12.0 NOISE AND VIBRATION

12.1 INTRODUCTION

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration effects on local residential amenity from the proposed development. A full description of the proposed development is provided in Chapter 3 (Description of the Proposed Development).

Noise and vibration impact assessments have been prepared for the operational, construction, and decommissioning phases of the proposed development to the nearest noise sensitive locations (NSLs). To inform this assessment baseline noise levels have been surveyed at ten representative NSLs surrounding the proposed wind farm site. Noise predictions for the nearest NSLs have been prepared for all key elements of the proposed development that have the potential for noise and vibration impacts and effects.

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

12.1.1 Statement of Authority

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

Dermot Blunnie (Associate (Acoustics)) 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.

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

12.1.2 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 enormous range of pressure levels that can be detected by the ear, it is widely accepted that sound levels are measured and expressed using a decibel scale i.e., a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels is 0 dB (for the threshold of hearing) to 120 dB (for the threshold of pain). In general, a subjective impression of a doubling of loudness corresponds to a tenfold increase in sound energy, which 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, will increase the SPL by 3 dB. This results in the subjective impression of a slight increase in noise level.

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. To rank the SPL of various noise sources, the measured level must 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.

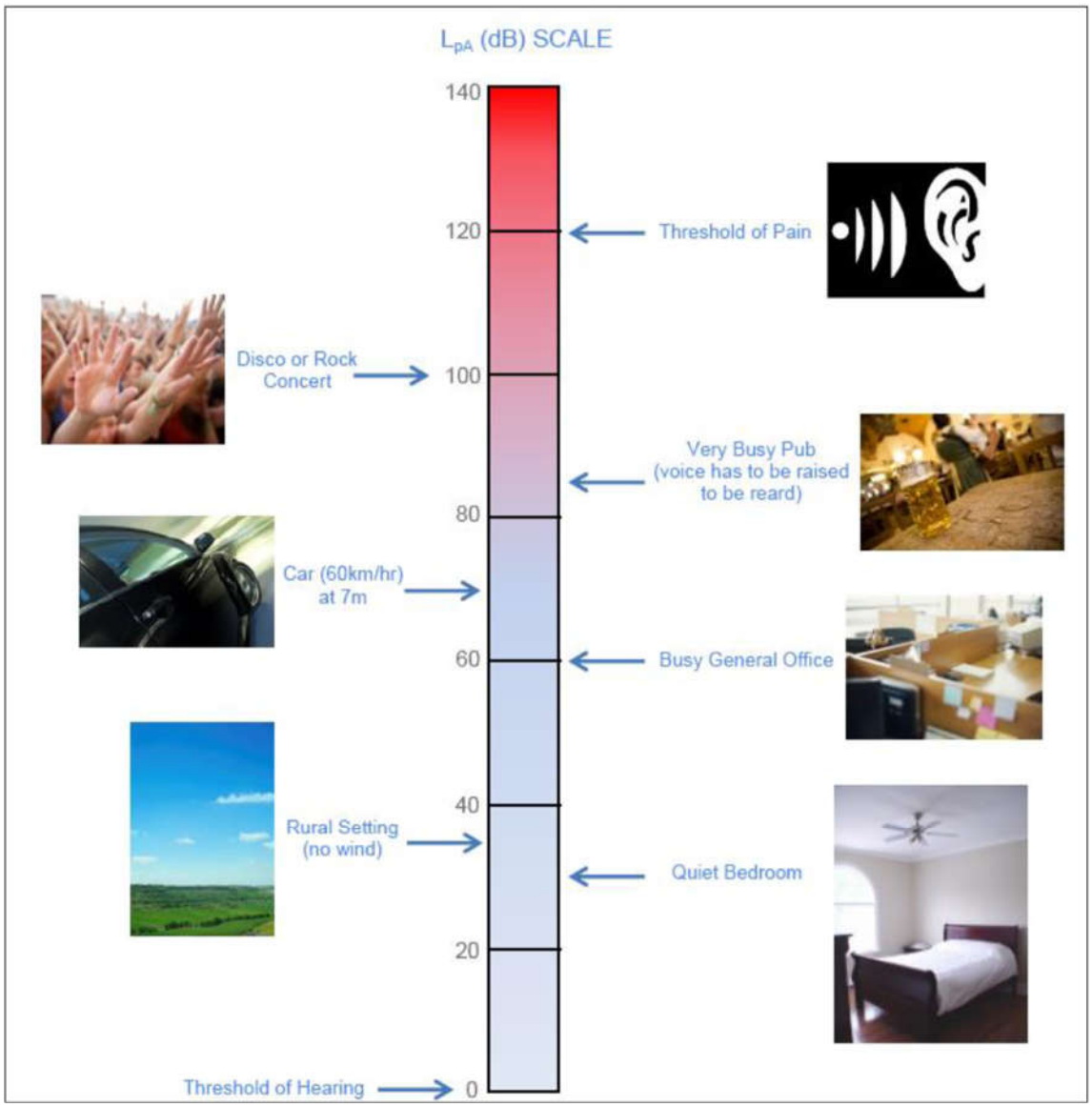

Figure 12-1:dB(A) Scale & Indicative Noise Levels – (EPA: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4 – 2016))

12.2 CONSULTATION

There were no consultations with Local Authorities, Government Departments, NGOs or Stakeholders that affected the assessment and preparation of the Noise and Vibration Chapter for this EIAR. Refer to Chapter 1 (Introduction) for full details of consultations.

