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 (Wind Farm and Grid Connection) and its component parts which are the subject of separate planning applications under Section 37E (Proposed Wind Farm) and Section 182A (Proposed Grid Connection) of the Planning and Development Act 2000, as amended. The current application for planning permission to An Bord Pleanála (ABP) in accordance with Section 37E of the Planning and Development Act 2000, (as amended) is for the Proposed Wind Farm. 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 operational, construction, and decommissioning phases of the Proposed Project on the nearest noise sensitive locations (NSL's). To inform this assessment baseline noise levels have been surveyed at 6 no. representative NSL's surrounding the Site. Noise predictions to the nearest NSL's have been prepared for all key elements of the Proposed Project with the potential for noise and vibration impacts and effects.

The Wind Energy Development Guidelines for Planning Authorities, published by the Department of the Environment, Heritage and Local Government in 2006, defines a noise sensitive location as any occupied dwelling house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational amenity importance.

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

For the purposes of this EIAR:

- The '**Proposed Wind Farm**' refers to the 9 no. turbines and supporting infrastructure which is the subject of this Section 37E application.
- The '**Proposed Grid Connection**' refers to the 110kV substation and supporting infrastructure which will be the subject of a separate Section 182A application.
- The '**Proposed Project**' comprises the Proposed Wind Farm and the Proposed Grid Connection, all of which are located within the EIAR Study Boundary (the '**Site**') and assessed together within this EIAR.

Please see section 1.1.1 of this EIAR for further details. A detailed description of the Proposed Project is provided in Chapter 4 of this EIAR.

12.1.2 Statement of Authority

This chapter of the EIAR has been prepared 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.

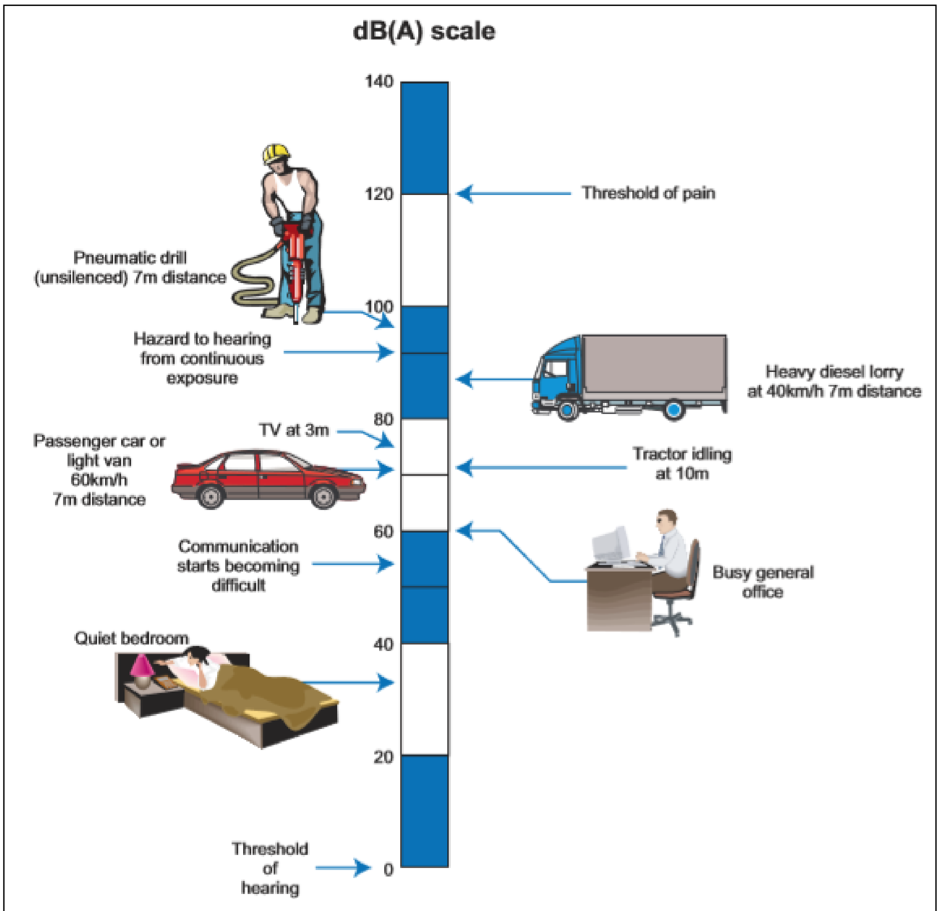

Figure 12-1 The level of typical common sounds on the dB(A) scale (National Roads Authority (NRA) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)

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 location in the receiving environment of the Proposed Project;
- Undertake predictive noise calculations to assess the potential impacts associated with the construction and decommissioning phases of the Proposed Project at NSL's;
- Undertake predictive noise calculations to assess the potential impacts associated with the operational phase of the Proposed Project at NSL's;
- 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 EPA Description of Effects

The significance of effects of the Proposed Project shall be described in accordance with the EPA guidance document *Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR), 2022.* Details of the methodology for describing the significant of the effects are provided in Chapter 1 – Introduction.

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

12.3.2 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here. 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 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)
- *Draft Revised Wind Energy Development Guidelines* 2019 Department of Housing, Local Government and Heritage (2019 draft WEDGs)

12.3.2.1 Construction Phase

12.3.2.1.1 *Construction Phase – Noise*

General Construction

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of construction works and may consider noise limits at their discretion.

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

Table 12-1. The threshold values are applicable to both construction and decommissioning noise.

Table 12-1 Example Threshold of Potential Significant Effect at Noise Sensitive Locations

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

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

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

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.

Please see Section 12.5.2 for the detailed assessment in relation to the construction of the Proposed Project. If the specific construction noise level exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,T}$ during daytime periods) then a potential significant impact is deemed to have occurred. In order to determine the significance of the effects it is important to consider that duration of the impacts.

Linear Construction Works

Due to the linear progressive nature of the construction works associated with Proposed Grid Connection underground cabling, and construction of roads and tracks, 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;*
> - *75 decibels (dBA) in urban areas near main roads in heavy industrial areas".*

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

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) proposes daytime period (Monday to Friday 0700 – 1900 hrs) construction noise limits of 70 dB $L_{Aeq,1hr}$.

In this assessment, a construction noise limit of 70 dB $L_{Aeq,1hr}$ is proposed for linear construction activities (Grid Connection underground cabling route). Noise levels above 70 dB $L_{Aeq,1hr}$ would indicate a significant impact depending on the duration and frequency of occurrence.

12.3.2.1.2 Additional Vehicular Activity on Public Roads - Noise

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that construction traffic from the Proposed 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 and 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, 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	No Change
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 12.3.2.1.

12.3.2.1.3 Construction Phase - Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to the Proposed 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 Table 12-3.

Table 12-3 Allowable Transient Vibration at Properties

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

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

12.3.2.2 Operational Phase

12.3.2.2.1 *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 2006 WEDGs. 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 "2006 WEDGs" publication where necessary.

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

The core of the noise guidance contained within the 2006 WEDGs document is based on the 1996 ETSU publication *The Assessment and Rating of Noise from Wind Farms (ETSU-R-97).*

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

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

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 noise sensitive locations 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 12.3.6.1.

Wind Energy Development Guidelines

Section 5.6 of the 2006 WEDGs 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 2006 WEDGs outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- 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 (2019 draft WEDGs)) 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 public consultation several concerns relating to the proposed approach of the 2019 draft WEDGs 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 2019 draft WEDGs.

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

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

Communications (DECC), which has primary responsibility for environmental noise matters. 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 2006 WEDGs 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.

12.3.2.2.2 Noise from Substation

For the proposed 110kV 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 noise sensitive locations in the vicinity of the site 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 noise sensitive locations 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 noise sensitive locations.

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 NSL's 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 noise sensitive location for noise from the substation is robust to prevent adverse impacts at NSL's.

12.3.3 Special Characteristics of Turbine Noise

12.3.3.1 Infrasound/Low Frequency Noise

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

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

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

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

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

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

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

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

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

The article concludes that:

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

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[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.

[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*

12.3.3.2 Amplitude Modulation

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

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

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

- 'Normal' AM (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.

12.3.3.2.1 *Frequency of Occurrence of AM*

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

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."*

12.3.3.2.2 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. Any 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.

12.3.4 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 in approximately 610m (being the distance from turbine T06 to NSL ref. H005). 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.

12.3.5 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.

12.3.5.1 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".*

12.3.5.2 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.

12.3.5.3 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.

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[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*

12.3.5.4 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."*

12.3.5.5 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.

12.3.6 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 NSL's 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 and proposed wind turbines.

An appraisal of the wider study area identified that the nearest other wind turbine development (existing, permitted and proposed) is located approximately 8 km from the Proposed Wind Farm. At this distance there is no potential for cumulative turbine noise impacts and in accordance with best practice guidance discussed in Section 12.3.2.2.1; as such, no other wind farm is required to be included in the operational noise assessment.

Appendix 12.5 shows the relevant noise contours map and identifies the 35 dB L_{A90} noise contour area.

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 Proposed Project.

NSL's 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 works associated with the

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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*

construction and decommissioning phases, the study area is based on the nearest NSL's to the working areas, these distances are confirmed in the relevant sections and are representative of the closest identified NSL or at defined set back distances from proposed activity.

12.3.7 Background Noise Assessment

A background noise survey was undertaken to establish typical background noise levels at representative NSL's 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.

All background noise surveys have been carried out in accordance with the IOA GPG discussed in the following sections.

12.3.7.1 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 12.3.7.1 for detail on wind turbine noise calculations). Any noise sensitive location 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 12-4 and Figure 12-2. At location NML1 and NML6 the noise monitoring equipment was moved part-way through the survey period; the locations are identified as 'a' and 'b' in Table 12-5, further details are provided in section 12.3.6.2.1 and 12.3.6.2.6.

