12. NOISE AND VIBRATION

12.1 Introduction

12.1.1 Background & Objectives

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impacts associated with the Proposed Development. The Proposed Development will comprise of 9 no. turbines with a tip height in the range 179.5 metres minimum to 185 metres maximum and all associated foundations and hardstanding areas, access roads and entrance(s) including upgrade of existing site roads and provision of new roads, 110kV electrical substation and wind farm control building(s), borrow pit(s), electrical cabling for 110kV grid connection, temporary construction compounds, a permanent meteorological mast, recreation and amenity works, temporary transition compound, forestry felling, and upgrades to roads along the turbine delivery route. A full description of the Proposed Development is provided in Chapter 4 Description of Proposed Development.

Noise and vibration impact assessments have been prepared for the construction, operational and decommissioning phases of the Proposed Development to the nearest noise sensitive locations (NSLs). To inform this assessment background noise levels have been measured at several 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. In this instance all of the NSLs are treated as dwellings.

There are 526 no. NSLs within 3 km of the proposed turbine locations. The nearest NSL to a proposed turbine is H492 being 751 m from turbine T06. Existing wind turbines, those under construction, those permitted and proposed wind farm developments have been identified in the wider study area considered for inclusion in a cumulative 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 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). Further details on each of these developments is provided in Chapter 2 of this EIAR.

12.1.2 Statement of Authority

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

Mike Simms

Mike Simms (Principal 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 (MIET). Mike has worked in the field of acoustics for over 20 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.

Leo Williams

Leo Williams (Senior Acoustic Consultant) graduated from TCD with a BA, BAI (Mechanical and Manufacturing Engineering) and a MAI (Mechanical and Manufacturing Engineering). Leo is a Member of the Institute of Acoustics (IOA) and has extensive experience in environmental noise impact assessment, in particular industrial/manufacturing and renewable energy noise sources. He has experience in room and building acoustics modelling and assessment. He completed the IOA Diploma in Acoustics and Noise Control and is a registered sound insulation tester under the Sound Insulation Testing Register, Ireland (SITRI).

12.2 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 human 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. SPLs 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 12-1.

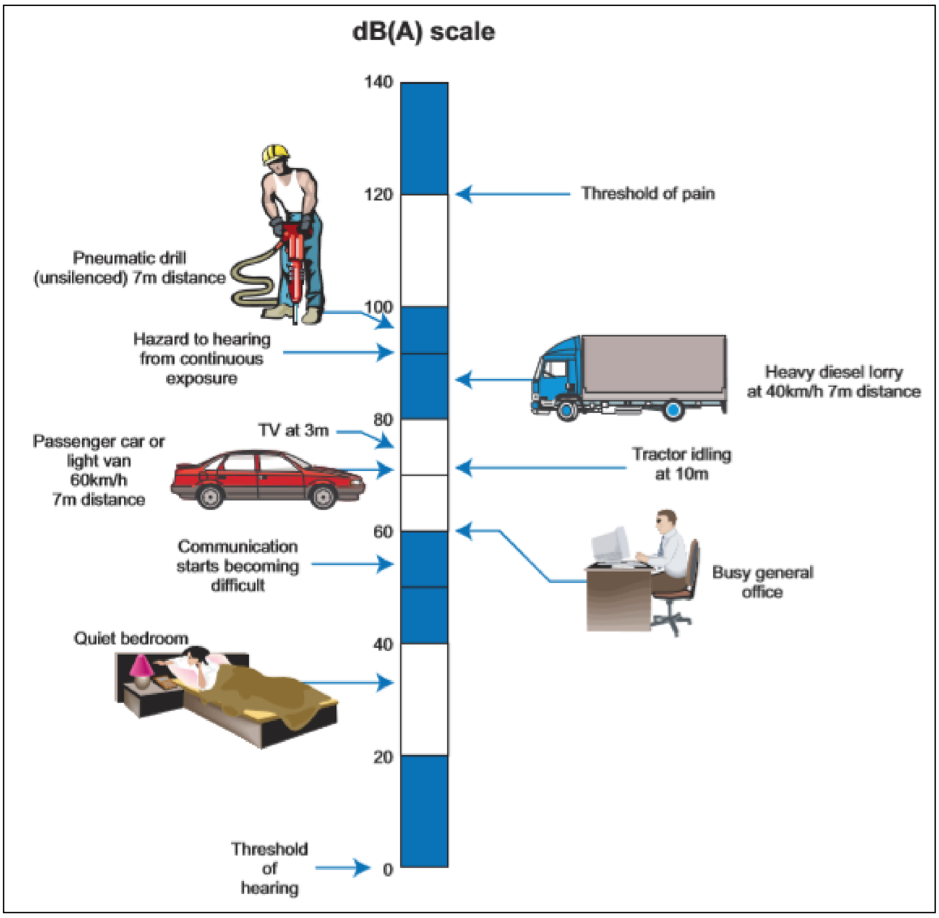

Figure 12-1 The level of typical common sounds on the dB(A) scale (National Roads Authority (NRA) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)

For a glossary of terms used in this chapter please refer to Appendix 12-1.

12.3 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 construction, operational and decommissioning 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 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 the construction, operational, and decommissioning 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 and decommissioning phases 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.

12.3.1 EPA Description of Effects

The significance of effects of the Proposed Development shall be described in accordance with the EPA guidance document *Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR), 2022.* 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.

12.3.2 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.

12.3.2.1 Construction Phase

12.3.2.1.1 *Construction Phase – Noise*

General Construction

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 12-1 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 both construction and decommissioning noise.

Table 12-1 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)	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.

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 development have daytime ambient noise levels that typically range from 40 to 50 dB $L_{Aeq,1hr}$. Therefore, as a precautionary approach, all properties will be afforded a Category A designation.

Please see Section 12.5.2 for the detailed assessment in relation to this site. 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.

Construction Of Underground Cable

In the case of the underground cable, due to the linear progressive nature of the works, fixed noise limit is adopted. In relation to fixed limits, BS 5228-1 paragraph E.2 states:

> *"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut."*

Paragraph E.2 goes on to state: -

> *"Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed: -*

- 70 decibels (dBA) in rural, suburban areas away from main road traffic and industrial noise;
- 75 decibels (dBA) in urban areas near main roads in heavy industrial areas".

In this assessment, a construction noise limit for underground cable works of 70 dB $L_{Aeq,T}$ is adopted. Noise levels above 70 dB $L_{Aeq,T}$ would indicate a significant impact.

12.3.2.1.2 Additional Vehicular Activity on Public Roads - Noise

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that construction 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 12-2, adapted from United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (UKHA 2020), offers guidance as to the likely impact in the short-term associated with any change in traffic noise level.

Table 12-2 Classification of magnitude of traffic noise changes in the short-term (Source DMRB, 2020)

Change in Sound Level (dB(A))	Subjective Reaction	DMRB Magnitude of Impact (Short-term)	EPA Significance of Effect
Less than 1 dB	Inaudible	No Change	Imperceptible
1.0 – 2.9	Barely Perceptible	Minor	Slight/Moderate

Change in Sound Level (dB(A))	Subjective Reaction	DMRB Magnitude of Impact (Short-term)	EPA Significance of Effect
3.0 – 4.9	Perceptible	Moderate	Significant
≥5	Up to a doubling of loudness	Major	Very Significant

The guidance outlined in Table 12-2 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 12.3.2.1.

12.3.2.1.3 Construction Phase - 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 12-3.

Table 12-3 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

12.3.2.2 Operational Phase

12.3.2.2.1 *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.

12.3.2.2.2 *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 is considered:

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

While this comment is noted it is 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.

The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB LA90 and/or a higher level above the prevailing background noise level. In line with the guidance a lower threshold of 45 dB $L_{A90,10min}$ is applicable to NSLs involved that are involved in proposed developments. There are no involved receptors for the Proposed Development in question.

In summary, the Wind Energy Development Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- an appropriate absolute limit level for quiet daytime environments with background noise levels 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 $L_{A90,10min}$ 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 been adopted for this assessment.

This set of criteria has been chosen as it is considered to be 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 12.4.2.

12.3.2.2.3 *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.

12.3.2.2.4 *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.

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

The World Health Organisation (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 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.

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.

12.3.2.2.6 Future Potential Guidance Change

The 2006 Guidelines were issued by the Minister pursuant to section 28 of the 2000 Act which, so far as relevant, provides: "(1) The Minister may, at any time, issue guidelines to planning authorities regarding any of their functions under this Act and planning authorities shall have regard to those guidelines in the performance of their functions ... (2) Where applicable, the Board shall have regard to any guidelines issued to planning authorities under subsection (1) in the performance of its functions."

Section 143 of the 2000 Act provides that: –

"(1) The Board shall, in performing its functions, have regard to – (a) the policies and objectives for the time being of the Government, a State authority, the Minister, planning authorities and any other body which is a public authority whose functions have, or may have, a bearing on the proper planning sustainable development of cities, towns or other areas, whether urban or rural.

The 2006 Guidelines are accordingly the guidelines that must be considered, and not any drafts. As per the High Court decision in Element Power Ireland Ltd v An Bord Pleanála (2017) nothing in the planning legislation, authorises the planning authorities to take into account drafts, or the prospect of new or modified government or local authority policy or objectives. Without prejudice to that background, in December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG19) were published for consultation and 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 ESTU 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 (WEDG06).

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.

In the event that updated Wind Energy Guidelines are published during the planning application process for the Proposed Development it is anticipated that any relevant changes affecting the noise (if any) will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

12.3.3 Special Characteristics of Turbine Noise

12.3.3.1 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:

[1] *EPA South Australia, 2013, Wind farms* https://www.epa.sa.gov.au/files/477912_infrasound.pdf

> *"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."*

There is a significant body of evidence to show that the infrasound associated with wind turbines will be below perceptibility thresholds and typically in line with existing baseline levels of infrasound within the environment.

12.3.3.2 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.

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.

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[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*

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.

12.3.3.2.1 Frequency of Occurrence of AM

Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report *Research into Aerodynamic Modulation of Wind Turbine Noise* (2007). The broad conclusions of this report were that aerodynamic modulation was only considered to be an issue at 4, and a possible issue at a further 8, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the 4 sites where AM was confirmed as an issue, it was considered that conditions associated with AM might occur between about 7% and 15% of the time. It also emerged that for three out of the four sites the complaints have subsided, in one case due to the introduction of a turbine control system. The research has shown that AM is a rare and unlikely occurrence at operational wind farms.

It should be noted that AM is associated with wind turbine operation and it is not possible to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule.

RenewableUK Research Document states the following in relation to matter:

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"even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."

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"It has also been the experience of the project team that, even at those wind farm sites where AM has been reported or identified to be an issue, its occurrence may be relatively infrequent. Thus, the capture of time periods when subjectively significant AM occurs may involve elapsed periods of several weeks or even months."