12.3 LEGISLATION, POLICY AND GUIDANCE

The assessment of effects for the proposed development has been undertaken with reference to the most relevant guidance documents relating to environmental noise and vibration. The following guidance documents have been consulted when preparing this chapter of the EIAR:

- *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* and its *Supplementary Guidance Notes* (IOA GPG) (2013);
- *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*, Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA) (2004).
- *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*;
- EPA document *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)* (EPA, 2011);
- EPA document *'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)* (EPA, 2016)*;*
- 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); and,
- Department for Business, Energy & Industrial Strategy *Wind Turbine AM Review: Phase 2 Report Project Number: 3514482A Issue: 3 Issued August 2016*

12.3.1 Environmental Protection Agency (EPA) Description of Effects

The significance of effects of the proposed development shall be described in accordance with the EPA guidance document *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EIAR)*, (2022). Details of the methodology for describing the significance of the effects are provided in Chapter 1 (Introduction).

The effects associated with the proposed development are described in the relevant sections of this chapter in accordance with the EPA guidance set out in Chapter 1 (Introduction) 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.

12.3.2.1 Construction and Decommissioning Phase – Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation 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 *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* (BS5528-1).

The approach adopted here calls for the designation of an NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. A threshold noise value is applied to each category. Exceedances (construction noise only) of the threshold value, at the facade of a noise-sensitive location (NSL) during construction, indicates a potential significant noise impact associated with the construction activities. The threshold values recommended by BS5228-1 are depicted in Table 12-1. The threshold values are applicable to both construction and decommissioning noise. It should be noted that this assessment method is only valid for residential properties.

Table 12-1 Example Threshold of Potential Significant Effect at Dwellings

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

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

Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.

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

Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The following method should be followed.

For each period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5 dB. At some properties, particularly those located close to busy roads, the ambient noise levels are expected 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 55 dB $L_{Aeq.1hr}$. Therefore, for the purposes of this assessment, as a worst case, all properties will be afforded a Category A designation.

If the specific construction noise level exceeds the category threshold value (e.g., 65 dB $L_{Aeq,T}$ during daytime periods) then a significant effect is considered to occur. In order to determine the significance of the effects it is important to consider the duration of the impacts.

12.3.2.2 Additional Vehicular Activity on Public Roads Construction Phase

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the proposed development will make use of existing roads already carrying traffic volumes, it is appropriate to assess the calculated increase in traffic noise levels that will arise because of vehicular movements associated with the proposed development.

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

Table 12-2 taken from DMRB LA 111 offers guidance as to the likely short-term impact associated with any change in traffic noise level.

Table 12-2 Likely Impacts Associated with Change in Traffic Noise Level (Source LA 111 DMRB, 2020).

Change in Sound Level (dB L_{A10})	Magnitude of Impact
Less than 1 dB	No change
1 – 2.9	Minor
3 – 4.9	Moderate
≥5	Major

The DMRB guidance will be used to assess the predicted increases in traffic levels on public roads associated with the proposed development (this includes the Turbine Delivery Route) and comment on the likely '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 threshold values outlined previously in this section.

12.3.2.3 Consideration of Duration When Assessing Effects

Section 3.19 of LA 111, DMRB states that construction noise and construction traffic noise shall constitute a significant effect where it is determined 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.

12.3.2.4 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 this proposed development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

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

- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (BSI, 1993) (BS7385).
- BS 5228-2:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (BSI, 2014) (BS5228-2).

BS7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at 4 Hz rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS5228-2 recommends that, for soundly constructed residential properties 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 15 Hz. Below these vibration magnitudes minor damage is unlikely, although the standard notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (2004) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 12-3.

Table 12-3 Allowable Vibration at Sensitive Properties (NRA, 2004)

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 suggested vibration criteria discussed above from BS7385, BS5228-2 and the NRA Guidelines, the values in Table 12-3 from the NRA Guidelines are considered appropriate for this assessment.

12.3.2.5 Operational Phase Noise – Wind Turbines

The noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines for Planning Authorities* (WEDG) published by the Department of the Environment,

Heritage and Local Government in 2006. These guidelines are based on detailed recommendations set out in the Department of Trade and Industry (UK) Energy Technology Support Unit (ETSU) publication *The Assessment and Rating of Noise from Wind Farms* (1996) (ETSU-R-97). The ETSU document has been used to supplement the guidance contained within the WEDGs, where appropriate and necessary.

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

The core of the noise guidance contained within the WEDGs is based on the ETSU publication ETSU-R-97.