Table 12-5 Noise Measurement Location Coordinates

Location (Ref)	Coordinates – Irish Transverse Mercator (ITM)	
	Easting	Northing
NML-1a (H009)	612,541	675,656
NML-1b (H009)	612,506	675,625
NML-2 (H007)	611,878	673,861
NML-3 (H008)	612,424	673,213
NML-4 (H016)	614,149	674,459
NML-5 (H011)	613,941	676,087
NML-6a (H029)	613,591	677,585
NML-6b (H029)	613,589	677,553

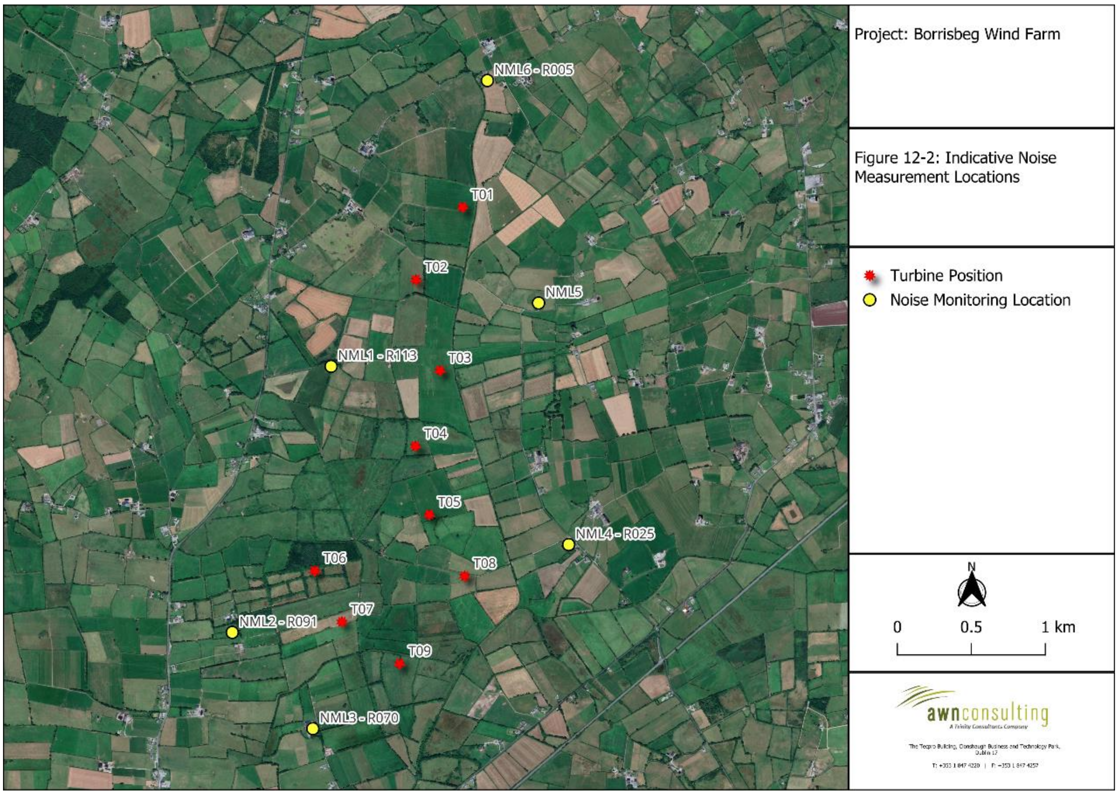

Figure 12-2 Noise measurement locations.

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.

12.3.7.1.1 *NML-1*

The noise meter at NML-1 was initially installed in the front garden to the east of the property (NML-1a). During site visits, recorded noise sources included barking dogs and distant road traffic. On review of the measured data during the survey period, it was observed that an atypical local noise source was present. It was determined following discussions with the resident at the property that the noise originated from a pump located at the property, which operated on a timer during night time periods.

The sound level meter (SLM) was relocated on 23 February 2023 to another position at the property (NML-1b) in an attempt to minimise the contribution of the pump noise in the measurements. However, the pump continued to influence the recorded noise levels. The measured data is presented in Figure 12-4. For the purpose of the assessment, the background night noise levels at NML-1 will be disregarded, and reference will be made to nighttime noise levels measured at representative locations in the survey. This approach aligns with the guidance and methodology from the IOA GPG.


Plate 12-1 NML-1a


Plate 12-2 NML-1a


Plate 12-3 NML-1b

Plate 12-4 NML-1b

12.3.7.1.2 *NML-2*

The meter at NML-2 was installed in a garden to the rear of the property. Distant road traffic was noted to be the dominant noise source at this location.

Plate 12-5 NML-2

Plate 12-6 NML-2

12.3.7.1.3 NML-3

At NML-3, the meter was installed at a small field next to the farmhouse. No significant noise sources were noted at this location.

Plate 12-7 NML-3

Plate 12-8 NML-3

12.3.7.1.4 NML-4

The noise monitoring equipment at NML-4 was installed to the rear of the property. Significant noise sources include barking dogs and distant road traffic noise.

Plate 12-9 NML-4

Plate 12-10 NML-4

12.3.7.1.5 *NML-5*

NML-5 was positioned to the rear of the property with no significant noise sources noted.

Plate 12-11 NML-5

12.3.7.1.6 *NML-6*

NML-6 was originally positioned to the rear of the property (NML-6a). Distant road traffic noise was noted in the environment. During a site visit it was noted that there was a radio playing at a low level in a nearby shed. The noise levels were very low and not expected to impact the noise data. However, as a precautionary measure to ensure no influence on the measured noise data during night time periods when background noise levels typically decrease, the SLM meter was moved further away from the shed to a new position (NML-6b) on 9 February 2023. Upon reviewing the final data sets, there was no evidence in the measured data to suggest that the presence of the radio playing in the shed had any influence on the noise measurements.

Plate 12-12 NML-6a

Plate 12-13 NML-6a

Plate 12-14 NML-6b

Plate 12-15 NML-6b

12.3.7.2 Survey Periods

The survey duration was 4 weeks, or until 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 Tableb12-6.

Table 12-6 Measurement Periods

Location	Start Date	End Date
NML-1a	19 January 2023	18 February 2023
NML-1b	23 February 2023	2 March 2023
NML-2	19 January 2023	7 March 2023
NML-3	19 January 2023	23 February 2023
NML-4	19 January 2023	23 February 2023
NML-5	19 January 2023	23 February 2023
NML-6a	19 January 2023	7 February 2023
NML-6b	9 February 2023	23 February 2023

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 period detailed in Table 12-6.

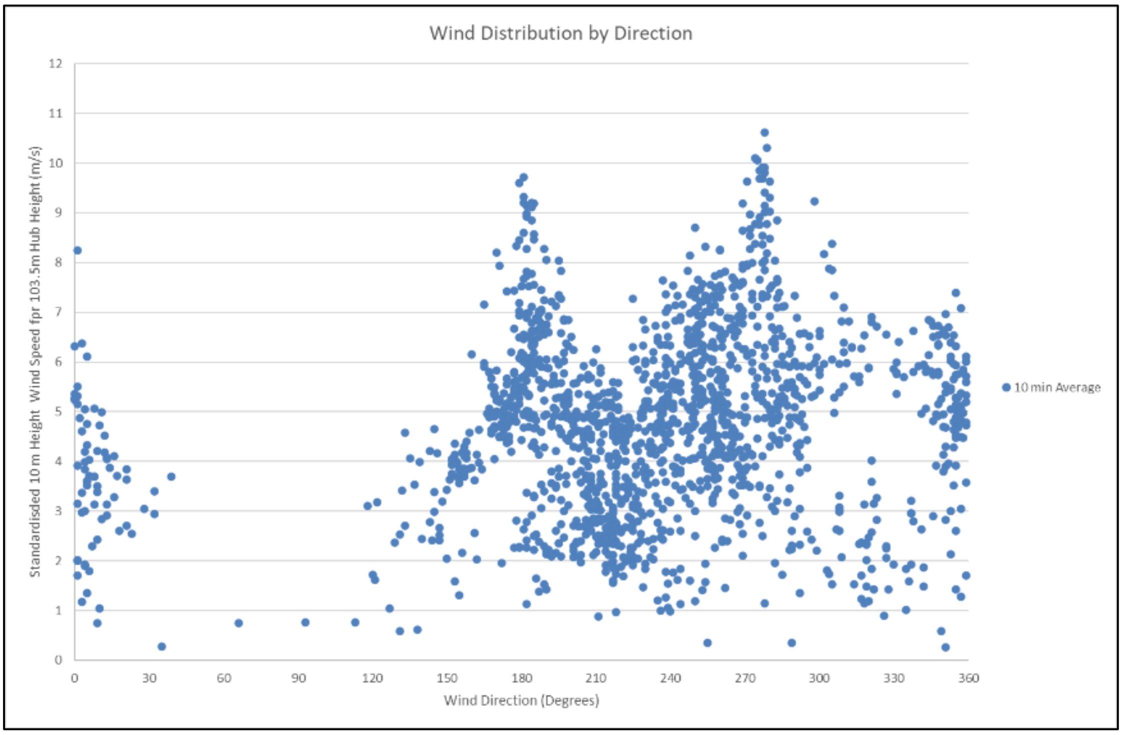

Figure 12-3 Distributions of Wind Speeds and Directions over the Survey Period

12.3.7.3 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-1	Rion NL-52	564808
NML-2	Rion NL-52	164427
NML-3	Rion NL-52	575785
NML-4	Rion NL-52	998410
NML-5	Rion NL-52	164426
NML-6	Rion NL-52	764925

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 12-2.

Rainfall was monitored and logged using a Texas Instruments TR-525 console and a data logger that was installed on-site for the duration of the surveys (at NML-1 and NML-4). This allows for the identification of periods of rain fall 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 on the Site and was supplied to AWN for data analysis.

Table 12-8 Met Mast Details

Description	Coordinates (ITM)	
	Easting	Northing
Met Mast	613,176	674,906

12.3.7.4 Procedure

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

12.3.7.5 Analysis of Background Noise Data

12.3.7.5.1 *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.

12.3.7.5.2 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.

12.3.7.5.3 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 10m height wind speed reference unless otherwise stated.

12.3.8 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.

12.3.8.1 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

12.3.8.2 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. Additional information relating to the noise model inputs and calculation settings is provided in Appendix 12-4.

12.3.8.2.1 *Proposed Turbine Details*

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

Table 12-9 Proposed Wind Farm Turbine Co-ordinates

Turbine	ITM Easting	ITM Northing	Top of Foundation Levels (metre OD)
T01	613,427	676,731	115
T02	613,113	676,241	110
T03	613,277	675,630	110
T04	613,112	675,119	110
T05	613,207	674,658	110

Turbine	ITM Easting	ITM Northing	Top of Foundation Levels (metre OD)
T06	613,447	674,244	110
T07	612,619	673,934	110
T08	613,447	674,244	110
T09	613,009	673,653	110

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 NSL's 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 12-3.

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 LAeq 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.

12.3.8.2.2 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, the NSL and turbine co-ordinates, and the turbine sound power emissions used in for the Proposed Wind Farm are included Appendix 12.3.

12.3.8.3 Assessment of Turbine Noise Levels

The predicted turbine noise level from the Proposed Wind Farm 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.

12.3.9 Assessments of Construction Impacts

The potential impacts of the construction phase noise and vibration in addition to the potential impacts from additional vehicular activity on public roads will be assessed in accordance with best practice guidance as outlined in Section 12.3.2.1.

12.4 Receiving Environment

This stage of the assessment was to determine typical background noise levels at representative NSL's 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 12.3.6.2 above.

