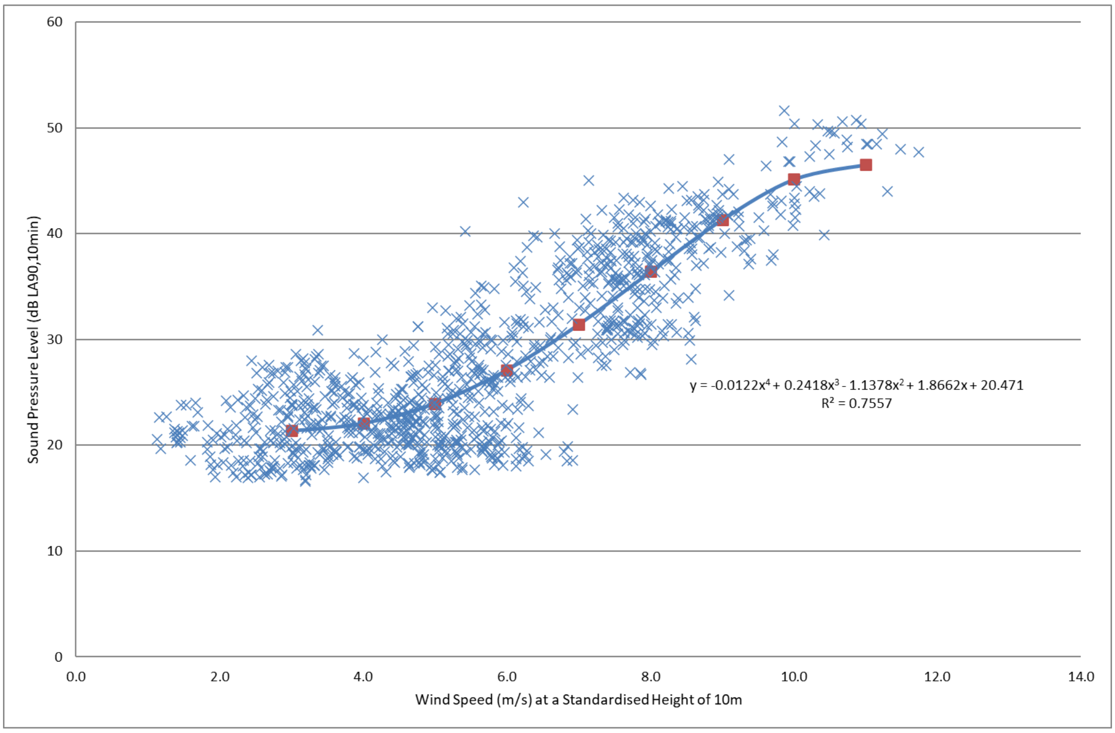

Figure 11-6 Location B (H013) Daytime Regression Analysis

11.4.1.2.2 Night-time Periods

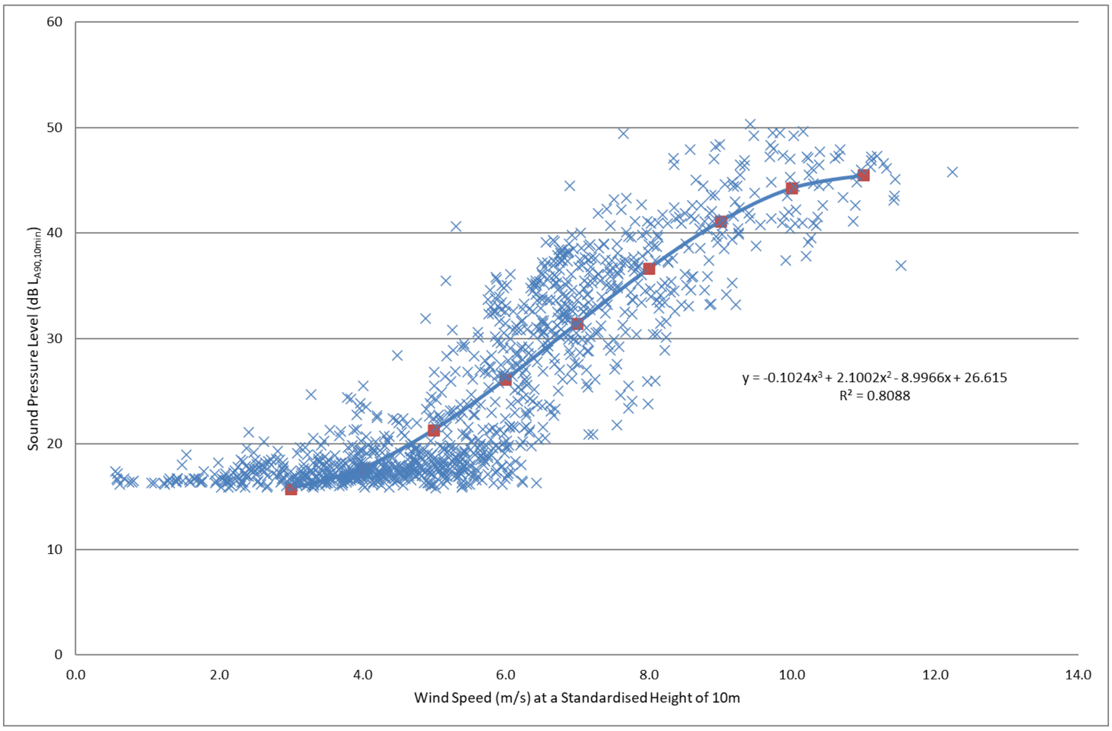

Figure 11-7 Location B (H013) Night-time Regression Analysis

11.4.1.3 Location C (H024)

11.4.1.3.1 Daytime Periods

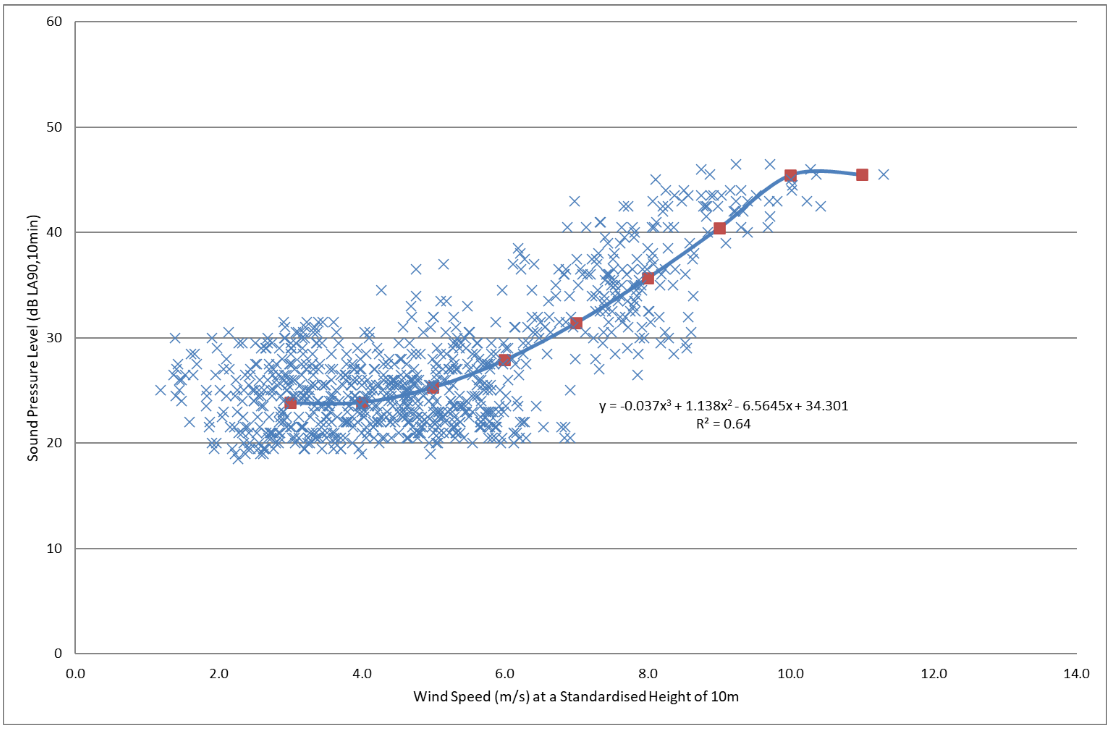

Figure 11-8 Location C (H024) Daytime Regression Analysis

11.4.1.3.2 *Night-time Periods*

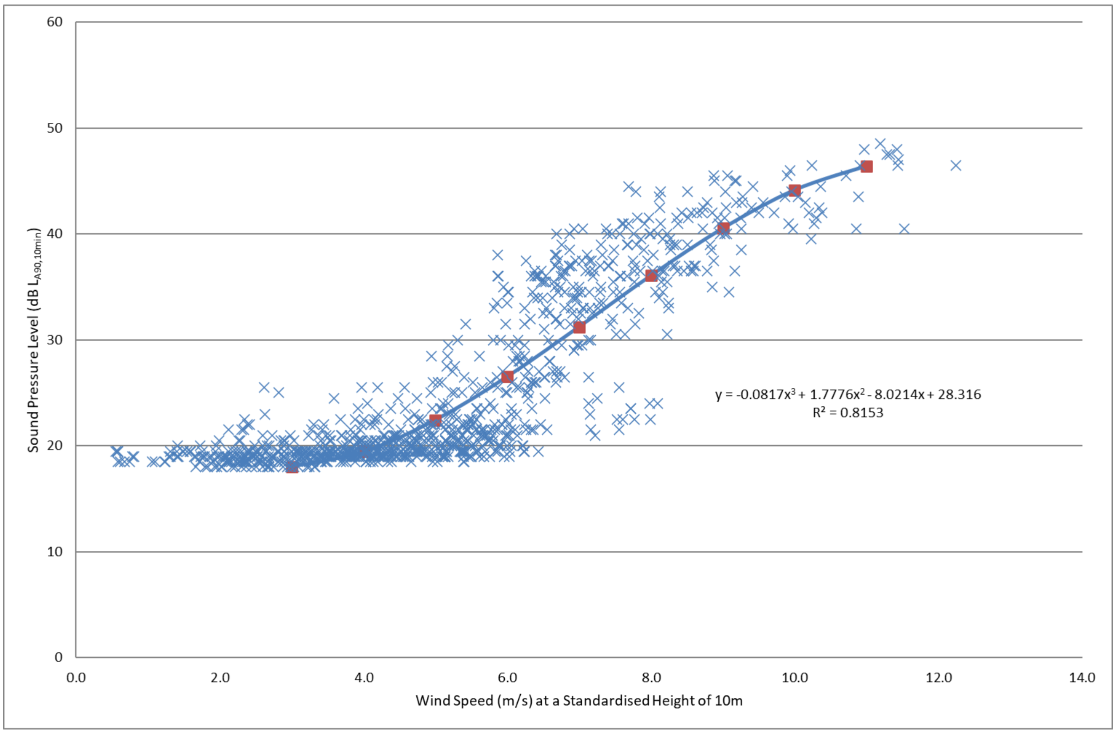

Figure 11-9 Location C (H024) Night-time Regression Analysis

11.4.1.4 Location D (H025)

11.4.1.4.1 *Daytime Quiet Periods*

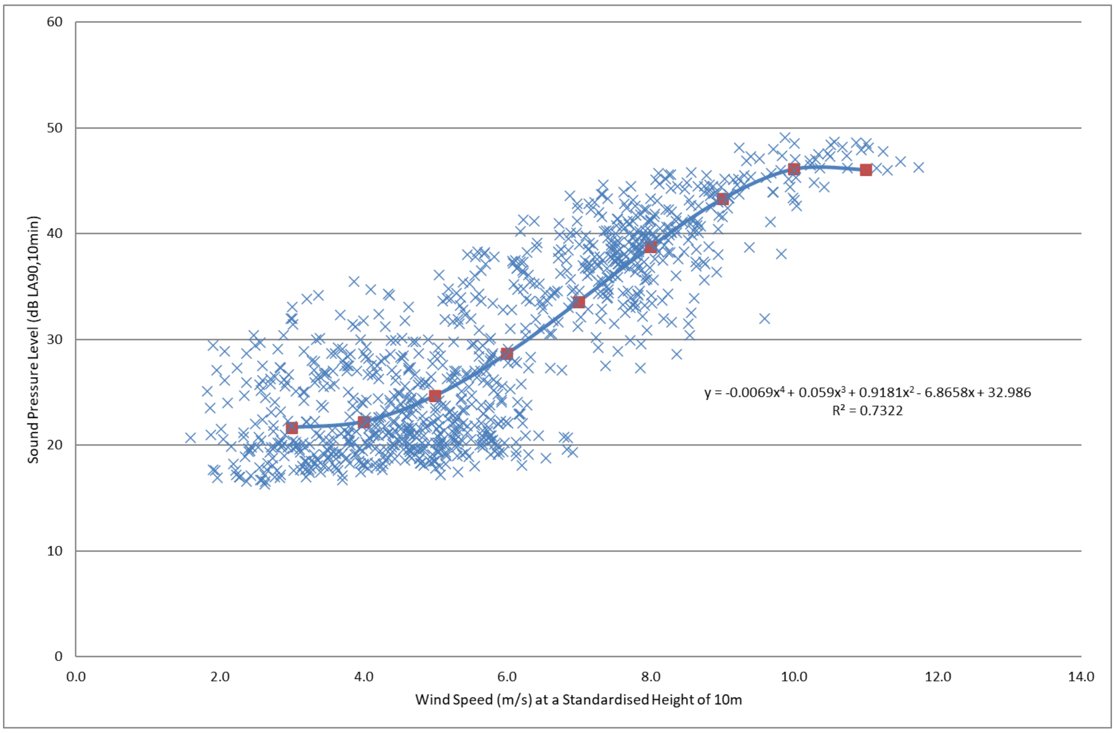

Figure 11-10 Location D (H025) Daytime Regression Analysis

11.4.1.4.2 Night-time Periods

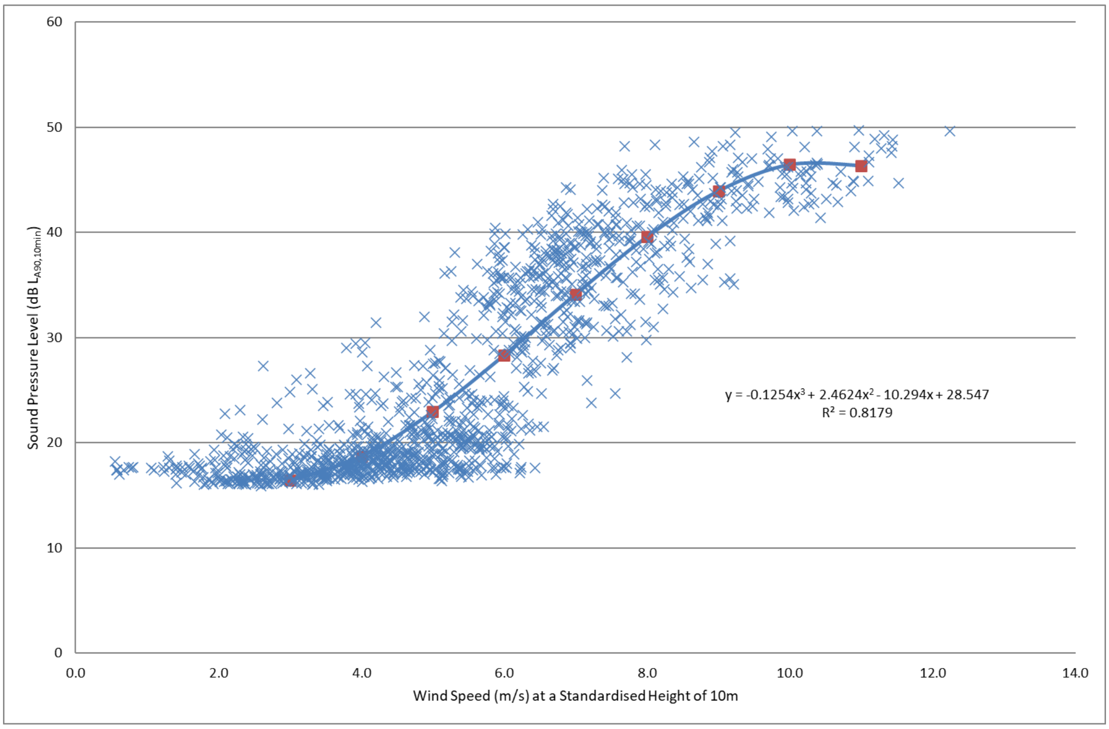

Figure 11-11 Location D (H025) Night-time Regression Analysis

11.4.1.5 Summary

Table 11-9 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night-time periods. These levels have been derived using regression analysis carried out on the data sets in line with guidance contained the IoA *GPG* and its SGN No. 2 *Data Collection.*

As detailed in Section 11.3.7.2.1 above, the hub height assumed and modelled for the purposes of this assessment is 100.5 m and so, the calculation of the prevailing background noise level in terms of wind speeds at standardised 10m height results in a slight change in background noise levels with respect to the permitted Coole Wind Farm.

Table 11-9 Derived Noise Levels of $L_{A90,10min}$ for Various Wind Speeds

Location	Period	Derived $L_{A90, 10 min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)								
		3	4	5	6	7	8	9	10	11
A (H004)	Day	26.0	26.2	27.8	31.2	36.1	41.8	47.2	50.7	50.5
	Night	18.9	20.4	23.7	28.4	34.0	39.8	45.0	48.5	49.0
B (H013)	Day	21.4	22.1	24.0	27.1	31.4	36.4	41.3	45.2	46.5
	Night	15.8	17.7	21.3	26.1	31.4	36.6	41.1	44.3	45.5
C (H024)	Day	23.9	23.9	25.3	27.9	31.4	35.7	40.4	45.5	45.5
	Night	18.0	19.4	22.4	26.5	31.2	36.1	40.5	44.2	46.4

Location	Period	Derived $L_{A90,\,10\,min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)								
		3	4	5	6	7	8	9	10	11
D (H025)	Day	21.7	22.2	24.7	28.6	33.6	38.8	43.3	46.1	46.1
	Night	16.4	18.7	23.0	28.3	34.1	39.6	43.9	46.4	46.4
Envelope	Day	21.4	22.1	24.0	27.1	31.4	35.7	40.4	45.2	45.5
	Night	15.8	17.7	21.3	26.1	31.2	36.1	40.5	44.2	45.5

The background noise data is used to derive appropriate noise limits for each of the NSLs where measurements took place. At all remaining locations, the worst-case envelope based on the lowest average levels across the various locations at each wind speed is used, considered separately for daytime and night-time.

11.4.2 Wind Turbine Noise Criteria

With respect to the relevant guidance documents outlined in Section 11.3.2 the following noise criteria curves have been identified for the Proposed Development. The criteria curves have been derived following a detailed review of the background noise data conducted at the nearest noise sensitive locations.

It is proposed to adopt a lower daytime threshold of 40 dB $L_{A90,10\text{-}min}$ for low noise environments where the background noise is less than 30 dB(A). This follows a review of the prevailing background noise levels and is considered appropriate in light of the following:

- The EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. The proposed lower threshold here is 5 dB more stringent than this level.
- It is reiterated that the 2006 Wind Energy Development Guidelines states that "*An appropriate balance must be achieved between power generation and noise impact.*" Based on a review of other national guidance in relation to acceptable noise levels in areas of low background noise it is considered that the criteria adopted as part of this assessment are robust.

Following comparison of the previously presented guidance the proposed operational limits in $L_{A90,10min}$ for the Proposed Development are:

- 40 dB $L_{A90,10min}$ for quiet daytime environments of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ for daytime environments greater than 30 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), and;