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"There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm

> *site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."*

12.3.3.2.2 Assessment of AM

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.

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.

12.3.4 Comments on Human Health Impacts

12.3.4.1 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".*

12.3.4.2 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[4]. 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.

[4] *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*

12.3.4.3 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.

12.3.4.4 The Australian Medical Association

The Australian Medical Association put out a position statement, Wind Farms and Health 2014[5]. 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 below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."*

12.3.4.5 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 he 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.

12.3.4.6 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.

12.3.5 Vibration

A 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

[5] *Australian Medical Association, 2014, Wind farms and health. Available at https://ama.com.au/position-statement/wind-farms-and-health-2014*

300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

Considering the distances from nearest NSL's to any of the turbines in the Proposed Development (>800m) the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria have not been specified for the operational phase of the Proposed Development.

12.3.6 Background Noise Assessment

An environmental noise survey was undertaken to determine typical background noise levels at representative NSLs surrounding the development site. The background noise survey was conducted through the installation of unattended sound level meters at seven 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 noise sensitive locations surrounding the site.

As set out in the IOA GPG:

> *"Where a new wind farm is proposed and a receptor is also within the area acoustically affected by an already operational wind farm, then noise from the existing wind farm must not be allowed to influence the background noise measurements for the proposed development."*

For each measurement location, noise data collected during the survey has been filtered to exclude periods where the measurement locations were downwind of existing operational wind turbines.

In this instance, the permitted developments included in the assessment are not yet constructed, therefore there was no need to apply directional filter to the background noise measurements.

12.3.6.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing and using the wind turbine noise model (See 12.3.7 for more detail on wind turbine noise calculations). Noise contours for the surrounding area were produced, (see Appendix 12-2) and 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 12-4 and Figure 12-2 .

Table 12-4 Noise Measurement Location Coordinates

Location	Coordinates – Irish Transverse Mercator (ITM)	
	Easting	Northing
A (H310)	553057	670890

Location	Coordinates – Irish Transverse Mercator (ITM)	
	Easting	Northing
B (H493)	557716	670588
C (H505)	550992	667829
D (H491)	557734	669010
E (H582)	555728	668530
F (H427)	559072	671140
G (H432)	558768	670902

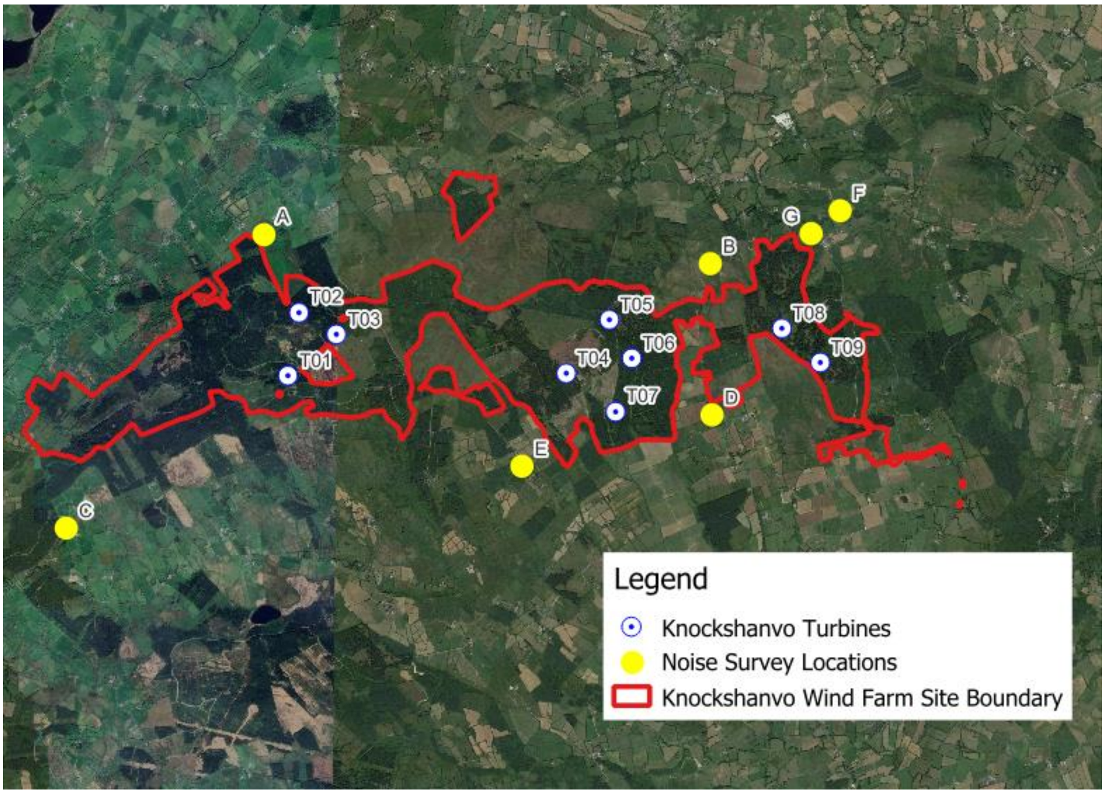

Figure 12-2 Noise measurement locations.

Significant noise sources in this area were noted to be distant traffic movements, intermittent local traffic movements, activity in and around the residences and wind generated noise from local foliage and other typical anthropogenic sources typically found in such rural settings. There were no perceptible sources of vibration noted at any of the survey locations.

Location A

The noise meter at Location A was positioned on a lawn at approximately 15m southwest of the dwelling, 70m from a local road and 1.5m above the low-level surrounding grass.

Location B

Location B was positioned on a lawn 22m southwest of the dwelling, 40m west from a local road and 1.5m above the low-level surrounding grass.

Location C

Location C was positioned 40m west of the dwelling, 80m west of a local road and 1.5m above the above the low-level surrounding grass.

Location D

Location D was positioned in a grassy area at 35m to the southwest of the dwelling, 55 m west of the local road and 1.5m above the low-level surrounding grass.

Location E

Location E was positioned on grassy area at 17m to the southwest of the dwelling, 45 m to the west of the local road and 1.5m above the low-level surrounding grass.

Location F

Location F was positioned on lawn area at 13m to the south of the dwelling, at 25m to the north of a local road and 1.5m above the low-level surrounding grass.

Location G

Location G was positioned on a gravelled area to the side of the dwelling, at 18m to the north of a local road and 1.5m above the ground.

12.3.6.2 Measurement Periods

Noise measurements were conducted at each of the monitoring locations over the periods outlined in Table 12-5.

Table 12-5 Measurement Periods

Location	Start Date	End Date
A (H310)	11:10 on 31 Mar 2023	13:53 on 18 May 2023
B (H493)	13:20 on 31 Mar 2023	11:46 on 18 May 2023
C (H505)	12:00 on 31 Mar 2023	10:58 on 18 May 2023
D (H496)	12:50 on 31 Mar 2023	11:21 on 19 Apr 2023
E (H582)	10:20 on 31 Mar 2023	10:11 on 18 May 2023
F (H427)	14:10 on 31 Mar 2023	02:59 on 17 May 2023
G (H432)	12:50 on 18 May 2023	10:00 on 17 July 2023

A variety of wind speed and weather conditions were encountered over the survey periods in question. Figure 12-3 and illustrates the distributions of wind speed and wind direction standardised to 10 metre height over the survey period detailed in Table 12-5.

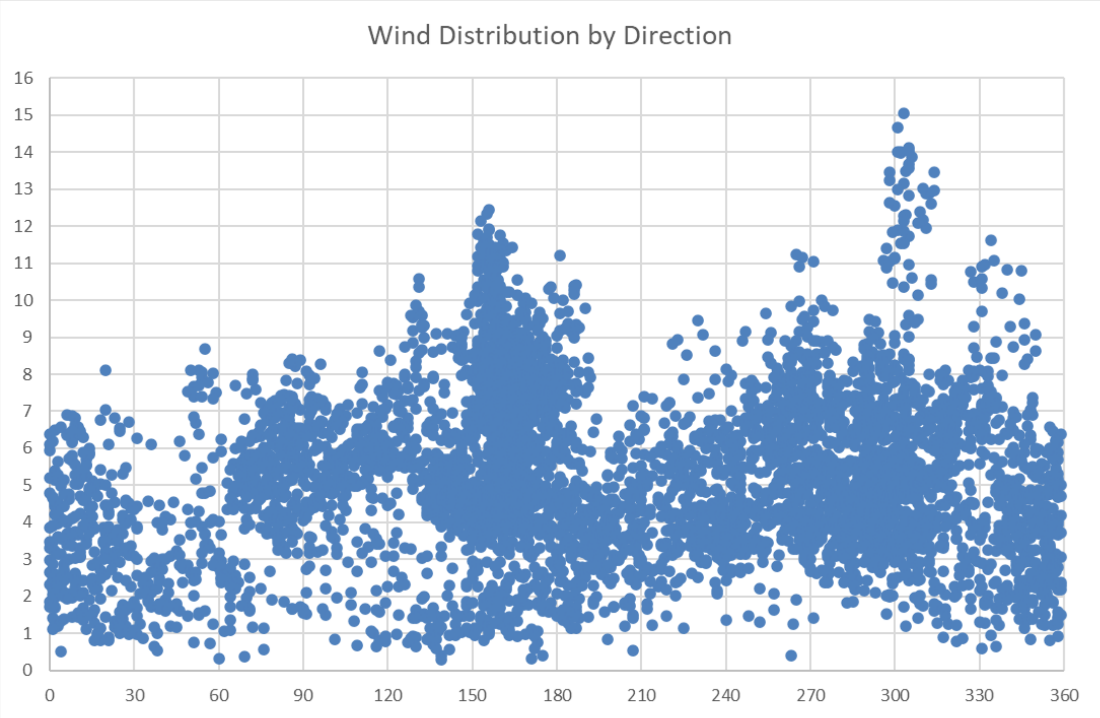

Figure 12-3 Distributions of Wind Speeds and Directions Over the Survey Period

12.3.6.3 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 12-6 Instrumentation Details

Location	Equipment	Serial Number
A (H310)	Rion NL-52	186670
B (H493)	Rion NL-52	998411
C (H505)	Rion NL-52	564809
D (H496)	Rion NL-52	564808
E (H582)	Rion NL-52	998409
F (H427)	Rion NL-52	186669
G (H432)	Rion NL-52	998409

Before and after the survey the measurement apparatus was check calibrated using a sound level calibrator where appropriate. Instruments were calibrated on each interim visit and any drift noted. Relevant calibration certificates are presented in Appendix 12-3.

Rainfall was monitored and logged using a Texas Instruments TR-525 console and a data logger that was installed on-site 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 LIDAR unit (Vaisala Wind Cube LiDAR) located within the site of the Proposed Development and was supplied to AWN for data analysis.