12.4.1 Background Noise Levels

The following sections present an overview and results of the noise monitoring data obtained from the background noise survey in accordance with the methodology discussed in Section 12.3.6.

12.4.1.1 NML-1

12.4.1.1.1 Daytime Quiet Periods

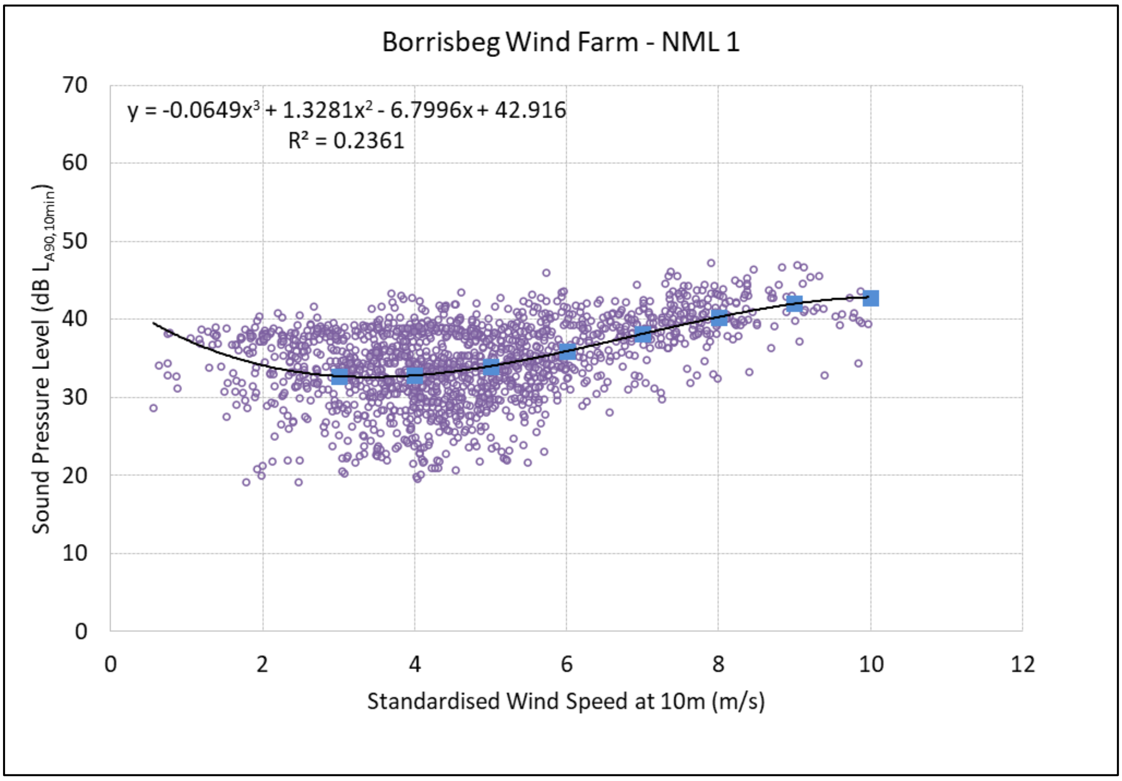

Figure 12-4 NML-1 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Daytime for 103.5 m Hub Height

12.4.1.1.2 Night-time Periods

As discussed in Section 12.3.7.1.1 the data from NML-1 during night tine periods has been disregarded for the assessment but is presented in Figure *12-5* for informational purposes.

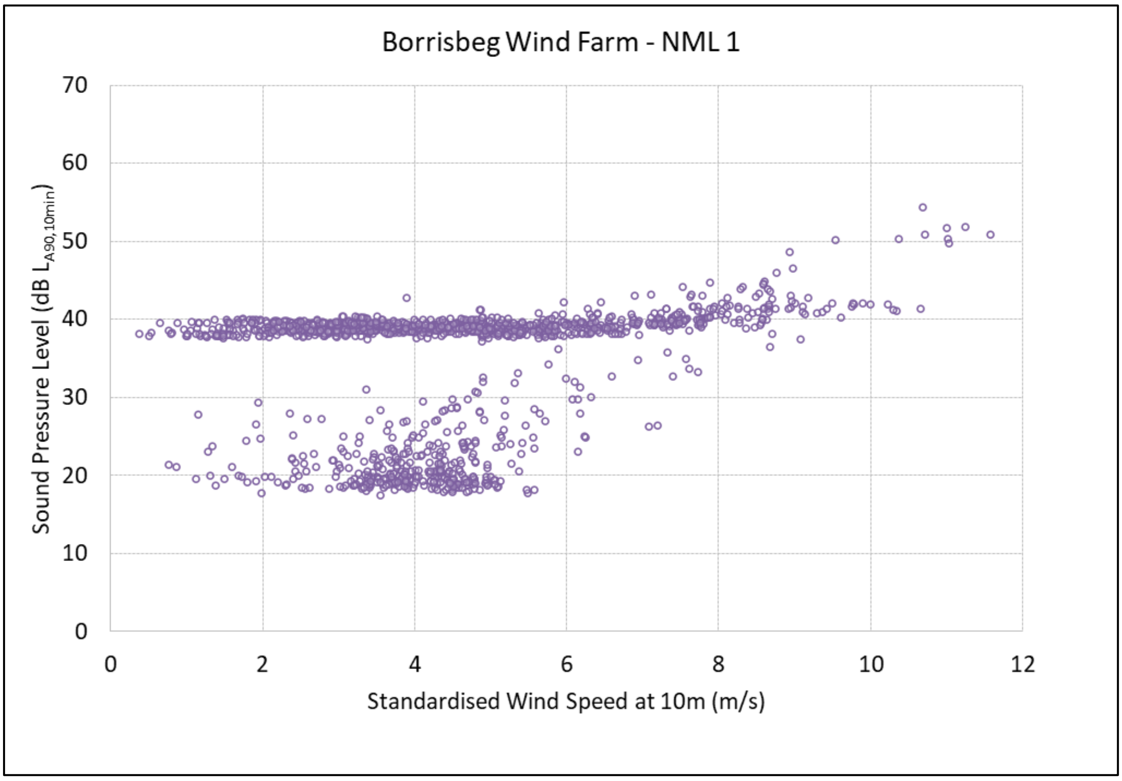

Figure 12-5 NML-1 Background Noise Levels $L_{A90,\ 10\ min}$ dB –Night-time for 103.5 m Hub Height

12.4.1.2 NML-2

12.4.1.2.1 Daytime Quiet Periods

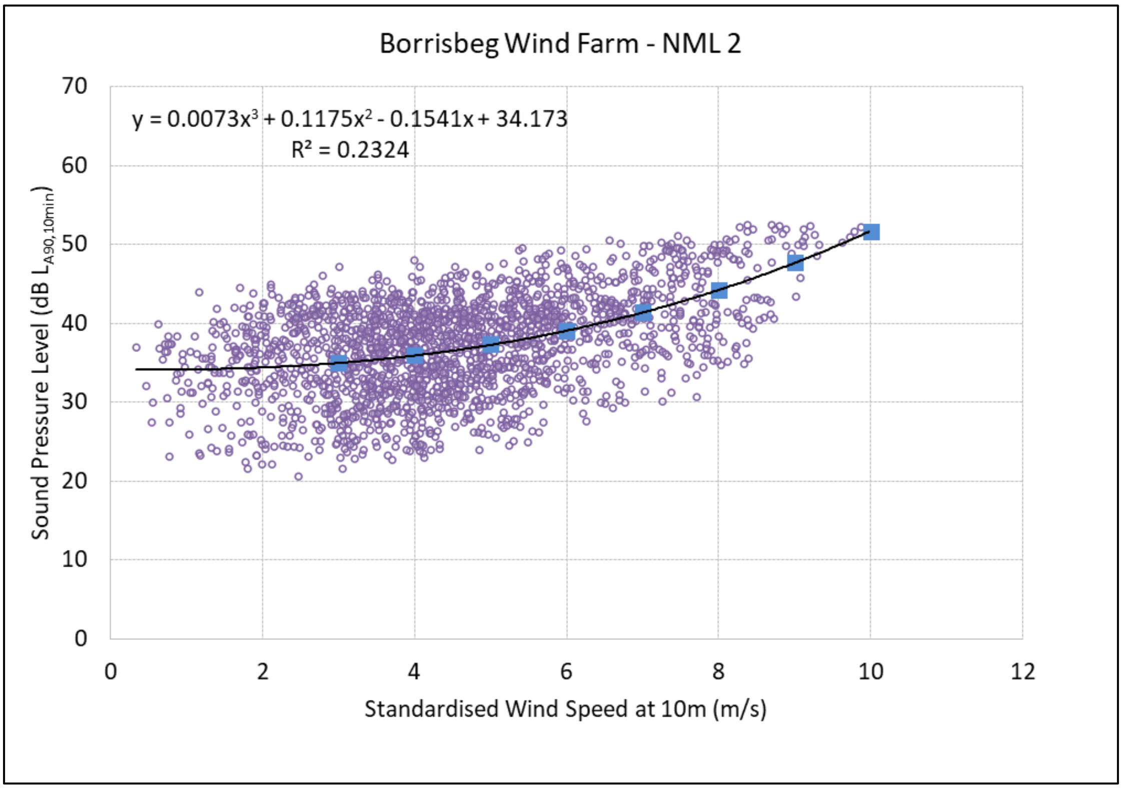

Figure 12-6 NML-2 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Daytime for 103.5 m Hub Height

