Planning and Environmental Consultants

Environmental Impact Assessment Report

Briskalagh Renewable Energy Development, Co. Kilkenny

Chapter 12 – Noise and Vibration

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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 Project (Proposed Wind Farm and Proposed Grid Connection) and its component parts. A full description of the Proposed Project is provided in Chapter 4 of this EIAR.

A noise and vibration impact assessment has been prepared for the construction, operational, and decommissioning phases of the Proposed Project on the nearest Noise Sensitive Locations (NSLs). To inform this assessment, baseline noise levels have been surveyed at 6 no. representative NSLs surrounding the Site. Noise predictions to the nearest NSLs have been prepared for all key elements of the Proposed Project with the potential for noise and vibration impacts and effects.

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

12.1.2 Statement of Authority

This chapter of the EIAR has been prepared by 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.

This chapter of the EIAR has been reviewed by Dermot Blunnie of AWN Consulting Ltd. Dermot Blunnie (Principal Acoustic Consultant) holds a BEng (Hons) in Sound Engineering, MSc in Applied Acoustics and has completed the Institute of Acoustics (IOA) Diploma in Acoustics and Noise Control. He has been working in the field of acoustics since 2008 and is a member of the Institute of Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA). He has extensive knowledge and experience in relation to commissioning noise monitoring and impact assessment of wind farms as well as a detailed knowledge of acoustic standards and proprietary noise modelling software packages. He has commissioned noise surveys and completed noise impact assessments for numerous wind farm projects within Ireland.

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 0 dB (for the threshold of hearing) to 120 dB (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 10 dB 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 250 Hz. 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.

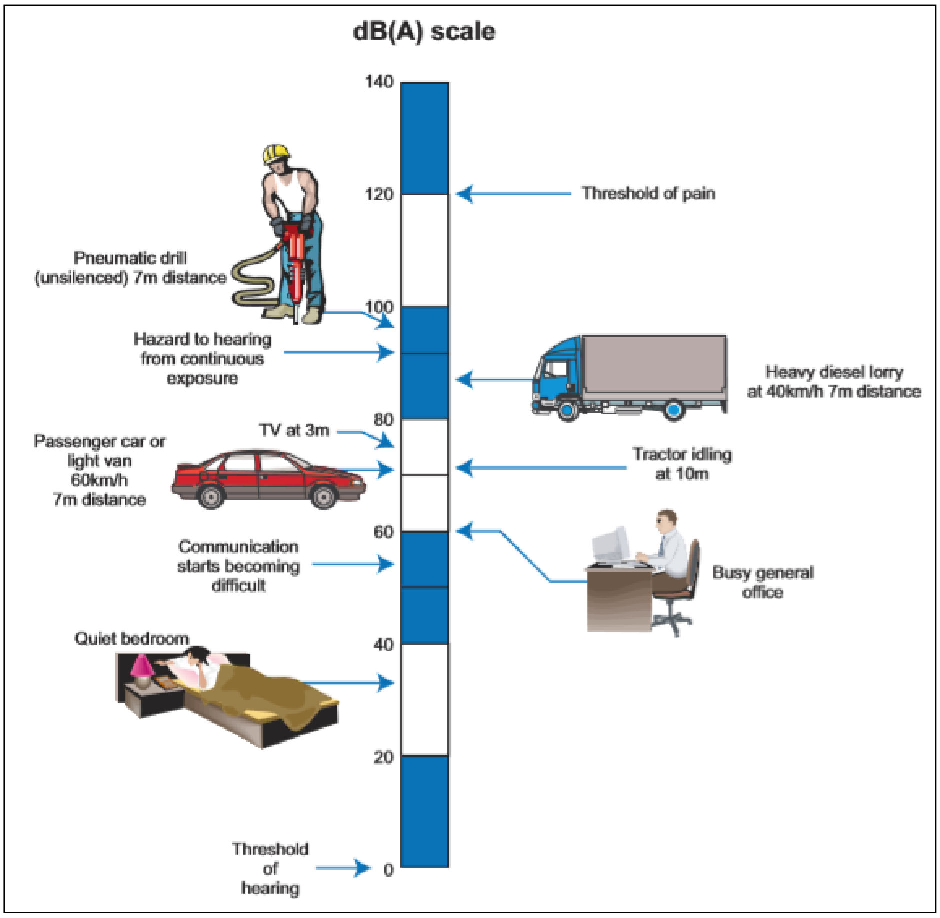

Figure 12-1 The level of typical common sounds on the dB(A) scale (National Roads Authority (NRA) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)

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 associated with the Proposed Project.

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

- Review of appropriate guidance to identify appropriate noise and vibration criteria for both the construction, operational, and decommissioning phases;
- Characterise the receiving environment through noise surveys at various locations in the receiving environment of the proposed wind turbines;

- Undertake predictive noise calculations to assess the potential impacts associated with the construction, operational and decommissioning phases of the Proposed Project at NSLs;
- Evaluate the potential noise and vibration impacts and describe the effects;
- Specify mitigation measures to reduce, where necessary, the identified potential noise and vibration impacts from the Proposed Project; and
- Describe the significance of the residual noise and vibration effects associated with the Proposed Project, including cumulative effects.

12.3.1 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. The relevant guidance documents are listed below and are discussed where relevant in the various sections of this chapter.

- *EPA Guidelines on the Information to be contained in Environmental Impact Statements*, (EPA, 2022).
- *Wind Energy Development Guidelines for Planning Authorities*, Department of the Environment, Heritage, and Local Government, 2006 (the Guidelines), with cognisance of *Draft Revised Wind Energy Development Guidelines* 2019 Department of Housing, Local Government and Heritage (the draft Guidelines).
- *The Assessment and Rating of Noise from Wind Farms*, Department of Trade, and Industry (UK) Energy Technology Support Unit (ETSU) (1996).
- *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (IOA GPG) (2013).
- *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes, Transport Infrastructure Ireland* (TII) (formerly National Roads Authority (NRA) (2014).
- British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise.*
- British Standard BS 5228-2:2009+A1:2014 *Code of practice for vibration control on construction and open sites – Vibration.*
- British Standard BS 7385 – *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration* (BSI, 1993).
- *Design Manual for Roads and Bridges* (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (National England (now National Highways) 2020)
- ISO 1996: 2017: *Acoustics – Description, measurement, and assessment of environmental noise.*
- *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites* (NG3) (EPA, 2011).
- *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4),* EPA, 2016 (NG4).
- World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018).

12.3.1.1 Construction Phase

12.3.1.1.1 *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* (BS 5228-1).

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 NSLs, indicates a potential significant noise impact is associated with the construction activities. The threshold values are applicable to both construction and decommissioning noise.

Table 12-1 presents the threshold values which, if exceeded, potentially signify a significant effect as recommended by BS 5228 – 1. The threshold levels relate to construction noise only.

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.

It should be noted that this assessment method is only proposed for residential properties. The following method should be applied:

For each period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5 dB. At some sensitive properties, especially those situated near busy roads, ambient noise levels are anticipated to be relatively high. However, given the rural nature of the site in general, reference has been made to the quietest properties near the development which have daytime ambient noise levels typically in the range of 30 to 50 dB $L_{Aeq,1hr}$. Therefore, for the purposes of this assessment, as a precautionary approach, all properties will be afforded a 'Category A' designation for initial assessing of construction noise impacts.

BS 5228-1 states that:

> *If the site noise level exceeds the appropriate category value [the CNT], then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect.*

Please see Section 12.5.2 for the detailed assessment in relation to the construction of the Proposed Project.

Linear Construction Works

Due to the linear, progressive nature of the construction works associated with Proposed Grid Connection underground cabling, a fixed noise limit is proposed. This is deemed appropriate in that noise from associated construction activities is variable and typically occurs for a short period of time only and is at its highest when closest to the NSL. As the works progress, construction noise levels at the NSL will reduce due to the works taking place at greater distances, resulting overall in shorter periods of exposure to noise impacts.

In relation to an appropriate fixed noise limit value, 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;*

This construction noise criterion is similar to that in the Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (TII, 2014) construction noise limits of 70 dB $L_{Aeq,1hr.}$ for weekday periods (Monday to Friday 0700 – 1900 hrs) and 65 dB $L_{Aeq,1hr}$. on Saturdays (08:00 to 16:30hrs).

In this assessment, a construction noise limit of 70 dB $L_{Aeq,T}$ is adopted for the Proposed Grid Connection underground cabling works. However, in the determination of the significance of impact of noise from linear works, the following is noted: In accordance with the DMRB Noise and Vibration Guidance, construction noise and construction traffic noise effects shall constitute a significant effect where it is determined that a major or moderate magnitude of effect will occur for a duration exceeding:

- Ten or more days or night in any 15 consecutive day or nights, or
- A total number of days exceeding 40 in any six consecutive months.

The duration and noise effects of linear works is discussed in Section 12.5.2.2.2.

12.3.1.1.2 *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 Project 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 Project.

For the assessment of potential noise impacts from construction related traffic along public roads it is proposed to adopt guidance from Highways England (now National Highways) Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA 111 Noise and Vibration (Revision 2) (hereafter referred to as DMRB).

Table 12-2 below, taken from DMRB, offers guidance as to the likely short-term impact 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))	DMRB Magnitude of Impact (Short-term)
Less than 1 dB	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
≥5	Major

Section 3.19 of LA 111, DMRB states that construction traffic noise shall constitute a significant effect where it is found that a major or moderate magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or
- A total number of days exceeding 40 in any 6 consecutive months.

The DMRB guidance will be used to assess the predicted increases in traffic levels on public roads associated with the Proposed Project and comment on the short-term impacts during the construction phase. Where a major or moderate 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 12.3.1.1.

12.3.1.1.3 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 Project, 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 5228-2 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 Table12-3.

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

Following review of the guidance documents set out above, the values in Table 12-3 are considered appropriate for this assessment.

12.3.1.2 Operational Phase

12.3.1.2.1 *Wind Turbine Noise*

The noise assessment summarised in the following sections is based on guidance in relation to acceptable levels of noise from wind farms as contained in the Guidelines. 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 Guidelines publication where necessary.

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

The core of the noise guidance contained within the Guidelines 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 NSLs. 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 NSL. 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…".* The potential for other wind farms to contribute to the NSLs in the study area is assessed in Section 12.7.4 and Appendix 12-2.

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 L_{A90} and/or a higher level above the prevailing background noise level.

Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts 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 six Supplementary Guidance Notes (IOA GPG). These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described including the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG is considered to represent best practice and has been adopted for this assessment.