- 43 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher) for night time periods.

Table 11-10 outlines the derived noise criteria curves based on the information contained within Table 11-9.

Table 11-10 Noise Criteria Curves

Location	Period	Derived $L_{A90, 10\ min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)								
		3	4	5	6	7	8	9	10	11
A (H004)	Day	40.0	40.0	40.0	45.0	45.0	46.8	52.2	55.7	55.5
	Night	43.0	43.0	43.0	43.0	43.0	44.8	50.0	53.5	54.0
B (H013)	Day	40.0	40.0	40.0	40.0	45.0	45.0	46.3	50.2	51.5
	Night	43.0	43.0	43.0	43.0	43.0	43.0	46.1	49.3	50.5
C (H024)	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.4	50.5	50.5
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.5	49.2	51.4
D (H005)	Day	40.0	40.0	40.0	40.0	45.0	45.0	48.3	51.1	51.1
	Night	43.0	43.0	43.0	43.0	43.0	44.6	48.9	51.4	51.4
Envelope	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.4	50.2	50.5
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.5	49.2	50.5

A worst-case envelope based on the lowest average levels at the various wind speeds has been presented in Table 11-10. Therefore, the noise criteria curves for this assessment will be based on this baseline noise levels envelope. This is considered a worst-case approach to this aspect of the assessment.

11.4.3 Background Noise Survey along Grid Connection Route

As the Proposed Development includes the grid connection and works at the existing Mullingar Substation, it is necessary to characterise the existing noise environment along the route and in the vicinity of the substation works. The grid connection route is approximately 26km in length and the existing noise environment varies along the route. Noise sensitive locations are positioned at variable set-back distances along the route.

Three measurement locations were selected along the proposed grid connection route in order to obtain representative baseline noise levels at the nearest noise-sensitive locations. The proposed onsite substation is located in an area of existing commercial forestry. Therefore, in addition to the attended noise survey reference is made to background noise levels measured at location H004. Refer to Section 11.4.3.6 below.

Figures 1 to 5 Appendix 11-9 presents the measurement locations with measurement coordinates and descriptions provided in Table 11-11. The location of H004 is presented in Figure 11-2.

Table 11-11 Noise Monitoring locations for Grid Connection

Location	Coordinates – Irish Transverse Mercator (ITM)		Distance to Grid Connection Route (m)	Description
	Easting	Northing		
NML1	639,089	768,245	9	In proximity of dwellings along the L1826 local road. This location is representative of the most sensitive noise receptors along the route due to the distances from significant noise sources in the receiving environment.
NML2	640,972	760,907	23	Situated approximately 50m from the N4 road. This location is representative of noise sensitive receivers along the N4 section of the route where existing baseline noise levels are relatively high due to the proximity to the national road.
NML3	642,305	754,363	470	This location is representative of noise sensitive locations along the section of the route from N4 to the grid connection end point.

11.4.3.1 Methodology

An attended noise survey was undertaken at locations NML1 to NML3 to obtain typical baseline noise levels at noise sensitive locations on the 5th October 2019. Measurements were carried out on a cyclical basis with measurement durations of 15 minutes over three rotations.

11.4.3.2 Instrumentation

The measurements were made using a Brüel & Kjaer type 2250 Logging integrating Sound Level Meter. The instrument was calibrated with a Brüel & Kjaer Type 4231 calibrator prior to and after the measurement period. The microphone was protected using a proprietary Brüel and Kjær windshield. The sound level meter was mounted on a tripod approximately 1.5 metres above ground level and at least 3m away from any reflective surfaces.