Table 12-7 Wind Measurement Location

Description	Coordinates (ITM)	
	Easting	Northing
LIDAR Unit	556358	669744

12.3.6.4 Procedure

Measurements were conducted at the seven locations over the survey periods outlined in Table 12-5. Data samples for all measurements (noise, rainfall and wind) were logged continuously at 10-minute interval periods for the duration of the survey.

12.3.6.5 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*.

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.

12.3.6.5.1 *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 100m and 80m heights have been corrected to a height of 110.5m (the hub height adopted for the 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.

The IoA GPG presents the following equations in relation to the derivation of a standardised wind speed at 10m above ground level:

Shear Exponent Profile:	$U = U_{ref} [(H / H_{ref})]^m$

Where:

U	Calculated wind speed
U_{ref}	Measured HH wind speed.
H	Height at which the wind speed will be calculated.
H_{ref}	Height at which the wind speed was measured.
M	shear exponent = $\log(U/U_{ref})/\log(H/H_{ref})$

The Calculated hub height wind speeds have been standardised to 10 m height using the following equation:

Roughness Length Shear Profile:	$U_1 = U_2 \times [(\ln(H_1/z))/ (\ln(H_2/z))]$

Where:

H_1	The height of the wind speed to be calculated (10m)
H_2	The height of the measured or calculated HH wind speed.
U_1	The wind speed to be calculated.
U_2	The measured or calculated HH wind speed.
Z	The roughness length.

Note: A roughness length of 0.05m is used to standardise hub height wind speeds to 10m height in the IEC 61400-11:2003 standard, regardless of what the actual roughness length seen on a site may have been. This 'normalisation' procedure was adopted for comparability between test results for different turbines.

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

12.3.7 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.

12.3.7.1 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).

12.3.7.2 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 12-4.

12.3.7.2.1 *Turbine Details*

Table 12-8 details the co-ordinates of the 9 No. proposed turbines that are being considered in this assessment.

Table 12-8 Proposed Knockshanvo Turbine Co-ordinates

Turbine	ITM X	ITM Y	Top of Foundation Levels metre above Ordnance Datum
T01	553,306	669,420	248
T02	553,422	670,076	232.5
T03	553,812	669,851	266.5
T04	556,212	669,444	221.5
T05	556,663	670,003	191.5
T06	556,896	669,601	180.5
T07	556,727	669,042	176
T08	558,463	669,913	186
T09	558,864	669,557	196.5

The planning permission being sought related to a range of turbine dimensions. In order to assess the range of possible turbine technologies and dimensions, the following list of turbines have been considered:

- Vestas V150 6.0MW @ 185m tip (110 m hub height)
- Siemens Gamesa SG 155 6.6MW @ 150m tip (107.5 m hub height)
- Nordex N149 5.7MW at 185m tip (110.5 m hub height)

- Vestas V162 6.2MW @ 185m tip (104 m hub height)
- Nordex N163 6.0MW @ 185m tip (103.5 m hub height)

The dimensions of the above turbines all vary but are all within the proposed range of dimensions as described in Chapter 4 of this EIAR (Description of the Proposed Development).

In terms of predicting noise levels at noise-sensitive locations however, the turbine technology is described by two parameters:

- The hub height, and
- The sound power level.

In accordance with the IOA GPG, sound power levels for each of the turbines listed above, referred to wind speeds at standardised 10 m height are presented in Table 12-9 and Figure 12-4

Table 12-9 Sound Power Level for various turbine technologies

Wind Speed (m/s)	Sound Power Level dB L_{WA}				
	V150	**SG155**	**N149**	**V162**	**N163**
3	92.6	93.0	94.0	94.2	95.0
4	96.4	98.0	95.2	95.8	96.5
5	100.7	102.8	99.7	99.8	101.0
6	103.6	105.0	104.0	103.4	105.4
7	104.2	105.0	105.5	104.3	106.5
8	104.9	105.0	105.6	104.3	106.6
9	104.9	105.0	105.6	104.3	106.6

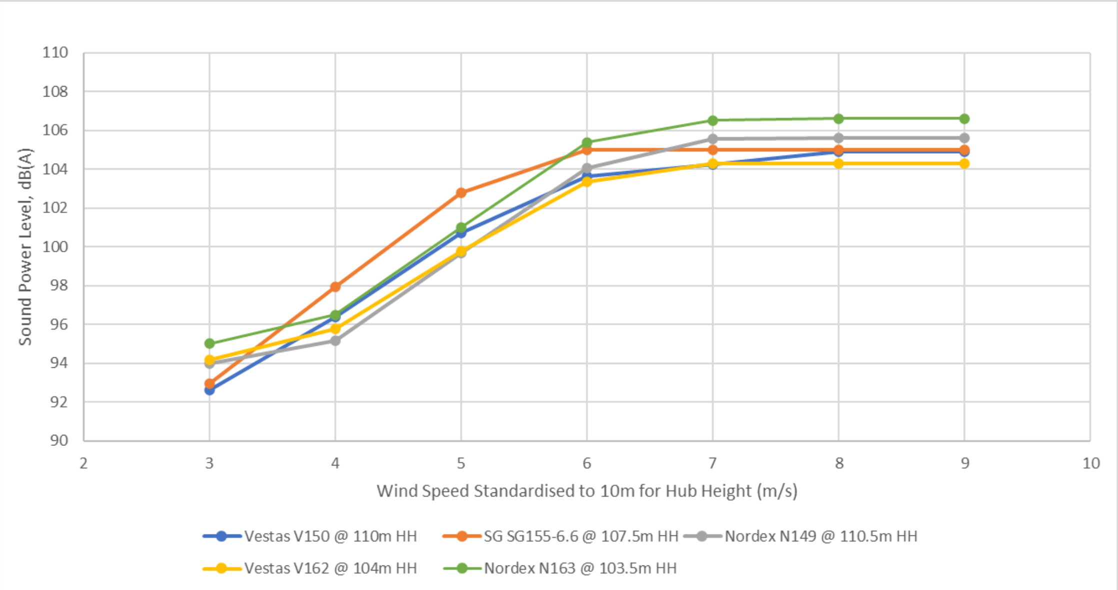

Figure 12-4 Graphical comparison of Sound Power Level for various turbine technologies

In order to assess the range of wind turbines, rather than prepare a set of noise predictions for each turbine, the sound power levels from each turbine are combined, selecting that with the highest overall sound power level in dB(A) at each wind speed, as in Table 12-10.

Table 12-10 Sound Power Level Spectra for Knockshanvo Wind Farm

Wind Speed (m/s)	Octave Band Centre Frequency (Hz)								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
3: N163	81.0	85.7	88.0	88.5	88.9	86.8	77.3	58.4	95
4: V150	77.4	85.1	89.8	91.5	90.4	86.2	79.1	69.0	96.4
5: V150	81.7	89.4	94.1	95.8	94.7	90.5	83.5	73.4	100.7
6: N163	91.4	96.1	98.4	98.9	99.3	97.2	87.7	68.8	105.4
7: N163	92.5	97.2	99.5	100.0	100.4	98.3	88.8	69.9	106.5
8: N163	92.6	97.3	99.6	100.1	100.5	98.4	88.9	70.0	106.6
9: N163	92.6	97.3	99.6	100.1	100.5	98.4	88.9	70.0	106.6

Thus, the sound power levels in Table 12-10 at a hub height of 110.5 m represent the maximum turbine envelope in this planning application and it is these parameters that are the main focus of the noise assessment.

In the case of environmental noise, in order to assess the minimum turbine envelope, the same sound power levels are used at the lowest hub height, i.e. 102.5 m. Assessment minimum turbine envelope is discussed in Section 12.5.3.1.4.

12.3.7.2.2 Cumulative Noise Study Area

An appraisal of the wider EIAR Study Area around the site identified the potential for cumulative impacts from the operation of the Proposed Development in combination with other wind farms in the surrounding area. Appendix 12-5 presents details of the screening exercise which confirms which wind farms are required to be included for the cumulative wind farm assessment.

The Institute of Acoustics document *Good Practice Guide To The Application Of Etsu-R-97 For The Assessment And Rating Of Wind Turbine Noise* states, in section 2.2 in relation to the extent of the study area:

> *The 'study area' for background noise surveys (and noise assessment) should, as a minimum, be the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35 dB L_{A90} at up to 10 m/s wind speed. (Note: unless stated, in this document the wind speed reference for noise data is the 10 metre standardised wind speed, derived from the wind speed at turbine hub height as explained in Section 2.6).*

The cumulative 35 dB(A) contour is shown in Figure 12-5. Based on this, all noise-sensitive locations within a 3 km distance to any Knockshanvo turbine have been included in the noise assessment. Further details on the cumulative noise assessment are presented in Appendix 12-5.

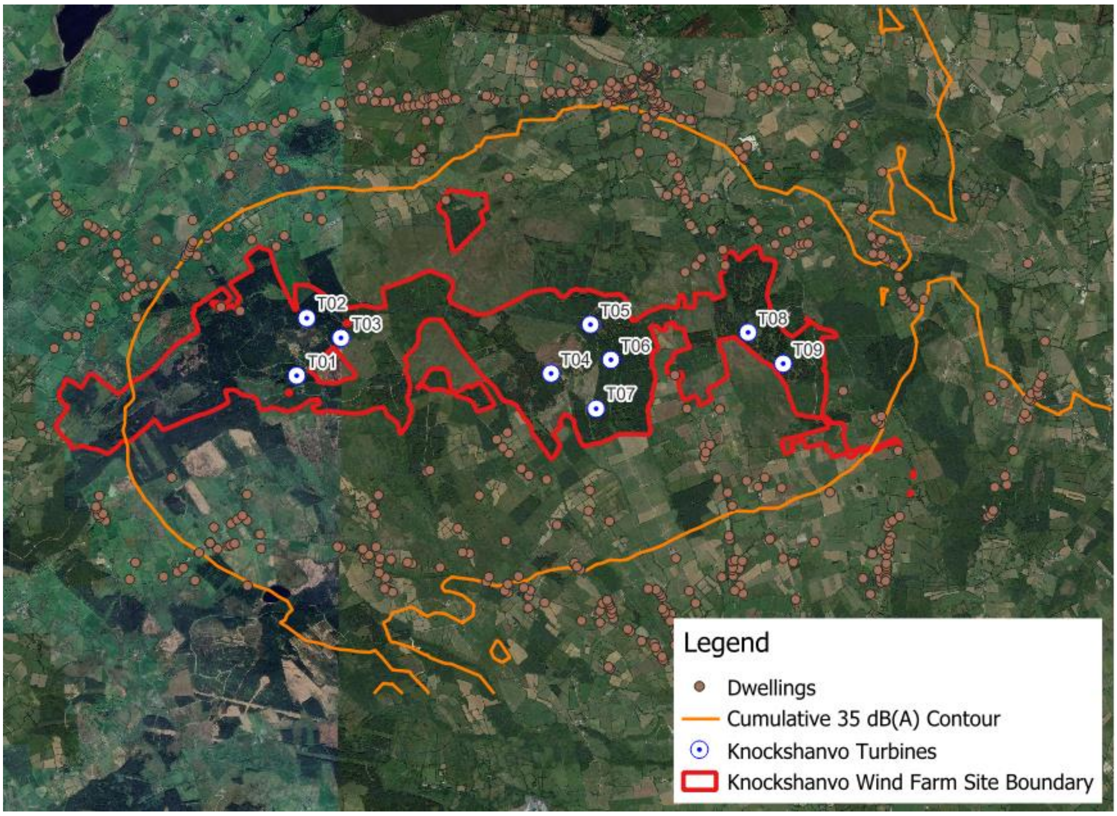

Figure 12-5 35 dB(A) Cumulative contour and Noise-Sensitive Locations

The wind farms which are included in the noise assessment are listed below::