The IOA GPG states, that at a minimum continuous background noise monitoring should be carried out at NSL for typically a two-week period and should capture a representative sample of wind speeds in the area (i.e., from cut in speeds to the wind speed that generate the highest sound power output from the proposed turbine(s)). 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 used on the data sets to calculate background noise levels at different wind speeds, the resulting background noise curve can be used to establish appropriate turbine noise criteria at each location.

The noise levels associated with the wind turbines are 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 other factors, 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 to satisfy any adopted criteria, consideration can be given to detailed wind directional analysis and operating turbines in low noise mode, which is typically offered by modern wind turbine units.

For guidance on the methodology for the background noise survey and operation impact assessment for wind turbine noise the IOA GPG has been adopted.

The IOA GPG states that cumulative noise exceedances should be avoided and where existing or permitted development is at the noise limit, any new turbine noise sources should be designed to be 10 dB below the limit value. Reference will be made to this guidance when considering potential cumulative impacts from any other existing permitted or proposed wind farms in the surrounding environment and the need to considered other development in the wind turbine noise assessment.

Section 5.1 of the IOA GPG states the following:

> "*Cumulative impact assessment necessary:*
>
> *5.1.4 During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.*
>
> *5.1.5 Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary.*"

An appraisal of the study area to determine whether a cumulative turbine noise impact assessment is required is presented Section 12.7.4 and Appendix 12-2.

Wind Energy Development Guidelines

Section 5.6 of the Guidelines addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

The following extracts from this document are 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."*

The issues identified in this extract have been incorporated into our assessment and are addressed in Section 12.4.2.

> *"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 locations 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 L_{A90}, 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 and represents the commonly adopted night time noise criterion curve in relation to wind farm developments.

In summary, the Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at NSLs:

- An appropriate absolute limit level in the range of 35 – 40 dB L_{A90} for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels of not less than 30 dB $L_{A90,10min}$ 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, this is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by ABP.

The proposed operational turbine noise criteria are presented in Section 12.4.2.

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."*

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

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

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

> *"Even though correlations between noise indicators tend to be high (especially between LAeq-like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in L_{den} is converted from original sound pressure level values.*

> *The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes...*
>
> *Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region."*

Based upon the review outlined 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 developments in Ireland.

Future Potential Guidance Changes for Wind Turbine Noise

In December 2019, the Draft Revised Wind Energy Development Guidelines (the draft Guidelines) were published for consultation and at the time of writing, updated guidelines have yet to be published. It is important to note that during the related public consultation several concerns relating to the proposed approach of the draft Guidelines were expressed by various parties. Specific concerns expressed by a group of acoustic professionals working in the field are most relevant. The group was made up of acousticians who act for wind farm developers, Councils, Government bodies and residents' groups (all of whom are members of the Institute of Acoustics, IOA). The group contained several of the authors / contributors to ETSU-R-97, the IOA Good Practice Guide (IOA GPG) and the IOA Amplitude Modulation Working Group, which are all referenced extensively in the draft Guidelines.

A statement from the cross party group 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 response:

> "*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*"

The following statements was submitted by the Minister for Housing, Local Government and Heritage during a Dail Eireann Debates on 13 June 2023[1]:

> "*My Department is currently undertaking a focused review of the 2006 Wind Energy Development Guidelines. The review is addressing a number of key aspects including noise, setback distance, shadow flicker, community obligation, community dividend and grid connections.*
>
> *Guidance on the noise aspect, which is highly technical in nature, is currently being finalised by my Department in conjunction with the Department of the Environment, Climate and Communications (DECC), which has primary responsibility for environmental noise matters.*

[1] https://www.oireachtas.ie/en/debates/question/2023-06-13/780/

Both Departments are engaging on proposals regarding the measurement and assessment of noise from wind turbines to ensure they are robust and fit for purpose having regard to, inter alia, the revised 2030 target to generate up to 80% of our electricity from renewable sources.

In this connection, DECC has recently appointed an acoustic expert, who has commenced work to inform any amendments to the noise aspect of the Guidelines. My Department in conjunction with DECC will make any further changes to the draft Guidelines which are deemed necessary or appropriate in the wake of this work, with a view to bringing the review of the Guidelines to a conclusion. My Department will be in a better position to provide an update on the expected publication date of the revised Guidelines once this process has concluded.

It should be noted that Action EL/23/4 of the Climate Action Plan 2023 Annex of Actions contains a commitment to having new draft Guidelines prepared by the end of Q4 2023, with revised Guidelines to be published in 2024.

When finalised, the revised Guidelines will be issued under section 28 of the Planning and Development Act 2000, as amended. Planning authorities and, where applicable, An Bord Pleanála, must have regard to guidelines issued under section 28 in the performance of their functions generally under the Planning Acts. In the meantime, the current 2006 Wind Energy Development Guidelines remain in force."

The assessment of wind turbine noise presented in this EIAR is based on the guidance outlined in the Guidelines and has been supplemented with best practice guidance from ESTU-R-97 and the IOA GPG.

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

12.3.1.2.2 Noise from Substation

For the proposed 38kV substation, it is proposed to set fixed noise limits and consideration has been given to the following best practice guidance.

EPA NG4

In order to establish whether the NSLs in the vicinity of the proposed onsite 38kV substation would be considered 'low background noise' areas as defined in the Environmental Protection Agency (EPA) publication Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) guidance, the noise levels measured during the environmental noise survey need to satisfy the following criteria:

- Arithmetic Average of L_{A90} During Daytime Period ≤40 dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Evening Period ≤35 dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Night-time Period ≤30 dB L_{A90}.

Table 12-4 outlines the noise emission limit criteria detailed in the NG4 document.

Table 12-4 NG4 Approach for Determining Appropriate Noise Criteria

Scenario	Daytime Noise Criterion, dB $L_{Ar,T}$ (07:00 to 19:00hrs)	Evening Noise Criterion, dB $L_{Ar,T}$ (19:00 to 23:00hrs)	Night Noise Criterion, dB $L_{Aeq,T}$ (23:00 to 07:00hrs)

Areas of Low Background Noise	45	40	35
All other Areas	55	50	45

Based on a review of the measured noise from the background noise survey (Section 12.5.1), the NSL in the vicinity of the site are defined as areas of low background noise as per the NG4 guidance. As the proposed substation will run on a 24-hour basis, the potential impact during night-time periods governs this assessment. A night time criterion of 35 dB $L_{Aeq,T}$ is considered appropriate for the operation of the substation. The design must ensure that the noise emissions do not contain audible tones or impulsive characteristics at the nearest NSLs.

35 dB $L_{Aeq,T}$ is considered a low level of noise. However, it is important to consider the likelihood of adverse noise impacts when assessing noise from fixed plant. The NG4 guidance refers to the assessment method prescribed in BS 4142:2014: *Methods for rating and assessing industrial and commercial sound* that can be used to assess the likelihood of complaints from specific plant noise sources.

Other Guidance – BS 4142

BS 4142:2014: *Methods for rating and assessing industrial and commercial sound* is the industry standard method for analysing fixed plant sound emissions to residential receptors. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

For a BS 4142 assessment it is necessary to compare the measured external background sound level (i.e. the $L_{A90,T}$ level measured in the absence of plant items) to the rating level ($L_{Ar,T}$) of the various plant items, when operational. Where sound emissions are found to be tonal, impulsive, intermittent or to have other sound characteristics that are readily distinctive against the residual acoustic environment, BS 4142 recommends that penalties be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal sound characteristics outlined in BS 4142 recommends the application of a 2 dB penalty for a tone which is just perceptible at the receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible. In relation to intermittency, BS 4142 recommends that if the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied. The following definitions as discussed in BS 4142 as summarised below:

"*ambient sound level, $L_{Aeq,T}$* — *equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at any given time, usually from many sources near and far, at the assessment location over a given time interval, T.*

residual sound level, $L_{Aeq,T}$ — *equivalent continuous A-weighted sound pressure level of the residual sound (i.e. ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound) at the assessment location over a given time interval, T.*

specific sound level, $L_{Aeq,T}$ — *equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T.*

Rating level, $L_{Ar,T}$	*specific sound level plus any adjustment for the characteristic features of the sound.*
background sound level, $L_{A90,T}$	*A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.*"

To establish an initial estimate of impact, BS 4142 states the following:

"*Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following:*

a. *Typically, the greater this difference, the greater the magnitude of the impact.*

b. *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

c. *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*

d. *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.*

Note Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact."

BS4142 contains the following pertinent factor that must be considered with respect to the context of the sound, which is relevant to this assessment as the background noise levels are typically low at NSLs during periods of low wind speeds:

> *"The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.*
>
> *Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."*

In light of the above guidance from EPA's NG4 and BS4142, is it considered that the proposed absolute criterion of 35 dB $L_{Aeq,T}$ at the NSL for noise from the substation is robust to prevent adverse impacts at NSLs.

12.3.2 Special Characteristics of Turbine Noise

12.3.2.1 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)[2] found that the level of infrasound from wind turbines is insignificant and no different to any other source of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people.

The study included several houses in rural and urban areas, both adjacent to and away from a wind farm, and measured the levels of infrasound with the wind farms operating and switched off.

There were no noticeable differences in the levels of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building.

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

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

A German report[3], 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 in 2016 by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg 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) [4]"*

> *"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.

12.3.2.2 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:

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[2] *EPA South Australia, 2013, Wind farms https://www.epa.sa.gov.au/files/477912_infrasound.pdf*
[3] *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*
[4] *DIN 45680:2013-09 – Draft "Measurement and Assessment of Low-frequency Noise Emissions" November 2013*

"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 (described as 'blade swish'), and;
- 'Other' AM (sometimes referred to 'abnormal' or 'enhanced' 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.

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.

12.3.2.2.1 ***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.

It is not possible to predict an occurrence of AM at the planning stage. While OAM can occur, it is noted that the research has shown that it is a rare event associated with a limited number of wind farms.

RenewableUK Research Document states the following in relation to matter:

Page 68 Module F	*"even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."*
Page 6 Module F	*"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."*
Page 61 Module F	*"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."*

12.3.2.2.2 Comments on AM

There is no industry consensus or recognised methodology that can be applied to predict the likelihood of AM at a particular wind farm at the planning stage. A site specific assessment would need to be undertaken at post commissioning stage.

Research and Guidance in the field of wind turbine noise AM 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.

A 2016 report commissioned by the UK government *Wind turbine AM review: Phase 2 report. 3514482A Issue 3. Department for Business, Energy & Industrial Strategy* completed by WSP Parsons Brinckerhoff recommended the use of a penalty approach for AM. Research is ongoing and to date, there is no clear consensus on how AM should be regulated or managed at the planning stage.

The assessment of AM at post commissioning stage is discussed in section 12.6.2.1.2.