ETSU-R-97 advises regulating wind turbine noise by establishing noise limits at the properties most sensitive to noise. The document suggests that applying fixed noise limits across all wind speeds may not be appropriate for wind turbine projects. Instead, it recommends setting noise limits in relation to the prevailing background noise levels at sensitive locations. A crucial step in assessing noise for wind energy projects involves identifying the existing background noise levels through on-site surveys.

Page 58 of ETSU-R-97 states: "*…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 development 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* (IOA GPG) including 6 Supplementary Guidance Notes. 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 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 (2024). This

is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds, and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

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

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. In the first instance, to determine if they need to be included in the wind turbine noise assessment or if they can be scoped out of the cumulative assessment.

Section 5.1 of the IOA GPG provide criteria to determine if a cumulative turbine noise assessment is 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 in Section 12.4.3.4.

Wind Energy Development Guidelines for Planning Authorities

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

The following extracts from this document should be considered:

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

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

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

The issues identified in this extract have been incorporated into the assessment to determine the applicable turbine noise limits in Section 12.5.2.

> *"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 properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of the $L_{A90,\ 10min}$ 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. This represents the commonly adopted night time noise criterion curve in relation to wind farm developments.

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

- An appropriate absolute limit level in the range of 35 – 40 dB LA90 for quiet daytime environments with background noise levels of less than 30 dB LA90,10min;
- 45 dB LA90,10min 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 LA90,10min and;
- 43 dB LA90,10min for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the WEDGs, an allowance for same is commonly applied in noise assessments

prepared and is accepted as detailed in numerous examples of planning conditions issued by An Bord Pleanála.

Planning Conditions for Operational Noise on Existing Wind Energy Developments in the Area

The ABP planning permission for the Sliabh Bawn wind farm development (Ref: PL20.239743) enforces a lower threshold of 43 dB $L_{A90,10\text{-}min}$ through Condition no. 8 of the grant of planning. It is understood that this condition relates to all periods, day and night.

> "*8. Noise levels emanating from the proposed development following commissioning shall not exceed the greater of 43dB(A) L_{90}, or 5 dB(A) above the background noise level…"*

Future Potential Guidance Changes

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

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

The following statement is of note from the response:

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

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

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

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

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 Guidelines are published during the application process for the proposed development 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.

World Health Organization (WHO) Noise Guidelines for the European Region

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'.

A strong recommendation, "*can be adopted as policy in most situations*" whereas a conditional recommendation, "*requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply*".

The objective of the WHO Environmental Noise Guidelines for the European Region 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 risk of 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 policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."*

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

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

There is potential for 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, from within Environmental Noise Guidelines:

> *"Even though correlations between noise indicators tend to be high (especially between L_{Aeq}-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 Lden 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."

It is considered that the conditional WHO recommended average noise exposure level (i.e. 45 dB L_{den}), if applied as target noise criteria for an existing or proposed wind turbine development in Ireland, should be done with caution. The conditional WHO recommendation for average noise exposure level (i.e., 45 dB L_{den}) may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.

Low Frequency Noise and Infrasound

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200 Hz whereas infrasound is typically described as sound at frequencies below 20 Hz. 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."

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. The article notes the following with respect to infrasound:

"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 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."

In conclusion, low frequency noise and infrasound associated with wind turbines is expected to be below perceptibility thresholds and are not likely to result in any significant effects at NSLs. The are no criteria proposed to assess low frequency noise or infrasound as part of the EIAR.

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* (IOA, 2016) as:

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

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

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

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

'Normal' AM

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

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

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

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.

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 conclusions of this report were that aerodynamic modulation was only considered to be an issue at four, and a possible issue at a further eight, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the four 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."*

Concluding Comments on AM

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.

There is no clear industry consensus on how AM should be regulated or managed at the planning stage. Consequently, there is no methodology that can be applied to predict the likelihood of AM at a particular wind farm site. Any site-specific assessment would need to be undertaken at post commissioning stage. The assessment of AM at post commissioning stage is discussed in Section 12.7.2.2.

12.3.2.6 Operational Phase Noise – Fixed Plant Items

For the proposed Substation and Battery Storage Facility (fixed mechanical and electrical plant), it is proposed to set fixed noise limits in accordance with the following best practice guidance.

EPA NG4

In order to establish whether the NSLs would be considered 'low background noise' areas as defined in the EPA publication, Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities 2016 (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 LA90 During Night-time Period ≤30 dB L_{A90}.*

Determining Appropriate Noise Criteria

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

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.

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

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

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

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

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

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

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

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

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

> "*The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.*

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

12.3.2.7 Operational Phase Vibration

Vibration generated from the operation of a wind turbine unit will decrease rapidly with distance. Typically, at 100 m from a 1 MW turbine unit the level of vibration associated with a turbine is the order of 10^{-5} mm/s.

A report from Germany published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016, "*low frequency noise incl. infrasound from wind turbines and other sources*" conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300 m 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 development to the nearest NSL is in excess of 780 m (distance from turbine T01 to NSL ref. P1133). 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 development.

12.3.2.8 *Human Health Effects*

There is currently no credible evidence to link wind turbine noise exposure in the environment to adverse health impacts. For further details of potential health impacts effects associated with the proposed development, refer to Chapter 6 (Population and Human Health).