12.4.1.2.2 Night-time Periods

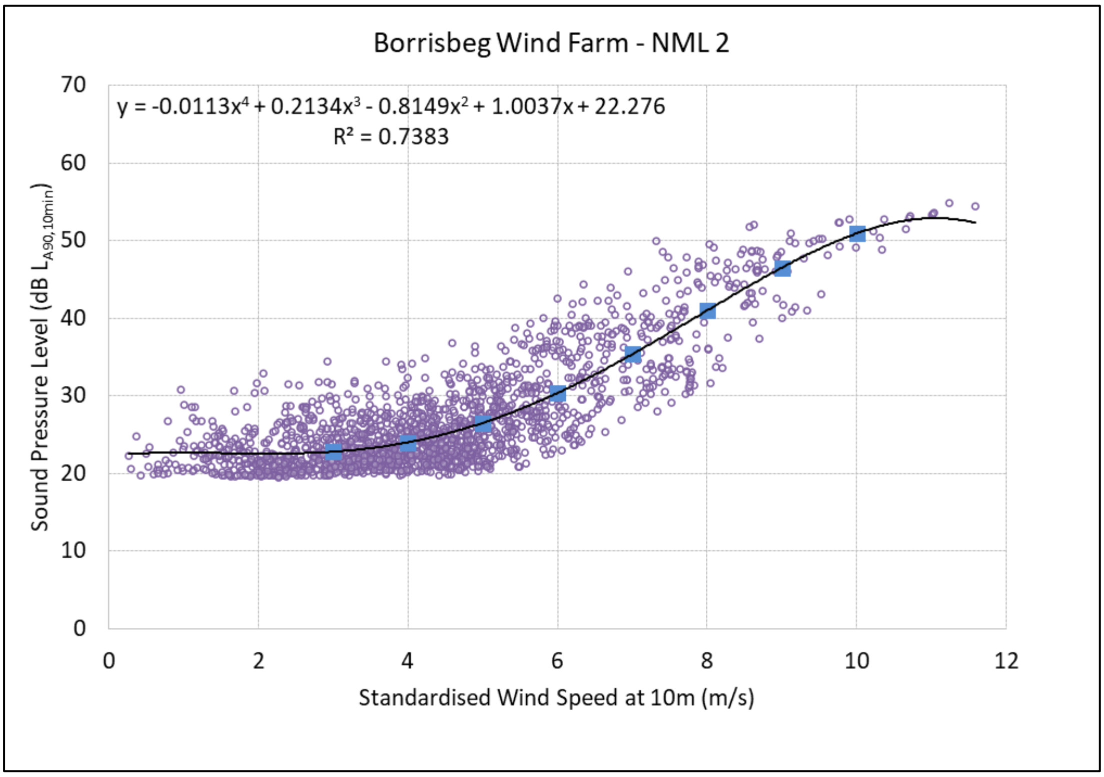

Figure 12-7 NML-2 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Night-time for 103.5 m Hub Height

12.4.1.3 NML-3

12.4.1.3.1 Daytime Quiet Periods

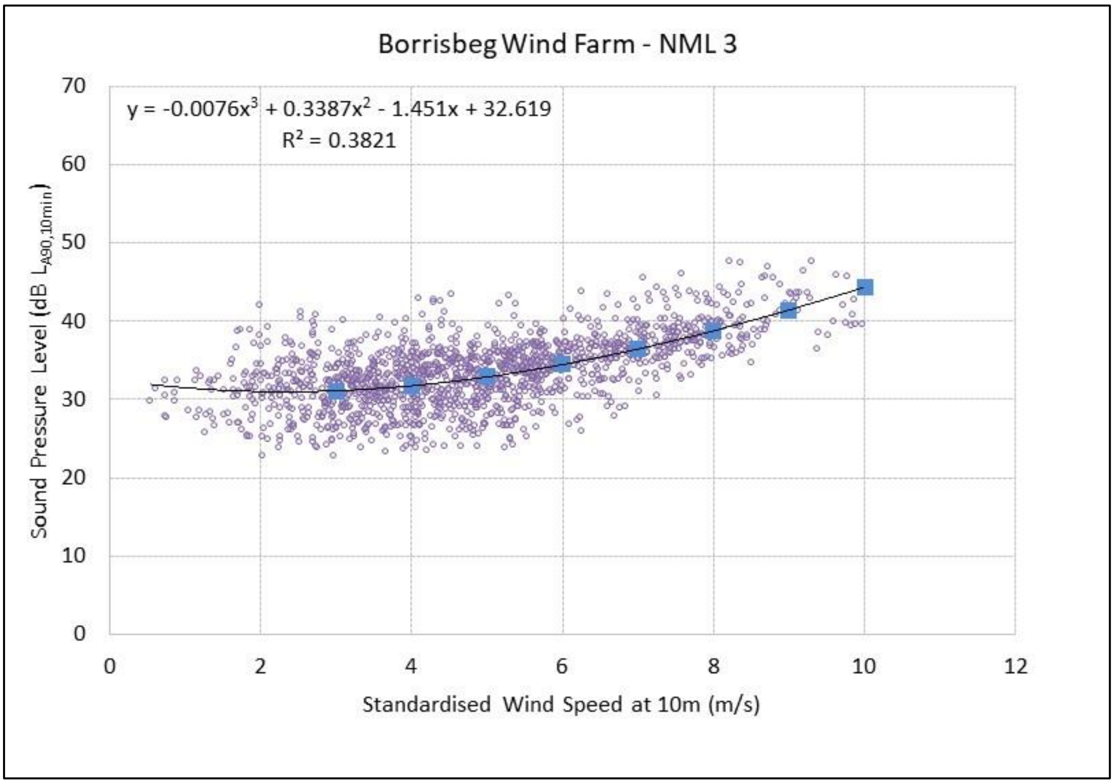

Figure 12-8 NML-3 Background Noise Levels $L_{A90,\ 10\ min}$ dB –Daytime for 103.5 m Hub Height

12.4.1.3.2 Night-time Quiet Periods

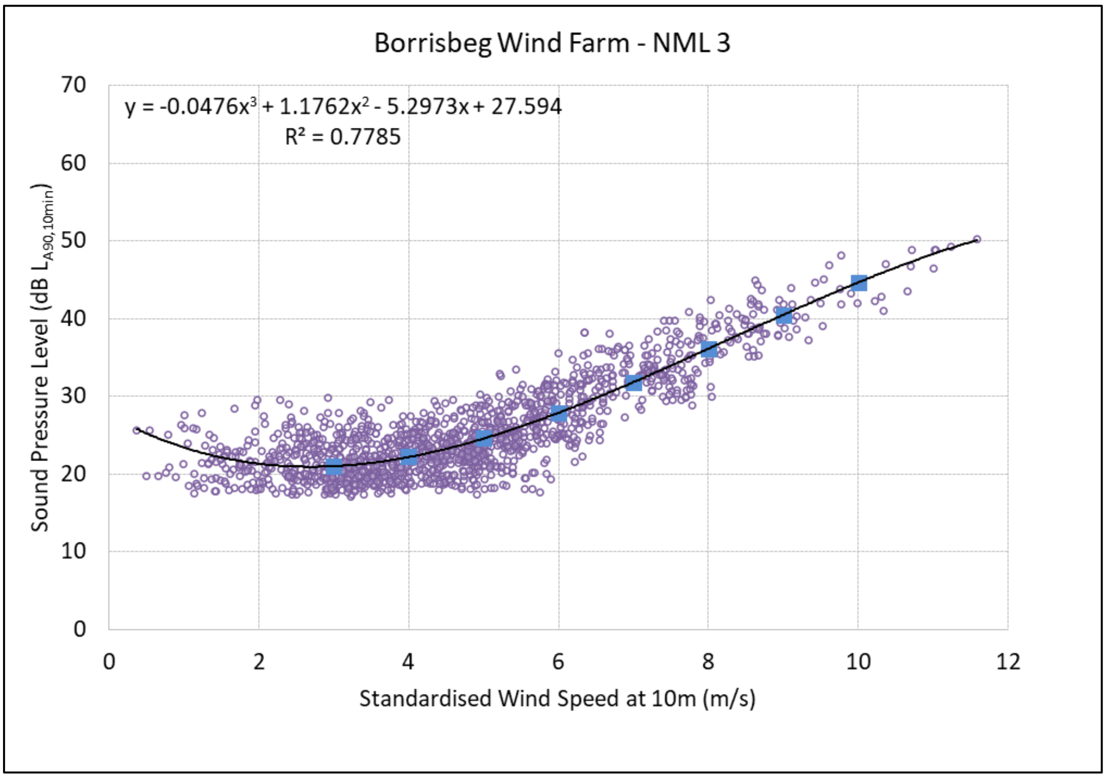

Figure 12-9 NML-3 Background Noise Levels $L_{A90,\ 10\ min}$ dB –Night-time for 103.5 m Hub Height

12.4.1.4 NML-4

12.4.1.4.1 Daytime Quiet Periods

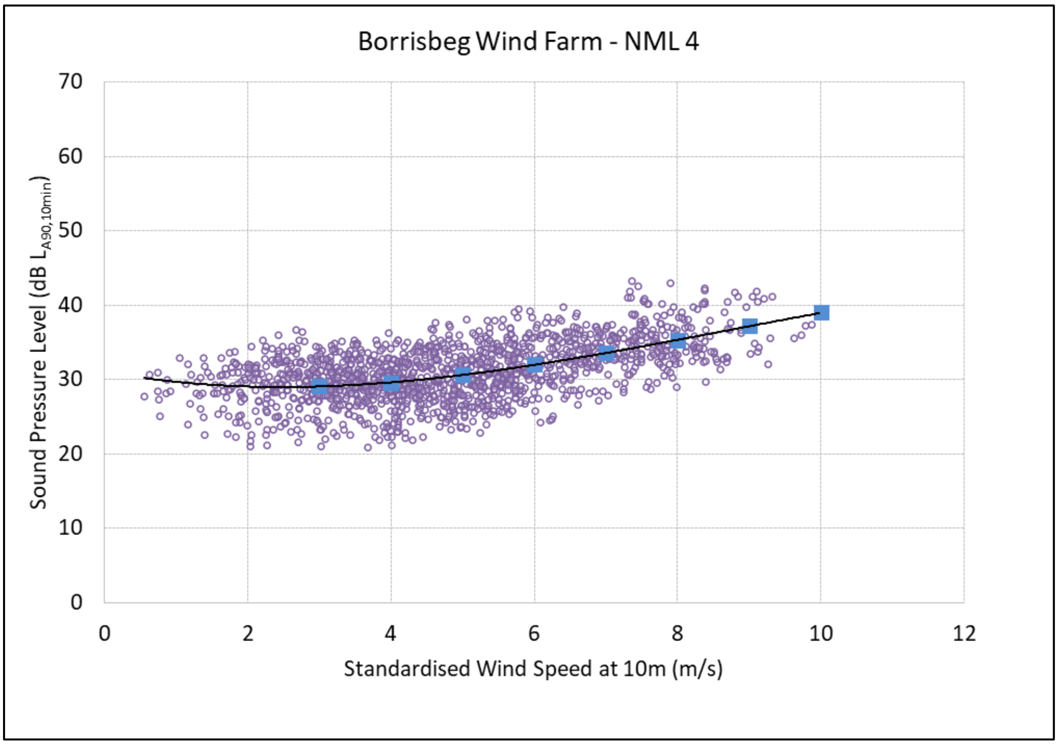

Figure 12-10 NML-4 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Daytime for 103.5 m Hub Height for 103.5 m Hub Height