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

The shortest distance from any turbine in the Proposed Wind Farm to the nearest NSL is greater than 500m. At that distance, the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria are not specified for the operational phase of the Proposed Wind Farm.

12.3.4 Comments on Human Health Impacts

The peer-reviewed research outlined in the proceeding sections supports that there are no direct negative health effects on people with long term exposure to wind turbine noise in the environment. For further details of potential health impacts associated with the Proposed Project refer to Chapter 5 of the EIAR.

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

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

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.

[5] *Health Canada 2014, Wind Turbine Noise and Health Study: Summary of Results. Available at* https://www.canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html

12.3.4.4 The Australian Medical Association

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

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

12.3.5 Study Area

The study area for the noise and vibration impact assessment was defined by the area where there is potential for noise and vibration impacts at NSLs associated with the Proposed Project during the construction, decommissioning, and operational phases.

For the operational phase the study area should cover, at a minimum, the area predicted to exceed 35 dB L_{A90} from all existing, permitted and proposed wind turbines. An appraisal of the list of wind farm development in Table 2-5 in Chapter 2 identified that the nearest other wind turbine developments (existing, permitted or proposed) are Foyle Wind Farm located approximately 2.5 km and Kyleballyoughter Wind Farm located at 3.2 km from the Proposed Wind Farm.

Foyle Wind Farm, including 4 no constructed turbines and a further 1 permitted turbine, have been included in the cumulative assessment presented in this Chapter. Similarly, the two permitted turbines at Kyleballyoughter are also included.

Ballybay Wind Farm, Farranroy Wind Farm and An Cnoc wind farm are between 5 and 10 km from the proposed turbines. In Appendix 12-2, these wind farms are screened out of the cumulative assessment.

Other wind farms within a 25 km distance (namely Ballincurry, Ballynalacken, Bruckana, Freneystown, Gurteen Lower, Kiloshulan, Knockroe, Lisdowney, Lisheen I, Lisheen II, Lisheen III, Littleton and Loughhill and White Hill) were not included in the cumulative assessment on the basis of being at a distance more than 10 km from the proposed turbines.

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

During the construction and decommissioning phases, noise could occur at any location within the Site and along public roads where there are increases in traffic associated with the Proposed Project. There is also a potential for noise impacts from HGVs along Turbine Delivery Route (TDR) during the construction and decommissioning phases of the Proposed Project.

NSLs in proximity to specific construction sites and those situated along haul routes have the most potential to experience noise and vibration impacts. Taking account of the typical works associated with the construction and decommissioning phases, the study area is based on the nearest NSLs to the working areas, these distances are confirmed in the relevant sections and are typically representative of the closest identified NSL or at defined set back distances from proposed activity.

12.3.6 Background Noise Assessment

A background noise survey was undertaken to establish typical background noise levels at representative NSLs surrounding the Proposed Wind Farm site. The background noise survey was conducted through installing unattended sound level meters at 6 no. representative locations in the surrounding area.

This background noise survey has been carried out in accordance with the IOA GPG discussed in the following sections.

12.3.6.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment (See Section 12.3.6.1 for detail on wind turbine noise calculations). Any NSL that fell inside the predicted 35 dB L_{A90} noise contour was 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 a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps).

The selected locations for the noise monitoring are outlined in the following sections. Coordinates for the noise monitoring locations are detailed in Table 12-5 and in Figure 12-2.

Table 12-5 Noise Measurement Location Coordinates

Location (Ref)	Coordinates – Irish Transverse Mercator (ITM)	
	Easting	Northing
NML-A – H009	639,471	655,205
NML-B – H013	641,260	654,845
NML-C – H001	640,817	653,813
NML-D – H029	639,247	652,429
NML-E – H049	638,111	653,680
NML-F – H060	638,645	654,574

Figure 12-2 Noise measurement locations.

Site visits by survey personnel were carried out during the morning and afternoon time; during these visits, noise sources in this area were noted to be distant traffic movements, activity in and around the properties 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. Plate 12-1 to Plate 12-6 illustrate the installed noise monitoring equipment at each location.

12.3.6.1.1 NML-A

The noise meter at NML-A was installed to the east of the property at a distance of 15 m from the dwelling and 64 m from the local road to the north.

Plate 12-1 NML-A

12.3.6.1.2 NML-B

The meter at NML-B was installed in the garden to the east of the property at a distance of 31 m from the dwelling and 60 m from the road.

Plate 12-2 NML-B

12.3.6.1.3 NML-C

At NML-C, the meter was installed in a field at a distance of 35m from the dwelling.

Plate 12-3 NML-C

12.3.6.1.4 NML-D

The noise monitoring equipment at NML-D was installed in a field to the side of farmyard, at distance of 85 m from the road to the south.

Plate 12-4 NML-D

12.3.6.1.5 NML-E

NML-E was positioned a distance of 80m from the dwelling in a field on the opposite side of the local road.

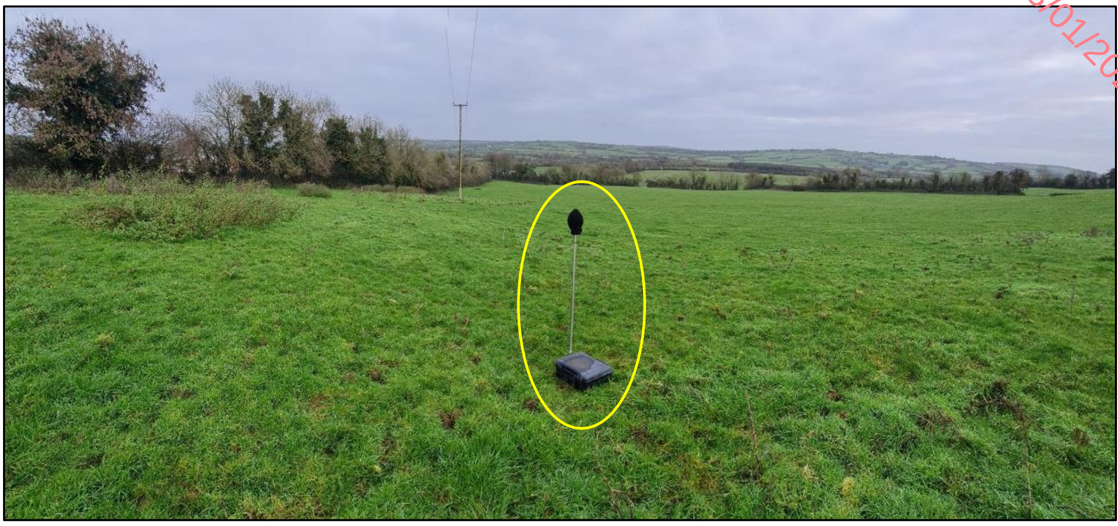

Plate 12-5 NML-E

12.3.6.1.6 NML-F

NML-F was positioned in a field to the rear of the dwelling, at a distance of 25 m from the building and 50 m from the local road.

Plate 12-6 NML-F

12.3.6.2 Survey Periods

The survey duration was 8 weeks, allowing such time that enough data points were captured at each survey locations. Section 2.9.1 of the IOA GPG states:

> *"The duration of a background noise survey is determined only by the need to acquire sufficient valid data over the range of wind speeds (and directions, if relevant). It is unlikely that this requirement can be met in less than 2 weeks."*

An ongoing review of the survey data was conducted at regular intervals to establish when adequate data had been captured. Noise measurements were conducted at each of the monitoring locations over the periods outlined in Table 12-6

Table 12-6 Measurement Periods

Location	Start Date	End Date
NML-A	9 November 2023	14 December 2023
NML-B	9 November 2023	14 December 2023
NML-C	14 December 2023	24 January 2024
NML-D	9 November 2023	14 December 2023
NML-E	14 December 2023	24 January 2024
NML-F	14 December 2023	24 January 2024

A variety of wind speed and weather conditions were encountered over the survey period. Figure 12-3 and illustrates the distributions of wind speed and wind direction standardised to 10 m height over the survey periods detailed in Table 12-6.

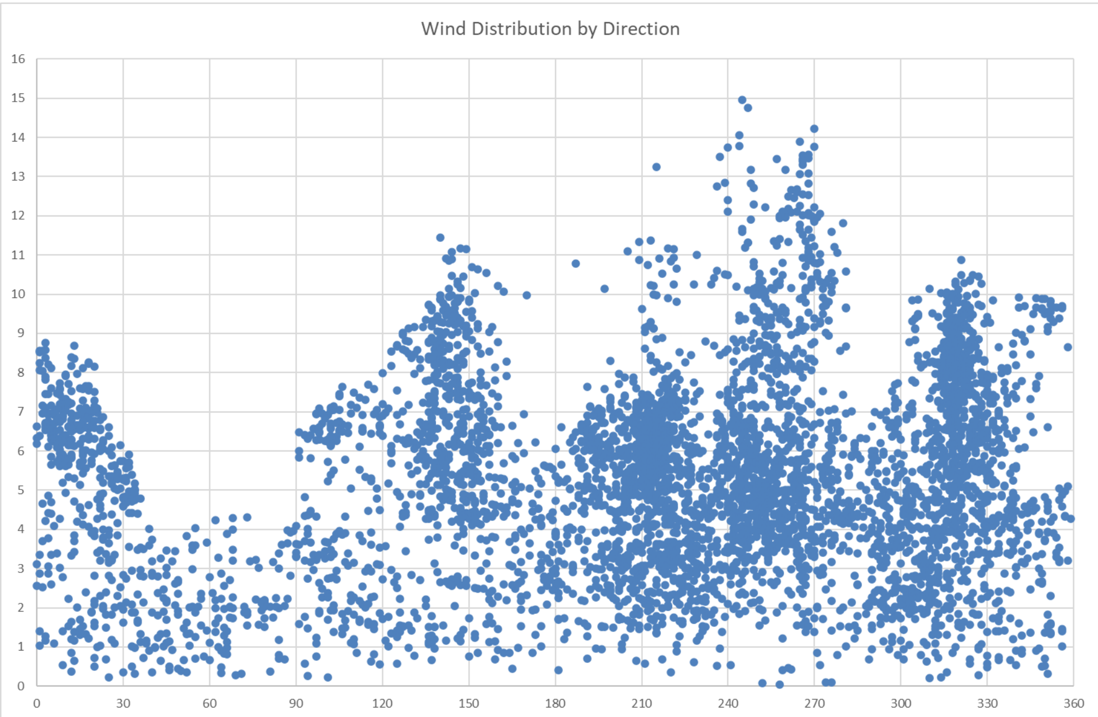

Figure 12-3 Distributions of Wind Speeds and Directions over the Survey Period

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. Details of the instrumentation used at the various locations is details in Table 12-7.