12.4 ASSESSMENT METHODOLOGY

The outline methodology adopted for this assessment is summarised as follows:

- Review of best practice guidance to identify appropriate noise and vibration criteria for the construction, operational and decommissioning phases;
- Characterise the receiving environment through baseline noise surveys at various NSLs surrounding the proposed development;
- Undertake predictive calculations to assess the potential effects associated with the construction phase of the proposed development;
- Undertake predictive calculations to assess the potential effects associated with the operation of the proposed development at NSLs;
- Undertake predictive calculations to assess the potential effects associated with the decommissioning of the proposed development at NSLs;
- Specify mitigation measures to reduce, where necessary, the identified potential outward effects relating to noise and vibration from the proposed development; and,
- Describe the significance of the residual noise and vibration effects associated with the proposed development.

12.4.1 Study Area

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

12.4.1.1 Operational Phase Noise

For the operational phase the study area should cover, at a minimum, the area predicted to exceed 35 dB L_{A90} from all existing, permitted, and proposed wind turbines. Due to the potential for cumulative effects with other existing wind farm developments, the study area for the operational phase of the proposed development covered the area predicted to exceed 30 dB L_{A90} at the maximum predicted noise emission level. Refer to Appendix 12-5 which displays the relevant noise contours maps which identify this area.

The NSLs identified within this study area have been considered in the assessment of operational noise from proposed fixed plant (Substation and Battery Storage Facility).

12.4.1.2 Construction and Decommissioning

During the construction and decommissioning phases, noise could occur at any location within the redline boundary and along public roads where there are increases in traffic associated with the proposed development. There is also a potential for noise impacts from HGVs along the proposed turbine delivery route (TDR).

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

12.4.2 Background Noise Survey

A background noise survey was undertaken to establish typical background noise levels at representative NSLs surrounding the proposed wind farm site. The background noise survey was conducted through installing unattended sound level meters at 10 no. representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with the IOA GPG and accompanying *Supplementary Guidance Note 1: Data Collection* (2014) discussed in the following sections.

12.4.2.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Any locations 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 co-ordinates for selected locations for the noise monitoring locations are outlined in Table 12-5 and identified on a map in Figure 12-2.

Table 12-5 Noise Measurement Coordinates

Location Reference	Co-ordinates (ITM)	
	Easting	Northing
Location A	602,904	770,195
Location B	605,146	772,130
Location C	604,661	767,075
Location D	607,636	766,798
Location E	606,646	765,048
Location F	610,819	764,664
Location G	604,525	768,883
Location H	605,356	770,327
Location I	606,904	763,428
Location J	609,090	765,456

The noise environment has been observed during equipment installations, site visits to maintain the equipment, and equipment collections. In general, the significant noise sources in the area were noted to be local and distant traffic movements, activity in and around the residences, wind generated noise from local foliage and other typical anthropogenic sources typically found in such rural settings.

Site visits by survey personnel were carried out during the morning and afternoon time; during these visits, primary noise sources contributing to noise build-up were noted. In respect of night-time periods, when noise due to traffic on local roads, agricultural activities and other sources tend to reduce, there was no indication of any significant local night-time sources of noise at any location.

Noise from the operation of existing turbines located at Sliabh Bawn wind farm were not noted to be audible at any of the locations during site visits. It should be noted that the level of wind turbine noise is variable, it is dependent on the operational condition of the turbine, wind speed and direction, distance from the turbines, and the levels of background noise at the location.

It is important to note that any noise from the existing wind turbines in the area should not form part of the background noise environment at noise sensitive locations. This issue is discussed further later in this section.

No significant sources of vibration were noted at any of the survey locations.

8°0'0"W
7°55'0"W
7°50'0"W
53°42'0"N
53°40'0"N
53°38'0"N
772000
768000
764000
601000
605600
610200

N

Location A
Location B
Location C
Location D
Location E
Location F
Location G
Location H
Location I
Location J

T01
T02
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Maxar, Microsoft

Legend

- Proposed wind farm site boundary
- Turbine Location
- Noise monitoring locations

0 1 2
Kilometres

NOTES

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING\
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE\
3. ENGINEER TO BE INFORMED OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES\
4. ALL LEVELS RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

A	25/11/2024	First issue	D.E	I.H
Rev	Date	Description	By	Chkd

Client:
Bord na Móna

Project:
Derryadd Wind Farm

Title:
Figure 12-2
Noise monitoring locations

Scale @ A3: 1:40,000

Prepared by:	Checked by:	Date:
D.Ekpo	I.Heanue	November 2024

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Map Ref: 11399-017-N.M.L-P.APP.BO-TOB-A

Draft: A

Plate 12-1 to Plate 12-10 illustrate the installed noise monitoring kits at each location.

Location A

The sound meter at Location A was installed in the garden to the rear of the property. There were no significant or atypical noise sources noted at this location. An observation of some cows lowing in the field next to the property at the time of installation was noted.