- Carrownagowan, a wind farm to the north east, which is permitted but not yet constructed, planning reference An Board Pleanála (ABP) 03.308799, where the turbine model is assumed to be a Vestas V136 with a hub height of 101m;
- Lackeragh Wind Farm at the 'planning' stage, a 7-turbine wind farm to the west of the Proposed Development; based on details available the wind turbine technology assumed to be a Siemens-Gamesa SG155 with a hub height of 105m;
- Fahybeg Wind Farm, planning reference ABP 317237, an 8-turbine wind farm to the west of the Proposed Development; based on details available the wind turbine technology assumed also to be a Siemens-Gamesa SG155 with a hub height of 105m;
- Ballycar Wind farm, planning reference ABP 315239, an 11-turbine wind farm to the south of the Proposed Development; based on details available the wind turbine technology assumed also to have a rotor diameter of 116 m and a hub height of 100m.
- Oatfield, planning reference PC03.315239 an 11-turbine wind farm to the north of Knockshanvo wind farm T05 and to the south of Knockshanvo with farm T01. Based on details available the wind turbine technology assumed also to have a rotor diameter of 150 m and a hub height of 105m.

The sound power levels used for each turbine technology are listed in Appendix 12-6.

Other wind turbine developments within the 20 km buffer area are not included the analysis in Appendix 12-5 demonstrates that there is no cumulative impact possible:

- Knockballymeath single wind turbine,
- Vistakon single wind turbine,
- Castlewaller Wind Farm.

All turbine sound power levels presented in this chapter and appendices are derived based on measurements in terms of the L_{Aeq} acoustic parameter. 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 below, 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 the tables above are the corrected levels following the adding of +2dB for uncertainty and subtracting of 2dB to obtain the L_{A90} and the noise-sensitive location.

Finally, best practice specifies that should any tonal component be present, a penalty shall be added to the predicted noise levels. The level of this penalty is described in ETSU-R-97[6], and is related to the level by which any tonal components exceed audibility. For the purposes of this assessment a tonal penalty has not been included within the predicted noise levels. A warranty will be provided by the manufacturers of the selected turbine to ensure that the noise output will not require a tonal noise correction under best practice guidance.

12.3.7.3 Assessment of Turbine Noise Levels

The predicted cumulative turbine noise level from the Proposed Development will be compared against the derived turbine noise limits and any exceedances of the limits will be identified and assessed. Where necessary, appropriate mitigation measures will be detailed.

The following presents a breakdown of the various steps involved in the assessment of operational turbine noise level:

- Screen the cumulative turbine noise predictions against the lowest potential (worst-case) criteria outlined in Section 12.3.2.2.2 to identify any locations with a potential exceedance.
- Identify any locations with potential cumulative exceedances that occur as result of the Proposed Development only (i.e. Knockshanvo Wind Farm).
- Where necessary, calculate the level of attenuation required from the Knockshanvo Wind Farm to achieve the adopted turbine noise criteria or the attenuation required to Knockshanvo Wind Farm such that the predicted contribution of the Knockshanvo Wind Farm is 10 dB below the cumulative turbine limit value in accordance with best practice guidance.

12.3.7.4 Consideration of Wind Direction and Noise Propagation

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 issue, 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°);

[6] UK Department of Trade and Industry: ETSU-R-97 The assessment of rating of Noise from wind farms, 1996

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

Figure 12-6 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°).

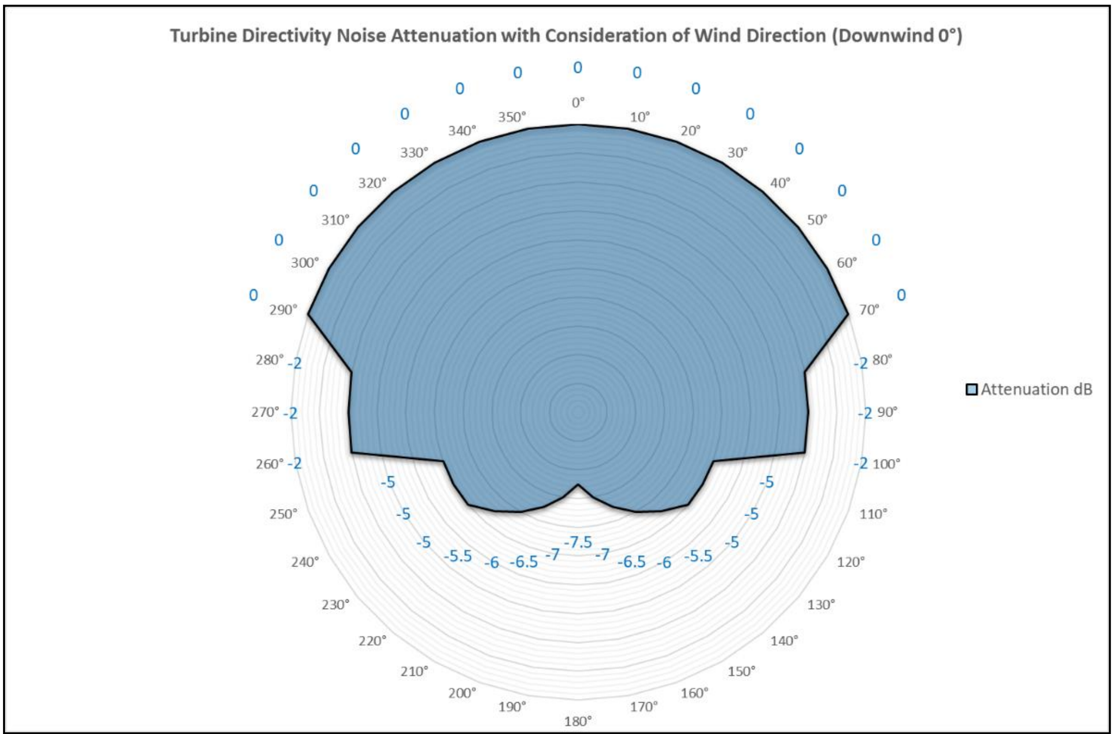

Figure 12-6 Turbine Directivity Attenuation with Consideration of Wind Direction

12.3.8 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 12.3.2.1.

12.4 Receiving Environment

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

12.4.1 Background Noise Levels

Appendix 12-7 presents the results of the background noise surveys as analysed in accordance with the methodology discussed above.

Table 12-11 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 analysis carried out on the data sets in line with guidance contained the IoA *GPG* and its SGN No. 2 *Data Collection.*

Table 12-11 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
A	Day	33.5	33.7	34.4	35.4	36.4	37.3	37.8
	Night	24.3	25.2	26.2	27.5	29.0	30.8	32.7
B	Day	27.0	27.8	28.9	30.3	31.9	33.8	36.0
	Night	18.9	19.5	20.7	22.4	24.7	27.5	30.9
C	Day	31.4	32.3	33.5	35.1	37.1	39.5	42.3
	Night	24.0	25.2	26.7	28.6	31.1	34.4	38.5
D	Day	27.4	28.9	30.8	33.0	35.3	37.4	39.3
	Night	21.0	21.9	23.2	24.9	27.1	29.9	33.3
E	Day	30.7	31.3	32.0	32.9	34.0	35.5	37.5
	Night	19.8	20.9	22.3	24.1	26.4	29.1	32.4
F	Day	33.9	34.3	34.9	35.7	36.7	37.9	39.2
	Night	25.4	25.7	26.3	27.3	28.6	30.2	32.2
G	Day	26.6	27.7	29.6	31.9	34.6	37.3	40.0
	Night	19.1	20.2	21.9	24.1	27.0	30.8	35.4
Minimum	Day	26.3	26.6	27.7	29.6	31.9	33.8	36.0
	Night	18.5	19.1	20.2	21.9	24.1	27.0	30.8

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

12.4.2 Wind Turbine Noise Criteria

With respect to the relevant guidance documents outlined in Section 12.3.2.2.1 noise criteria curves have been established for the proposed Wind Farm. The criteria curves have been derived following a detailed review of the background noise data conducted at representative NSL's described in Section 12.3.6.

This set of criteria adopted is in line with the intent of the applicable Irish guidelines for wind turbine noise and is comparable to noise planning conditions applied to similar sites previously granted planning permission by ABP and local planning authorities in Ireland. For the proposed Wind Farm, it is considered that a lower daytime threshold of 40 dB $L_{A90,10min}$ for low noise environments where the background noise is less than 30 dB(A) would be appropriate in respect of the following points:

- 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'. Turbine noise limits are detailed in terms of the L_{A90} parameter while the NG4 daytime limit is detailed in terms of the LAeq. The accepted difference between the LAeq and L_{A90} for wind turbine noise assessments is 2 dB, i.e., 45 dB LAeq equates to 43 L_{A90}. This approach implies a 3 dB difference when accounting for difference parameters between the NG4 limits, expressed in the LAeq parameter, and the 2006 WEDGs limits, expressed in the L_{A90} parameter. The proposed lower threshold daytime criterion of 40 dB LA90 for wind turbine noise here is 3 dB more stringent than the equivalent daytime noise limit for areas of low background noise outlined in NG4.
- A lower threshold of 40 or 43 dB is commonly adopted in planning conditions for similar developments that have been granted planning permission by ABP and local planning authorities in recent years for example, Derrinlough Wind Farm (ABP Ref: 306706-20), Coole Wind Farm (ABP Ref: PL25M.300686) Cloncreen (ABP Ref: PA0047), Meenbog (ABP Ref: PL05E.300460), Castlebanny (ABP Ref: 309306-21), Lyrenacarriga Wind Farm (ABP Ref: 309121-21) and Seven Hills Wind Farm (ABP Ref: 313750-22).
- The 2006 WEDGs 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.

The proposed turbine noise criteria summarised below should apply at all noise sensitive locations within the study area. The proposed turbine noise limits shall be cumulative and relate to noise from the contribution of all operational wind turbines.

In summary, the operational noise limits proposed for the proposed Wind Farm are:

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

Day and night-time noise criteria curves have been determined from review of the derived background noise levels at 7 no. NSL's surrounding the proposed Wind Farm and are presented in the relevant sections of this chapter.