Table 12-7 Instrumentation Details

Location	Equipment	Serial Number
NML-A	Rion NL-52	564808
NML-B	Rion NL-52	164427
NML-C	Rion NL-52	186671
NML-D	Rion NL-52	186669
NML-E	Rion NL-52	998413
NML-F	Rion NL-52	564808

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-525i console and a data logger at NML-B and then NML-C and a Texas Instruments TR-525M console and a data logger at NML-F that were installed on-site for the duration of the surveys. This allows for the identification of periods of rainfall to allow for the removal of sample periods affected by rainfall from the noise monitoring data sets in line with best practice when calculating the prevailing background noise levels.

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

Table 12-8 Met Mast Details

Description	Coordinates (ITM)	
	Easting	Northing
Met Mast	640347	654213

12.3.6.4 Procedure

Measurements were conducted at the six locations over the survey periods outlined in Table 12-6. 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

12.3.6.5.1 *Atypical 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 form the data sets. The assessment methods outlined above are in line with the guidance contained in the IOA GPG.

12.3.6.5.2 Assessment Periods

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.

12.3.6.5.3 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 80 m and 65 m heights have been corrected to a height of 103.5 m (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 10 m 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 subsequent reference to wind speed in this chapter should be understood to be the standardised 10 m 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 potential turbine noise level associated with the operational phase of the Proposed Wind Farm on the receiving environment. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

12.3.7.1 Noise Modelling Software

The selected software, DGMR iNoise Enterprise (Version 2023.02) 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 Noise Prediction Model - Input Data and Assumptions

The calculation settings, input data and any assumptions made in the assessment are described in the following sections.

12.3.7.2.1 *Proposed Turbine Details*

Table 12-9 details the co-ordinates of the 7 No. proposed turbines that are being considered in this assessment.

Table 12-9 Proposed Wind Farm Turbine Co-ordinates

Turbine	ITM Easting	ITM Northing
T01	640090	655005
T02	640421	654817
T03	639527	654696
T04	640641	654405
T05	640064	654240

Turbine	ITM Easting	ITM Northing
T06	639538	654087
T07	639059	653638

The turbine noise assessment has been undertaken for a turbine hub height of 103.5 m, a rotor diameter of 163 m and a tip height of 185 m over the top of foundation level. The following section presents details of the sound power level data for the turbine unit that has been used for the operational turbine noise prediction modelling assessment.

The turbine unit is considered representative of the type of turbine that would be installed on the site taking into consideration the proposed dimensions and the nominal generation capacity.

The turbine noise levels have been predicted at NSLs for a range of operational wind speeds based on the source of noise at a hub height of 103.5 m and noise emission data for the Nordex N163 turbine.

While the noise profiles of the Nordex N163 wind turbine has been used for the purposes of this assessment, the exact make and model of the turbine installed on the site will be dictated by a competitive procurement process but will adhere to the specifications and parameters set out above.

The wind turbine eventually selected for installation on site will not give rise to noise levels of greater significance than that used for the purposes of this assessment, to ensure the findings of this assessment remain valid. Any references to the N163 turbines in this assessment must be considered in the context of the above statements and should not be interpreted as meaning it is the only make or model of wind turbine that could be installed on the site.

Table 12-10 details the turbine noise data used in the noise predictions models for the Proposed Wind Farm, the noise data is for turbines with Serrated Trailing Edge (STE) blades. In accordance with the IOA GPG, sound power levels referred to wind speeds at standardised 10 m height. The sound power frequency octave band noise levels used for the Nordex N163 are presented in Appendix 12-4.

Table 12-10 Sound Power Level for Nordex N163 with STE Blades at 103.5 m Hub Height

Wind Speed (m/s)	Sound Power Level dB L_{WA}
3	95.0
4	96.5
5	101.0
6	105.4
7	106.5
8	106.6
9	106.6

The turbine sound power levels outlined in Table 12-10 are presented in terms of the L_{Aeq} parameter. As per best practice guidance contained within the IOA GPG, an allowance for uncertainty in the measurement of turbine source levels of +2 dB is applied in modelling to all turbine sound power levels presented in the tables above.

As explained below in Section 12.3.2.4, the criteria are 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". A 2 dB reduction has therefore been applied in the noise model calculation. All predicted noise levels in this chapter are presented in terms of L_{A90} parameter, i.e., this reduction of 2 dB is applied in the noise prediction modelling.

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 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.

12.3.7.2.2 *Modelling Calculation Parameters*

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, 1996. Comprehensive details of noise prediction calculation settings are included Appendix 12-5.

12.3.7.3 Assessment of Turbine Noise Levels

The predicted cumulative turbine noise levels will be compared against the derived turbine noise criteria set out in Section 12.4.2. and any exceedances of the limits will be identified and assessed. Where necessary, appropriate mitigation measures will be discussed.

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

Figure 12-4 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°).

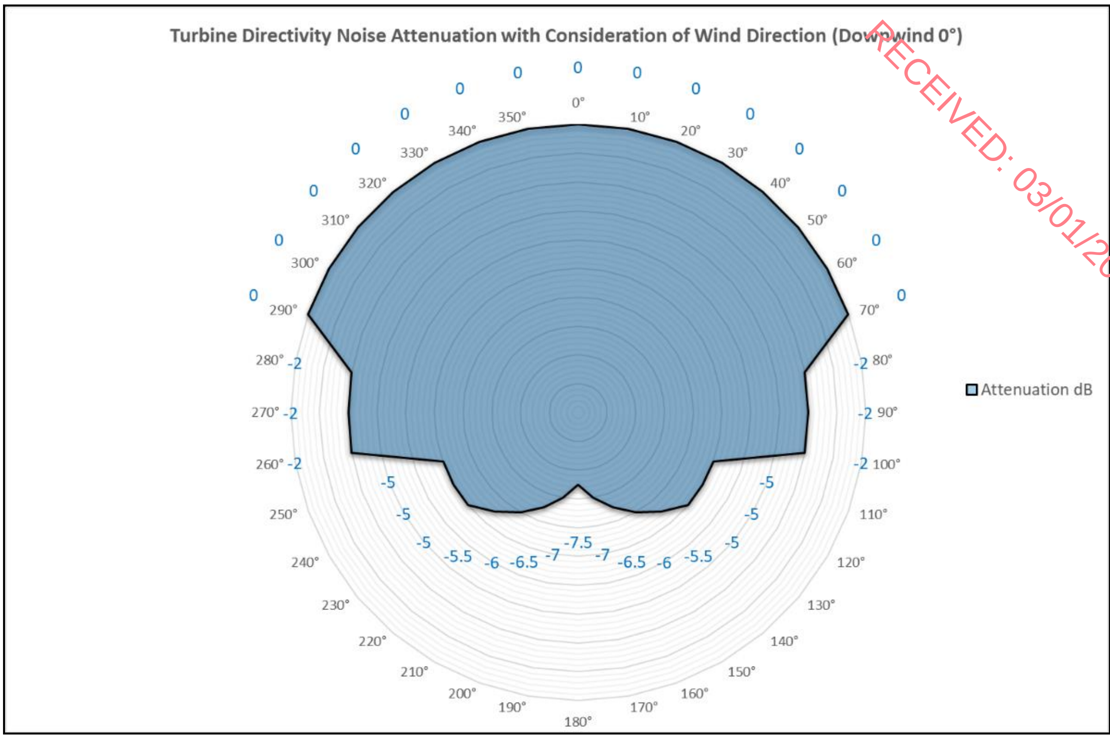

Figure 12-4 Turbine Directivity Attenuation with Consideration of Wind Direction

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 12.3.1.1.

12.3.9 Description of Effects

The significance of effects of the Proposed Project shall be described in accordance with the EPA guidance document EPA, 2022.

The effects associated with the Proposed Project are described in the relevant sections of this chapter in accordance with the EPA guidance set out in Chapter 1 of the EIAR.

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 six locations in the surrounding area as presented in section 12.3.6 above.

12.4.1 Background Noise Levels

Appendix 12-6 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*. A conservative 'envelope', based on the lowest derived background levels at the various wind speeds for both day and night-time is also presented in Table 12-11.

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 Standardised 10m Height Wind Speed (m/s)						
		3	4	5	6	7	8	9
NML-A	Day	25.1	26.2	27.5	28.7	30.5	33.5	37.0
	Night	21.0	22.7	24.4	24.8	26.8	30.9	35.7
NML-B	Day	25.5	26.3	27.5	29.2	31.4	34.1	37.5
	Night	21.3	22.1	23.2	24.7	26.9	30.0	34.3
NML-C	Day	26.8	28.2	30.7	33.8	37.5	41.6	45.7
	Night	23.3	25.0	27.6	30.9	34.7	38.8	43.1
NML-D	Day	31.9	32.6	33.4	34.3	35.3	36.6	38.2
	Night	29.8	30.6	31.5	32.5	33.6	34.7	35.9
NML-E	Day	27.9	28.5	30.0	31.2	33.2	36.2	39.5
	Night	25.4	25.5	26.9	27.2	29.3	33.5	37.4
NML-F	Day	27.3	29.1	31.2	33.1	35.4	38.1	40.7
	Night	27.6	27.8	29.1	30.6	33.1	36.3	39.7
Envelope	Day	25.1	26.2	27.5	28.7	30.5	33.5	37.0
	Night	21.0	22.1	23.2	24.7	26.8	30.0	34.3

The background noise data is utilised to establish suitable noise criteria curves for each of the NSLs where measurements were undertaken. For all other locations, in the absence of specific background noise measured a background noise envelope based on the lowest levels derived from the various survey locations has been employed for the purpose of this assessment. This is a conservative approach to the assessment and is applied separately for daytime and night-time periods. The actual wind turbine noise limits for a given NSL shall be defined relative to the background noise levels at each NSL as discussed in detail in Section 12.4.2 in accordance with the Guidelines.

12.4.2 Wind Turbine Noise Criteria

With respect to the relevant guidance documents outlined in Section 12.3.1.2.1 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 NSLs and are described in Section 12.4.2.

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 LA90 for wind turbine noise assessments is 2 dB, i.e., 45 dB LAeq equates to 43 LA90. This approach implies a 3 dB difference when accounting for difference parameters between the NG4 limits, expressed in the LAeq parameter, and the Guidelines limits, expressed in the LA90 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 Guidelines state 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 NSLs 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 $L_{A90,10min}$;
- 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 6 no. NSLs 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 NSLs where noise monitoring has been undertaken. 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 IOAGPG. However, in this assessment the approach used is to assign the envelope criteria to all locations where background noise data has not been measured as a conservative approach to this aspect of the assessment.