Factory calibration certificates for the noise level meter and acoustic calibrator, detailing equipment serial numbers are presented in Appendix 11-3 of this report. The survey results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for later analysis. Survey personnel noted the primary sources contributing to noise build-up during the survey.

11.4.3.3 Measurement Parameters

Several parameters were measured in order to interpret the noise levels. These included the following;

- L_{Aeq} This is the equivalent continuous A weighted sound pressure level. It is an average of the total sound energy (noise) measured over a specified time period.
- L_{A90} Noise level exceeded for 90% of measurement period (steady underlying noise level).
- L_{A10} Noise level exceeded for 10% of measurement period. It is typically a descriptor of traffic noise.
- L_{Amax} Maximum A weighted noise level measured.
- L_{Amin} Minimum A weighted noise level measured.

The "A" suffix denotes that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. The "F" suffix denotes that the parameter has been measured with 'Fast' time-weighting applied. All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pascal (Pa).

11.4.3.4 Meteorological Conditions

Meteorological conditions were dry, with temperature of approximately 11° C with light winds less than 1 meter per second (ms^{-1}). The noise levels measured at NML1, NML2 and NML3 are therefore representative of quiet background conditions. It is not necessary to evaluate the background noise levels over various wind speeds as is the case for the impact assessment if the wind farm itself.

11.4.3.5 Noise Monitoring Results

Table 11-12 presents a summary of the baseline noise levels measured at NMLs 1, 2 and 3.

Table 11-12 Noise Survey Results at NMLs 1, 2 and 3

Location	Start Time	Measured Noise Levels [dB re. 2x10-5 Pa]			
		LAeq	LAmax	LA10	LA90
NML1	12.16	52	79	42	31
	13.18	47	71	43	26
	13.40	50	74	43	27
NML2	12.30	63	75	67	53
	14.10	65	74	68	57
	15.20	76	87	81	53
NML3	14.45	62	86	57	36
	15.46	63	82	59	35
	16.03	68	84	73	36

Noise sources noted at NML1 were intermittent local road traffic, birdsong and occasional dog barking. The ambient noise level ranged from 47 to 52dB(A) and the background noise level ranged from 26 to 31dB(A). This location was relatively quiet with background noise levels noted to be low.

The dominant noise source at NML2 was road traffic noise from the N4. The ambient noise level ranged from 63 to 76dB(A) and the background noise level ranged from 53 to 57dB(A).

During the measurement at NML2 at 15:20, the traffic was considerably heavier than was observed than in the first periods hence higher noise levels were measured.

Noise sources noted at NML3 were local road traffic and birdsong. The measurement location was close to the road and therefore the measured ambient noise levels were elevated due to passing vehicle events. The ambient noise level ranged from 62 to 68dB(A) and the background noise level ranged from 35 to 36dB(A). This location was relatively quiet with background noise levels noted to be low.

11.4.3.6 Location H004

The proposed onsite substation is located in an area of existing commercial forestry. Therefore, in addition to the attended noise survey for the grid connection reference is made to background noise levels measured at location H004 which was monitored as part of the noise impact assessment for the proposed wind farm and is located at a distance of 1,080 m from the proposed onsite substation. See Section 11.3.6.1 for full details. The measured noise levels are summarised in Section 11.4.3.6. The location of H004 is shown in Figure 11-2.

The nearest occupied noise sensitive location to the onsite substation is and H004 at a distance of 1,080 metres.

An unattended noise survey was conducted in the grounds of House H004 at ITM Coordinates 640,304E, 773,677N between 17th January to 14th February 2017.

On review of the measured data it is confirmed that the typical noise levels were as follows:

- Daytime ambient noise levels of typically 40 - 45dB $L_{Aeq,T}$
- Daytime background noise levels of typically 25dB $L_{A90,T}$
- Night time ambient noise levels of typically between 35 - 40dB $L_{Aeq,T}$
- Night time background noise levels of typically 20dB $L_{A90,T}$

11.4.4 Vibration

There are no significant sources of vibration in the receiving environment therefore there is no requirement to measurement baseline vibration as part of this assessment.

11.5 Likely Significant Effects and Associated Mitigation Measures

11.5.1 Do-Nothing Scenario

An alternative land-use option to developing the Proposed Development would be, as detailed in Section 1.1 of Chapter 1, to construct a permitted wind energy project comprising of 13 turbines and all associated infrastructure on the Proposed Development site. The permitted wind energy project was designed to co-exist and operate in conjunction with and independently of land-use practices of commercial peat-harvesting and forestry to minimise impacts. Whilst there would be a change of land use within the footprint of the Proposed Development, to facilitate the wind turbines and infrastructure, this was found to be an acceptable part of the permitted development.

This EIAR assesses the potential for peat extraction works on the site to continue as a worst-case scenario. The Proposed Development has been designed to operate on this site in conjunction with any peat extraction activities. The section of the Proposed Development site that does not form part of the currently permitted wind energy development site has a current-land use practice of low-intensity pastoral agriculture and commercial forestry. An alternative land-use option to developing a renewable energy project at this section of the Proposed Development site would be to leave the site as it is, with no changes made to the current land-use practices of low intensity pastoral agriculture and commercial forestry. The environmental effects of this are considered to be neutral.

A second potential Do-Nothing scenario exists for this project i.e. assuming that the permitted development is not constructed. In this scenario the existing baseline environment will evolve in one of two potential ways, either the peat extraction ceases and a rehabilitation plan is developed or the peat extraction continues and then a rehabilitation plan is developed.

The existing noise environment will remain largely unchanged notwithstanding other proposed and permitted wind turbine developments in the area. In areas where traffic noise is a significant source in the environment, increases in traffic volumes on the local road network would be expected to result in slight increases in overall ambient and background noise in the area over time.

11.5.2 Construction Phase Potential Impacts

A variety of items of plant will be in use for the purposes of site preparation, construction of turbines, roads, onsite substation, grid connection and works at Mullingar substation options. There will be vehicular movements to and from the site that will make use of existing roads. Due to the nature of these activities, there is potential for generation of significant levels of noise.

The predicted noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. It should also be noted that the predicted "worst case" levels are expected to occur for only short periods of time at a very limited number of properties. Construction noise levels be lower than these levels for most of the time at most properties in the vicinity of the Proposed Development.

11.5.2.1 Turbines, Hardstands, Onsite Substation, Grid Connection, Internal Roads and Road Widening

11.5.2.1.1 *Noise*

The standard best practice approach is to predict typical noise levels at the nearest sensitive receptor using guidance set out in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise. Construction noise predictions have been carried out using guidance set out in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra from BS 5228 at various distances from these works.

The noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. The predicted "worst case" levels are expected to occur for only short periods of time at a very limited number of properties. It is expected that construction noise levels will be lower than these levels for most of the time at properties in the vicinity of the Proposed Development.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather period or at critical periods within the programme it could occasionally be necessary to work out with these hours. Any such out of hours working would be agreed in advance with the local planning authority.

Turbines and Hardstands

Works at the proposed turbines and hardstands will be located at a significant distance from noise sensitive locations. The closest occupied dwelling H14 (i.e. dwelling not involved with the Proposed Development) is located at a distance of approx. 700 metres from the nearest proposed turbine T11. There are 2 no. dwellings, H18 & H24 which are located at distances of 638m and 679m from T15 respectively however these are individuals involved with the Proposed Development.

Several indicative sources that would be expected on a site of this nature have been identified and noise predictions of their potential impacts prepared to nearby houses. The assessment is representative of a worst-case, construction noise levels will be lower at properties located further from the works.

Table 11-13 outlines the noise levels associated with typical construction noise sources assessed in this instance along with typical sound pressure levels and spectra from BS 5228 – 1: 2009. Noise from piling operations at the turbine bases has been included in the assessment. There are no items of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 11-13.

Table 11-13 Typical Construction Noise Levels – Turbines and Hardstands

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[8]	Predicted Noise Level (dB $L_{Aeq,T}$) at 638 m distance
HGV Movement (C.2.30)	Removing soil and transporting fill and other materials.	79	37
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	35
Excavator Mounted Rock Breaker (C9.12)	Excavation in rocky areas	85	43
Piling Operations (C.12.14)	Standard pile driving.	88	47
General Construction (Various)	All general activities plus deliveries of materials and plant.	84	42
Concrete Mixer Truck and Concrete Pump (C.4.27)	Turbine Foundations	75	33
Dumper Truck (C.4.4)	Backfilling Turbine Foundations	76	34
Mobile Telescopic Crane (C.4.39)	Turbine Erection	77	35
Dewatering Pumps (D.7.70)	If required.	80	38
JCB (D.8.13)	For services, drainage and landscaping.	82	40
Vibrating Rollers (D.8.29)	Road surfacing.	77	35

8 All plant noise levels are derived from BS5228: Part 1

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[8]	Predicted Noise Level (dB $L_{Aeq,T}$) at 638 m distance
Total			51

The predicted noise levels from construction activities are in the range of 33 to 47dB $L_{Aeq,1hr}$ at these locations with a cumulative level of the order of 51dB $L_{Aeq,1hr}$.

In all instances the predicted noise levels are below the appropriate Category A value (i.e. 65dB $L_{Aeq,1hr}$) presented in 11.3.2.1. and therefore a potential significant effect is not predicted in relation to the nearest noise sensitive locations in terms of construction noise.

With respect to the EPA's guidance for description of effects the potential worst-case associated effect at the nearest NSL associated with the grid connection route construction phase is expected to be Negative, Slight and Short-term.

Construction of Internal Roads

It is proposed to upgrade existing internal roads and also to construct new internal roads as part of the development. Review of the road layout has identified that the nearest NSL to any point along the proposed new internal roads is approximately 78 metres distance to H049, as shown in Figure 11-2. All other locations are at greater distances with the majority at significantly greater distances. The full description of the new roads is outlined in Chapter 4 of the EIAR.

Table 11-14 outlines the typical construction noise levels associated with the proposed works for this element of the construction.

Table 11-14 Typical Construction Noise Emission Levels – Internal Roads

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,T}$) [9]	Highest Predicted Noise Level at 78m (dB $L_{Aeq,T}$)
HGV Movement (C.2.30)	79	55
Tracked Excavator (C.4.64)	77	53
Dumper Truck (C.4.4)	76	52
Excavator Mounted Rock Breaker (C9.12)	85	61
Vibrating Rollers (D.8.29)	77	53
Total Construction Noise (cumulative for all activities)		63

At H049, the nearest NSL, the predicted noise levels from construction activities are of the order of 63 dB $L_{Aeq,T}$, which is within the significance threshold of 65dB $L_{Aeq,1hr}$. It should be noted that as the works will progress along the internal road routes, the worst-case predicted impacts will be reduced. It is envisioned that they will be at the closest position to the nearest NSLs for no more than 2 to 3 days

[9] *All plant noise levels are derived from BS 5228: Part 1*

and therefore the impact will not be significant. The contractor shall adopt practical mitigation measures referred to in Section 11.5.4 in line with best practice guidance to minimise potential impacts at the NSLs.

With respect to the EPA's guidance for description of effects the potential worst-case associated effect at the nearest NSL associated with construction of internal roads phase is expected to be Negative, Slight and Temporary.

Junction Upgrades and Road Widening Works

As detailed in Chapter 4, Section 4.3.17, the junction accommodation works along the proposed turbine delivery route will encompass hardsurfacing at the following locations: the N4 in the vicinity of its junction with the L1927 local road in the townland of Joanstown, in proximity to the railway line level crossing on the L1927, the L1927 and L5828 junction in the townland of Boherquill, at the gentle right turn from the L5828 onto the R395, access and egress at the proposed link road which abuts the R395 and the R396. Hardsurfacing will also be required at site access points off the R396 and at four points along the L5755 within the wind farm site boundary. Clearing of vegetation at this locations will also be required.