The derived turbine noise limits have been assigned to the various NSL's where noise monitoring has been undertaken.

Table 12-12 outlines the operational noise criteria that apply to this assessment. the derived noise criteria curves based on the information contained within Table 12-11.

Table 12-12 Noise Criteria Curves

Location	Period	Derived $L_{A90,\ 10\ min}$ Levels (dB) at various Standaridsed 10m Height Wind Speed (m/s)					
		4	5	6	7	8	9
A	Day	45	45	45	45	45	45

Location	Period	Derived $L_{A90, 10 min}$ Levels (dB) at various Standaridsed 10m Height Wind Speed (m/s)					
		4	5	6	7	8	9
	Night	43	43	43	43	43	43
B	Day	40	40	45	45	45	45
	Night	43	43	43	43	43	43
C	Day	45	45	45	45	45	47.3
	Night	43	43	43	43	43	43.5
D	Day	40	45	45	45	45	45
	Night	43	43	43	43	43	43
E	Day	45	45	45	45	45	45
	Night	43	43	43	43	43	43
F	Day	45	45	45	45	45	45
	Night	43	43	43	43	43	43
G	Day	40	40	40	45	45	45
	Night	43	43	43	43	43	43
Minimum	Day	40	40	45	45	45	45
	Night	43	43	43	43	43	43

Where background noise measurements have been conducted in the vicinity and/or are judged to be typical/indicative of the background noise levels at other locations, the guidance allows that these levels can be assigned to other nearby similar locations for the purposes of setting appropriate turbine noise limits for the assessment. This approach is in line with best practice guidance set out in the IOA GPG. Table 12-13 details the assignment of noise criteria to noise-sensitive locations.

Table 12-13 Baseline Noise levels and Representative Receiver Locations

Representative Baseline Noise Levels	Noise-sensitive Locations
A	H310
B	H493, H494 and H495
C	H505
D	H491 and H492
E	H582, H583, H594, and H585

Representative Baseline Noise Levels	Noise-sensitive Locations
F	H427
G	H432
Minimum	All other locations

12.5 Likely Significant Effects and Associated Mitigation Measures

12.5.1 Do-Nothing Scenario

If the Proposed Development were not developed, the site will continue to function as it does at present, with no changes made to the current land-use of commercial forestry. The impact of this is considered neutral in the context of the EIAR. If the Proposed Development were not to proceed, the opportunity to capture an even greater part of County Clare's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

12.5.2 Construction Phase Potential Impacts

A variety of items of plant will be in use for the purposes of site preparation, construction of turbines, roads, substation, and grid connection 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 levels of noise at noise-sensitive locations. This is discussed in the following sections.

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. Noise levels are predicted at the nearest NSL to each element of the works and compared against the criteria in Section 12.3.2.1.1.

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 will be lower than these levels for most of the time at most properties in the vicinity of the Proposed Development.

As tree felling will be required at certain locations a chain saw is included in the calculations of construction noise from within the Wind Farm Site.

In this section the Proposed Development is considered in two parts: the Wind Farm Site and the Grid Connection. Please see Chapter 4 for a description of these elements.

12.5.2.1 Noise – Wind Farm Site Construction

12.5.2.1.1 *Turbines, Hardstands and Meteorological Mast*

Works for the turbines are at a significant distance from the closest noise sensitive receptors, with the nearest noise-sensitive location (NSL) being H492 at a distance of 751 m from T06.

A permanent meteorological mast is proposed at the coordinates E556203 N669109. The nearest noise-sensitive location to any of the proposed mast is H585 at a distance of 594m.

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 12-14 details 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. Calculations have assumed an on-time of 66% for each item of plant i.e. 8 hours over a 12-hour assessment period.

Table 12-14 Typical Construction Noise Levels – Turbines and Hardstanding, Substation, Grid Connection and Met Mast

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[7]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)	
			594 m	751 m
HGV Movement (C.2.30)	Removing soil and transporting fill and other materials	79	36	34
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation	77	34	32
Excavator Mounted Rock Breaker (C9.12)	Excavation in rocky areas	85	42	40
Piling Operations (C.12.14)	Standard pile driving	88	45	43
General Construction (Various)	All general activities plus deliveries of materials and plant	84	41	39
Concrete Mixer Truck and Concrete Pump (C.4.27)	Turbine Foundations	75	32	30
Dumper Truck (C.4.4)	Backfilling Turbine Foundations	76	33	31
Mobile Telescopic Crane (C.4.39)	Turbine Erection	77	34	32
Dewatering Pumps (D.7.70)	If required	80	37	35

7 *All plant noise levels are derived from BS5228: Part 1*

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[7]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)	
			594 m	751 m
JCB (D.8.13)	For services, drainage and landscaping	82	39	37
Petrol-drive Chainsaw (D.2.14)	Tree felling	86	43	41
Vibrating Rollers (D.8.29)	Road surfacing	77	34	32
Cumulative Predicted Construction Noise Level		–	50	48

These levels of noise are within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the access roads, therefore no specific mitigation measures are required.

12.5.2.1.2 110kV Electrical Substation

An on-site 110kV electrical substation is proposed, as described in Chapter 4. The nearest NSL to the proposed substation is H492 at 277 m.

As a worst-case example assuming the same construction activities as outlined in Section 12.5.2.1.1, it is predicted that the potential noise levels from construction activities associated with the substation will be 57 dB $L_{Aeq,T}$. This level of noise is within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the substation, therefore no specific mitigation measures are required.

12.5.2.1.3 Access Roads

It is proposed to construct new internal access roads as part of the development. Review of the road layout has identified that the closest NSL to any proposed new internal road H442 at a distance of 64 m. All other locations are at greater distances with the majority at significantly greater distances. The full description of the new roads is given in Chapter 4 of the EIAR.

The closest area where tree felling is required in the construction of access roads is at a distance of 750 m to the northwest of H442.

Table 12-15 details the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant.

Table 12-15 Typical Construction Noise Emission Levels – Access Roads

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$)[8]	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,12hr}$)	
		64 m	750 m
HGV Movement (C.2.30)	79	58	34

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

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$) [8]	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,12hr}$)	
		64 m	750 m
Tracked Excavator (C.4.64)	77	56	32
Dumper Truck (C.4.4)	76	55	31
Petrol-drive Chainsaw (D.2.14)	86	n/a	41
Vibrating Rollers (D.8.29)	77	56	32
Total Construction Noise **(cumulative for all activities)**		**62**	**43**

These levels of noise are within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the access roads, therefore no specific mitigation measures are required.

12.5.2.1.4 *Junction Accommodation Works*

In order to facilitate the delivery of large turbine components, it is proposed to carry out works along the R465 Regional Road at three locations. Two of these locations are between NSLs H442 and H443, as shown in Figure 12-7 and one location further south as shown in Figure 12-8. Note that the construction of the site access road itself is discussed in the previous section.

Figure 12-7 Location of Junction Accommodation Works near site entrance

The distance from the junction accommodation works to NSLs H442 and H443 are 280m in both cases. Using the same plant items and assumptions as for the construction of access roads, the predicted noise level at H442 and H443 due to junction accommodation works is 47 dB $L_{Aeq,T}$.

The third location at which the junction accommodation is required is further to the south along the R465, at 95m to the east of a noise-sensitive location with Eircode V94 N9CX. Again using the same plant items, the predicted noise level due to junction accommodation works is 58 dB $L_{Aeq,T}$.

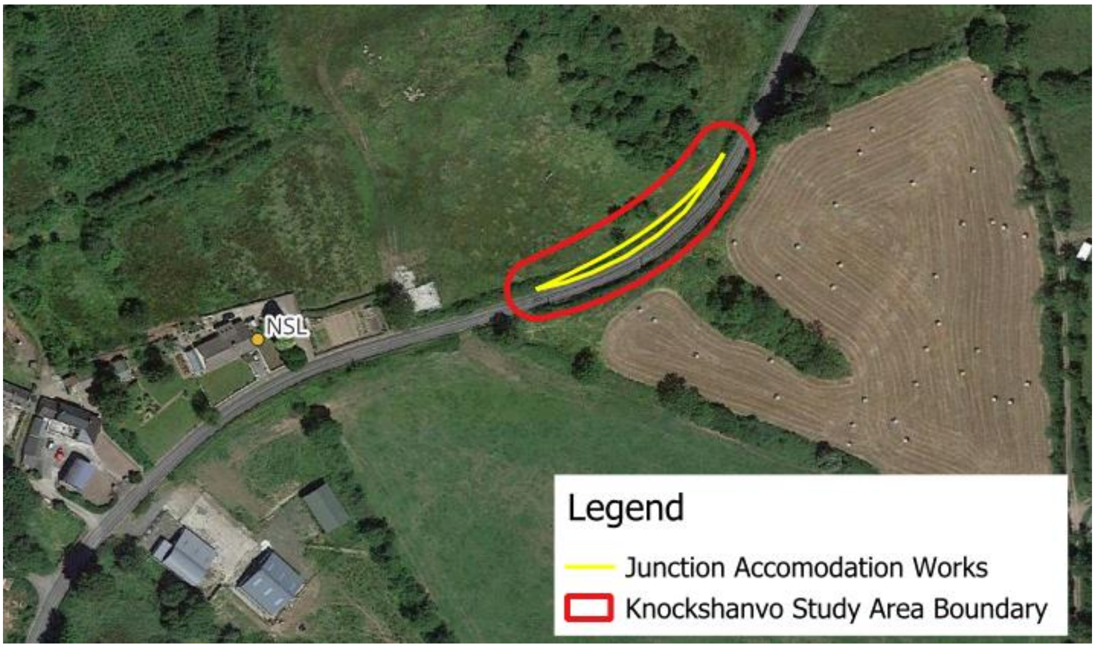

Figure 12-8 Location of Junction Accommodation Works along R465

These level of noise are within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the junction accommodation works, therefore no specific mitigation measures are required.

12.5.2.1.5 Temporary Construction Compounds

Also within the construction works of the Wind Farm Site are three construction compounds, Near T03, T06 and T09. The nearest NSL to each are:

- Construction Compound 1 near T09 is 770 m from H490;
- Construction Compound 2 near T06 is 900 m from H492, and
- Construction Compound 3 near T03 is 1080 m rom H359.

As a worst-case example assuming the same construction activities as outlined in Section 12.5.2.1.1, it is predicted that the potential noise levels from construction activities associated with the construction compounds will be:

- 47 dB $L_{Aeq,T}$ at H490
- 46 dB $L_{Aeq,T}$ at H492
- 44 dB $L_{Aeq,T}$ at H359

These levels of noise are within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the temporary construction compounds, therefore no specific mitigation measures are required.

12.5.2.1.6 Underground Cabling

The noise assessment of underground cabling works is presented in Section 12.5.2.2.