The ETSU-R-97 guidance (refer to Section12.3.1.2.1) 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 L_{A90} and/or a higher level above the prevailing background noise level. In line with the ETSU-R-97 guidance a lower threshold of 45 dB $L_{A90,10min}$ has been applied to the NSLs involved with wind energy development.

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 $L_{A90,10min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)						
		3	4	5	6	7	8	9
NML-A	Day	40	40	40	40	45	45	45
	Night	43	43	43	43	43	43	43
NML-B	Day	40	40	40	40	45	45	45
	Night	43	43	43	43	43	43	43
NML-C	Day	40	40	45	45	45	46.6	50.7
	Night	43	43	43	43	43	43.8	48.1
NML-D	Day	45	45	45	45	45	45	45
	Night	43	43	43	43	43	43	43
NML-E	Day	40	40	45	45	45	45	45
	Night	43	43	43	43	43	43	43
NML-F	Day	40	40	45	45	45	45	45.7
	Night	43	43	43	43	43	43	44.7
Envelope	Day	40	40	40	40	45	45	45
	Night	43	43	43	43	43	43	43

12.5 Likely Significant Effects

12.5.1 Do-Nothing Effect

If the Proposed Project is not progressed, the existing noise environment will remain unchanged. Traffic noise is currently a noise source in the vicinity of some road networks in the area.

In the absence of the Proposed Project any increases in traffic volumes on the local road network over time would not be expected to result in a significant change to the overall ambient and background noise levels in the receiving environment.

If the Proposed Project were not to proceed, the opportunity to capture part of Kilkenny's valuable renewable energy resource would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

12.5.2 Construction Phase Potential Impacts

The noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. The highest predicted noise 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 the properties in the vicinity of the Proposed Project.

A variety of items of plant will be in use for the various elements of the construction activities. 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 NSLs. This is discussed in the following Sections.

Construction noise prediction calculations have been conducted using the assessment methodology outlined in Section 12.3.8. Noise levels are predicted at the nearest NSL to each element of the works and compared against the criteria in Section 12.3.1.1.

In general, the distances between the construction activities associated with the Proposed Project and the nearest NSLs are such that there will be no significant noise and vibration impacts at NSLs. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration impacts, all other stages and elements are considered unlikely to have any significant noise and vibration impacts.

Construction activities will be carried out during normal daytime working hours (i.e., 0700 – 1900 Monday to Saturday). However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (e.g., concrete pours, erection of turbines) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be notified in advance to the Local Authority.

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

12.5.2.1 Proposed Wind Farm

12.5.2.1.1 *Turbines and Hardstands and Met Mast*

Noise

Works for the turbines are at a significant distance from the closest NSL, with the nearest NSL being H001 at a distance of greater than 500m from T04. The nearest non-involved NSL is H075, at a distance of greater than 740m from T03.

Several noise 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. This represents a conservative approach to the assessment; construction noise levels will be lower at properties located further from the works.

Table 12-13 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 12-13 Typical Construction Noise Levels – Turbines and Hardstanding, 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) 504 m	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m) 742 m
HGV Movement (C.2.30)	Removing soil and transporting fill and other materials	79	38	34
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation	77	36	32
Excavator Mounted Rock Breaker (C9.12)	Excavation in rocky areas	85	44	40
Piling Operations (C. 12.14)	Drilling cores for the installation of concrete piles	88	47	43
General Construction (Various)	All general activities plus deliveries of materials and plant	84	43	39
Concrete Mixer Truck and Concrete Pump (C.4.27)	Turbine Foundations	75	34	30
Dumper Truck (C.4.4)	Backfilling Turbine Foundations	76	35	31

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

Mobile Telescopic Crane (C.4.39)	Turbine Erection	77	36	32
Dewatering Pumps (D.7.70)	If required	80	39	35
Vibrating Rollers (D.8.29)	Road surfacing	77	36	32
Hand-held circular saw (C.4.72)	Cutting concrete/ steel	79	38	34
Poker vibrator (C.4.33)	Concrete pouring	78	37	33
Cumulative Predicted Construction Noise Level			**51**	**47**

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 turbines and hardstands, and met mast, therefore no specific mitigation measures are required.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSL's associated with construction of turbines and hardstanding, and met mast areas are described as negative, not significant, and short-term.

12.5.2.1.2 *Proposed Access Roads and Existing Road Upgrades*

Noise

It is proposed to construct new internal access roads and upgrade existing roads as part of the Proposed Wind Farm site, as well as to upgrade part of an existing road leading from the temporary road to the site. Underground cabling is also proposed along certain sections of proposed internal roads. A review of the road layout has identified that the closest NSLs are H015, H050, H083, H039 and H040 which are at distances of 27 m, 27 m, 33 m , 46 m and 95 m, from the proposed road works, respectively. The full description of the proposed works for new and existing access road is provided in Chapter 4 of the EIAR. Table 12-14 presents outline noise calculations, considering the plant anticipated for methods of construction, at varying distances from the construction works. Calculations have assumed a conservative on time of 66% for each item of plant.

Table 12-14 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 $L_{Aeq,12hr}$)			
		27 m	50 m	75 m	90 m
HGV Movement (C.2.30)	79	66	59	55	67
Tracked Excavator (C.4.64)	77	64	57	53	65
Dumper Truck (C.4.4)	76	63	56	52	64

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

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 $L_{Aeq,12hr}$)			
		27 m	50 m	75 m	90 m
Vibrating Rollers (D.8.29)	77	64	57	53	65
Total Construction Noise (cumulative for all activities)		**70**	**60**	**59**	**58**

The predicted noise levels at the closest NSLs, at distances of 27m or greater from works will not have the potential to exceed the construction noise criterion of 70 dB $L_{Aeq,1hr}$ set out in Section 12.3.1.1.1. On this basis noise control mitigation measures will not be required.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSLs associated with construction of turbines and hardstanding areas are described as negative, not significant, and short-term.

12.5.2.1.3 *Temporary Construction Compounds*

Noise

There are two construction compounds associated with the proposed wind farm, as follows:

- At 200 m north of T01 and
- At 420m South of T07.

The closest house to either compound is H005 at 510 m distance. Assuming the same set of construction plant as for access roads outlined in Table 12-14, the predicted noise levels are 42 dB $L_{Aeq,T}$ at H005. This level of noise is within the construction noise criterion of 65 dB L_{Aeq}, 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.

The temporary construction compound associated with the grid connection is discussed in Section 12.5.2.2.1.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSLs associated with Construction Compound areas are described as negative, not significant, and short-term.

12.5.2.1.4 *Borrow Pit*

It is intended to obtain materials for the construction of the Proposed Wind Farm from the proposed on-site borrow pit. To assess the potential noise impacts from borrow pit operation a comparative noise assessment has been prepared and is outlined in the following paragraphs. The two scenarios that have been considered are 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 a rock breaker will be in use on site.
- For the purposes of this assessment, we have assumed the plant is working simultaneously.
- Table 12-15 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 10to 15 blasts will be required over an 12 to 16-week period. It is expected that no more than 1 blast would occur in a single working day.

Noise

Sound power levels for the dominant noise generating plant items in the borrow pit plant is presented in Table 12-15

Table 12-15 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 noise prediction model has been prepared using proprietary software package iNoise to calculate the expected noise emissions from the two scenarios outlined above for operation of the borrow pit. A percentage on-time of 66% has been assumed for the noise calculations. The predicted levels are detailed in Table 12-16 at the 10 no. NSLs with the highest predicted noise levels due to the borrow pit activity.

Table 12-16 Noise Levels at NSLs due to borrow pit activity.

NSL Ref	Predicted Noise Level (dB $L_{Aeq,12hr}$)	
	Scenario A	Scenario B
H005	51	51
H030	49	50
H062	48	49
H080	47	48
H083	47	48
H089	46	47
H106	45	45
H009	44	45
H117	44	45
H116	43	43

Review of the data contained in Table 12-16 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 construction of the borrow pit, 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.

Description of Effects

The predicted impacts are likely to be below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest noise sensitive locations associated with construction of the borrow pit are described as negative, not significant, and short-term.

12.5.2.1.5 *Other Proposed Construction Works*

Noise

Other elements of the proposed construction works include spoil management areas, biodiversity management and enhancement measures (refer to Appendix 6-4) and areas of tree felling. These works will be temporary in duration and similar to general agricultural works which take place regularly in the local area. Taking this into account, and considering the distances from these elements of the construction works to NSLs, no significant noise effects are expected.

Description of Effects

With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSLs associated with spoil management areas, biodiversity management and enhancement programme and areas of tree felling are described as negative, not significant, and short-term.

12.5.2.2 Proposed Grid Connection

12.5.2.2.1 *38kV Electrical Substation and Temporary Construction Compound*

Noise

An on-site 38kV electrical substation is proposed, as described in Chapter 4. A temporary construction compound is also proposed adjacent to the substation. The nearest NSL to the these areas is H048 at 236m. As a conservative assessment 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 58 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 on-site 38kV electrical substation and temporary construction compound, and no specific mitigation measures are required.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSLs associated with Construction Compound areas are described as negative, not significant, and Temporary.

12.5.2.2.2 *38kV Underground Electrical Cabling Route*

A connection between the proposed onsite 38kV electrical substation and the national electricity grid will be necessary to export the electricity generated by the Proposed Wind Farm. The proposed underground electrical cabling route is approximately 23 km long; details of the route are presented in Chapter 4.

Noise

Table 12-17 presents outline noise calculations, considering the anticipated plant required and methods of construction. Calculations have been prepared taking account of the distances to the nearest NSLs and assume that plant items are operating at nominal on-times noted.

Table 12-17 Indicative noise calculations for construction – Underground 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			
		15m	25m	50m	100m
Tracked Excavator (C.2.7)	70	63	57	50	43
Vibratory Plate (C.2.41)	80	73	67	60	53
Dumper Truck (C.4.4)	76	69	63	56	49
Total Construction Noise		75	69	62	55

It is important to note that the works for the construction of the underground electrical cabling will vary and will not be continuous in nature. The associated construction works will occur for short durations (rolling construction method, approx. 100 – 200 m per day over an estimated 115 – 230 working days) at varying distances from NSLs. Works will therefore be in proximity to the closest NSLs for limited amount of time, i.e. less than one day.

The predicted noise levels at the closest NSLs, at distances of within 25m from works have the potential to exceed the construction noise criterion of 70 dB $L_{Aeq,1hr}$ set out in Section 12.3.1.1.1, if the works generate high noise level in proximity to the NSLs. However, on this basis that the duration of the noise effect is brief, mitigation measures are not required. These are detailed in Section 12.6.1.