Plate 12-1 Noise monitor Installed at Location A

Location B

At Location B, the monitoring equipment was installed in the garden to the rear of the property. There were no significant or atypical noise sources noted at this location. Wind generated noise in trees and birdsong were noted as prominent noise sources.

Plate 12-2 Noise monitor Installed at Location B

Location C

The meter at Location C was installed in a field beside the property. Distant traffic noise was audible intermittently on the nearby road. It was also reported that chickens were in a nearby area, but they were not considered to make any significant impact on the measurements.

Plate 12-3 Noise monitor Installed at Location C

Location D

The sound meter installed at Location D was set up in the garden to the rear of the property. There were no significant or atypical noise sources noted at this location at the time of the installation or during any site visits.

Plate 12-4 Noise monitor Installed at Location D

Location E

The installation at Location E was in the garden at the rear of the property. This distant road noise was audible at the time of the installation.

Plate 12-5 Noise monitor Installed at Location E

Location F

At Location F, the noise meter was installed in the rear garden of the property. It was reported that this garden was quite sheltered, and that noise from a nearby lock in canal was the dominant and consistent noise source.

Plate 12-6 Noise monitor Installed at Location F

Location G

At Location G, the monitoring equipment was installed in the garden to the rear of the property. It was reported that road traffic noise from the N63 road was a dominant source of noise at this location. It was also noted that there was a large number of trees, and that wind in the trees was another consistent noise source.

Plate 12-7 Noise monitor Installed at Location G

Location H

The installation at Location H was in the garden with the bogland located to the west. There were no significant or atypical noise sources noted at this location, with wind generated noise in trees and birdsong noted to be the dominant noise sources.

Plate 12-8 Noise monitor Installed at Location H

Location I

The meter at Location I was installed in the front garden of the property. It was noted that road traffic from the R392 was a dominant source of background noise at this location in the absence of any wind generated noise.

Plate 12-9 Noise monitor Installed at Location I

Location J

At Location J, the sound level meter was installed in a field to the west of the property. There were no significant or atypical noise sources noted at this location.

Plate 12-10 Noise monitor Installed at Location J

12.4.2.2 Survey Periods

The survey duration was typically four 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 undertaken at relevant monitoring locations over the periods outlined in Table 12-6 Noise Measurement Periods.

Table 12-6 Noise Measurement Periods

Location Reference	Survey Period	
	Start Date	End Date
Location A	12/05/2022 12:00 hrs	17/06/2022 12:50 hrs
Location B	12/05/2022 10:20 hrs	17/06/2022 00:00 hrs
Location C	23/05/2022 14:00 hrs	21/06/2022 03:40 hrs
Location D	03/06/2022 12:40 hrs	27/06/2022 05:30 hrs
Location E	12/05/2022 14:00 hrs	28/06/2022 14:00 hrs
Location F	12/05/2022 13:20 hrs	26/06/2022 13:00 hrs
Location G	12/05/2022 11:40 hrs	26/06/2022 00:30 hrs
Location H	12/05/2022 11:10 hrs	26/06/2022 17:10 hrs
Location I	12/05/2022 12:30 hrs	23/06/2022 03:20 hrs
Location J	12/05/2022 14:30 hrs	12/06/2022 14:10 hrs

A variety of wind speed and weather conditions were encountered over the survey periods in question. Figure 12-3 shows the distribution of wind speed and direction recorded at the met masts for all periods of day and night between 12 May 2022 and 26 June 2022. The wind speed data presented below relates to a turbine hub height of 107.5 m.