12.5.2.1.7 Borrow Pits

Five borrow pits are proposed at the coordinates presented in Table 12-16. To inform this aspect of the assessment a comparative noise assessment has been prepared and is outlined in the following paragraphs. Two situations have been considered as follows:

- Scenario A Blasting operation
- Scenario B Rock breaking operation

In terms of these activities please note the following:

- It is assumed that construction works at the borrow pit will only occur during daytime periods only (07:00 to 19:00hrs).
- A mobile crusher will operate on site for both options.
- In Scenario B two rock breakers will be in use on site during daytime periods.
- For the purposes of this assessment, we have assumed the plant is working simultaneously in the vicinity of all proposed borrow pit locations indicated in Table 12-16.
- Table 12-17 outlines the assumed noise levels for the plant items as extracted from BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.
- If the blasting option is undertaken, it is estimated that some 6 to 10 blasts will be required over a 6 to 8-week period. It is expected that no more than 1 blast would occur in a single working day.

Table 12-16 Borrow Pit Coordinates

Borrow Pit Name	Easting	Northing
BP1	553448	669357
BP2	555633	669824
BP3	556337	669149
BP4	556686	669606
BP5	559146	669532

Sound power levels for the plant items in each borrow pit plant is presented in Table 12-17.

Table 12-17 Typical Plant Noise Levels – Borrow Pits

Item	BS 5228 Ref:	dB L_w Levels per Octave Band (Hz)								dB(A)
		63	125	250	500	1k	2k	4k	8k	
Tracked Excavator (each of 6 no)	C.2.21	75	76	72	68	65	63	57	49	71
HGV Movement	C.2.30	85	74	78	73	73	74	67	63	79
Dump Truck	C.4.2	85	80	77	72	74	70	65	58	78
Tracked Semi-Mobile Crusher	C.9.15	98	98	97	94	91	88	82	72	96
Semi-mobile screen/stockpiler	C.10.15	93	86	79	78	75	71	69	62	81
Excavator-mounted Rock Breaker	C9.12	86	86	83	78	80	78	76	71	85

A construction noise model has been prepared to consider the expected noise emissions from the proposed construction works for the two scenarios outlined above. A percentage on-time of 66% has been assumed for the noise calculations. The predicted levels are detailed in Table 12-18, at the 10 no. NSLs with the highest predicted noise levels due to the borrow pit activity.

Table 12-18 Noise Levels at NSLs due to borrow pit activity

NSL Ref	Predicted Noise Level (dB $L_{Aeq,12hr}$)	
	Scenario A	Scenario B
H585	53	53
H584	52	52

NSL Ref	Predicted Noise Level (dB $L_{Aeq,12hr}$)	
	Scenario A	Scenario B
H583	52	52
H582	51	52
H581	50	51
H492	50	51
H921	50	50
H580	50	50
H610	49	49
H491	49	49

Review of the data contained in Table 12-18 confirms the following:

- Predicted construction noise levels for both Scenario A and B are well within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the activity at borrow pits, therefore no specific mitigation measures are required.
- The blasting proposal results in lower levels of construction noise as the rock breaking plant is not required to operate to the same extent in this scenario. Predicted noise levels are lower at all assessed locations for Scenario A.
- It is accepted that the individual blast events will be audible at certain locations which may result in slight impacts. Blast events will be designed and controlled such that the best practice limits values outlined in the mitigation section of this chapter are not exceeded.

12.5.2.1.8 *Temporary Transition Compound on N69 at Kildimo*

A Temporary Transition Compound(TTC) is proposed, on the north side of the N69 road at approximately 1.7 km to the east of Kildimo. The nearest residential NSLs to the TTC are at 325 m distance to the north, and also at 325 m distance to the east.

As a worst-case example assuming the same construction activities as outlined in Section 12.5.2.1.1, it is predicted that the potential noise levels from construction activities associated with the construction compounds will be 56 dB $L_{Aeq,T}$ at 325m distance.

This level of noise is within the construction noise criterion outlined in Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the TTC, therefore no specific mitigation measures are required.

12.5.2.2 Noise - 110kV Grid Connection Construction

A connection between the proposed 110kV electrical substation and the national electricity grid will be necessary to export the electricity generated by the Proposed Development. Details of the proposed underground 110kV electrical cabling route are presented in Chapter 4.

The associated construction works will occur for short durations (rolling construction method, approximately 100 – 200 m per day over an estimated 70 days required to construct the full length of the route.) at varying distances from noise sensitive locations (NSLs). Review of the grid connection route has identified that the nearest NSLs to the proposed underground cable route, along local roads, are located at 10 – 30 m at the namely, H471, H489, H491, H501, H504, H507, H492, H472, H470, H479, H467, H914, H480 and H506.

As described, construction activity will vary and will not be continuous in nature. The assessment sets out that the various activities that will contribute noise levels that, over a standard workday will be above the significance criteria, the noise levels are not predicted to exceed these criteria continuously.

Table 12-19 Indicative noise calculations for construction – Underground Electrical Cabling Routes

Plant Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$)	Calculated Construction Noise Levels dB $L_{Aeq,12hr}$ at reference distance from works			
		10 m	20 m	30 m	40 m
Mini Tracked Excavator with Rock Breaker (C5.2)	83	81	75	69	66
Dumper Truck (C.4.4)	76	74	68	62	59
Wheeled Loader Lorry (C.2.28)	76	74	68	62	59
HGV Movement (C.2.30)	79	77	71	65	62
Vibrating Rollers (D.8.29)	77	75	69	63	60
Total Construction Noise (cumulative for all activities)		**84**	**78**	**72**	**69**

It is important to note that the works for the construction of the grid connection will progress along the route. Works will therefore be in proximity to the closest an NSLs for limited amount of time, i.e. of the order of days.

The predicted Construction Phase noise levels at the closest sensitive receptors, at distances of less than 40m from works, are above the construction noise criterion of 70 dB $L_{Aeq,12hr}$ set out in Section 12.3.2.1.1 and therefore, without mitigation, negative, significant and brief to temporary effects are associated. This applies to 84 NSLs along the grid connection route.

With respect to the EPA's guidance for description of effects as referenced in Section 12.3.2.1.1, the potential worst-case associated effect at the nearest NSL associated with the Grid Connection construction phase is expected to be Negative, Significant and Brief to Temporary. As described, construction activity will vary and will not be continuous in nature. A conservative estimation of 66% on-times has been considered. The assessment sets out that the various activities contribute noise levels that, over a standard work day will be above the significance criteria, the noise levels are not predicted to exceed this criteria continuously.

On this basis noise control mitigation measures will be required. These are detailed in Section 12.5.4.1.1.

12.5.2.3 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. 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 and related works.

With regards to piling it is considered that, taking into account the large distances between locations where piling will take place and the nearest noise sensitive locations, no significant impact will be experienced. Therefore, no mitigation measures are proposed.

12.5.2.4 Construction Traffic

This section has been prepared to review potential noise impacts associated with construction traffic on the local road network. The information presented in Chapter 15 Material Assets – Traffic and Transport has been used to inform the assessment here.

The following stages are commented upon here:

- Stage 1a – Wind Turbine Foundation Concrete Pouring;
- Stage 1b – Site Preparation and Ground Works;
- Stage 2a – Delivery of Large Equipment Using Extended Articulated Vehicles, and
- Stage 2b – Other deliveries using conventional articulated HGVs.

Changes in the traffic noise levels associated with the additional traffic for each of the construction stages listed above have been calculated for several road links.

Table 12-20 presents a summary of the data used for the calculations in this assessment. The traffic figures have been derived from the traffic data in Chapter 15 with corrections applied for the passenger car unit (PCU) factors.

Table 12-20 Construction Traffic Data for Assessment

Route	Stage	Light Vehicles	HGV
1 - N69 – East of Foynes	Existing	6,306	578
	Existing + 1a	6,376	728
	Existing +1b	6,376	612
	Existing +2a	6,351	149
	Existing +2b	6,351	586
2 – R463 – Athlunkard Street	Existing	13,793	282
	Existing + 1a	13,863	432
	Existing +1b	13,863	315
	Existing +2a	13,838	78

Route	Stage	Light Vehicles	HGV
	Existing +2b	13,838	290
3 – R463 – Corbally Road	Existing	17,980	405
	Existing + 1a	18,050	555
	Existing +1b	18,050	438
	Existing +2a	18,025	107
	Existing +2b	18,025	413
4 – R465 – North of Carmody's Cross	Existing	1,570	91
	Existing + 1a	1,640	241
	Existing +1b	1,640	125
	Existing +2a	1,615	32
	Existing +2b	1,615	99
5 – R466 – East of Broadford	Existing	1,250	93
	Existing + 1a	1,320	243
	Existing +1b	1,320	126
	Existing +2a	–	–
	Existing +2b	–	–
6 – R465 – North of Broadford	Existing	2,870	183
	Existing + 1a	2,940	333
	Existing +1b	2,940	217
	Existing +2a	–	–
	Existing +2b	–	–
6 – R465 – South of Broadford	Existing	1,735	101
	Existing + 1a	1,805	251
	Existing +1b	1,805	135
	Existing +2a	–	–
	Existing +2b	–	–

Based on the traffic data presented in Table 12-20 the changes in noise level relative to the expected traffic noise from the baseline traffic flows have been calculated and are outlined in Table 12-21.

Table 12-21 Calculated Changes in Traffic Noise Levels

Stage	Route	Change in Traffic Noise Level dB(A)	Significance of effect	Estimated Number of Days
Stage 1a – Wind Turbine Foundation Concrete Pouring	1 N69 – East of Foynes	+0.9	Imperceptible	9
	2 R463 – Athlunkard Street	+1.1	Not Significant	
	3 R463 – Corbally Road	+0.9	Imperceptible	
	4 R465 – North of Carmody's Cross	+3.6	Slight/Moderate	
	5 R466 – East of Broadford	+3.7	Slight/Moderate	
	6 R465 – North of Broadford	+2.2	Not Significant	
	7 R465 – South of Broadford	+3.4	Slight/Moderate	
Stage 1b - Site Preparation and Ground Works	1 N69 – East of Foynes	+0.9	Imperceptible	350
	2 R463 – Athlunkard Street	+1.1	Imperceptible	
	3 R463 – Corbally Road	+0.9	Imperceptible	
	4 R465 – North of Carmody's Cross	+3.6	Not Significant	
	5 R466 – East of Broadford	+3.7	Not Significant	
	6 R465 – North of Broadford	+2.2	Imperceptible	
	7 R465 – South of Broadford	+3.4	Not Significant	
Stage 2a – Delivery of Large Equipment Using	1 N69 – East of Foynes	+0.2	Imperceptible	15
	2 R463 – Athlunkard Street	+0.2	Imperceptible	

Stage	Route	Change in Traffic Noise Level dB(A)	Significance of effect	Estimated Number of Days
Extended Articulated Vehicles	3 R463 – Corbally Road	+0.1	Imperceptible	
	4 R465 – North of Carmody's Cross	+0.9	Imperceptible	
Stage 2b – Other deliveries using conventional articulated HGVs	1 N69 – East of Foynes	+0.1	Imperceptible	9
	2 R463 – Athlunkard Street	+0.1	Imperceptible	
	3 R463 – Corbally Road	+0.1	Imperceptible	
	4 R465 – North of Carmody's Cross	+0.3	Imperceptible	

In the majority of cases the predicted increases in traffic noise levels during each of the construction stages are less than 3 dB; with reference to the DMRB magnitude of impact set out in Section 12.3.2.1.2, the potential effects are classified as 'imperceptible' to 'not significant'.