The proposed works will require placement of temporary hardcore surfacing and creation of visibility splays so the areas can be used during the delivery of large turbine components and will be reinstated to their original condition or as required in consultation with Westmeath County Council.

The nearest NSL to the road widening works are H079, H084 and H096, at approximately 50m from the works, as shown in Figure 11-2.

The proposed access to T15 includes the widening of an existing road. The nearest potential NSL is H034 at a distance of approximately 20m, however this is a derelict structure.

Typical construction plant items and their associated noise levels at various distances are presented in Table 11-15.

Table 11-15 Typical Construction Noise Levels for the Junction Accommodation and Road Widening works.

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,T}$) [10]	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)		
		50	100	150
HGV Movement (C.2.30)	79	60	50	46
Tracked Excavator (C.4.64)	77	58	45	41
Vibrating Rollers (D.8.29)	77	56	48	44
Total Construction Noise		61	53	49

At a distance of 50m, the predicted noise levels from construction activities are of the order of 61 dB $L_{Aeq,T}$, which is below the significance threshold of 65dB $L_{Aeq,1hr}$. Similarly, as the works will progress along the route the worst-case predicted impacts will be reduced. It is envisioned that they will be at the closest position to the nearest NSLs for no more than 2 to 3 days and therefore the impact will not be significant. The contractor shall adopt practical mitigation measures referred to in Section 11.5.4 in line with best practice guidance to minimise potential impacts at the NSLs. With respect to the EPA's

[10] *All plant noise levels are derived from BS 5228: Part 1*

guidance for description of effects, the potential worst-case associated effect at the nearest NSL associated with the road widening works are expected to be Negative, Slight and Temporary.

Onsite Substation

The nearest NSL to the proposed onsite substation is H004 at a distance of over 1,080 m to the north. As a worst-case example assuming the same construction activities as outlined for the turbines and hardstands in Table 11-13 above, it is predicted that the likely worst-case potential noise levels from construction activities associated with the onsite substation will be in the order of 47 dB $L_{Aeq,T}$ at Location H004. This level of noise is within the construction noise criterion outlined in Table 11-1.

It is concluded that there will be no significant noise impact associated with the construction of the onsite substation, therefore no specific mitigation measures are required.

With respect to the EPA's guidance for description of effects, the potential worst-case associated effect at the nearest NSL associated with the onsite substation construction is expected to be Negative, Not Significant and Temporary.

Grid Connection Route

The construction works associated with the proposed grid connection will occur for short durations at varying distances from NSLs, at various locations along the route. Table 11-16 presents outline noise calculations, considering the typical anticipated methods of construction, at varying distances from the construction works. The calculations assume there is no acoustic screening (i.e. barriers) in place between the site works and the NSL.

*Table 11-16 Indicative noise calculations for construction – Grid Connection Route Note * Assume noise control measures as outlined in Table B1 of BS 5228 – 1 (i.e. fit acoustic exhaust)*

Item (BS 5228 Ref.)	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,1hr}$)			
	20m	40m	60m	100m
Pneumatic breaker (C.8.12)	65	59	55	51
Wheeled loader (C.3.51)*	62	56	52	48
Tracked excavator (C.3.43)*	63	57	53	49
Dozer (C.3.30)*	64	58	54	50
Dump truck (C.3.60)*	60	54	50	46
Compressor (C.7.27)	61	55	51	47
Road Roller (C.3.114)	65	59	55	51
HGV Movements (10 per hour)	53	50	49	46

The noise levels presented are within the potential significant noise impact values (i.e. 65 dB $L_{Aeq,T}$) as shown in Table 11-1, for daytime periods on weekdays, at distances of 20m or greater from the works.

Similarly to the above, where a noise sensitive location is within 20m of works detailed consideration to potential construction noise impacts will be required and appropriate mitigation measures implemented in order to manage associated impacts. As the works will progress along the route the worst-case predicted impacts will be reduced. It is envisioned that they will be at the closest position to the nearest NSLs for no more than 2 to 3 days and therefore the impact will not be significant. The contractor shall adopt practical mitigation measures referred to in Section 11.5.4 in line with best practice guidance to minimise potential impacts at the NSLs. These effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

With respect to the EPA's guidance for description of effects, the potential worst-case associated effect at the nearest NSL associated with the road widening works are expected to be Negative, Slight and Short-term.

Mullingar Substation Site

A dedicated bay will be constructed at the existing Mullingar substation site as part of connection works. A detailed description is provided in Chapter 4.

Table 11-17 Typical Construction Noise Levels for the works at Mullingar Substation Site.

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,T}$) [11]	Highest Predicted Noise Level at 78m (dB $L_{Aeq,T}$)
Tracked Excavator (C.4.64)	77	59
Pneumatic Circular Saw (D.7.79)	75	57
Concrete Mixer Truck and Concrete Pump (C.4.27)	75	57
Mobile Telescopic Crane (C.4.39)	77	59
Total Construction Noise (cumulative for all activities)		64

It is concluded that there will be no significant noise impact associated with the construction of the onsite substation, therefore no specific mitigation measures are required.

With respect to the EPA's guidance for description of effects, the potential worst-case associated effect at the nearest NSL associated with the onsite substation construction is expected to be Negative, Not Significant and Temporary.

11.5.2.1.2 Vibration

As would be expected, vibration associated with construction activities is typically greater in magnitude in close proximity to the plant or equipment generating the vibration. AWN previously measured vibration generated by breaking activities on an unrelated site. At distances of 50-60m measured vibration levels were in the range 0.13 – 0.25 mm.s-1 Peak Particle Velocity.

[11] *All plant noise levels are derived from BS 5228: Part 1*

With reference to the vibration criteria presented in Table 11-2, these levels are an order of magnitude lower than the lowest recommended vibration level. Therefore, when considering the Proposed Development, the distance between areas of works and the nearest or the order of 100 meters or more. Considering the low levels of vibration close to construction sources and the dissipation of vibration over distance, there will be no vibration impact on sensitive locations in the area surrounding the development.

It is noted that piling is proposed in relation to turbine foundations, however, considering the distance between these construction activities and nearby noise sensitive locations, vibration from these activities would not be perceptible and would be orders of magnitude below levels where cosmetic or structural damage would be expected.

With respect to the EPA's guidance for description of effects, the potential worst-case associated effect at the nearest NSL associated with construction vibration is expected to be Neutral, Imperceptible and Short-Term.

11.5.2.2 Construction Traffic

This section has been prepared in order to review potential noise impacts associated with construction traffic on the local road network. The information presented in Chapter 14 has been used to inform the assessment. The following situations are commented upon here:

- Stage 1a – Site Preparation – Concrete Pouring
- Stage 1b – Site Preparation & Ground Works, including onsite substation
- Stage 2a – Turbine Construction Stage – Extended Artic Deliveries
- Stage 2b – Turbine Construction Stage – Other Conventional Deliveries

Changes in traffic noise levels along the six identified road links have been estimated and are commented upon. The following assumptions have been made in relation to the calculation of changes in traffic noise levels on the local road network due to the additional construction traffic volumes:

Table 11-18 Assumptions for Construction Traffic Noise Assessment

Route	Stage	Flows	%HGV	Speed (km/hr)
R396 towards site	Existing	1,606	9%	100
	1a	1,866	17%	100
	1b	1,769	10%	100
	2a	1,716	11%	100
	2b	1,708	10%	100
R395 west of Coole	Existing	2,941	9%	80
	1a	3,201	14%	80
	1b	3,104	10%	80
	2a	3,051	10%	80
	2b	3,043	10%	80
L5828	Existing	916	9%	80

Route	Stage	Flows	%HGV	Speed (km/hr)
	1a	1,176	21%	80
	1b	1,079	11%	80
	2a	1,026	11%	80
	2b	1,018	10%	80
L1927 south of L5828	Existing	1,359	9%	80
	1a	1,619	18%	80
	1b	1,522	11%	80
	2a	1,469	11%	80
	2b	1,461	10%	80
L1927 north of Rathowen	Existing	1,526	9%	80
	1a	1,786	17%	80
	1b	1,689	10%	80
	2a	1,636	11%	80
	2b	1,628	10%	80
N4 south of Rathowen	Existing	14,329	9%	80
	1a	14,589	11%	80
	1b	14,492	10%	80
	2a	14,439	10%	80
	2b	14,431	10%	80

Based on the assumptions presented above changes in noise level based on the existing flows have been estimated as presented in Table 11-19:

Table 11-19 Estimated Changes in Traffic Noise Levels

Route	Stage	Change in Traffic Noise Level, dB(A)
R396 towards site	Existing	–
	1a	+2.2
	1b	+0.6
	2a	+0.5

Route	Stage	Change in Traffic Noise Level, dB(A)
	2b	+0.4
R395 west of Coole	Existing	–
	1a	+1.3
	1b	+0.3
	2a	+0.3
	2b	+0.2
L5828	Existing	–
	1a	+3.3
	1b	+1.0
	2a	+0.8
	2b	+0.6
L1927 south of L5828	Existing	–
	1a	+2.5
	1b	+0.7
	2a	+0.6
	2b	+0.4
L1927 north of Rathowen	Existing	–
	1a	+2.3
	1b	+0.6
	2a	+0.5
	2b	+0.4
N4 south of Rathowen	Existing	–
	1a	+0.3
	1b	0.0
	2a	0.0
	2b	0.0

Along the road links listed above the increases predicted in traffic noise are negligible over a typical working day during stages 1b (Site Preparation & Ground Works), 2a (Turbine Delivery) and 2b (Other Deliveries). This is due to the fact that the additional construction traffic is a small percentage of the existing traffic volumes on these road links.

With regards to Stage 1a (i.e. concrete pours for the turbine bases) the traffic noise increase at properties along the L5828 are predicted to be the order of 3.3dB. Such an increase in noise would be considered a moderate impact however this is mitigated by the fact that that these traffic volumes are expected on only 15 days (e.g. one pour day for each turbine). Taking this into account, the noise impact construction traffic during Stage 1a is considered Negative, Slight and Temporary.

The works programme for Stage 1b is expected to last approximately 12 months. The increase in traffic noise along the delivery route due to additional construction traffic for this Stage is predicted to be less than 1dB. An increase of this order of magnitude is considered negligible.

In relation to Stage 2a, turbine delivery to site will occur where possible at night and will be undertaken by means of escorted convoys during the night, with some 5 transporters in each convoy. One convoy will occur over a night and there are of the order of 27 such events predicted over the course of the construction programme. Residents along the delivery route will be advised of dates of times of such convoys.

With respect to the EPA's guidance for description of effects, the potential worst-case associated noise effect from construction traffic is considered Negative, Not Significant and Short-term.

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle's wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

It has been found that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Problems attributable to road traffic vibration can therefore be largely avoided by maintenance of the road surface.

11.5.2.3 Borrow Pit

As detailed in Section 4.3.8.2 in Chapter 4 of this EIAR, rock blasting has been omitted as a method for rock extraction at the borrow pit and rock breaking operations are the proposed extraction method. Regarding rock breaking operations, the following should be noted:

- A mobile crusher will operate on site.
- One rock breaker will be in use on site during daytime periods for an estimated three-month period.
- The rock breaker will move to various locations on the proposed borrow pit location. For the purposes of this assessment it is assumed the plant is working in the vicinity of the proposed borrow pit location.