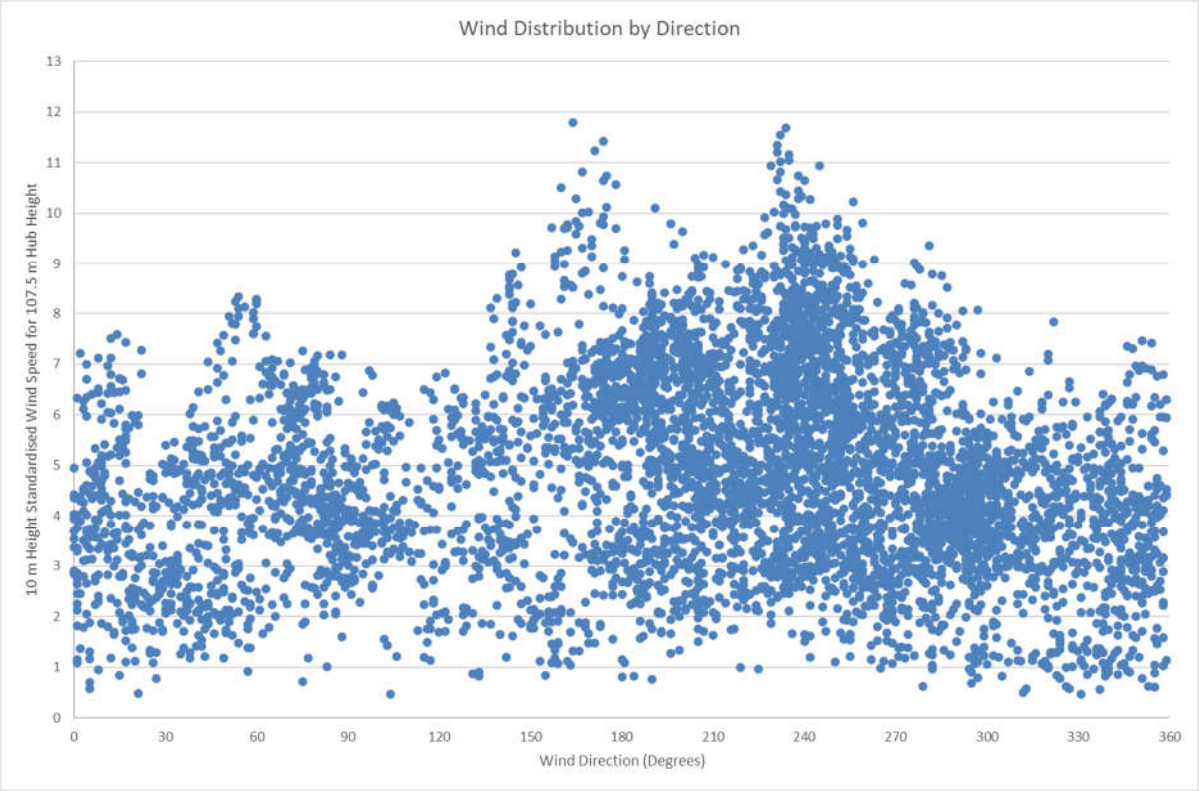

Figure 12-3 Distribution of Wind Speeds and Direction at Met Mast during Survey Period

It is confirmed that survey periods were of sufficient duration to measured adequate data to derive a suitable representation of typical background at all locations in accordance with guidance contained within the IOA GPG.

12.4.2.3 Instrumentation

Table 12-7 confirms the details of the instrumentation installed at each location.

Table 12-7 Details of Noise Measurement Instrumentation

Location Reference	Equipment Make and Model	Serial Number
A	Rion NL-52	1076330
B	Rion NL-52	564809
C	Rion NL-52	586940
D	Rion NL-52	764925
E	Rion NL-52	575785
F	Rion NL-52	976162
G	Rion NL-52	998409
H	Rion NL-52	164426
I	Rion NL-52	998410
J	Rion NL-52	998411

Before, after and during each survey period, the measurement instrument was checked and calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator. All calibration drifts were less than +/- 0.5 dB. Copies of the relevant calibration certificates are included in Appendix 12-2.

Rainfall was logged and recorded using rain gauges installed at Location B and Location E. The rainfall data allows for the identification of periods of rainfall so that they can be removed from the noise monitoring data sets, in line with best practice, when calculating the prevailing background noise levels at the various locations.

Wind speed measurements were obtained from an onsite met mast with anemometers situated at 100 m and 80 m. The location of the met mast is provided in Table 12-8.

Table 12-8 Met Mast Location

Met Mast Reference	Co-ordinates (ITM)	
	Easting	Easting
Lough Bannow	608,039	764,920

12.4.3 Analysis of Survey Data

12.4.3.1 Measurement Procedure

Measurements were conducted at all locations over the survey periods outlined in Table 12-6. Data samples for all measurements (noise, rainfall, and wind) were logged continuously at 10-minute interval periods for the duration of the survey. The $L_{Aeq,10min}$ and $L_{A90,10min}$ noise parameters were measured in this instance and the results were saved to the instrument memory for later analysis.

Survey personnel noted potential primary noise sources contributing to noise build-up during the installation and removal of the sound level meters from site. Description of the observed noise environment at each of the monitoring locations is presented in Section 12.5.112.4.2.1.

12.4.3.2 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 removed from the data sets.

12.4.3.3 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.

The assessment methods outlined above are in line with the guidance contained in the IOA GPG.

12.4.3.4 Noise from Existing Turbines

An appraisal of the wider study area identified the operational Sliabh Bawn wind farm which is located approximately 8 km to the northwest of the proposed wind farm site boundary. Review of the data confirmed that the Sliabh Bawn wind farm does not have potential for cumulative turbine noise impacts and in accordance with best practice guidance discussed in Section 12.3.2.5, the Sliabh Bawn turbines have not been included in the assessment.

12.4.3.5 Consideration of Wind Shear

As part of a robust wind farm noise assessment due consideration should be given to the issue of wind shear. It is standard procedure to reference noise data to standardised 10 metre wind speed. Wind shear has been considered in this assessment in accordance with the guidance contained in the IOA GPG, Supplementary Guidance Note (SGN) 4: Wind Shear, July 2014. This guidance presents the following equations in relation to the derivation of a standardised wind speed at 10 m above ground level:

Equation A this uses the following equation:

Shear Exponent Profile:

$$U = U_{ref}\left[\frac{H}{H_{ref}}\right]^{m}$$

Where:
U calculated wind speed.

U_{ref}	measured wind speed.
H	height at which the wind speed will be calculated.
H_{ref}	height at which the wind speed is measured.
m	shear exponent.