12.4.1.5 NML-4

12.4.1.5.1 Night-time Periods

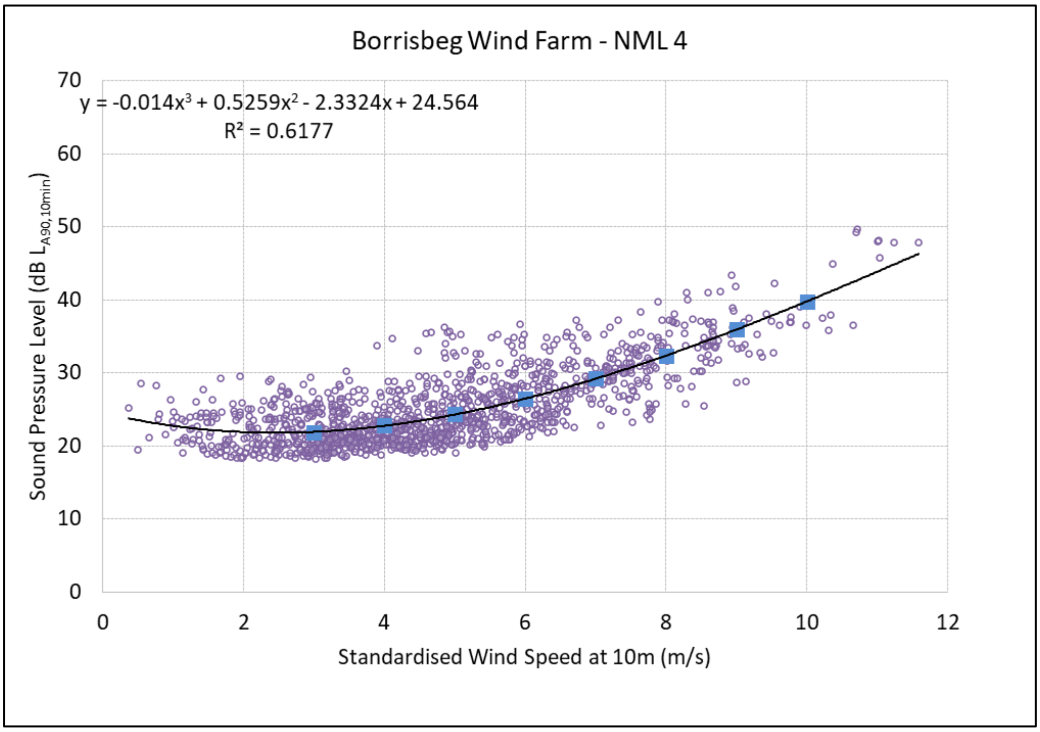

Figure 12-11 NML-4 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Night-time for 103.5 m Hub Height for 103.5 m Hub Height

12.4.1.6 NML-5

12.4.1.6.1 Daytime Quiet Periods

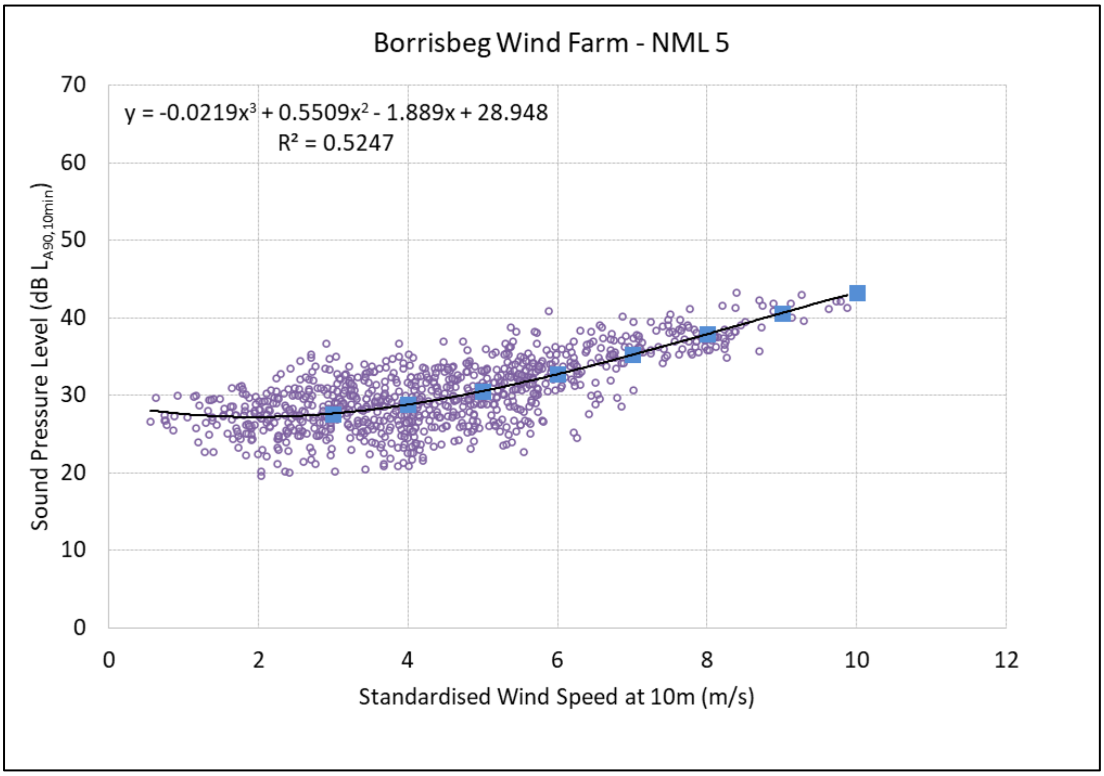

Figure 12-12 NML-5 Background Noise Levels $L_{A90,\ 10\ min}$ dB –Daytime for 103.5 m Hub Height

12.4.1.6.2 Night-time Periods

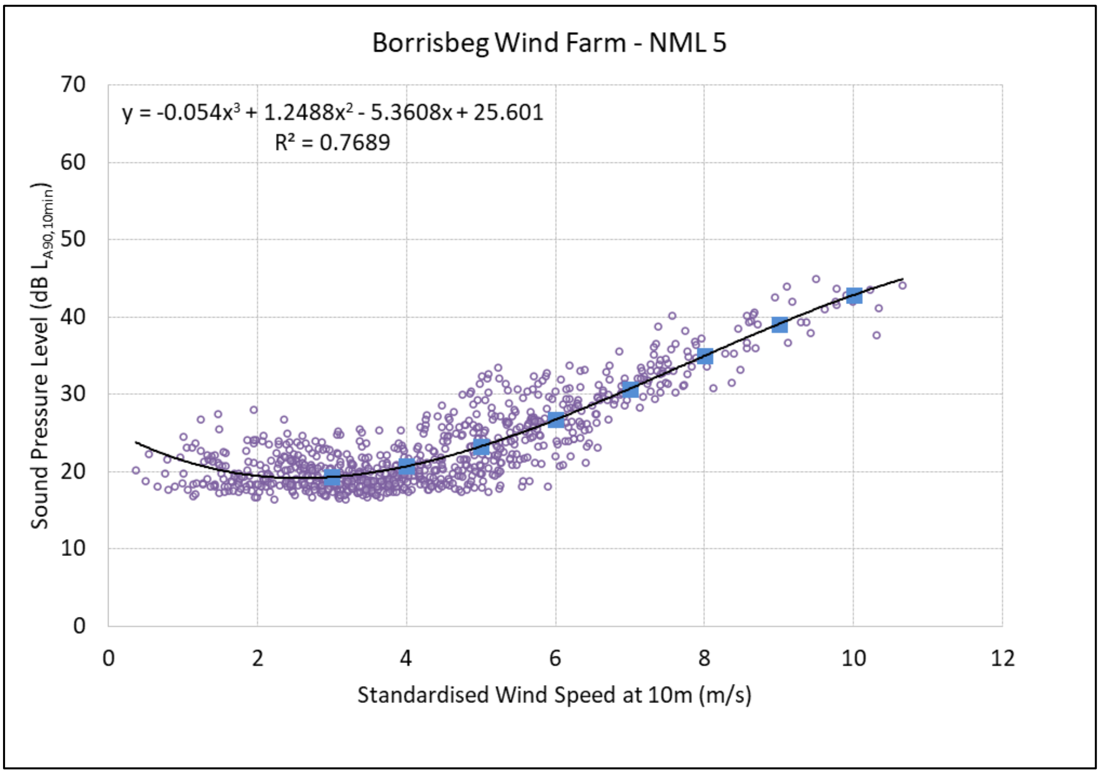

Figure 12-13 NML-5 Background Noise Levels $L_{A90,\ 10\ min}$ dB – Night-time for 103.5 m Hub Height

12.4.1.7 NML-6

12.4.1.7.1 Daytime Quiet Periods

As discussed in Section 12.3.7.1.6 the data from NML-6a and NML-b showed no disenable variation in the dataset between the positions; the datasets have been combined to derive the background noise levels at NML 6.

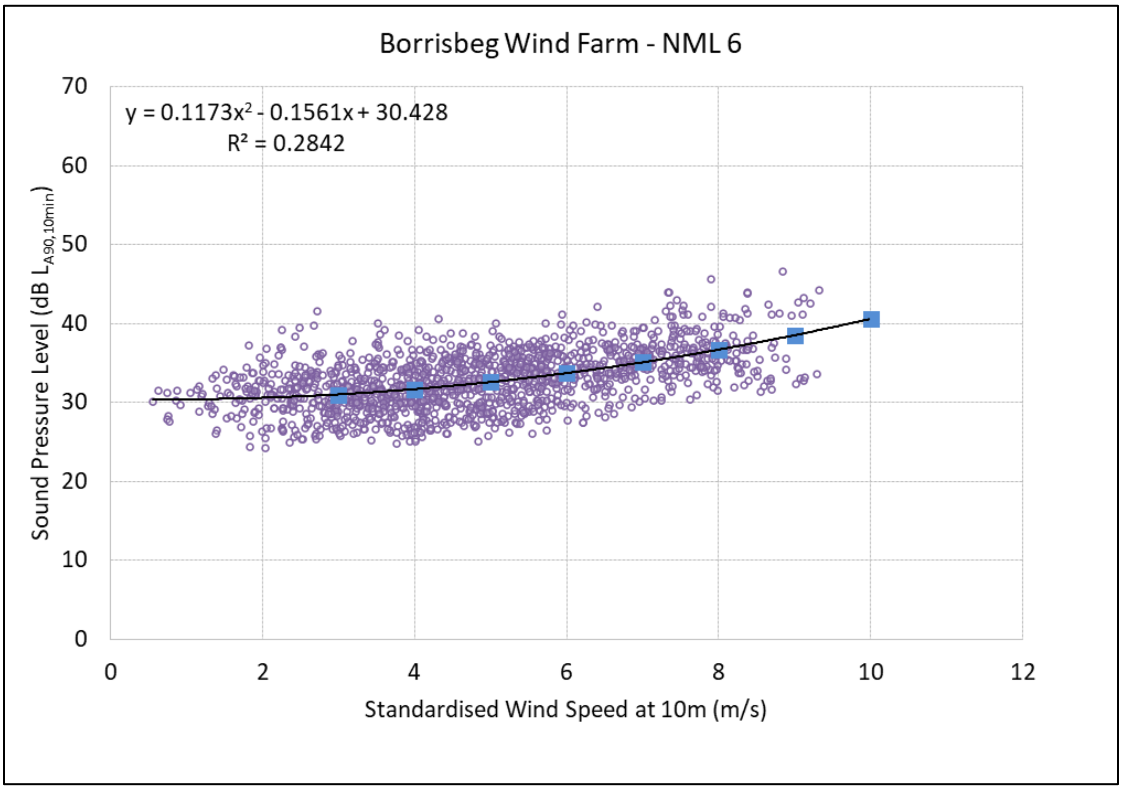

Figure 12-14 Location F (H427) Background Noise Levels $L_{A90,\ 10\ min}$ dB – Daytime for 103.5 m Hub Height