Description of Effects

With respect to the EPA's guidance for description of effects as referenced in Section 12.3.1.1.1, the potential noise construction effect at the nearest NSL associated with the Proposed Grid Connection underground cabling route are considered to be Negative, Not Significant, and Brief.

12.5.2.3 Construction Vibration

During rock breaking, there is potential for vibration to be generated through the ground. Empirical data for this activity is not provided in the BS 5228-2:2009+A1:2014 standard, however the likely level of vibration from this activity is expected to be significantly below the vibration criteria for building damage in Table 12-3. AWN Consulting Ltd have previously conducted vibration measurements under controlled conditions, during trial construction works, where breaking was carried out. The trial construction works consisted of the use of the following plant and equipment when measured at various distances:

- 3 tonne hydraulic breaker on small CAT tracked excavator; and
- 6 tonne hydraulic breaker on large Liebherr tracked excavator.

Vibration measurements were conducted during various staged activities and at various distances. Peak vibration levels during staged activities using the 3 Tonne Breaker ranged from 0.48 PPV (mm/s) to 0.25 PPV (mm/s) at distances of 10m to 50m respectively from the breaking activities. Using a 6 Tonne

Breaker, measured vibration levels ranged between 1.4 PPV (mm/s) to 0.24 PPV (mm/s) at distances of 10m to 50m respectively. These values are significantly below the 8 to 20 mm/s referred to in

Table 12-3. Considering the additional distance from areas where rock breaking will be required to any NSLs, the likely vibration values are well below the criteria in Table 12-3

Description of Effects

With respect to the EPA's guidance for description of effects and the criteria in Section 12.3.1.1.3, the potential construction vibration effects are expected to be negative, not significant, and short-term.

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 – General construction and Grid Connection construction;
- Stage 1b – Turbine Delivery and Grid Connection construction;
- 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 routes.

Table 12-18 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 conversions applied for the passenger car unit (PCU) factors.

Table 12-18 Construction Traffic Data for Assessment

Route	Stage	Light Vehicles	HGV
1 – N10 – between M9 and Kilkenny	Existing	8965	287
	Existing + 1a	9,008	320
	Existing + 1b	8,996	309
	Existing + 2a	9,035	447
	Existing + 2b	9,010	293
2 – N76 – east of Callan	Existing	8363	848
	Existing + 1a	8,406	881
	Existing + 1b	8,394	870

	Existing + 2a	8,433	1008
	Existing + 2b	8,408	854
3 – R695 – north of Callan	Existing	3014	216
	Existing + 1a	3,057	250
	Existing + 1b	3,045	239
	Existing + 2a	3,084	376
	Existing + 2b	3,059	222
4 – R695 – south of Kilmanagh	Existing	820	36
	Existing + 1a	863	69
	Existing + 1b	851	58
	Existing + 2a	890	196
	Existing + 2b	865	42
5 – L1009 – west of Kilmanagh	Existing	1175	60
	Existing + 1a	1,218	94
	Existing + 1b	1,206	83
	Existing + 2a	1,245	220
	Existing + 2b	1,220	66
6 – R695 – east of Kilmanagh	Existing	1004	45
	Existing + 1a	1,047	78
	Existing + 1b	1,035	68
	Existing + 2a	1,074	205
	Existing + 2b	1,049	51

Based on the traffic data presented in Table 12-16 the changes in noise level relative to the expected traffic noise from the baseline traffic flows have been calculated and are outlined in

Table 12-19.

Table 12-19 Calculated Changes in Traffic Noise Levels

Stage	Route	Change in Traffic Noise Level dB(A)	Significance of effect	Estimated Number of Days
1a – General construction and Grid Connection Construction	1 – N10 – between M9 and Kilkenny	+0.3	Negligible	222
	2 – N76 – east of Callan	+0.1	Negligible	
	3 – R695 – north of Callan	+0.5	Negligible	
	4 – R695 – south of Kilmanagh	+2.3	Minor	
	5 – L1009 – west of Kilmanagh	+1.6	Minor	
	6 – R695 – east of Kilmanagh	+1.9	Minor	
1b – Turbine Delivery and Grid Connection Construction	1 – N10 – between M9 and Kilkenny	+0.2	Negligible	7
	2 – N76 – east of Callan	+0.1	Negligible	
	3 – R695 – north of Callan	+0.4	Negligible	
	4 – R695 – south of Kilmanagh	+1.7	Minor	
	5 – L1009 – west of Kilmanagh	+1.1	Minor	
	6 – R695 – east of Kilmanagh	+1.4	Minor	
2a – Concrete foundation delivery	1 – N10 – between M9 and Kilkenny	+1.4	Minor	7
	2 – N76 – east of Callan	+0.7	Negligible	
	3 – R695 – north of Callan	+2.1	Minor	
	4 – R695 – south of Kilmanagh	+6.3	Major	

	5 – L1009 – west of Kilmanagh	+4.8	Moderate	
	6 – R695 – east of Kilmanagh	+5.6	Major	
2b – Delivery of large components	1 – N10 – between M9 and Kilkenny	+0.1	Negligible	7
	2 – N76 – east of Callan	+0.0	Negligible	
	3 – R695 – north of Callan	+0.1	Negligible	
	4 – R695 – south of Kilmanagh	+0.6	Negligible	
	5 – L1009 – west of Kilmanagh	+0.4	Negligible	
	6 – R695 – east of Kilmanagh	+0.5	Negligible	

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 0 the potential impacts are classified as 'negligible' to 'minor'.

During Stage 2a, along route links 4, 5 and 6, the change in noise levels correspond to potential 'moderate' to 'major' impacts; however, the predicted traffic noise level, at 5m from the road edge is 62 dB $L_{Aeq, 12hr}$ for each link. This is within the criteria in Section 12.3.2.1 of 65 dB $L_{Aeq, 12hr}$; taking into account that this stage lasts just 7 days, the effect is considered 'not significant'.

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

Description of Effects

With respect to the EPA criteria for description of effects, the potential effects at the NSL associated with the additional traffic generated during the construction phase are described as Negative, Moderate, 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

The list of cumulative projects from Appendix 2-3 of the EIAR have been reviewed. It is not anticipated that there will be any other construction activities that would give rise to significant cumulative impacts during the construction phase. The contractor for the Proposed Project will coordinate construction schedules with other contractors to ensure that significant cumulative noise impacts do not occur.

12.5.3 Operational Phase Potential Impacts

This section presents an assessment of the elements of the Proposed Project that are likely to generate operational noise with the potential for adverse effects on NSLs.

12.5.3.1 Turbine Noise Assessment

Using the assessment methodology described in Section 12.3.6.1, the predicted turbine noise levels have been calculated at all NSLs within the study area of the Proposed Project. A conservative omni-directional turbine noise prediction assessment has been carried out using the ISO 9613-2 calculation standard and best practice guidance for turbine noise prediction contained in the IOA GPG. These calculations are based on conditions favourable to noise propagation, i.e., downwind propagation from source to receiver and/or downward refraction under temperature inversions.

The results of the noise prediction models have been compared against the turbine noise limits that have been assigned to each of the NSLs as presented in Section 12.4.2 which in turn have been derived in accordance with the criteria set out in Section 12.3.1.2.1. Results for the full set of NSLs are presented in Appendix 12-7, and noise contours are presented in Appendix 12-8.

Table 12-20 presents the locations where potential exceedances of the derived noise criteria have been predicted in the model.

Table 12-20 Review of Predicted Turbine Noise Levels against Relevant Criteria

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m height						
		3	4	5	6	7	8	9
H008	Predicted Turbine Noise Level	30.0	31.5	36.0	40.4	41.5	41.6	41.6
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.4	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H012	Predicted Turbine Noise Level	30.3	31.8	36.2	40.6	41.8	41.8	41.8
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.6	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H048	Predicted Turbine Noise Level	30.2	31.6	35.8	40.2	41.4	41.5	41.5
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.2	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	–	–	–
H260	Predicted Turbine Noise Level	35.8	35.9	36.2	40.6	43.1	43.7	43.7
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	–	–	–	0.6	–	–	–
	Night Limits	43	43	43	43	43	43	43
	Potential Night-time Exceedance	–	–	–	–	0.1	0.7	0.7

Location H260

In the first instance, it is noted that the H260 is significantly closer to Foyle wind farm than to the Proposed Wind Farm. The contribution from Proposed Wind Farm is more than 10 dB below that of Foyle Wind Farm, which indicates that wind turbine noise at H260 is governed by Foyle Wind Farm rather than the Proposed Project. Therefore, it is not necessary to apply mitigation measures in respect noise at this location.

Moreover; the potential exceedances in Table 12-20 are based on criteria established through background noise surveys near the Proposed Wind Farm and conservative noise prediction calculations for the assessment of the Proposed Project only. The potential exceedances indicated in Table 12-20 should not be interpreted as an indication of noise issues associated with the operation of the Foyle Wind Farm.

H008, H012, and H048

At these locations, potential exceedances of 0.2 dB to 0.6 dB at wind speeds of 6 m/s, during daytime periods only, based on the conservative envelope criteria in Table 12-12, and based on omni-directional propagation.

This section of the assessment considers the effect of the directional pattern of noise from turbines on the predicted noise levels at H008, H012 and H048.

As presented in Section 12.3.7.3, the effect of the directionality of noise emissions from wind turbines means that in certain wind directions, noise levels are less than the values presented Table 12-18, 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 H008, H012 and H048 where potential exceedances of the daytime noise criteria were noted at 6 m/s windspeed. The results are presented in Table 12-21.

Table 12-21 Predicted Directional Noise Levels at H008, H012 and H048.