Equation B this uses the following equation:

Roughness Length Shear Profile:

$$U_1 = U_2 \frac{\ln(H_1/z)}{\ln(H_2/z)}$$

Where:

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

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

The derived background noise level at integer wind speeds (standardised 10 m height) is dependent on the specific hub height; an assessment hub height of 107.5 m has been used in this assessment. Any reference to wind speed in the following sections of this chapter should be understood to be the standardised 10 m height wind speed reference unless otherwise stated.

12.4.4 Construction Noise Calculations

A variety of items of plant will be used for the purposes of site preparation, construction, and site works. There will be vehicular movements to and from the site that will make use of existing roads. There is the potential for generation of significant levels of noise from these activities.

Due to the nature of construction activities, it is difficult to calculate the actual magnitude of emissions to the local environment in the absence of details on the specific plant items and methods to be employed. The standard best practice approach is to predict typical noise levels at the NSLs using guidance set out in British Standard *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra from BS 5228-1 at various distances from these works.

12.4.5 Operational 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 development on the

receiving environment. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

12.4.5.1 Noise Prediction Software

The selected software, DGMR *iNoise Enterprise (Version 2024.2.1)* calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 2024).

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 (LWA);
- The distance between the source and receiver;
- The presence of obstacles such as screens or barriers in the propagation path;
- The presence of reflecting surfaces;
- The hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impacts at distances greater than approximately 400 m).

12.4.5.2 Noise Prediction Model - Input Data and Assumptions

Information available for the site was input into the iNoise noise modelling software using the ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 2024) The input data and assumptions made are described in the following sections.

Proposed Turbine Details

Table 3-1 in Chapter 3 (Description of the Proposed Development) details the co-ordinates of the 22 number turbines of the proposed development.

The turbine noise assessment has been undertaken for a turbine hub height of 107.5 m, a rotor diameter of 165 m and a tip height of 190 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 noise levels have been predicted at NSLs for a range of operational wind speeds based on the source of noise at a hub height of 107.5 m and noise emission data for the Vestas V162-7.2MW turbine. 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.

While the noise profiles of the Vestas V162[3] 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

[3] EnVestas V162-7.2MW 50/60 Hz Document no. 0116-1715_00

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 V162 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 12-9 details the turbine noise data used in the noise predictions models for the proposed development, the noise data is for turbines with serrated trailing edge (STE) blades.

Table 12-9 LWA Levels for – V162-7.2MW with 107.5 m Hub Height

Wind Speed (m/s at 10m Standardised Height)	dB L_{WA}
3	94.0
4	94.8
5	99.1
6	103.3
7	104.6
8	104.8
9	105.0
10	105.4
11	105.5

The manufacturer's turbine sound power levels outlined in

Table 12-9 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 Table 12-9.

As explained in Section 12.3.2.512.3.2.5, the criteria are couched in terms of a L_{A90} criterion. Best practice guidance in the IOA GPG states that "*L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB*". A 2 dB reduction has therefore been applied in the noise model calculation. All predicted noise levels in this chapter are presented in terms of L_{A90} parameter, i.e., this reduction of 2 dB is applied in the noise prediction modelling.

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

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, 2024*.

Additional Information

Appendix 12-3 provides comprehensive details of noise prediction calculation settings, the NSL and turbine co-ordinates, and the turbine sound power emissions.

12.5 EXISTING ENVIRONMENT

This section of the chapter documents the typical background noise levels measured in the vicinity of the NSLs in closest proximity to the proposed wind farm site.

12.5.1 Derived Background Noise Levels

The following section presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and nighttime periods. These levels have been derived using regression analysis carried out on the data sets measured in line with best practice guidance Section 12.4.212.4.3.

12.5.1.1 Location A

Figure 12-4 and Figure 12-5 shows the derived daytime and night-time background noise level for Location A.