Table 11-20 outlines the assumed noise levels for the plant items as extracted from the British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

Table 11-20 Typical Borrow Pit Plant Noise Levels

Item	BS 5228 Ref:	dB L_w Levels per Octave Band (Hz)								dB(A)
		63	125	250	500	1k	2k	4k	8k	
Crusher	Table C1.14	121	114	107	109	103	99	94	87	110
Rock Breaker	Table C9.11	119	117	113	117	115	115	112	108	121

A construction noise model has been prepared to consider the expected noise emissions from the proposed construction works for rock breaking as outlined above. The predicted levels are detailed in Table 11-21 at the closest noise sensitive locations identified within the study area. A percentage on-time of 100% has been assumed per hour. This represents a worst-case scenario. A full listing of predictions to all locations in the study area is presented in Appendix 11-5. One potential borrow pit is proposed for the site and has been assessed in order to demonstrate the likely noise impacts associated with this aspect of the Proposed Development.

Review of the data contained in Table 11-21 confirms the following:

- Where rock breaking is proposed, the 65dB $L_{Aeq,1hr}$ potential significant impact criterion is exceeded at the nearest locations to the site (i.e. H11 and H12). Specific mitigation measures will be formulated by the appointed contractor in relation to such operations in order to mitigate these impacts such that the 65dB $L_{Aeq,1hr}$ significance criterion is adhered too. Indicative measures that will be considered are outlined in Section 11.5.4.

Table 11-21 Predicted Construction Noise Levels from Borrow Pit

Location	Predicted Construction Noise Level (dB $L_{Aeq,1hr}$)
	Rock Breaking Operations
H011	69
H012	67
H010	64
H009	60
H027	54
H013	51
H034	49
H007	48

With respect to the EPA's guidance for description of effects the potential worst-case associated effect at the nearest NSL associated with the borrow pit activity is expected to be Negative, Moderate and Short-term.

11.5.3 Operational Phase Potential Impacts

11.5.3.1 Turbine Noise Assessment

For details of the noise modelling methodology, assumptions and noise calculation software, refer to Section 11.3.7 above.

In the first instance a worst-case assessment has been completed assuming all noise sensitive locations are downwind of all turbines at the same time. The predicted levels have been compared against the adopted noise criteria curves as detailed in Table 11-10. Table 11-22 presents the details of the exercise at all locations considered within 2.5 kilometres of all turbine locations, as part of this assessment. See Appendix 11-6 for a complete list of coordinates of the 197 locations assessed.

Table 11-22 Review of Predicted Turbine Noise Levels against Relevant Criteria

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H001	Dwelling	25.5	26.7	30.8	35.1	36.6	36.9	36.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H002	Dwelling	25.8	27	31.1	35.4	37	37.2	37.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H003	Dwelling	26.2	27.4	31.6	35.9	37.4	37.6	37.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H004	Dwelling	26.1	27.3	31.4	35.7	37.2	37.5	37.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H005	Dwelling	25.4	26.6	30.7	35	36.5	36.8	36.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H006	Dwelling	25.9	27.1	31.2	35.5	37.1	37.3	37.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H007	Derelict	33.7	34.9	39.3	43.6	45.2	45.3	45.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	3.6	0.2	0.3	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	0.6	2.2	2.3	–
H008	Dwelling	24.8	26	30.1	34.4	35.9	36.2	36.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H009	Dwelling	26	27.2	31.3	35.6	37.1	37.4	37.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H010	Dwelling	26.4	27.6	31.7	36	37.5	37.8	37.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H011	Dwelling	28	29.2	33.4	37.7	39.2	39.5	39.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H012	Dwelling	28.2	29.4	33.6	37.9	39.4	39.6	39.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H013	Dwelling	31.1	32.3	36.6	40.9	42.4	42.6	42.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	0.9	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H014	Dwelling	30.4	31.6	35.9	40.2	41.7	42	42
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	0.2	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H015	Dwelling	27.4	28.6	32.8	37.1	38.6	38.8	38.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H016	Dwelling	27.2	28.4	32.6	36.9	38.5	38.7	38.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H017	Dwelling	28.7	29.9	34.2	38.5	40	40.2	40.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H018	Dwelling	29.4	30.6	34.9	39.2	40.7	40.9	40.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H019	Dwelling	29.5	30.7	35	39.3	40.8	41.1	41.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H020	Dwelling	29.5	30.7	35	39.3	40.8	41	41

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H021	Dwelling	29.4	30.6	34.9	39.2	40.7	41	41
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H022	Dwelling	29.4	30.6	34.9	39.2	40.7	40.9	40.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H023	Dwelling	30	31.2	35.5	39.8	41.3	41.5	41.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H024	Dwelling	29.7	30.9	35.2	39.5	41	41.2	41.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H025	Dwelling	24.3	25.5	29.6	33.9	35.4	35.7	35.7
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H026	Derelict	24.1	25.3	29.3	33.6	35.2	35.4	35.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H027	Derelict	28.6	29.8	34	38.3	39.8	40.1	40.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H028	Dwelling	25.5	26.7	30.8	35.1	36.6	36.9	36.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H029	Dwelling	26.5	27.7	31.8	36.1	37.7	37.9	37.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H030	Derelict	27.8	29	33.3	37.6	39.1	39.3	39.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H031	Derelict	25.6	26.8	31	35.3	36.8	37	37
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H032	Derelict	27.3	28.5	32.7	37	38.5	38.8	38.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H033	Dwelling	24.1	25.3	29.4	33.7	35.2	35.4	35.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H034	Derelict	33.1	34.3	38.6	42.9	44.5	44.7	44.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	2.9	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	1.5	1.7	–
H035	Commercial / Agricultural	24.8	26	30.1	34.4	35.9	36.1	36.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H036	Commercial / Agricultural	27.1	28.3	32.5	36.8	38.3	38.5	38.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H037	Commercial / Agricultural	27.6	28.8	33.1	37.4	38.9	39.1	39.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H038	Commercial / Agricultural	29.3	30.5	34.8	39.1	40.6	40.8	40.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H039	Commercial / Agricultural Dwelling	30.2	31.4	35.7	40	41.5	41.8	41.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H040	Commercial / Agricultural	32.3	33.5	37.9	42.2	43.7	43.9	43.9

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	2.2	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	0.7	0.9	–
H041	Commercial / Agricultural	36.4	37.6	42.1	46.4	47.9	48	48
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	2.1	6.4	2.9	3.0	2.6
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	3.4	4.9	5.0	2.5
H042	Dwelling	29.5	30.7	35	39.3	40.8	41.1	41.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H043	Derelict	29.9	31.1	35.5	39.8	41.3	41.5	41.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H044	Dwelling	25.4	26.6	30.7	35	36.6	36.8	36.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H045	Commercial / Agricultural	24.3	25.5	29.6	33.9	35.4	35.7	35.7

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H046	Dwelling	27.1	28.3	32.6	36.9	38.4	38.6	38.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H047	Dwelling	24.7	25.9	30.1	34.4	35.9	36.1	36.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H048	Dwelling	24.3	25.5	29.6	33.9	35.5	35.7	35.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H049	Dwelling	26.5	27.7	31.9	36.2	37.7	38	38
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H050	Dwelling	23.7	24.9	29	33.3	34.8	35.1	35.1
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H051	Dwelling	22.8	24	28	32.3	33.9	34.1	34.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H052	Dwelling	21.6	22.8	26.7	31	32.5	32.8	32.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H053	Dwelling	23.5	24.7	28.7	33	34.5	34.8	34.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H054	Dwelling	24.4	25.6	29.7	34	35.5	35.7	35.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H055	Dwelling	23.3	24.5	28.5	32.8	34.3	34.6	34.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H056	Dwelling	23	24.2	28.2	32.5	34	34.3	34.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H057	Dwelling	22.3	23.5	27.5	31.8	33.3	33.6	33.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H058	Dwelling	20.9	22.1	26	30.3	31.8	32.1	32.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H059	Dwelling	22.2	23.4	27.4	31.7	33.2	33.5	33.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H060	Dwelling	22.9	24.1	28.1	32.4	33.9	34.2	34.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H061	Dwelling	22.6	23.8	27.9	32.2	33.7	33.9	33.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H062	Dwelling	22.2	23.4	27.4	31.7	33.2	33.4	33.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H063	Dwelling	22	23.2	27.2	31.5	33	33.3	33.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H064	Dwelling	22.2	23.4	27.3	31.6	33.1	33.4	33.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H065	Dwelling	22.1	23.3	27.3	31.6	33.1	33.4	33.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H066	Dwelling	22.2	23.4	27.4	31.7	33.2	33.5	33.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H067	Dwelling	20.3	21.5	25.4	29.7	31.2	31.5	31.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H068	Dwelling	22.7	23.9	27.9	32.2	33.8	34	34
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H069	Dwelling	21.8	23	27	31.3	32.8	33	33
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H070	Dwelling	21.6	22.8	26.7	31	32.5	32.8	32.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H071	Dwelling	21.3	22.5	26.5	30.8	32.3	32.6	32.6

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H072	Dwelling	21.2	22.4	26.3	30.6	32.1	32.4	32.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H073	Dwelling	21.4	22.6	26.5	30.8	32.3	32.6	32.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H074	Dwelling	20.7	21.9	25.8	30.1	31.6	31.9	31.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H075	Dwelling	21.2	22.4	26.3	30.6	32.1	32.4	32.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H076	Dwelling	20.9	22.1	26.1	30.4	31.9	32.1	32.1
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H077	Dwelling	20.7	21.9	25.8	30.1	31.6	31.9	31.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H078	Dwelling	20.6	21.8	25.7	30	31.5	31.8	31.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H079	Dwelling	20.7	21.9	25.8	30.1	31.7	31.9	31.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H080	Dwelling	20.5	21.7	25.5	29.8	31.3	31.6	31.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H081	Dwelling	20.5	21.7	25.6	29.9	31.4	31.7	31.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H082	Dwelling	20.1	21.3	25.2	29.5	31	31.3	31.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H083	Dwelling	20.4	21.6	25.4	29.7	31.2	31.5	31.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H084	Dwelling	20.5	21.7	25.6	29.9	31.4	31.7	31.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H085	Dwelling	20	21.2	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H086	Dwelling	17.9	19.1	23	27.3	28.8	29.1	29.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H087	Dwelling	20.4	21.6	25.5	29.8	31.3	31.6	31.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H088	Dwelling	18.4	19.6	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H089	Dwelling	20.3	21.5	25.3	29.6	31.1	31.4	31.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H090	Dwelling	20.3	21.5	25.3	29.6	31.1	31.4	31.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H091	Dwelling	20	21.2	25.1	29.4	30.9	31.2	31.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H092	Dwelling	19.9	21.1	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H093	Dwelling	20.7	21.9	25.7	30	31.6	31.8	31.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H094	Dwelling	20.4	21.6	25.5	29.8	31.3	31.5	31.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H095	Dwelling	20.1	21.3	25.2	29.5	31	31.3	31.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H096	Dwelling	20.2	21.4	25.3	29.6	31.1	31.4	31.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H097	Dwelling	20.1	21.3	25.1	29.4	30.9	31.2	31.2