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
H008	North	26.8	28.3	32.8	37.2	38.3	38.4	38.4
	Northeast	23.8	25.3	29.8	34.2	35.3	35.4	35.4
	East	23.7	25.2	29.7	34.1	35.2	35.3	35.3
	Southeast	26.4	27.9	32.4	36.8	37.9	38.0	38.0
	South	29.1	30.6	35.1	39.5	40.6	40.7	40.7
	Southwest	30.0	31.5	36.0	**40.4**	41.5	41.6	41.6
	West	30.0	31.5	36.0	**40.4**	41.5	41.6	41.6
	Northwest	29.2	30.7	35.2	39.6	40.7	40.8	40.8
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	0.4	None	None	None
H012	North	26.6	28.1	32.5	36.9	38.1	38.1	38.1
	Northeast	24.0	25.5	29.9	34.3	35.5	35.5	35.5
	East	24.2	25.7	30.1	34.5	35.7	35.7	35.7

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
	Southeast	26.9	28.4	32.8	37.2	38.4	38.4	38.4
	South	29.6	31.1	35.5	39.9	41.1	41.1	41.1
	Southwest	30.3	31.8	36.2	**40.6**	41.8	41.8	41.8
	West	30.3	31.8	36.2	**40.6**	41.8	41.8	41.8
	Northwest	29.6	31.1	35.5	39.9	41.1	41.1	41.1
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	0.6	None	None	None
H048	North	27.1	28.5	32.7	37.1	38.3	38.4	38.4
	Northeast	29.2	30.6	34.8	39.2	40.4	40.5	40.5
	East	29.9	31.3	35.5	39.9	41.1	41.2	41.2
	Southeast	30.1	31.5	35.7	**40.1**	41.3	41.4	41.4
	South	29.1	30.5	34.7	39.1	40.3	40.4	40.4
	Southwest	27.2	28.6	32.8	37.2	38.4	38.5	38.5
	West	24.7	26.1	30.3	34.7	35.9	36	36
	Northwest	25.0	26.4	30.6	35.0	36.2	36.3	36.3
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	0.1	None	None	None

Thus, once directionality is considered, the H008 and H012 have exceedances in the range 0.4 to 0.6 dB in southwest and west wind directions only and H048 has an exceedance of 0.1 dB in southeast wind direction only.

As discussed in Section 12.3.6.1, it is noted again that the noise prediction calculations have been made using the ISO 9613-2 standard and relate to conditions favourable to noise propagation (typically downwind propagation from source to receiver and/or downward refraction under temperature inversions). A +2 dB uncertainty has been applied to turbine emissions in line with the IOA GPG.

Mitigation in the form of turbine curtailment is addressed in Section 12.6.2.1.

Remaining NSLs

At all of the remaining (the majority) NSLs, the omni-directional turbine noise levels are below the noise criterion curves, therefore no mitigation is required in respect of noise.

12.5.3.1.2 *Description of Effects*

With the exception of locations H008, H012 and H048, it is considered that no significant effect is associated with the operation of the Proposed Wind Farm, since the predicted noise levels associated with the Proposed Wind Farm will be within the relevant best practice noise criteria curves for wind farms according to current guidelines

A new source of noise will be introduced to the receiving environment. While ambient noise levels will increase by varying degrees, depending on receptor location, and turbine operating conditions typically dictated by the wind speed, the predicted noise levels are within criteria.

With respect to the EPA criteria for description of effects, the potential effects at the nearest NSLs associated with the operation of the proposed wind turbines are described below.

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

At location H008, H012, and H048, potential exceedances of between 0.1 and 0.6 dB of the criterion are predicted at 6 m/s for the N163 turbine used for this assessment. While the magnitude of the predicted exceedances is considered imperceptible in the context of environmental noise and the perception of the average human ear, they are slightly above the applicable wind turbine noise criteria and can be defined as having a slight impact. With respect to the EPA criteria for description of effects, the predicted effects at these locations can be described as follows:

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

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

Mitigation measures in respect of wind turbine noise are discussed in Section 12.6.2.1.

12.5.3.2 Substation

Details of the proposed 38kV substation are described in Chapter 4 of the EIAR. The substation will typically 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.

As part of the Proposed Project, 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 92 dB(A) L_w.

Noise prediction calculations for the operation of the 38kV substation have been undertaken in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation* (1996). The predicted noise level from the operation of the substation at the nearest NSL (H060) at approximately 230 m from the noise source at the substation (transformer of substation layout) is 24 dB $L_{Aeq,T}$. This level of noise is considered low, and it is concluded that there will be no significant noise emissions from the operation of the substation at any NSL. At the detailed design stage plant will be selected to ensure that there are no tonal or impulsive characteristics from the plant audible at any NSL during night time periods.

The predicted noise level is below the criterion for fixed mechanical plant outlined in Section 12.3.1.2.2 and unlikely to result in any adverse impacts at nearby NSLs.

12.5.3.2.1 Description of Effects

With respect to the EPA's criteria for description of effects, the potential effects at the nearest NSLs associated with the operation of the proposed substation is described below.

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

12.5.4 Decommissioning Phase

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase of the Proposed Wind Farm would arise, as similar tools and equipment will be used. It is not intended to decommission the Proposed Grid Connection. Considering that in all aspects of the construction phase, the predicted noise levels are expected to be below the appropriate criteria at all NSLs, it can be concluded that for the decommissioning phase, the impact is not significant.

Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest NSLs associated with construction of turbines and hardstanding areas are described as negative, not significant, and short-term.

12.6 Mitigation Measures

12.6.1 Construction Phase

Due to the potential for significant construction noise impact effects at receptors within 25m of the existing road upgrades and Proposed Grid Connection underground cabling route, specific mitigation measures are provided in Section 12.6.1.2 and 12.6.1.3.

For all other elements of the construction phase the assessment of potential impacts has demonstrated that the Proposed Project is expected to comply with the criteria and therefore no specific mitigation measures are required. Notwithstanding this, the following best practice mitigation measures from BS5528-1 standard will be implemented for the duration of the construction phase:

- limiting the hours 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 noise generating / vibratory plant as far away from sensitive properties as possible within the site constraints, and;
- regular maintenance and servicing of plant items.

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

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate close to NSLs outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Section 12.3.2.1.1 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 considered, where necessary, to mitigate noise emissions from these activities:

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency.
- Ensure all leaks in air lines are sealed.
- 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.

If blasting is undertaken as part of the Proposed Project, a detailed assessment will be undertaken by a specialist blast design engineer to determine the blast design parameters; all mitigation measures specified by the blast design engineer to keep vibration values within the criteria in Section 12.3.1.1.3 will be implemented.

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. Should complaints arise, they are likely to be received from an area downwind of the blast site, and therefore, blasting will be postponed during unfavourable weather conditions. Furthermore, 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 the potential for 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.

Summary

To ameliorate any potential noise impacts that may be present during the construction phase, a schedule of noise control measures has been formulated in accordance with best practice guidance. These are outlined in the Construction and Environmental Management Plan (CEMP) that has been prepared for the Proposed Project.

12.6.1.2 Proposed Access Roads and Existing Road Upgrades

As discussed in section 12.5.2.1.2, some sections of the existing road upgrades are within 25 m of NSLs and mitigation measures are required in respect of noise. The contractor will utilise screening in order to reduce noise impacts on nearby sensitive receptors when the works take place proximate to them along the proposed route. It is noted that the closest NSL to these works (H015) is involved in the Proposed Project.

Proprietary screens are available from suppliers that can be mounted to mobile fencing, with suitable care and attention this method can provide up to 10 dB of attenuation.

With this mitigation measure in place, noise levels at 10 m distance from construction activity are predicted to be within the criterion for linear construction works in Section 12.3.1.1.1. The resulting noise effect is negative, not significant and brief to temporary.

Additional or alternative mitigation measures included:

- Monitoring typical levels of noise and vibration during critical periods and at noise 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 noise sensitive properties as permitted by site constraints.

12.6.1.3 Proposed Grid Connection Underground Cabling Route

As shown in section 12.5.2.2.2, for linear works, the brief nature of the noise effects at any individual NSL implies that the noise effects are not significant, therefore mitigation measures are not required.

12.6.2 Operational Phase

12.6.2.1 Wind Turbines

12.6.2.1.1 *Turbine Curtailment*

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 of this Chapter. The findings of the assessment, presented in Section 12.5.3 confirm predicted operational noise levels will be within the relevant best practice noise criteria curves at all locations with the exceptions of H008, H012 and H048 where potential exceedances of 0.1 to 0.6 dB(A) are noted at wind speeds of 6 m/s during daytime periods only.

Modern wind turbines can be programmed to run in reduced modes of operation (or low noise modes) in order to achieve noise criteria during certain periods (i.e. day or night) and in specific wind conditions (i.e. wind speed and direction).

If the Proposed Project is granted planning permission, once constructed, a compliance noise survey will be carried out to quantify the wind turbine noise levels due to the Proposed Project and assess their compliance with noise criteria.

Should predicted exceedances be confirmed at the commissioning stage of the Proposed Wind Farm, it is proposed to mitigate this through curtailment of turbine(s) in the relevant wind speed and directions. The curtailment strategy will be developed for the specific relevant turbine installed on the Site and the associated noise emissions at the various operational wind speeds. If necessary, a detailed curtailment strategy matrix will be developed at the detailed design stage in order to achieve the relevant noise criteria at all NSLs.

For the Nordex N163 turbine adopted for this assessment, the potential exceedance, if realised, can be mitigated through curtailment of the specific turbine(s) for the relevant wind speeds directions and periods. The N163 turbines have been modelled with all turbines operating in normal mode ('Mode 0') with STE blades. The N163 turbines can be configured for up to 18 no. operating modes. Full details of the wind turbine noise prediction assessment are presented in Section 12.3.7 and Appendix 12-3

As an example of this turbine control capability, the following table shows the sound power levels for the Nordex N163 turbine at the hub height of 103.5m for Normal Operation and should be read as augmenting Table 12-10, along with the sound power levels for the various operational modes that can be applied to this turbine. As can be seen at mid to higher wind speeds a reduction in the noise level of the order of 5dB can be achieved dependent on the operational mode set on the specific turbines.

Table 12-22 Sound Power Levels at Reduced Modes

Wind Speed m/s	Sound Power Levels, dB LWA						
	Mode 0 (Normal Operation)	Mode 1	Mode 3	Mode 4	Mode 5	Mode 7	Mode 9
3	95.0	95.0	95.0	95.0	95.0	95.0	95.0
4	96.5	96.5	96.5	96.5	96.6	96.6	96.6
5	101.0	101.0	101.0	101.0	101.0	101.0	100.5

Wind Speed m/s	Sound Power Levels, dB LWA						
	Mode 0 (Normal Operation)	Mode 1	Mode 3	Mode 4	Mode 5	Mode 7	Mode 9
6	105.4	105.4	104.9	104.7	104.2	103.3	101.0
7	106.5	106.3	105.5	105.0	104.5	103.5	101.0
8	106.6	106.4	105.5	105.0	104.5	103.5	101.0
9	106.6	106.4	105.5	105.0	104.5	103.5	101.0

In order to address the exceedances in at H012, the curtailment strategy in Table 12-23 has been developed and would apply during daytime periods at windspeeds of 6 m/s in southwest and west wind conditions. Any curtailment would have to be verified by the manufacturer based on the control and physical limitation of the turbine.