12.4.1.7.2 Night-time Periods

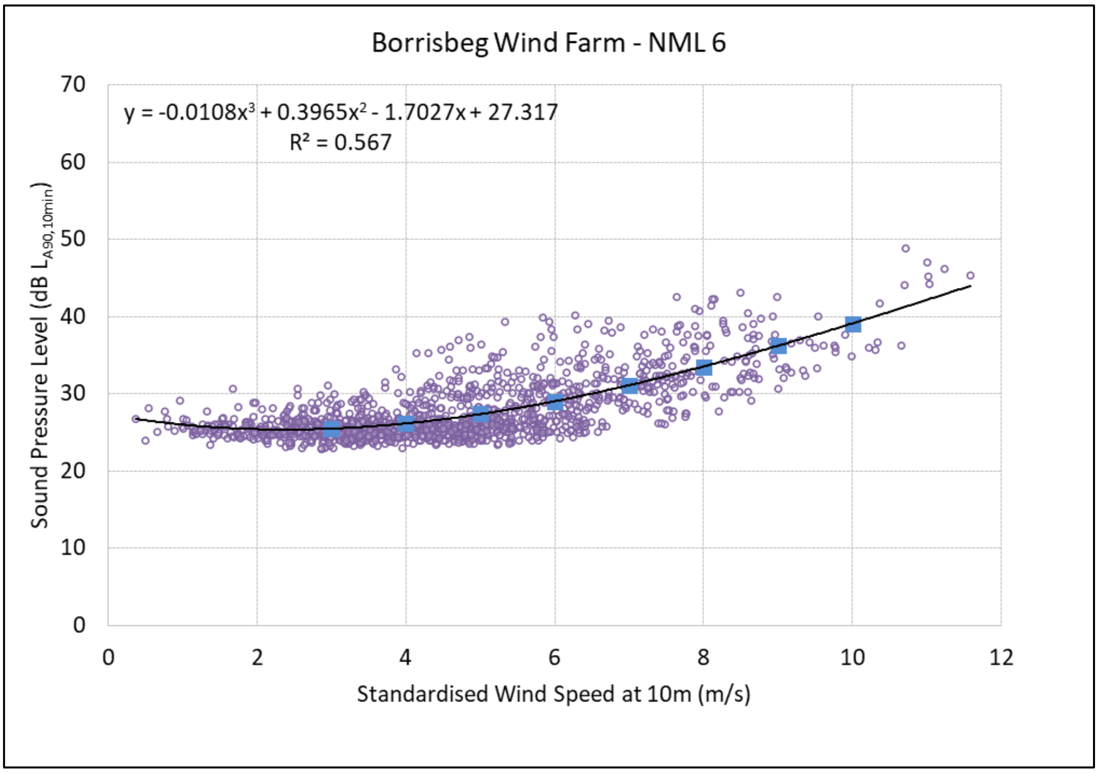

Figure 12-15 Location F (H427) Background Noise Levels $L_{A90,\ 10\ min}$ dB – Night-time for 103.5 m Hub Height

12.4.1.8 Summary

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 Standaridsed10m Height Wind Speed (m/s)						
		3	4	5	6	7	8	9
NML-1	Day	32.7	32.8	34.0	35.9	38.1	40.3	42.0
	Night	–	–	–	–	–	–	–
NML-2	Day	35.0	35.9	37.3	39.1	41.4	44.2	47.7
	Night	22.8	24.0	26.5	30.4	35.4	41.0	46.5
NML-3	Day	31.1	31.7	32.9	34.5	36.4	38.8	41.4
	Night	21.0	22.2	24.6	27.9	31.8	36.1	40.5
NML-4	Day	29.1	29.6	30.6	32.0	33.6	35.3	37.2
	Night	21.9	22.8	24.3	26.5	29.2	32.4	35.9

Location	Period	Derived $L_{A90,\,10\,min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)						
		3	4	5	6	7	8	9
NML-5	Day	27.6	28.8	30.5	32.7	35.2	37.9	40.6
	Night	19.3	20.7	23.3	26.7	30.7	35	39.1
NML-6	Day	31.0	31.7	32.6	33.7	35.1	36.7	38.5
	Night	25.5	26.2	27.4	29.0	31.1	33.5	36.2
Envelope	Day	27.6	28.8	30.5	32.0	33.6	35.3	37.2
	Night	19.3	20.7	23.3	26.5	29.2	32.4	35.9

The background noise data is utilised to establish suitable noise criteria curves for each of the noise-sensitive locations 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 and 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 noise sensitive location as discussed in detail in Section 12.4.2 in accordance with the 2006 WEDG.

12.4.2 Wind Turbine Noise Criteria

With respect to the relevant guidance documents outlined in Section 12.3.2.2.1 noise criteria curves have been established for the Proposed Wind Farm. The criteria curves have been derived following a detailed review of the background noise data conducted at representative NSL's described in Section 12.4.1.8.

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

Lyrenacarriga Wind Farm (ABP Ref: 309121-21) and Seven Hills Wind Farm (ABP Ref: 313750-22).
- The 2006 WEDGs states that "*An appropriate balance must be achieved between power generation and noise impact.*" Based on a review of other national guidance in relation to acceptable noise levels in areas of low background noise it is considered that the criteria adopted as part of this assessment are robust.

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

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

- 40 dB $L_{A90,10min}$ in quiet environments with typical background noise of less than 30 dB $L_{A90,10min}$;
- 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. NSL's surrounding the Proposed Wind Farm and are presented in the relevant sections of this chapter.

The derived turbine noise limits have been assigned to the various NSL's where noise monitoring has been undertaken. 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 Section12.3.2.2.1) 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 NSL's 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-1	Day	45.0	45.0	45.0	45.0	45.0	45.3	47.0
	Night	–	–	–	–	–	–	–
NML-2	Day	45.0	45.0	45.0	45.0	46.4	49.2	52.7
	Night	43.0	43.0	43.0	43.0	43.0	46.0	51.5

Location	Period	Derived $L_{A90, 10 min}$ Levels (dB) at various Standaridsed10m Height Wind Speed (m/s)						
		3	4	5	6	7	8	9
NML-3	Day	45.0	45.0	45.0	45.0	45.0	45.0	46.4
	Night	43.0	43.0	43.0	43.0	43.0	43.0	45.5
NML-4	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML-5	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.1
NML-6	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Envelope	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0

12.5 Likely Significant Effects and Associated Mitigation Measures

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 Tipperary'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.

If the Proposed Project were not to proceed, the opportunity to retore a segment of the Eastwood River by improving channel stability, instream habitat and establishing a natural wooded riparian buffer would be lost. Please see Appendix 6-4 Biodiversity Management and Enhancement Plan for details.

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 noise-sensitive locations. This is discussed in the following Sections.

Construction noise prediction calculations have been conducted using the assessment methodology outlined in Section 12.3.9. Noise levels are predicted at the nearest NSL to each element of the works and compared against the criteria in Section 12.3.2.1.

In general, the distances between the construction activities associated with the Proposed Project and the nearest NSL's are such that there will be no significant noise and vibration impacts at NSL's. 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., weekdays 0700 – 1900 hrs and Saturdays 0700 – 1900 hrs). However, to ensure that optimal use is made of good weather period 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

Noise

Works for the turbines are at a significant distance from the closest noise sensitive receptors, with the nearest noise-sensitive property (NSL) being H005 at a distance of 610 m from T06.

Several indicative sources that would be expected on a site of this nature have been identified and noise predictions of their potential impacts prepared to nearby houses. 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 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, Substation,

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) 145 m	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m) 610 m
HGV Movement (C.2.30)	Removing soil and transporting fill and other materials	79	50	36
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation	77	48	34
Excavator Mounted Rock Breaker (C9.12)	Excavation in rocky areas	85	56	42
Piling Operations (C.12.14)	Standard pile driving	88	–	45
General Construction (Various)	All general activities plus deliveries of materials and plant	84	55	41
Concrete Mixer Truck and	Turbine Foundations	75	46	32

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

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[7]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m) 145 m	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m) 610 m
Concrete Pump (C.4.27)				
Dumper Truck (C.4.4)	Backfilling Turbine Foundations	76	47	33
Mobile Telescopic Crane (C.4.39)	Turbine Erection	77	48	34
Dewatering Pumps (D.7.70)	If required	80	51	37
Vibrating Rollers (D.8.29)	Road surfacing	77	48	34
Cumulative Predicted Construction Noise Level		-	61	49

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, therefore no specific mitigation measures are required.

Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

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 noise sensitive locations associated with construction of turbines and hardstanding areas are described as negative, not significant, and short-term.

12.5.2.1.2 Access Roads

Noise

It is proposed to construct new internal access roads and upgrade existing roads as part of the Proposed Project. Review of the road layout has identified that the closest NSL's are H038, H052, H016 and H032 which are at a distance of 28 m, 38 m, 50 m and 56 m 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 typical anticipated 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 $L_{Aeq,12hr}$)				
		28 m	38 m	50 m	75 m	100 m
HGV Movement (C.2.30)	79	66	63	60	56	53
Tracked Excavator (C.4.64)	77	64	61	58	54	51
Dumper Truck (C.4.4)	76	63	60	57	53	50
Vibrating Rollers (D.8.29)	77	64	61	58	54	51
Total Construction Noise (cumulative for all activities)		**70**	**67**	**64**	**60**	**57**

These levels of noise predicted are within the fixed construction noise criterion for linear construction works as outlined in 12.3.2.1.1, therefore there will be no significant noise impact associated with the construction of the access roads, and no specific mitigation measures are required.

Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

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 noise sensitive locations associated with construction of turbines and hardstanding areas are described as negative, not significant, and short-term.

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

12.5.2.1.3 Temporary Construction Compounds

Noise

Two temporary construction compounds are proposed. The first construction compound is proposed near T02, where the compound is located 320 m from H014. The second compound is proposed adjacent to the proposed 110kV substation, with the compound located at 110m from H016.