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H098	Dwelling	20.6	21.8	25.7	30	31.5	31.8	31.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H099	Dwelling	20.1	21.3	25.2	29.5	31	31.3	31.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H100	Dwelling	19.9	21.1	24.9	29.2	30.7	31	31
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H101	Derelict	19.9	21.1	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H102	Dwelling	19.8	21	24.8	29.1	30.7	30.9	30.9
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H103	Dwelling	18.8	20	23.9	28.2	29.7	30	30
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H104	Dwelling	18.7	19.9	23.7	28	29.5	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H105	Dwelling	17.9	19.1	22.9	27.2	28.7	29	29
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H106	Dwelling	20.3	21.5	25.4	29.7	31.2	31.5	31.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H107	Dwelling	17.9	19.1	22.9	27.2	28.8	29	29
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H108	Derelict	20.4	21.6	25.5	29.8	31.3	31.6	31.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H109	Dwelling	20.2	21.4	25.3	29.6	31.1	31.4	31.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H110	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H111	Dwelling	17.9	19.1	22.9	27.2	28.7	29	29
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H112	Dwelling	20	21.2	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H113	Dwelling	19.7	20.9	24.7	29	30.5	30.8	30.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H114	Dwelling	19.6	20.8	24.7	29	30.5	30.8	30.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H115	Dwelling	19	20.2	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H116	Dwelling	17.7	18.9	22.8	27.1	28.6	28.9	28.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H117	Dwelling	18.7	19.9	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H118	Dwelling	19.7	20.9	24.7	29	30.6	30.8	30.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H119	Dwelling	19.6	20.8	24.6	28.9	30.4	30.7	30.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H120	Dwelling	19	20.2	24.1	28.4	29.9	30.2	30.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H121	Dwelling	19	20.2	24.1	28.4	29.9	30.2	30.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H122	Dwelling	17.6	18.8	22.6	26.9	28.4	28.7	28.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H123	Dwelling	19	20.2	24	28.3	29.8	30.1	30.1

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H124	Dwelling	17.7	18.9	22.8	27.1	28.6	28.8	28.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H125	Dwelling	20	21.2	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H126	Dwelling	18.9	20.1	24	28.3	29.8	30.1	30.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H127	Dwelling	18.1	19.3	23.1	27.4	28.9	29.2	29.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H128	Dwelling	20	21.2	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H129	Dwelling	20.1	21.3	25.1	29.4	30.9	31.2	31.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H130	Dwelling	18.9	20.1	24	28.3	29.8	30.1	30.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H131	Dwelling	18.8	20	23.9	28.2	29.7	30	30
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H132	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H133	Dwelling	19.9	21.1	25	29.3	30.8	31.1	31.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H134	Dwelling	17.4	18.6	22.4	26.7	28.2	28.5	28.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H135	Dwelling	18.5	19.7	23.4	27.7	29.2	29.5	29.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H136	Dwelling	19.3	20.5	24.3	28.6	30.1	30.4	30.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H137	Dwelling	18.7	19.9	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H138	Dwelling	18.4	19.6	23.5	27.8	29.3	29.6	29.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H139	Dwelling	19.6	20.8	24.6	28.9	30.4	30.6	30.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H140	Dwelling	17.3	18.5	22.4	26.7	28.2	28.4	28.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H141	Dwelling	17.9	19.1	22.8	27.1	28.6	28.9	28.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H142	Dwelling	19.3	20.5	24.3	28.6	30.1	30.4	30.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H143	Dwelling	17.2	18.4	22.3	26.6	28.1	28.3	28.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H144	Dwelling	19.6	20.8	24.6	28.9	30.4	30.7	30.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H145	Dwelling	17.2	18.4	22.3	26.6	28.1	28.4	28.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H146	Dwelling	19.6	20.8	24.6	28.9	30.5	30.7	30.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H147	Dwelling	18.9	20.1	23.9	28.2	29.7	30	30
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H148	Dwelling	19.2	20.4	24.2	28.5	30	30.3	30.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H149	Dwelling	19.1	20.3	24.1	28.4	29.9	30.2	30.2

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H150	Dwelling	18.5	19.7	23.5	27.8	29.4	29.6	29.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H151	Dwelling	19	20.2	24	28.3	29.8	30.1	30.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H152	Dwelling	19.5	20.7	24.5	28.8	30.3	30.6	30.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H153	Dwelling	19.8	21	24.8	29.1	30.6	30.9	30.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H154	Dwelling	19.5	20.7	24.5	28.8	30.3	30.6	30.6
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H155	Dwelling	19	20.2	24	28.3	29.8	30.1	30.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H156	Dwelling	18.3	19.5	23.4	27.7	29.2	29.5	29.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H157	Dwelling	19.4	20.6	24.4	28.7	30.2	30.5	30.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H158	Dwelling	18.4	19.6	23.3	27.6	29.1	29.4	29.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H159	Dwelling	19.3	20.5	24.3	28.6	30.1	30.4	30.4
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H160	Dwelling	18.9	20.1	23.9	28.2	29.7	30	30
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H161	Dwelling	17.9	19.1	22.8	27.1	28.7	28.9	28.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H162	Dwelling	18.9	20.1	23.9	28.2	29.7	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H163	Dwelling	19.4	20.6	24.4	28.7	30.2	30.5	30.5
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H164	Dwelling	18.9	20.1	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H165	Dwelling	19.5	20.7	24.5	28.8	30.3	30.6	30.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H166	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H167	Dwelling	19.2	20.4	24.2	28.5	30	30.3	30.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H168	Dwelling	18.8	20	23.8	28.1	29.6	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H169	Dwelling	18.8	20	23.8	28.1	29.6	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H170	Dwelling	18.8	20	23.7	28	29.6	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H171	Dwelling	18.8	20	23.7	28	29.6	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H172	Dwelling	18.7	19.9	23.7	28	29.5	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H173	Dwelling	18.7	19.9	23.7	28	29.5	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H174	Dwelling	19.5	20.7	24.5	28.8	30.3	30.6	30.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H175	Dwelling	18.7	19.9	23.7	28	29.5	29.8	29.8

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H176	Dwelling	18.7	19.9	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H177	Dwelling	18.7	19.9	23.6	27.9	29.5	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H178	Dwelling	18.7	19.9	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H179	Dwelling	19.1	20.3	24.1	28.4	29.9	30.2	30.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H180	Dwelling	18.6	19.8	23.5	27.8	29.4	29.6	29.6
	Daytime Criterion	40	40	40	40	45	45	45.4

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H181	Dwelling	18.6	19.8	23.5	27.8	29.3	29.6	29.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H182	Dwelling	17.5	18.7	22.5	26.8	28.3	28.6	28.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H183	Dwelling	19	20.2	24	28.3	29.8	30.1	30.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H184	Dwelling	18.9	20.1	23.9	28.2	29.7	30	30
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H185	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H186	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H187	Dwelling	18.1	19.3	23	27.3	28.8	29.1	29.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H188	Dwelling	18.8	20	23.8	28.1	29.6	29.9	29.9
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H189	Dwelling	18.2	19.4	23.2	27.5	29	29.3	29.3
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H190	Dwelling	18	19.2	22.9	27.2	28.7	29	29
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
	Night-time Excess	–	–	–	–	–	–	–
H191	Dwelling	18.7	19.9	23.7	28	29.5	29.8	29.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H192	Dwelling	18.6	19.8	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H193	Dwelling	18.6	19.8	23.5	27.8	29.3	29.6	29.6
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H194	Dwelling	18.1	19.3	23.1	27.4	28.9	29.2	29.2
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H195	Dwelling	18.7	19.9	23.6	27.9	29.4	29.7	29.7
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

House	Parameter	Noise Level, dB L_{A90} at Standardised Wind Speed, m/s						
		3.0	4.0	5.0	6.0	7.0	8.0	9.0
H196	Dwelling	18.1	19.3	23	27.3	28.8	29.1	29.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H197	Dwelling	18.1	19.3	23	27.3	28.8	29.1	29.1
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–
H198	Dwelling	17.8	19.0	22.7	27.0	28.5	28.8	28.8
	Daytime Criterion	40	40	40	40	45	45	45.4
	Daytime Excess	–	–	–	–	–	–	–
	Night-time Criterion	43	43	43	43	43	43	45.5
	Night-time Excess	–	–	–	–	–	–	–

A noise contour for the rated power wind speed of 8 m/s (i.e. windspeed at which the highest noise emission reached) has been presented in Appendix 11-7.

As previously stated the day to day operations of the Proposed Development will not result in a typical worst-case assumption of all noise locations being downwind of all turbines at the same time.

The predicted noise levels at various wind speeds have been compared against the noise criteria curves outlined in Table 11-10. The predicted noise levels at all locations for the various wind speeds do not exceed the noise criteria curves adopted for this assessment with the exception of locations: H007, H013, H014, H034, H40 and H041. Review of the designations of these properties confirms that two are derelict structures (H007 and H034), one is an agricultural shed (H40) and one is a shed (H41) used to store machinery/material supplies and therefore are not considered noise sensitive in the context of this assessment. The remaining two locations with potential exceedances of noise criteria under worst-case assumptions are H013 and H014.

11.5.3.1.1 Consideration of Wind Direction and Noise Propagation

The next stage in the assessment is to consider the potential exceedances remaining at H013 and H014.

When considering noise impacts of wind turbines, the effects of propagation in different wind directions should be considered. The day to day operations of the Proposed Development will not result in a worst-case condition of all noise locations being downwind of all turbines at the same time i.e. omni-directional predictions. Therefore, to address this, a review of expected noise levels downwind of the turbines has been prepared for various wind directions in accordance with the IoA GPG Guidance.

For any given wind direction, a property can be assigned one of the following classifications in relation to turbine noise propagation:

- Downwind (i.e. 0° ±80°);
- Crosswind (i.e. 90° ±10° and 270° ±10°);
- Upwind (i.e. 180° ±70°).

Figure 11-12 illustrates the directivity attenuation factor that has been applied to turbines when considering noise propagation in downwind conditions (downwind is represented by 0° with upwind being 180°).

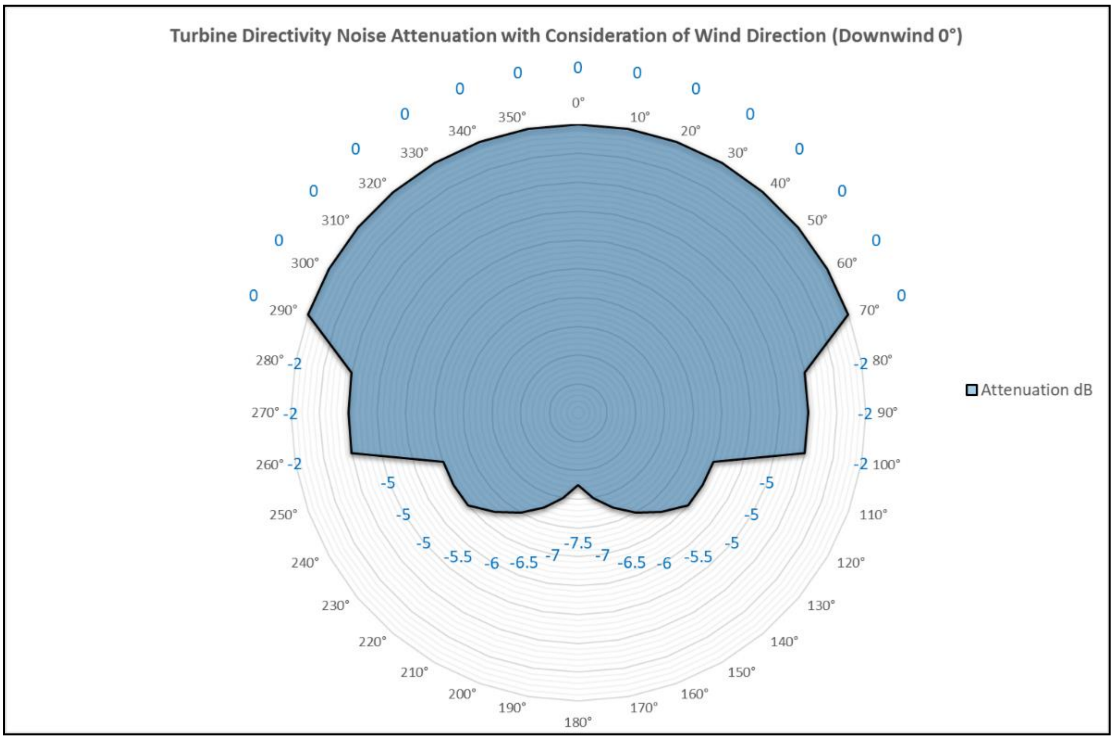

Figure 11-12 Turbine Directivity Attenuation with Consideration of Wind Direction

Directional noise predictions models have been developed to identify the number and magnitude of exceedances to the noise criteria at the various noise sensitive locations with the proposed turbines operating in standard mode. The full tabulated results of this assessment are shown in Appendix 11-8.