During the 9-day period of Stage 1a, 'slight to moderate' effect is indicated along route 4 R465 – North of Carmody's Cross, Route 5 R466 – East of Broadford and Route 7 R465 – South of Broadford.

It is concluded that there will be no significant noise effects associated with the additional traffic generated during the construction phase.

Temporary Transition Compound (TTC)

With reference to the TTC proposed along the N69 at Kildimo, the traffic flows will increase by 1.9% for a period of 85 days during the construction of this area. As stated in the DMRB Noise and Vibration (UKHA 2020), Volume 11, Section 3, Part 7, in order to increase traffic noise levels by 1 dB traffic volumes would need to increase by the order of 25%. It is therefore considered that noise effect of additional traffic introduced onto the local road network due to the construction of this transition area is imperceptible.

Description of Effects

With respect to the EPA criteria for description of effects, the potential effects at the nearest noise sensitive location associated with the additional traffic generated during the construction phase are described as Negative, Imperceptible to Moderate and Short term. This effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.5.2.5 Cumulative Construction Noise and Vibration Effects

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

12.5.2.6 Cumulative Construction Noise with Other Wind Farms

In general, potential construction noise impacts may occur if other developments are constructed at the same time as the Proposed Development.

Even if other developments, and Oatfield Wind Farm in particular, were to be constructed at the same time as the Proposed Development, given the distances between the construction works and noise-sensitive locations, it is not considered likely that exceedances of the construction noise criteria in Table 12-1 will occur.

The potential noise effects associated with cumulative construction of other wind farms is expected to be Negative, not Significant and Temporary. Further comment on cumulative construction impacts is presented in 12.6.4.1.

12.5.3 Operational Phase Potential Impacts

12.5.3.1 Turbine Noise Assessment

12.5.3.1.1 *Noise Levels due to Knockshanvo Wind Turbines Only*

The noise levels for the Proposed Development site have been calculated for a set of 526 no. NSLs identified within 3 km of the proposed turbines.

An omni-directional assessment has been completed assuming all noise locations are downwind of all proposed turbines at the same time. The predicted levels have been compared against the adopted noise criteria curves as detailed in Table 12-12. Table 12-22 presents the noise levels at the 10 locations with the highest predicted noise levels at 9 m/s wind speed, namely, H359, H434, H490, H491, H492, H493, H494, H582, H583, H584 and H585. Results for the full set of houses are presented in Appendix 12-8. No exceedances of the noise criteria are noted.

Table 12-22 Review of Knockshanvo Predicted Turbine Noise Levels against Relevant Criteria

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
H359	Dwelling	28.0	29.5	33.8	38.4	39.5	39.6	39.6
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H434	Dwelling	27.3	28.7	33.0	37.7	38.8	38.9	38.9
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H490	Dwelling	28.4	29.8	34.1	38.8	39.9	40.0	40.0
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H491	Dwelling	28.5	29.9	34.2	38.9	40.0	40.1	40.1
	Daytime Limits	40	40	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H492	Dwelling	30.2	31.7	36.0	40.6	41.7	41.8	41.8
	Daytime Limits	40	40	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H493	Dwelling	27.2	28.6	32.9	37.6	38.7	38.8	38.8
	Daytime Limits	40	40	40	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H494	Dwelling	26.8	28.2	32.5	37.2	38.3	38.4	38.4
	Daytime Limits	40	40	40	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H582	Dwelling	26.7	28.1	32.4	37.1	38.2	38.3	38.3
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H583	Dwelling	26.7	28.1	32.4	37.1	38.2	38.3	38.3
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H584	Dwelling	26.9	28.3	32.6	37.3	38.4	38.5	38.5
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H585	Dwelling	28.0	29.5	33.8	38.4	39.5	39.6	39.6
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–

12.5.3.1.2 Cumulative Noise of Knockshanvo, Ballycar, Carranagowan, Fahybeg Lackeragh and Oatfield

The IOA GPG states that all existing and permitted wind energy developments which contribute to the noise level at NSLs must be assessed cumulatively with the Proposed Development.

The predicted levels of the wind turbines at Knockshanvo, Ballycar, Carranagowan, Fahybeg, Lackeragh and Oatfield are compared against the adopted noise criteria curves as detailed in Table 12-12.

Table 12-23 presents the noise levels at the same 10 locations in Table 12-22, plus three locations H549, H550 and H943 at which potential exceedances of the noise criteria are noted at 6 m/s wind speed. Results for the full set of houses are presented in Appendix 12-9, and cumulative noise contours are presented in Appendix 12-10.

Table 12-23 Review of Cumulative Predicted Turbine Noise Levels against Relevant Criteria

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
H359	Dwelling	29.4	31.5	35.7	39.9	40.9	41.0	41.0
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H434	Dwelling	28.7	30.6	35.0	39.2	40.3	40.4	40.4
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H490	Dwelling	28.9	30.6	34.9	39.4	40.4	40.5	40.5
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H491	Dwelling	29.1	30.8	35.2	39.6	40.7	40.8	40.8
	Daytime Limits	40	40	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
H492	Dwelling	30.8	32.6	36.9	41.4	42.4	42.5	42.5
	Daytime Limits	40	40	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H493	Dwelling	29.9	32.3	36.6	40.6	41.6	41.7	41.7
	Daytime Limits	40	40	40	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H494	Dwelling	29.2	31.5	35.8	39.9	40.8	40.9	40.9
	Daytime Limits	40	40	40	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H549	Dwelling	29.2	32.2	36.5	40.1	40.9	41.0	41.0
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.1	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H550	Dwelling	29.2	32.2	36.5	40.1	41.0	41.0	41.0
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.1	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	≥9
H582	Dwelling	28.8	31.0	35.4	39.5	40.4	40.5	40.5
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H583	Dwelling	29.1	31.4	35.8	39.8	40.8	40.8	40.8
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H584	Dwelling	29.6	32.0	36.3	40.3	41.2	41.4	41.4
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H585	Dwelling	30.0	32.2	36.6	40.7	41.6	41.7	41.7
	Daytime Limits	45	45	45	45	45	45	45
	Potential Daytime Exceedance	–	–	–	–	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H943	Dwelling	29.3	32.5	36.8	40.1	40.8	40.9	40.9
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.1	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–

12.5.3.1.3 Location H549, H550 and H943

This section of the assessment considers the effect of the directional pattern of noise from turbines on the predicted noise levels at H549, H550 and H943.

As presented in Section 12.3.7.4, the effect of the directionality of noise emissions from wind turbines means that certain wind directions, noise levels are less than the values presented Table 12-22, as a given noise-sensitive location is not downwind of all turbines at the same time.

Noise levels taking turbine emission directionality into account have been predicted for the locations H549, H550 and H943 where potential exceedances of the daytime noise criteria were noted at 6 m/s windspeed. The results are presented in Table 12-24. Review of the table shows that once the effect of wind direction is taken into account, the predicted noise levels are within the criteria and therefore no mitigation measures are necessary.

Table 12-24 Predicted directional noise levels at H549, H550 and H943

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
H549	North	29.0	32.0	36.3	39.9	40.7	40.8	40.8
	Northeast	27.6	30.6	34.9	38.5	39.3	39.4	39.4
	East	26.1	29.1	33.4	37.0	37.8	37.9	37.9
	Southeast	24.1	27.1	31.4	35.0	35.8	35.9	35.9
	South	23.8	26.8	31.1	34.7	35.5	35.6	35.6
	Southwest	26.4	29.4	33.7	37.3	38.1	38.2	38.2
	West	27.9	30.9	35.2	38.8	39.6	39.7	39.7
	Northwest	28.7	31.7	36.0	39.6	40.4	40.5	40.5
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None
H550	North	29	32	36.3	39.9	40.8	40.8	40.8
	Northeast	27.7	30.7	35.0	38.6	39.5	39.5	39.5
	East	26.1	29.1	33.4	37.0	37.9	37.9	37.9
	Southeast	24.2	27.2	31.5	35.1	36.0	36.0	36.0
	South	23.8	26.8	31.1	34.7	35.6	35.6	35.6
	Southwest	26.4	29.4	33.7	37.3	38.2	38.2	38.2
	West	28.0	31.0	35.3	38.9	39.8	39.8	39.8

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
	Northwest	28.8	31.8	36.1	39.7	40.6	40.6	40.6
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None
H943	North	28.9	32.1	36.4	39.7	40.4	40.5	40.5
	Northeast	27.9	31.1	35.4	38.7	39.4	39.5	39.5
	East	26.0	29.2	33.5	36.8	37.5	37.6	37.6
	Southeast	24.1	27.3	31.6	34.9	35.6	35.7	35.7
	South	23.8	27.0	31.3	34.6	35.3	35.4	35.4
	Southwest	26.2	29.4	33.7	37.0	37.7	37.8	37.8
	West	28.0	31.2	35.5	38.8	39.5	39.6	39.6
	Northwest	28.8	31.8	36.1	39.7	40.6	40.6	40.6
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None

The predicted cumulative noise levels will be within the relevant best practice noise criteria, therefore it is not considered that a significant noise effect is associated with the Proposed Development.

12.5.3.1.4 Minimum of hub height range

In this noise assessment, the noise effects of the minimum turbine envelope are predicted by using the same sound power levels as the maximum turbine envelope, but at the lower hub height of 102.5 m, as described in Section 12.3.7.2.1. The resulting noise levels are similar to those presented in Tables 12-20 to 12-22 and similarly have no exceedances once the directionality of wind turbine noise emissions is taken into account.

Like the maximum turbine envelope, it is not considered that a significant noise effect is associated with the minimum turbine envelope.

12.5.3.1.5 Description of Effects

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 cumulative effects at the nearest noise sensitive locations associated with the operation of the turbines at the Wind Farm Site are described below.

Quality	*Significance*	*Duration*
Negative	Moderate	Long-term

12.5.3.2 110kV Electrical Substation

The substation will be operational on a continuous basis. The noise emission level associated with a typical substation that would support a development of this nature is the order of 93 dB(A) L_W.

Noise prediction calculations for the operation of the 110kV electrical substation have been undertaken in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation* (1996).