There is no significant construction activity or noise associated with the Construction Compound. Therefore it is concluded that any noise associated with the construction compounds is expected to be well below the construction noise significance threshold outlined in Table 12-1Table 12-1.

Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

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 noise sensitive locations 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 during daytime periods.
- 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 6 to 10 blasts will be required over an 8 to 12-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	dB L_w Levels per Octave Band (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Crusher	121	114	107	109	103	99	94	87	109
Tracked Excavator (each of 6 no)	77	88	95	93	93	92	86	76	98
HGV Movement	77	88	95	93	93	92	86	76	98
Dump Truck	87	92	99	97	102	99	94	85	105
Semi-mobile screen/stockpiler	95	98	105	103	103	100	98	89	107
Rock Breaker	119	117	113	117	115	115	112	108	121

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. NSL's with the highest predicted noise levels due to the borrow pit activity.

Table 12-16 Noise Levels at NSL's due to borrow pit activity.

NSL Ref	Predicted Noise Level (dB $L_{Aeq,12hr}$)	
	Scenario A	Scenario B
H004	46	55
H026	44	52
H021	41	49
H014	39	46
H024	38	45
H032	37	45
H078	37	45

NSL Ref	Predicted Noise Level (dB $L_{Aeq,12hr}$)	
	Scenario A	Scenario B
H069	37	44
H038	37	44
H052	36	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.

Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

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 turbines and hardstanding areas are described as negative, not significant, and short-term.

12.5.2.2 Proposed Grid Connection

12.5.2.2.1 *110kV Electrical Substation*

An on-site 110kV electrical substation is proposed, as described in Chapter 4. The nearest NSL to the proposed substation is H016 at 145 m.

Noise

As a conservative assessment assuming the same construction activities as outlined in Section 12.5.2.1 (excluding piling operations), it is predicted that the potential noise levels from construction activities associated with the substation will be 61 dB $L_{Aeq,T}$. This level of noise is within the construction noise criterion outlined in

Table 12-1, therefore it is concluded that there will be no significant noise impact associated with the construction of the substation, therefore no specific mitigation measures are required.

Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

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 noise sensitive locations associated with Construction Compound areas are described as negative, not significant, and Temporary.

12.5.2.2.2 110kV Electrical Cabling Route

A connection between the proposed 110kV electrical substation and the national electricity grid will be necessary to export the electricity generated by the Proposed Wind Farm. The proposed underground grid connection cabling route is approximately 2km long with just c.0.87km located in the local road network. Details of the proposed underground 110kV electrical cabling route connection to the nearby overhead line are presented in Chapter 4.

Noise

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

Table 12-17 Indicative noise calculations for construction – Underground Electrical Cabling Routes

Plant Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$)	Assumed % on-time	Calculated Construction Noise Levels dB $L_{Aeq,12hr}$ at reference distance from works			
			18m	25m	50m	100m
Tracked Excavator (C.2.7)	70	45%	62	55	48	40
Vibratory Plate (C.2.41)	80	25%	68	61	54	46

Plant Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$)	Assumed % on-time	Calculated Construction Noise Levels dB $L_{Aeq,12hr}$ at reference distance from works			
			18m	25m	50m	100m
Dumper Truck (C.4.4)	76	30%	66	59	52	44
Wheeled Loader Lorry (C.2.8)	68	25%	60	53	46	38
HGV (C.6.19)	76	45%	65	58	51	43
Total Construction Noise			72	65	58	50

The associated construction works will occur for short durations (rolling construction method, approx. 100m per day over an estimated 20.5 days) at varying distances from noise sensitive locations (NSL's). Review of the grid connection route has identified that the nearest NSL's to the proposed underground cable route, along local roads, are located at 18 – 25 m at the namely, H013, H018, H023 and H073. As described, construction activity will vary and will not be continuous in nature. The assessment sets out that the various activities that will contribute noise levels that, over a standard workday will be above the significance criteria, the noise levels are not predicted to exceed these criteria continuously.

It is important to note that the works for the construction of the grid connection cabling will progress along the route i.e. eventually moving away from sensitive receptors. It is estimated that the works will progress at a rate of 100 m per day. Works will therefore be in proximity to the closest NSL's for limited amount of time, i.e. less than a day.

The predicted noise levels at the closest sensitive receptors, at distances of 18 - 25 m from works, have the potential to exceed the construction noise criterion of 70 dB $L_{Aeq,1hr}$ set out in Section 12.3.2.1.1 if the works generate high noise level in proximity to the NSLs. On this basis noise control mitigation measures will be required. These are detailed in Section 12.6.

Vibration

When considering the nature of the proposed works it is expected that vibration levels at the closet sensitive receptors will be below the limit values outlined in section 12.3.2.1.3.

Description of Effects

With respect to the EPA's guidance for description of effects as referenced in Section 12.3.2.1.1, the potential noise effect at the nearest NSL associated with the 110kV Electrical Cable Route construction phase have the potential to be Negative, Significant, and Brief to Temporary when the works occurs at the closest sensitive receptors. The noise effects at most noise sensitive locations are expected to be negative, not significant, and short-term.

The potential vibration effects at the nearest sensitive receptor associated with the grid connection cabling construction phase have the potential to be Negative, Not significant, and Temporary.

12.5.2.2.3 Construction Compound

There is no significant construction activity or noise associated with the Construction Compound. Therefore it is concluded that any noise and vibration associated with the construction compounds is expected to be well below the construction noise significance threshold outlined in Table 12-1 12.3.2.1Table 12-1.

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 noise sensitive locations associated with Construction Compound is described as negative, not significant, and short-term.

12.5.2.3 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 situations are commented upon here:

- Stage 1a – Concrete Foundation Pouring Site Preparation and Ground Works.
- Stage 1b – Site Preparation and Ground Works.
- Stage 2a – Delivery of Large Equipment Using Extended Articulated Vehicles.
- 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 corrections applied for the passenger car unit (PCU) factors.

Table 12-18 Construction Traffic Data for Assessment

Route	Stage	Traffic Units	%HGV
1 – M7 between junctions 21 and 22	Existing	14,325	10.8
	1a	14,608	12.1
	1b	14,428	11.0
	2a	14,376	10.8
	2b	14,378	10.8
	Existing	4,691	10.5

Route	Stage	Traffic Units	%HGV
2 – N62 north of L3248	1a	4,974	14.2
	1b	4,794	11.0
	2a	4,742	10.5
	2b	4,743	10.5
3 – N62, Templemore Main Street	Existing	9,958	7.2
	1a	10,241	9.1
	1b	10,061	7.5
	2a	10,009	7.2
	2b	10,011	7.2
4 – N62, Templemore north	Existing	7,696	7.4
	1a	7,979	9.8
	1b	7,799	7.7
	2a	7,747	7.4
	2b	7,749	7.5
5 – N62 south of L3248	Existing	4,863	10.3
	1a	5,146	13.9
	1b	4,966	10.8
	2a	4,914	10.3
	2b	4,916	10.3
6 – L3248 leading to site	Existing	266	2.8
	1a	549	40.2
	1b	369	11.1
	2a	317	4.3
	2b	318	4.8
7 – R433	Existing	5,167	4.9
	1a	5,451	8.6
	1b	5,271	5.4

Route	Stage	Traffic Units	%HGV
	2a	5,218	5.0
	2b	5,220	5.0

Based on the traffic data presented in Table 12-18 the changes in noise level relative to the expected traffic noise from the baseline traffic flows has 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)	DMBR Magnitude of Impact	Estimated Number of Days
Stage 1a – Concrete Foundation Pouring Site Preparation and Ground Works	1	0.5	No Change	9
	2	1.3	Minor	
	3	0.8	No Change	
	4	1.0	Minor	
	5	1.3	Minor	
	6	11.7	Major	
	7	1.8	Minor	
Stage 1b – Site Preparation and Ground Works	1	0.1	No Change	341
	2	0.2	No Change	
	3	0.2	No Change	
	4	0.2	No Change	
	5	0.2	No Change	
	6	5.1	Major	
	7	0.4	No Change	
Stage 2a – Delivery of Large Equipment Using Extended Articulated Vehicles	1	0.0	No Change	24
	2	0.1	No Change	
	3	0.0	No Change	
	4	0.0	No Change	
	5	0.1	No Change	

Stage	Route	Change in Traffic Noise Level dB(A)	DMBR Magnitude of Impact	Estimated Number of Days
	6	1.7	Minor	
	7	0.1	No Change	
Stage 2b – Other deliveries using conventional articulated HGVs	1	0.0	No Change	9
	2	0.1	No Change	
	3	0.0	No Change	
	4	0.1	No Change	
	5	0.1	No Change	
	6	2.0	Minor	
	7	0.1	No Change	

With exception of Link 5 during Stage 1a an 1b, the predicted increases in traffic noise levels during each of the construction stages are less than 3 dB along all links, with reference to the DMRB magnitude of impact set out in Section 12.3.2.1.2 the potential impacts are classified as 'no change' to 'minor' change.

In Stage 1a on Link no. 5 the potential impact is 'major', however, the estimated duration of the corresponding phases is only 9 days and is therefore does not constitute a significant effect as the threshold of 10 or more days or nights in any 15 consecutive days or nights (See Section 12.3.2.1.2).

In Stage 1b on Link no. 5 the potential impact is 'major', as the 5 dB threshold is predicted to exceed by 0.1 dB. however, the estimated duration of the corresponding phases is only 9 days and is therefore does not constitute a significant effect as the threshold of 10 or more days or nights in any 15 consecutive days or nights.

As stated in Section 12.3.2.1.2 where potential significant effect is identified reference will be made to the overall predicted noise levels from the construction traffic against the construction noise criteria outlined in section 12.3.2.1.1. The predicted road traffic noise from construction traffic at 5 m from the edge of the road is 53 dB $L_{Aeq,12-hour}$. This is well below the construction noise criteria, and therefore will not constitute a significant effect.

It is concluded that there will be no significant noise impacts 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 nearest noise sensitive 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.

12.5.2.4 Cumulative Construction Noise and Vibration Effects

The list of cumulative projects from Chapter 2 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 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 and no specific mitigation measures are required.

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 12.3.7.1, the predicted turbine noise levels have been calculated at all NSL's 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 NSL's as presented in Section 12.4.2 which in turn have been derived in accordance with the criteria set out in Section 12.3.2.2.1. Results for the full set of NSL's are presented in Appendix 12-4.

Table 12-20 presents the details of the exercise at the locations with the top 10 predicted noise levels at 8 m/s (wind speed at maximum noise output for N163 turbine), which are:

- H004;
- H005;
- H006;
- H007;
- H008;
- H009;
- H011;
- H036;
- H043; and
- H050.