The predicted potential exceedances are presented in the tables below for each of the various wind direction sectors where exceedances have been noted.

Table 11-23 Summary of Predicted Potential Exceedances – H013

Dwelling H013		Excesses of Criterion dB LA90,10min at Various Standarised Wind Speeds (m/s)						
Wind Direction	Period	3	4	5	6	7	8	9
West	Daytime	–	–	–	0.2	–	–	–

Dwelling H013		**Excesses of Criterion dB LA90,10min at Various Standarised Wind Speeds (m/s)**						
Wind Direction	**Period**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Night-time	–	–	–	–	–	–	–
Northwest	Daytime	–	–	–	0.5	–	–	–
	Night-time	–	–	–	–	–	–	–

Table 11-24 Summary of Predicted Potential Exceedances – H014

Dwelling H014		**Excesses of Criterion dB LA90,10min at Various Standarised Wind Speeds (m/s)**						
Wind Direction	**Period**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
East	Daytime	–	–	–	0.2	–	–	–
	Night-time	–	–	–	–	–	–	–

At dwelling H013, there is a marginal potential exceedance predicted for daytime periods of the order of 0.2 – 0.5dB, at wind speeds of 6m/s for the west and northwest wind directions.

At dwelling H014, which lies to the northwest of the site, there remains a marginal potential exceedance is 0.2 dB(A) in the east wind direction at windspeeds of 6 m/s for daytime periods.

No exceedances of the night-time noise criteria are predicted.

Wind turbines can be programmed to run in reduced modes of operation (or low noise modes) in order to achieve noise criteria during certain periods (i.e. day or night) and in specific wind conditions (i.e. wind speed and direction). The turbine technology that has been assumed for this assessment offers various low noise modes of operation which typically will have an associated energy output reduction.

Operating the turbines in reduced modes is generally referred to as curtailment and in the context of this EIAR is a proven effective mitigation to ensure noise limits are complied with.

A detailed curtailment strategy matrix will be finalised as part of the detailed design for the selected turbine technology to achieve the noise criteria at each of the noise sensitive locations. To demonstrate the principle of curtailment, a typical curtailment strategy matrix has been developed and is presented in Table 11-25 for north-westerly winds to address the exceedance noted at H013 in this wind direction sector. The required noise emission reductions to the relevant turbines are summarised in Table 11-25.

Table 11-25 Indicative Turbine Curtailment Matrix for North Wind Direction

Wind Direction Sector	**Period**	**Turbine Curtailment (dB) at Standardised Wind Speeds (m/s)**					
		4	**5**	**6**	**7**	**8**	**9**
Northwest	Day	–	–	T05: -1 dB	–	–	–

Wind Direction Sector	Period	Turbine Curtailment (dB) at Standardised Wind Speeds (m/s)					
		4	5	6	7	8	9
				T06: -1 dB T09: -1 dB T10: -1 dB T13: -1 dB T14: -1 dB			
	Night	–	–	–	–	–	

With this curtailment in place, the predicted noise level falls within the daytime criterion of 40dB at wind speeds of 6 m/s.

Similarly, in order to address the predicted exceedances at H014 of 0.2 dB(A) at 6 m/s in the easterly wind direction, the noise emission reductions to the relevant turbines are summarised in Table 11-26.

Table 11-26 Indicative Turbine Curtailment Matrix for North Wind Direction

Wind Direction Sector	Period	Turbine Curtailment (dB) at Standardised Wind Speeds (m/s)					
		4	5	6	7	8	9
East	Day	–	–	T08: -1 dB T10: -1 dB T11: -1 dB	–	–	–
	Night	–	–	–	–	–	

11.5.3.1.2 Summary

For the purposes of this assessment, a specific turbine model has been assumed, as detailed in Section 11.3.7.2.1. The actual turbine to be installed on the site will be the subject of a competitive tender process and could include other turbines models (including models not currently available). Regardless of the make or model of the turbine eventually selected for installation on site, the noise it will give rise to will be capable of being controlled to achieve the noise emission limits at all noise sensitive locations. The turbines will be capable of achieving the limits set by the relevant guidance or planning permission conditions.

Assuming the implementation of the above or similar, it is not considered that a significant effect is associated with the operation of this development, since the predicted residual noise levels associated with the Proposed Development will be within the relevant best practice noise criteria curves for wind farms. As previously discussed, the following guidance is relevant for this assessment, "*Wind Energy Development Guidelines*" published by the Department of the Environment, Heritage and Local Government in 2006 and in the Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) publication "*The Assessment and Rating of Noise from Wind Farms*" (1996).

While noise levels at low wind speeds will increase due to the development, the predicted levels will remain low, albeit a new source of noise will be introduced into the soundscape.

With respect to the EPA criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with the operation of the wind turbines in Proposed Development are described Negative, Moderate and Long-term.

11.5.3.2 Site Roads

Considering that there is no significant traffic expected on site roads during the operational phase and the significant distances from any site road to the nearest NSL; there are no noise and vibration impacts anticipated from site roads during the operational phase.

With respect to the EPA criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations the operation of site roads are described Negative, Slight and Long-term.

11.5.3.3 Onsite Substation

The proposed substation location is shown in Figure 11-2. The substation will be located in an area of existing commercial forestry.

As part of the Proposed Development the substation will be operational on a 24/7 basis. The noise emission level associated with a typical substation that would support a development of this nature is the order of 93dB(A) L_W, as shown in Figure 11-13.

S

MADE BY SIEMENS, S.A.

Transformer type TLPN7747	Nr. LEL 111748	Year of manuf. 2013	Specification IEC 60076		
Rated power 40 000 / 50 000 kVA	---	U_m 52 / 24 kV	AC 95 / 50 kV	LI 250 / 125 kV	
Vector-group symbol Dyn11	Continuous	Rated frequency 50 Hz	Cooling method ONAN/ONAF		
Position	Voltage		Current		Impedance voltage
1	43 890 V	---	526 / 658 A	---	%
10	37 500 V	20 960 V	616 / 770 A	1102 / 1377 A	%
21	29 690 V	---	778 / 972 A	---	%
Max. altitude above sea level 1000 m		Upper limit of overcurrent (HV) 6.7 kA		Duration of short-circuit 2 s	
Temp. Rise (oil/winding) 60 / 65 K		Total mass 64 t		Mass of insul. oil 13 t	
Number of phases 3		Untaking mass 38 t		Transportation mass 56 t	
Sound power level 93 dB (A)		Temp. rise oil / winding 60 / 65 K		Ambient temp. max. 40 °C	
Tank and conservator full vacuum resistant		---		Type of oil Nynas Nytro Taurus	
Type of on-load tap changer VV III 600D-76-12233G		Rated current 600 A	U_m 76 kV	Revol. of driving shaft per step 33	

Figure 11-13 Statement of L_W for Typical Sub Station Used for Assessment

An iteration of the noise model has been developed to consider the expected noise level from the plant at the nearest noise sensitive locations. The closest occupied dwelling is located approximately 1,080m to the proposed substation location (i.e. Location H004). In order to give an indication of the range of noise levels at NSLs due to the substation, the NSLs with the highest ten substation noise levels are presented in Table 11-27.

Table 11-27 Predicted operational noise levels due to substation

Name	Description	Height (m)	Predicted Substation noise Level due to Onsite Substation, dB L_{Aeq}
			Substation
H001	Dwelling	4	26.6
H003	Dwelling	4	25.5
H004	Dwelling	4	27.1
H005	Dwelling	4	26.1
H007	Derelict	4	25.5
H008	Dwelling	4	26.6
H014	Derelict	4	27.7
H029	Dwelling	4	25.6
H030	Derelict	4	27.3
H031	Derelict	4	26.5

The worst-case predicted level is expected to be 27.7dB(A). This level is comparable to the lower noise levels measured in the area as part of the survey work undertaken for this assessment. In essence, the noise from such an installation would not be expected to be audible at the majority of noise-sensitive locations and will not significantly add to the overall noise levels associated with the proposed wind turbines themselves.

With respect to the EPA criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations the operation of the on-site substation are described Neutral, Imperceptible and Long-term.

11.5.3.4 Grid Connection

With respect to the EPA's guidance for description of effects the grid connection, once constructed, will not generate noise during the operational phase. The associated effects are Neutral, Imperceptible and Long Term.

11.5.3.5 Mullingar Substation Site

With respect to the EPA's guidance for description of effects the connection bay, once constructed, will not generate any significant noise during the operational phase. The associated effects are Neutral, Imperceptible and Long Term.

11.5.4 Construction Phase Mitigation Measures

Regarding construction activities, reference will be made to BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*, which offers detailed guidance on the control of noise & vibration from demolition and construction activities. It is proposed that various practices be adopted during construction, including:

- managing the hours according to the CEMP [Appendix 4-8 during which site activities likely to create high levels of noise or vibration are permitted;
- establishing channels of communication between the contractor/developer, Local Authority and residents;
- appointing a site representative responsible for matters relating to noise and vibration;
- monitoring typical levels of noise and vibration during critical periods and at sensitive locations;
- keeping site access roads even to mitigate the potential for vibration from lorries.

Furthermore, a variety of practicable noise control measures will be employed. These include:

- selection of plant with low inherent potential for generation of noise and/ or vibration;
- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- regular maintenance and servicing of plant items.

It is recommended that vibration from construction activities be limited to the values set out in Table 11-3. It should be noted that these limits are not absolute, but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage these limits may need to be reduced by up to 50%.

11.5.4.1 Construction Phase Mitigation Measures – Noise

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise.* The following list of measures will be implemented on site, to ensure compliance with the relevant construction noise criteria:

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate close to NSLs outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Section 11.3.2 using methods outlined in British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs Monday to Saturday. However, to ensure that optimal use is made of good

weather periods or at critical periods within the programme (i.e. concrete pours, rotor/tower deliveries) it will be necessary on occasion to work outside of these hours.

Where rock breaking is employed in relation to the proposed borrow pit, the following are examples of measures that will be considered, where necessary, to mitigate noise emissions from these activities:

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency.
- Ensure all leaks in air lines are sealed.
- Use a dampened bit to eliminated ringing.
- Erect acoustic screen between compressor or generator and noise sensitive area. When possible, line of sight between top of machine and reception point needs to be obscured.
- Enclose breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

11.5.4.2 Construction Phase Mitigation Measures – Vibration

While it was concluded above that there will be no significant vibration impacts associated with the construction of the Proposed Development and that no specific mitigation measures were required, it is recommended that vibration from construction activities will be limited to the values set out in Section 11.3.2.1.3. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage these limits may need to be reduced by up to 50%.

With regards to piling, considering the large distances between locations where works with the potential to generate significant vibration will take place and the nearest NSLs, no significant impact will be experienced. Therefore, no mitigation measures are proposed.

11.5.5 Operational Phase Mitigation Measures

An assessment of the operational noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 11.3.2.2 of this Chapter. The findings of the assessment identified that there are two NSLs where potential exceedances are predicted. If confirmed during post-construction monitoring, a curtailment strategy will be implemented to reduce noise levels due to the wind farm to within the criteria at all NSLs.