Table 12-23 Curtailment Scheme to address exceedance at H012

Turbine	Mode, at 6 m/s standardised wind speed at 10m	
	Southwest	West
T01	Mode 3	Mode 3
T02	Mode 4	Mode 5
T03	Mode 0 (Normal Operation)	Mode 0 (Normal Operation)
T04	Mode 4	Mode 4
T05	Mode 0 (Normal Operation)	Mode 0 (Normal Operation)
T06	Mode 0 (Normal Operation)	Mode 0 (Normal Operation)
T07	Mode 0 (Normal Operation)	Mode 0 (Normal Operation)

The measures in Table 12-23 were derived to address the exceedances at H012; H008 is adjacent to H012 thus the curtailment described above also addresses the exceedances at H008, as presented below in Table 12-25.

Similarly, for H048, the following curtailment strategy is proposed for southeast wind directions:

Table 12-24 Outline Curtailment Scheme to address exceedance at H048

Turbine	Mode, at 6 m/s standardised wind speed at 10m
T01	Mode 0 (Normal Operation)
T02	Mode 0 (Normal Operation)

T03	Mode 3
T04	Mode 0 (Normal Operation)
T05	Mode 0 (Normal Operation)
T06	Mode 0 (Normal Operation)
T07	Mode 0 (Normal Operation)

With the implementation of turbine curtailment as outlined in tables 12-23 & 12-24, the predicted noise levels are presented in Table 12-25; no exceedances of the criteria are noted at H012, H008 or H048.

Table 12-25 Review of Predicted Turbine Noise Levels against Relevant Criteria with mitigation measures

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
H008	North	26.8	28.3	32.8	37.2	38.3	38.4	38.4
	Northeast	23.8	25.3	29.8	34.2	35.3	35.4	35.4
	East	23.7	25.2	29.7	34.1	35.2	35.3	35.3
	Southeast	26.4	27.9	32.4	36.8	37.9	38.0	38.0
	South	29.1	30.6	35.1	39.5	40.6	40.7	40.7
	Southwest	30.0	31.5	36.0	39.7	41.5	41.6	41.6
	West	30.0	31.5	36.0	39.7	41.5	41.6	41.6
	Northwest	29.2	30.7	35.2	39.6	40.7	40.8	40.8
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None
H012	North	26.6	28.1	32.5	36.9	38.1	38.1	38.1
	Northeast	24.0	25.5	29.9	34.3	35.5	35.5	35.5
	East	24.2	25.7	30.1	34.5	35.7	35.7	35.7
	Southeast	26.9	28.4	32.8	37.2	38.4	38.4	38.4
	South	29.6	31.1	35.5	39.9	41.1	41.1	41.1
	Southwest	30.3	31.8	36.2	40.0	41.8	41.8	41.8
	West	30.3	31.8	36.2	40.0	41.8	41.8	41.8
	Northwest	29.6	31.1	35.5	39.9	41.1	41.1	41.1

House ID	Description	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.						
		3	4	5	6	7	8	9
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None
H048	North	27.1	28.5	32.7	37.1	38.3	38.4	38.4
	Northeast	29.2	30.6	34.8	39.2	40.4	40.5	40.5
	East	29.9	31.3	35.5	39.9	41.1	41.2	41.2
	Southeast	30.1	31.5	35.7	40.0	41.3	41.4	41.4
	South	29.1	30.5	34.7	39.1	40.3	40.4	40.4
	Southwest	27.2	28.6	32.8	37.2	38.4	38.5	38.5
	West	24.7	26.1	30.3	34.7	35.9	36	36
	Northwest	25.0	26.4	30.6	35.0	36.2	36.3	36.3
	Daytime Limits	40	40	40	40	45	45	45
	Potential Daytime Exceedance	None	None	None	None	None	None	None

As the predicted noise levels associated with the Proposed Wind Farm will be within the relevant best practice noise criteria curves for wind farms it is considered that no significant effect is associated with the operation of the Proposed Wind Farm.

12.6.2.1.2 *Amplitude Modulation*

In the event that a complaint which indicates potential Amplitude Modulation (AM) associated with turbine operation, the operator will employ a qualified 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 Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016) or subsequent revisions.

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

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

12.6.2.1.3 *Monitoring*

An operational noise survey will be undertaken to ensure compliance with any noise conditions applied to the development. It is common practice to commence surveys within six months of the Proposed

Wind Farm being fully commissioned. If an exceedance of the noise criteria is identified as part of the c assessment, the guidance outlined in the IOA GPG, specifically Supplementary Guidance Note 5: *Post Completion Measurements* (July 2014) will be followed, and relevant corrective actions taken. For example, implementation of noise reduced 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 condition limits. Such curtailment can be applied using the wind farm SCADA system without undue effect on the wind turbine performance. Following implementation of these measures, noise surveys will be repeated to confirm compliance with the noise criteria.

12.6.3 Decommissioning Phase

No specific mitigation measures are required for decommissioning. To ameliorate any potential noise impacts that may present during the decommissioning phase, a schedule of noise control measures has been formulated in accordance with best practice guidance. These are outlined in the Construction and Environmental Management Plan (CEMP) that has been prepared for the Proposed Project.

12.7 Description of Residual Effects

12.7.1 Construction Phase

During the construction phase of the Proposed Project there will be some short-term effect on nearby NSL due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby NSLs, and the fact that the various infrastructure elements of the construction phase are temporary to short term in nature, the combination of the various noise sources will not be excessively intrusive at any single NSL. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration effect is kept within the guidance limits.

Description of Effects

With respect to the EPA criteria for description of effects, the potential effects at the nearest NSLs associated with the various elements of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

12.7.1.2 Proposed Wind Farm

12.7.1.2.1 *Turbines and Hardstands*

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

12.7.1.2.2 *Proposed Access Roads and Existing Road Upgrades*

The predicted construction noise and vibration effects associated with proposed access roads and existing road upgrades are described as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

The likely predicted noise and vibration impacts are below the limits identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.7.1.2.3 *Temporary Construction Compounds*

The predicted construction noise and vibration effects associated the temporary construction compound is described as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.7.1.2.4 *Borrow Pit*

The predicted construction noise and vibration effects associated the borrow pit is described as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.7.1.2.5 *Other Proposed Construction Works*

The predicted construction noise and vibration effects associated spoil management areas, biodiversity management and enhancement programme and areas of tree felling is described as follows:

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.7.1.3 Proposed Grid Connection

12.7.1.3.1 *38kV Electrical Substation and Temporary Construction Compound*

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

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.7.1.3.2 *Proposed Grid Connection underground cabling route*

The predicted construction noise and vibration effects associated with the Proposed Grid Connection underground cabling route are described as follows:

Quality	Significance	Duration
Negative	Not Significant	Brief to Temporary

12.7.1.4 Construction Traffic

The predicted construction noise and vibration effects associated with construction traffic generated by the Proposed Project are summarised as follows:

Quality	Significance	Duration
Negative	Not significant	Short-term

12.7.2 Operational Phase

12.7.2.1 Noise

With respect to the EPA's criteria for description of effects, the potential associated effects at the nearest NSLs associated with the various elements of the operational phase are described below. All other elements of the Proposed Project are considered to have a neutral, imperceptible, and long-term effects.

12.7.2.1.1 *Wind Turbine Noise*

Compliance noise surveys at commissioning stage will ensure that the operational noise levels associated with the Proposed Wind Farm will be within best practice noise criteria curves recommended in the Guidelines, therefore, it is not considered that a significant effect is associated with the Proposed Wind Farm.

A new source of noise will be introduced to the receiving environment. While ambient noise levels will increase by varying degrees, depending on receptor location, and turbine operating conditions typically dictated by wind speed, the predicted noise levels are within criteria.

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

Quality	Significance	Duration

Negative	Not significant	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.

12.7.2.2 Proposed Grid Connection

12.7.2.2.1 38kV Substation Noise

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

Quality	Significance	Duration
Negative	Not significant	Long-term

12.7.3 Decommissioning Phase

During the decommissioning phase of the Proposed Project there will be noise emissions from site traffic and other on-site activities. A conservative assessment assuming similar overall noise levels as those calculated for the construction phase can be considered for elements that are proposed to be decommissioned. The Proposed Grid Connection including the underground cabling route and on-site 38kV substation will remain in place as they are not expected to be decommissioned. The noise and vibration impacts associated with any decommissioning of the site are considered to be less than those outlined in relation to the construction of the Proposed Project.

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

Quality	Significance	Duration
Negative	Not significant	Short-term

12.7.4 Cumulative Effects

12.7.4.1 Construction Phase

The list of cumulative projects detailed in Appendix 2-3 of the EIAR have been reviewed. 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 implementation of mitigation measures described in Section 12.6.1, 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 the Proposed Grid Connection underground cabling route, construction activities may occur near NSLs. The following comments are presented with respect to potential cumulative impacts associated with these works in combination with noise from other construction sites. The construction activities at the site which is closest to the NSL is expected to be the dominant noise source, with a lower contribution expected from sites farther away from the NSL. In most cases, the setback distances to the NSLs will ensure no significant cumulative impacts. In the unlikely event that works from other sites also occur near a receptor (within approximately 30 meters), it is assumed that the maximum increase in predicted construction noise levels due to cumulative contributions would be no more than 3 dB. While a 3 dB increase represents a doubling of sound energy, subjectively, any change in noise level below 3 dB would be barely perceptible. Additionally, as noted in Section 12.5.2.2.1, the works associated with the Proposed Grid Connection underground cabling route will occur for short durations and are expected to be near the closest NSLs for a limited amount of time, i.e., less than one day.

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

Quality	Significance	Duration
Negative	Slight	Short-term

12.7.4.2 Operational Phase

12.7.4.2.1 *Wind Turbine Noise*

Existing permitted and proposed wind farm developments with the potential for cumulative impacts have been considered as part of the turbine noise impact assessment. A review of existing, proposed and permitted wind turbine developments in the wider study area has been undertaken in accordance with the guidance contained in the IOA GPG. As discussed in 12.3.5, Foyle and Kyleballyoughter Wind Farms are included in the cumulative assessment presented in the Chapter.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest NSLs associated with cumulative impacts from the Proposed Wind Farm are described as:

Quality	Significance	Duration
Neutral	Imperceptible	Long-term

12.7.4.2.2 *Proposed Grid Connection*

It is not considered that any significant cumulative operational noise or vibration effects are likely in relation to the Proposed Grid Connection infrastructure. The underground cabling route will not generate any noise during the operational phase, and the predicted operational noise levels at the nearest NSL from the operation of the onsite 38kV substation are well below the noise criteria. Furthermore, the distance to any other developments will ensure that any contribution to cumulative noise will not be significant.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest NSLs associated with cumulative impacts from the Proposed Grid Connection are described as:

Quality	Significance	Duration
Negative	Not significant	Long-term