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
H004	Predicted Turbine Noise Level	30.2	31.6	36.0	40.4	41.7	41.8
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H005	Predicted Turbine Noise Level	31.1	32.5	36.9	41.3	42.6	42.7
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H006	Predicted Turbine Noise Level	30.7	32.1	36.5	40.9	42.2	42.3
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H007	Predicted Turbine Noise Level	30.9	32.3	36.7	41.1	42.4	42.5
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H008	Predicted Turbine Noise Level	30.1	31.5	35.9	40.3	41.6	41.7
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m height					
		3	4	5	6	7	≥8
H009	Predicted Turbine Noise Level	31.3	32.7	37.1	41.5	42.8	42.9
	Daytime Limits	45.0	45.0	45.0	45.0	45.0	45.3
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H011	Predicted Turbine Noise Level	30.8	32.2	36.6	41.0	42.3	42.4
	Daytime Limits	40.0	40.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H036	Predicted Turbine Noise Level	31.6	33.0	37.4	41.8	43.1	43.2
	Daytime Limits	40.0	40.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	0.1	0.2
H043	Predicted Turbine Noise Level	31.4	32.8	37.2	41.6	42.9	43.0
	Daytime Limits	40.0	40.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–
H050	Predicted Turbine Noise Level	31.2	32.6	37.0	41.4	42.7	42.8
	Daytime Limits	40.0	40.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–

At all NSL's the omni-directional turbine noise levels are below the noise criterion curves which the exception of a potential exceedance of 0.1 dB and 0.2 dB at location H036 at wind speeds of 7 and ≥8 m/s respectively, during night time periods only.

As discussed in Section 12.3.7.1, it 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.

The magnitude of the predicted potential exceedances for the N163 turbine are considered negligible in the context of this assessment, changes of this magnitude (±0.2 dB) would typically be imperceptible to the human ear. Notwithstanding this, mitigation in the form of turbine curtailment is addressed in Section 12.6.2.1.

12.5.3.1.1 Description of Effects

With the exception of location H036 it is considered that no significant effect is associated with the operation of this development, since the predicted noise levels associated with the Proposed Wind Farm will be within the relevant best practice noise criteria curves for wind farms. As previously discussed, the following guidance is relevant for this assessment, 2006 WEDG.

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 NSL's associated with the operation of the proposed wind turbines are described below.

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

At location H036 a potential exceedance of 0.1 and 0.2 dB of the criterion is predicted 7 and ≥8 m/s for the N163 turbine used for this assessment. While the magnitude of the predicted exceedances are considered imperceptible in the context of environmental noise, they are slightly above the applicable wind turbine noise criteria and can be defined as having a significant impact. With respect to the EPA criteria for description of effects, the predicted effects at H036 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.

12.5.3.2 Substation

Details of the proposed 110kV substation are described in Chapter 4 of the EIAR. The substation will be operational 24/7, and the noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the substation at the nearest NSL.

As part of the Proposed Project, the substation will be operational on a continuous basis. The noise emission level associated with a standard 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 110kV 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 (H016) at approximately 250 m from the noise source at the substation (transformer of substation layout) is 31 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 form the plant audible at any noise sensitive location during night time periods.

The predicted noise level is below the criterion for fixed machinal plant outlined in Section 12.3.2.2.2 and unlikely to result in any adverse impacts at nearby NSL's.

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 NSL's 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. Considering that in all aspects of the construction phase, the predicted noise levels are expected to be below the appropriate criteria at all NSL's, 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 noise sensitive locations associated with construction of turbines and hardstanding areas are described as negative, not significant, and short-term.

12.6 Mitigation

12.6.1 Construction Phase

Due to the potential for significant noise impact effects at receptors with 25 m of the 110kV electrical cabling works, specific mitigation measures are provided in section 12.6.1.1. 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.

The contract documents will specify that the Contractor undertaking the construction 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. To ameliorate any potential noise impacts that may 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.

12.6.1.1 110kV Underground Cabling

In respect of the grid connection construction, a temporary solid hoarding may be employed where there are NSL's within 25 m to the activity. This can be expected to reduce noise at the NSL by 5 - 10 dB. With this mitigation measure in place, noise levels at 18 m distance from construction activity are expected to be within the criterion for linear construction works in Section 12.3.2.1.1. 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 sensitive locations;
- Selection of plant with low inherent potential for generation of noise and/ or vibration, and;
- Placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints.

It is noted that the assessment presented in Section 12.5.2.2.212.3.2.1.312.5.2.2 is conservative, and the assessment has identified a potential exceedance of the noise criteria at two number NSL's with 25 m of the works. If the appointed contractor can demonstrate through onsite monitoring that mitigation measures are not required to meet the relevant criteria, then works can proceed without specific mitigation measures in place.

12.6.1.2 Comment on Blasting

If blasting is undertaken as part of the proposed development, 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 12.3.2.1.3 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 complaints could consist of some or all of the following:

- Restriction of hours within which blasting can be conducted (e.g. 09:00 – 18:00hrs).
- Notification to nearby residents before blasting starts (e.g. 24-hour written notification).
- The firing of blasts at similar times to reduce the 'startle' effect.
- On-going circulars informing people of the progress of the works.

- The implementation of an onsite documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.
- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

12.6.2 Operational Phase Mitigation Measures

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 of 12.3.2.2.1. The findings of the assessment, presented in Section 12.5.3.1 confirmed that the predicted operational noise levels will be within the relevant best practice noise criteria curves at all locations with the exception of location H036 where a potential exceedance of 0.1 dB and 0.2 dB at wind speeds of 7 and ≥8 m/s respectively during night time periods only.

Modern wind turbines can be programmed to run in reduced modes of operation (or low noise modes) to achieve the attenuation required in the specific wind conditions (i.e. wind speed and direction). Operating the turbines in reduced noise modes is referred to as curtailment, which typically results in a corresponding reduction in energy generation capacity for the turbine(s).

Should predicted exceedances be confirmed at the commissioning stage of the Proposed Wind Farm, it is proposed to mitigate for 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 NSL's.

For the Nordex N163 turbine adopted for this assessment the potential exceedance, if realised, can be mitigated through curtailment of the specific turbine for the relevant wind speed bins and period. 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 12.3.8 and Appendix 12.3. The following outline curtailment strategy applied to this assessment will ensure that the proposed wind farm can operate within the relevant best practice noise criteria.

The following outline curtailment strategy would apply during night time periods at windspeeds ≥7 m/s when the derived background level at location H036 is less than 38.2 dB L_{A90}.

- Turbine T04 operating in Mode 2; and
- Turbine T05 operating in Mode 1.

The updated turbine noise levels at H036 with mitigation in place on turbines T04 and T05 is presented in Table 12-21.

Table 12-21 Predicted Turbine Noise Levels at H036 with Turbine Curtailment applied.

House ID	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m height					
		3	4	5	6	7	≥8
H036	Predicted Turbine Noise Daytime (no Curtailment)	31.6	33.0	37.4	41.8	43.1	43.2
	Daytime Limits	40.0	40.0	45.0	45.0	45.0	45.0
	Potential Daytime Exceedance	–	–	–	–	–	–
	Predicted Turbine Noise Night Time (with Curtailment)	31.6	33.0	37.4	41.8	42.9	43.0
	Night Limits	43.0	43.0	43.0	43.0	43.0	43.0
	Potential Night-time Exceedance	–	–	–	–	–	–

If background noise levels at location H036 are ≥ 38.2 dB L_{A90} there would be no need for curtailment as proposed turbine noise limits have the allowance of +5 dB above background noise. It is reasonable to assume that the background noise levels at H036 will trigger an increase in the turbine noise limits at higher wind speeds; this is supported by review of the background noise data measured as part of this assessment and presented in Section 12.4.1.

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 this development.

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.

With respect to the EPA criteria for description of effects, with the implementation of mitigation, the potential noise effects at the nearest NSL's associated with the operation of the proposed wind turbines are described below.

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

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 will 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 commissioned. If an exceedance of the noise criteria is identified as part of the commissioning 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 conditions 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

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will be used. The noise and vibration impacts associated with any decommissioning of the Proposed Wind Farm can be considered to be comparable to those outlined in relation to the construction phase (as per Section 12.5.2), albeit less works will be required as only above ground structures will be removed. Turbine and mast foundations would remain underground and would be covered with earth and allowed to revegetate and cable ducting will remain in situ. The Grid Connection underground electrical cabling route and on-site substation will remain in place. Refer to Chapter 4 for full details.

12.6.3.1 Decommissioning Phase Mitigation

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 noise sensitive locations due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby noise sensitive locations, 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 noise-sensitive location. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration effect is kept within the guidance limits.

With respect to the EPA's criteria for description of effects, in terms of these construction activities, the potential associated effects at the nearest NSL's associated with the various elements of the construction phase are described below. All other elements of the construction phase are considered to have negative, imperceptible and short term effects.

12.7.1.1 Proposed Wind Farm

12.7.1.1.1 *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

12.7.1.1.2 *Access Roads*

The predicted construction noise and vibration effects associated with access roads 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.

12.7.1.1.3 *Temporary Construction Compound*

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

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.7.1.1.4 *Borrow Pit*

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

Quality	Significance	Duration
Negative	Not Significant	Short-term

12.7.1.2 Proposed Grid Connection

12.7.1.2.1 *110Kv Electrical Substation*

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

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.7.1.2.2 *110Kv Electrical Cabling Route*

The predicted construction noise and vibration effects associated with the 110Kv Electrical Cable Route are described as follows:

Quality	Significance	Duration
Negative	Not Significant	Brief to Temporary

12.7.1.3 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	Moderate	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 NSL's 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*

The predicted noise levels associated with the Proposed Wind Farm will be within best practice noise criteria curves recommended in the 2006 WEDGs, 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 noise sensitive locations 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 *110kV Substation Noise*

With the mitigation measures in place, the associated 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 some effect on nearby noise sensitive locations due to 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 Grid Connection underground electrical cabling route and on-site 110kV 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 noise sensitive locations 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 2-1 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 exception of proposed 'linear' construction works, the predicted noise emissions for the Proposed Project are not of enough magnitude to cause an increase in the cumulative construction noise emissions exceeding the threshold for significant impacts at any NSL.

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

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

Quality	Significance	Duration
Negative	Not significant	Short-term

12.7.4.2 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 has been undertaken in accordance with the guidance contained in the IOA GPG. Due to the distance between the turbines of the Proposed Wind Farm and the other wind energy developments considered, there are no cumulative effects anticipated.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest noise sensitive locations 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 110kV Electrical Cabling will not generate any noise during the operational phase, and the predicted operational noise levels at the nearest NSL from the operation of the 110kV Electrical 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 noise sensitive locations associated with cumulative impacts from the Proposed Grid Connection are described as:

Quality	Significance	Duration
Negative	Not significant	Long-term