In the unlikely event that an issue with low frequency noise is associated with the Proposed Development, it is recommended that an appropriate detailed investigation be undertaken. Due consideration should be given to guidance on conducting such an investigation which is outlined in Appendix VI of the EPA document entitled *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* (NG4) (EPA, 2016). This guidance is based on the threshold values outlined in the Salford University document *Procedure for the assessment of low frequency noise complaints, Revision 1, December 2011*.

The following programme of measures would be implemented in the event of an issue of aerodynamic modulation being identified and associated with the site:

- A detailed noise survey conducted by an appropriately qualified acoustic consultant will be commissioned in order to confirm the presence or not of the issue, the extent of the issue (i.e. number of locations, wind speeds and environmental conditions in which it is occurring);

- Based on the findings of this work and where aerodynamic modulation is identified a schedule of measures will be formulated and agreed with the planning authority, which would typically be envisaged to focus on control and regulation of the operation of turbine unit(s) in certain atmospheric and meteorological conditions.

The measurement method outlined in the IoA AMWG document, known as the '*Reference Method*', will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

11.5.5.1 Monitoring

Commissioning noise surveys are recommended to ensure compliance with any noise conditions applied to the Proposed Development. In the unlikely instance that an exceedance of these noise criteria is identified, the assessment guidance outlined in the IoA GPG and *Supplementary Guidance Note 5: Post Completion Measurements (July 2014)* should be followed and relevant corrective actions undertaken.

11.5.6 Decommissioning Phase

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will likely be used. During the decommissioning phase there may also be a need for rock breaking to remove the turbine foundations.

The wind turbines proposed as part of the Proposed Development are expected to have a minimum lifespan of 30 years. Following the end of their useful life, the wind turbines may be replaced with a new set of turbines, subject to planning permission being obtained, or the Proposed Development may be decommissioned fully. The onsite substation will remain in place as it will be under the ownership of EirGrid/ESB. A Decommissioning Plan for the Proposed Development is included as Appendix 4-11.

The noise and vibration impacts associated with any decommissioning of the site are considered to be comparable to those outlined in relation to the construction of the Proposed Development (as per Section 11.5.2). There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Section 11.5.2.

In all instances the total predicted construction and decommissioning noise levels are expected to be below the appropriate Category A value (i.e. 65dB $L_{Aeq,1hr}$) and therefore a significant effect is not predicted in relation to the nearest noise sensitive locations in terms of construction and decommissioning noise.

11.5.6.1 Decommissioning Phase Mitigation

The mitigation measures that will be considered in relation to any decommissioning of the site are the same as those proposed for the construction phase of the Proposed Development, i.e. as per Section 11.5.4.

11.5.7 Cumulative Impacts

This assessment has considered the potential cumulative impacts for both the construction and operational phases of the different elements of the Proposed Development, i.e. the wind farm, the onsite substation, the grid connection and the Mullingar Substation Site. Discussions on the potential cumulative impacts are presented in the following sections.

11.5.7.1 Construction Phase

It is not expected there will be any other construction activities that would give rise to significant cumulative impacts during the construction phase. The predicted noise emissions for the Proposed Development are not of enough magnitude to cause an increase in the cumulative construction noise emissions exceeding the threshold for significant impacts at any NSL.

The predicted noise levels from the construction activity would need to be in excess of 55 dB L_{Aeq} for the potential for a cumulative noise increase with other construction works that would result in an exceedance of the noise threshold. The only element of the construction phase where there may be potential for cumulative construction noise impacts are grid connection works occurring in proximity to an NSL. In such instance, the contractor will adopt appropriate mitigation measures to minimise any impacts in line with best practice as discussed in Section 11.5.4. It is expected that with appropriate mitigation measures in place, cumulative impacts during the construction phase will not be significant.

There are no significant cumulative noise impacts anticipated at sensitive locations during the proposed construction activities at the Mullingar Substation site.

11.5.7.2 Description of Effects

With respect to the EPA criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with the construction of Turbines, Hardstands, Onsite substation, Grid Connection, Internal Roads, and Road Widening of the Proposed Development are Negative, Moderate and Short-term.

It is not expected that there will be any significant cumulative impacts at NSLs should the various elements of the construction phase be undertaken simultaneously.

11.5.7.3 Operational Phase

A review of existing, proposed and permitted wind turbine developments in the wider study has been undertaken in accordance with the guidance contained in the IOA GPG. As discussed in Section 11.1, there are no other wind farm developments which need consideration for cumulative noise effects.

Once the grid connection works are completed, the potential noise impacts to the surrounding environment are not significant. The grid connection cable will not emit any noise emissions during the operational phase. The predicted noise emissions from the operation of the substation, at the nearest NSL, are not expected to generate any noise over or above the existing background noise environment. Similarly, the operation of the additional bay at the existing Mullingar substation is not expected to generate any significant additional noise against the backdrop of the existing substation, so cumulative impacts here are anticipated to be Not Significant.

11.6 Description of Residual Effects

11.6.1 Do-Nothing Scenario

An alternative land-use option to developing the Proposed Development would be, as detailed in Section 1.1 of Chapter 1, to construct a permitted wind energy project comprising of 13 turbines and all associated infrastructure on the Proposed Development site. The permitted wind energy project was designed to co-exist and operate in conjunction with and independently of land-use practices of commercial peat-harvesting and forestry to minimise impacts. Whilst there would be a change of land use within the footprint of the Proposed Development, to facilitate the wind turbines and infrastructure, this was found to be an acceptable part of the permitted development.

This EIAR assesses the potential for peat extraction works on the site to continue as a worst-case scenario. The Proposed Development has been designed to operate on this site in conjunction with any Peat extraction activities . The section of the Proposed Development site that does not form part of the currently permitted wind energy development site has a current-land use practice of low-intensity pastoral agriculture and commercial forestry. An alternative land-use option to developing a renewable energy project at this section of the Proposed Development site would be to leave the site as it is, with no changes made to the current land-use practices of low intensity pastoral agriculture and commercial forestry. The environmental effects of this are considered to be neutral.

A second potential Do-Nothing scenario exists for this project i.e. assuming that the permitted development is not constructed. In this scenario the existing baseline environment will evolve in one of two potential ways, either the peat extraction ceases and a rehabilitation plan is developed or the peat extraction continues and then a rehabilitation plan is developed.

The existing noise environment will remain largely unchanged notwithstanding other proposed and permitted wind turbine developments in the area. In areas where traffic noise is a significant source in the environment, increases in traffic volumes on the local road network would be expected to result in slight increases in overall ambient and background noise in the area over time.

11.6.2 Construction Phase

During the construction phase of the project there will be some effect on nearby noise sensitive properties due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby noise sensitive properties and the fact that the construction phase of the Proposed Development is temporary in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration effect is kept within the guidance limits.

With respect to the EPA's criteria for description of effects, in terms of these construction activities, the potential worst-case associated effects at the nearest noise sensitive locations associated with the various elements of the construction phase are described below.

11.6.2.1 Turbines and Hardstands

The predicted construction noise and vibration effects associated with turbines and hardstands are summarised as follows:

Quality	Significance	Duration
Negative	Slight	Short-term

11.6.2.2 Construction of Internal Roads

The predicted construction noise and vibration effects associated with internal roads are summarised as follows:

Quality	Significance	Duration
Negative	Slight	Short-term

11.6.2.3 Junction Upgrades and Road Widening Works

The predicted construction noise and vibration effects associated with the junction upgrades and road widening works are summarised as follows:

Quality	Significance	Duration
Negative	Slight	Short-term

11.6.2.4 Onsite substation

The predicted construction noise and vibration effects associated with the onsite substation are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Temporary

11.6.2.5 Grid Connection Route

The predicted construction noise and vibration effects associated with the grid connection route are summarised as follows:

Quality	Significance	Duration
Negative	Slight	Short-term

11.6.2.6 Mullingar Substation Site

The predicted construction noise and vibration effects associated with the upgrade works to the existing Mullingar Substation are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Temporary

11.6.2.7 Construction Traffic

The effects associated with the overall noise levels from construction traffic is summarised as follows, for the worst-case phase of the construction:

Quality	Significance	Duration
Negative	Not Significant	Temporary

11.6.2.8 Borrow Pit Activity

Taking account of mitigation measures to be implemented by the contractor, the noise and vibration will be managed so that the effects associated with proposed borrow pit activity at NSLs are summarised as follows:

Quality	Significance	Duration
Negative	Moderate	Temporary

11.6.3 Operational Phase

11.6.3.1 Noise

11.6.3.1.1 *Wind Turbine Noise*

The predicted noise levels associated with the Proposed Development will be within best practice noise criteria curves recommended in Irish guidance '*Wind Energy Development Guidelines for Planning Authorities'* therefore, it is not considered that a significant effect is associated with the Proposed Development.

While noise levels at low wind speeds will increase due to the Proposed Development and specifically the operation of the turbines, the predicted levels will remain low, albeit new sources of noise will be introduced into the soundscape.

The predicted residual operational turbine noise effects are summarised as follows at the closest noise sensitive locations to the site:

Quality	Significance	Duration
Negative	Moderate	Long-term

The above effect should be considered in terms that the effect is variable and that this assessment considers periods of the greatest potential effect.

For the majority of locations assessed here the effect of the operational turbines are considered as follows:

Quality	Significance	Duration
Negative	Slight	Long-term

Post construction commissioning noise surveys are recommended to ensure compliance with any noise conditions applied to the Proposed Development. In the instance that exceedances of these noise conditions arise and are identified the curtailment of turbine operation can be implemented for specific turbines in specific wind conditions in order to ensure predicted noise levels are within the planning conditions. Such curtailment can be applied using the wind farm SCADA system. As it has been demonstrated that the relevant national guidance in relation to noise associated with wind turbines can be satisfied, the predicted impact associated with the operational turbines is long term and not significant.

11.6.3.1.2 Internal Roads

The associated effect from the day to day operation of the onsite substation is summarised as follows:

Quality	Significance	Duration
Neutral	Slight	Long-term

11.6.3.1.3 Onsite Substation

The associated effect from the day-to-day operation of the onsite substation is summarised as follows:

Quality	Significance	Duration
Neutral	Imperceptible	Long-term

11.6.3.1.4 Grid Connection

The associated effect from the day-to-day operation of the grid connection is summarised as follows:

Quality	Significance	Duration
Neutral	Imperceptible	Long-term

11.6.3.1.5 Mullingar Substation

The associated effect from the day-to-day continued operation of the existing Mullingar Substation is summarised as follows:

Quality	Significance	Duration
Neutral	Imperceptible	Long-term

11.6.3.2 Vibration

Levels of vibration generated as a result of the operation of wind turbine units fall off rapidly with distance away from the units. Typically, at a distance of 100 metres from a 1 MW turbine unit the level of vibration associated with a turbine is the order of 10^{-5} mm/s. This level of vibration is significantly below any thresholds where either cosmetic or structural damage could be caused to a building as outlined in the relevant section of this document. In relation to vibration the associated effect is summarised as follows:

Quality	Significance	Duration
Neutral	Imperceptible	Long-term

11.6.4 Decommissioning Phase

During the decommissioning phase of the Proposed Development, there will be some effect on nearby noise sensitive properties due to noise emissions from site traffic and other on-site activities. Similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will be used. The noise and vibration impacts associated with any decommissioning of the site are considered to be comparable to those outlined in relation to the construction of the Proposed Development.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest noise sensitive locations associated with the decommissioning phase are described below.

Quality	Significance	Duration
Negative	Slight	Short-term