The ten highest predicted substation noise levels at any NSL are presented in Table 12-25. The highest predicted noise level is 32 dB L_{Aeq}. In selecting a suitable criterion for substations, reference is made to EPA Noise Guidance note NG4 where a noise criterion of 35 dB L_{Aeq} for night-time periods is stipulated.

Table 12-25 Predicted noise levels due to substation operation

NSL Reference	Noise Level due to Substation, dB $L_{Aeq,T}$
H492	32
H491	28
H490	28
H489	23
H488	22
H916	22
H487	21
H493	21
H494	20
H434	20

The substation will be operational 24/7 and the noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the Substation at the nearest NSL. The predicted noise effect of the substation is: Negative, Not Significant and Long-term.

12.5.4 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. The following measures will be adopted during construction:

- Managing the hours according to the CEMP [Appendix 4-3] 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.

12.5.4.1 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 during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate close to NSL's 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, the following are examples of measures that will be employed, 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 eliminate 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

Air overpressure from a blast is difficult to control, however, because of its variability much can be done to reduce the effect. A reduction in the amount of primer cord used, together with the adequate burial of any that is above the ground, can give dramatic reduction to air overpressure intensities especially in the audible frequency range. Most complaints are likely to be received from an area downwind of the blast site, and therefore, if air blast complaints are a continual problem, it would be advisable to postpone blasting during unfavourable weather conditions if at all possible. As air blast intensity is a function of total charge weight, then a reduction in the total amount of explosives used can also reduce the air overpressure value.

Further guidance will be obtained from the recommendations contained within BS 5228: Part 1 and the European Communities (Construction Plant and Equipment) (Permissible Noise Levels) Regulations 1988 in relation to blasting operations.

The methods used to minimise complaints could consist of some or all of the following:

- Restriction of hours within which blasting can be conducted (e.g. 09:00 – 18:00hrs).
- Notification to nearby residents before blasting starts (e.g. 24-hour written notification).
- The firing of blasts at similar times to reduce the ‘startle’ effect.
- On-going circulars informing people of the progress of the works.
- The implementation of an onsite documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.
- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

12.5.4.1.1 *110kV Underground Cabling*

In respect of the grid connection construction, a temporary solid hoarding will be employed where there are NSLs less than 40m to the activity. This can be expected to reduce noise at the NSL by 5 - 10 dB. With this mitigation measure in place, the resulting noise effect is negative, not significant and brief to temporary.

Additional or alternative mitigation measures include:

- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations;
- Selection of plant with low inherent potential for generation of noise and/ or vibration, and;
- Placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints.

It is noted that the assessment presented in Section 12.5.2.2 is conservative, and the assessment has identified a potential exceedance of the noise criteria at NSLs at less than 40 m of the works. If the appointed contractor can demonstrate through onsite monitoring that mitigation measures are not required to meet the relevant criteria, then works can proceed without specific mitigation measures in place.

12.5.4.2 Construction Phase Mitigation Measures – Vibration

While it was concluded in 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 12.3.2.1.3.

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%.

Considering the distances between locations where works with the potential to generate significant vibration will take place and the nearest NSL's, no significant impact will be experienced. Therefore, no mitigation measures are proposed for piling operations.

Specific to blasting the following mitigation measures will be employed to control the impact during blasts:

- Trial blasts may be undertaken to obtain scaled distance analysis;
- Ensuring appropriate burden to avoid over or under confinement of the charge;
- Accurate setting out and drilling;
- Appropriate charging;
- Appropriate stemming with appropriate material such as sized gravel or stone chipping;
- Delay detonation to ensure small maximum instantaneous charges;
- Decked charges and in-hole delays;
- Blast monitoring to enable adjustment of subsequent charges;
- Good blast design to maximise efficiency and reduce vibration;
- Avoid using exposed detonating cord on the surface.

12.5.5 Operational Phase Mitigation Measures

12.5.5.1 Wind Turbines

An assessment of the operational wind turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 12.3.2.2 of this Chapter. The findings of the assessment, presented in Section 12.5.3, confirm that the predicted operational noise levels will be within the relevant best practice noise criteria curves for wind farms at all locations.

In the unlikely event that an issue with low frequency noise is associated with the Proposed Development, an appropriate detailed investigation will be undertaken. Due consideration will 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.* If an exceedance of the threshold values is confirmed, measures to mitigate LFN at noise-sensitive locations will be implemented through operational controls for the relevant turbine type, which may include turbine curtailment under specific operational conditions.

Similarly, in the event that a confirmed complaint is received which indicates potential amplitude modulation (AM) associated with turbine operation, the operator will employ an independent acoustic consultant to assess the level of AM in accordance with the methods outlined in 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) or subsequent revisions.

The measurement method outlined in the IoA AMWG document, known as the '*Reference Method*', would 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.

These mitigation measures, if required, will consist of the implementation of operational controls for the relevant turbine type, which will include turbine curtailment turbines under specific operational conditions.

12.5.5.1.1 *Monitoring*

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

For example, implementation of noise operational modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure predicted noise levels are within the relevant noise criterion curves/planning conditions. Such curtailment can be applied using the wind farm SCADA system without undue effect on the wind turbine operation. Following implementation of these measures, noise surveys will be repeated to confirm compliance with the noise criteria.

12.5.6 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 be used. The noise and vibration impacts associated with any decommissioning of the Proposed Development are considered to be comparable to those outlined in relation to the construction of the Proposed Development (as per Section 12.5.2). 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 12.3.2.1.

Considering that in all aspects of the construction and decommissioning the predicted noise levels are expected to be below the appropriate Category A value (i.e. 65dB $L_{Aeq,T}$) at current noise sensitive locations for the decommissioning phase.

12.5.6.1 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 development, i.e. as per Section 12.5.2.

12.6 Description of Residual Effects

12.6.1 Construction Phase

In respect of the potential for cumulative construction effects due to the construction of Oatfield wind turbines, the following comments are offered: Predicted construction noise levels from Table 12-14 are of the order of 50 dB $L_{Aeq,T}$ which is more than 10 dB below the construction noise criterion of 65 dB $L_{Aeq,T}$. It is therefore unlikely that the construction of the Proposed Development turbines will give rise to construction noise levels above the criterion. No significant cumulative effects are likely.

In respect of potential construction effects for other developments, it is not anticipated that there will be any other construction activities that would give rise to significant cumulative impacts during the construction phase. With the exception of proposed 'linear' construction works, 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.

For construction activities occurring in close proximity to NSL's, considering the distance to any other projects and the noise emissions associated with these activities, cumulative construction noise or vibration effects are unlikely.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest noise sensitive locations associated with cumulative impacts during the construction phase are described as:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.1 Turbines, Hardstands, and Meteorological Mast

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

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.2 110kV Electrical Substation

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

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.6.1.3 Access Roads

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

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.6.1.4 Junction Accommodation Works

The predicted construction noise and vibration effects associated the junction accommodation works are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.6.1.5 Temporary Construction Compounds

The predicted construction noise and vibration effects associated the temporary construction compounds are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.6 Underground Cabling

The predicted construction noise and vibration effects associated the underground cabling are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.6.1.7 Borrow Pits

The predicted construction noise and vibration effects associated the borrow pits are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.8 Grid Connection Construction

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

Quality	Significance	Duration
Negative	Not Significant	Brief to Temporary

12.6.1.9 Vibration

The predicted construction noise and vibration effects associated the junction accommodation works are summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.10 Construction Traffic

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

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.1.11 Cumulative Construction Noise and Vibration Effects

It is not likely that there will be any significant cumulative impacts at NSLs should these various elements of the construction phase be undertaken simultaneously, summarised as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.6.2 Operational Phase

12.6.2.1 Noise

12.6.2.1.1 *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 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.

12.6.2.1.2 *Substation Noise*

The environmental noise effects from the day to day operation of the substation are summarised as follows:

Quality	Significance	Duration
Negative	Not significant	Long-term

12.6.2.2 Vibration

There are no expected sources of vibration associated with the operational phase of the Proposed Development. In relation to of vibration the associated effect is summarised as follows:

Quality	Significance	Duration
Negative	Imperceptible	Long-term

12.6.3 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

12.6.4 Cumulative Effects of other wind farms

12.6.4.1 Construction Phase

In respect of the potential for cumulative construction noise effects during the construction of Oatfield wind farm the following comment is made: the predicted noise levels at the nearest NSL for the construction of turbines and hardstands in Table 12-14 are of the order of 50 dB $L_{Aeq,T}$, which are well below the construction noise criterion of 65 dB $L_{Aeq,T}$, therefore the construction of Knockshanvo wind farm will not lead to a significant noise effect. Other elements of the construction (substation, junction accommodation, etc) are local to the nearest NSLs and therefore due to the distance to Oatfield works, no significant cumulative effects are likely.

In respect of other wind farms, it is not anticipated that there will be any other construction activities that would give rise to significant cumulative impacts during the construction phase. With the exception of proposed 'linear' construction works, the predicted noise emissions for the Proposed Project are not of enough magnitude to cause an increase in the cumulative construction noise emissions exceeding the threshold for significant impacts at any NSL.

For construction activities occurring in close proximity to NSLs, considering the distance to any other projects and the noise emissions associated with these activities, cumulative construction noise or vibration effects are unlikely. In particular, it is noted that the turbine delivery route for the proposed Oatfield wind farm follows a different route via Killaloe. Therefore significant cumulative construction traffic noise effects are not considered likely.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest noise sensitive locations associated with cumulative impacts during the construction phase are described as:

Quality	Significance	Duration
Negative	Not significant	Short-term

12.6.4.2 Operational Phase

The above operational noise assessment has considered the potential cumulative impacts of the Proposed Development in combination with other wind energy developments in the area as required by best practice guidance discussed in Section 12.3.

As concluded in Section 12.5.3.1, the predicted noise levels associated with the Proposed Development, which takes into account the set of cumulative wind farms, will be within best practice noise criteria curves recommended in Irish guidance '*Wind Energy Development Guidelines for Planning Authorities'*.

It is therefore considered that a significant effect is not associated with the Proposed Development in combination with other wind farm developments.

Quality	*Significance*	*Duration*
Negative	Moderate	Long-term

12.6.5 Cumulative Effects with other developments

In respect of the other developments listed in Chapter 4, the majority of the planning applications relate to private dwelling houses and modifications to houses. It is not considered that any significant cumulative construction or operational noise or vibration effects are likely.

The only development of scale is Planning Ref 18/567 for a land fill site to the south of location H435. This application was granted in 2018. It is not considered that any significant cumulative construction of operational noise or vibration effects are likely.

12.6.6 Cumulative Effects with commercial forestry

Other potential sources of noise in the cumulative context are the ongoing surrounding commercial forest management activities on Coillte-owned lands including felling and replanting of trees. Noise from commercial forest management will be managed in line with the operational conditions of the felling licence and therefore no long-term cumulative noise impacts are anticipated between the Proposed Development in combination with commercial forestry activities.