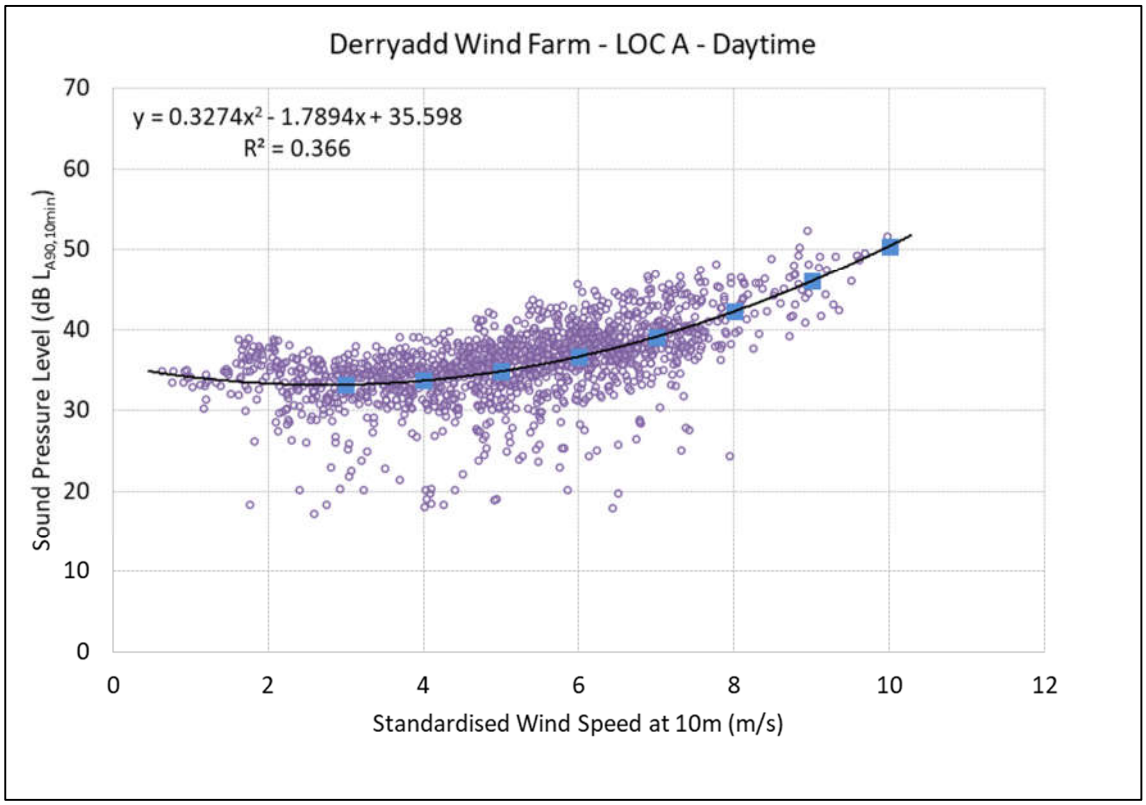

Figure 12-4 Location A – Background Noise – Daytime – 107.5 m Hub Height

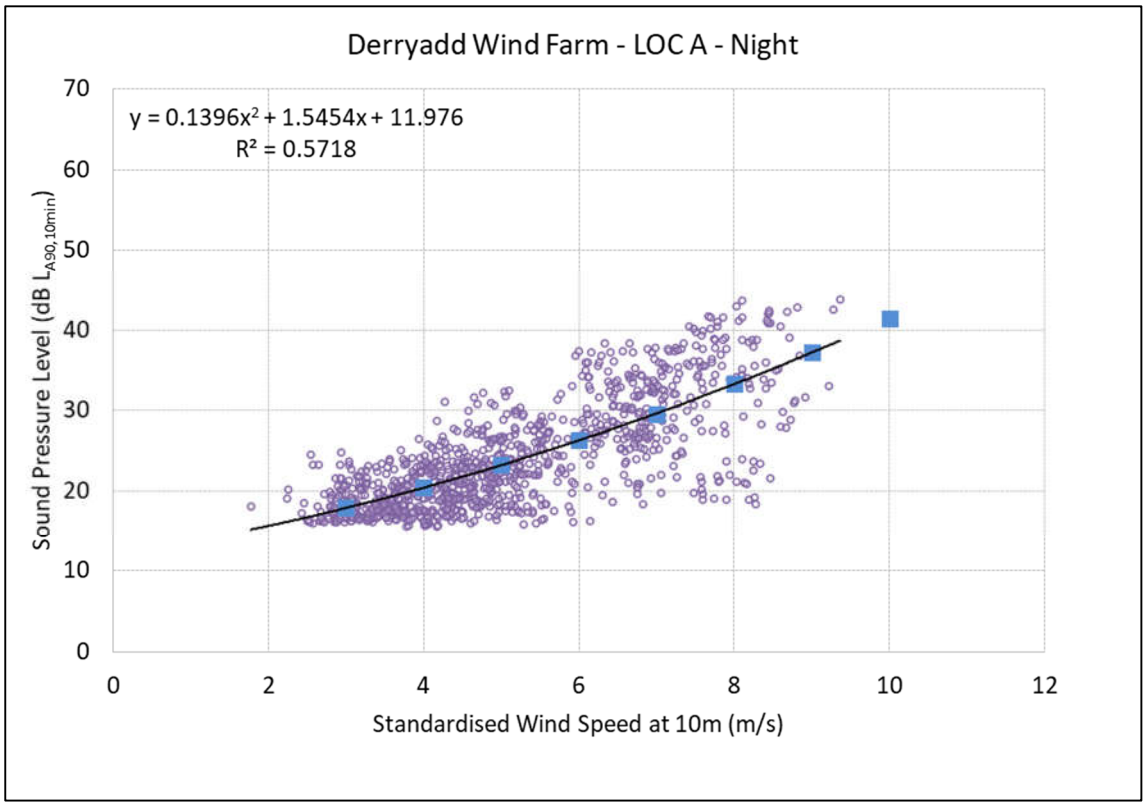

Figure 12-5 Location A – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.2 Location B

Figure 12-6 and Figure 12-7 shows the derived daytime and night-time background noise level for Location B.

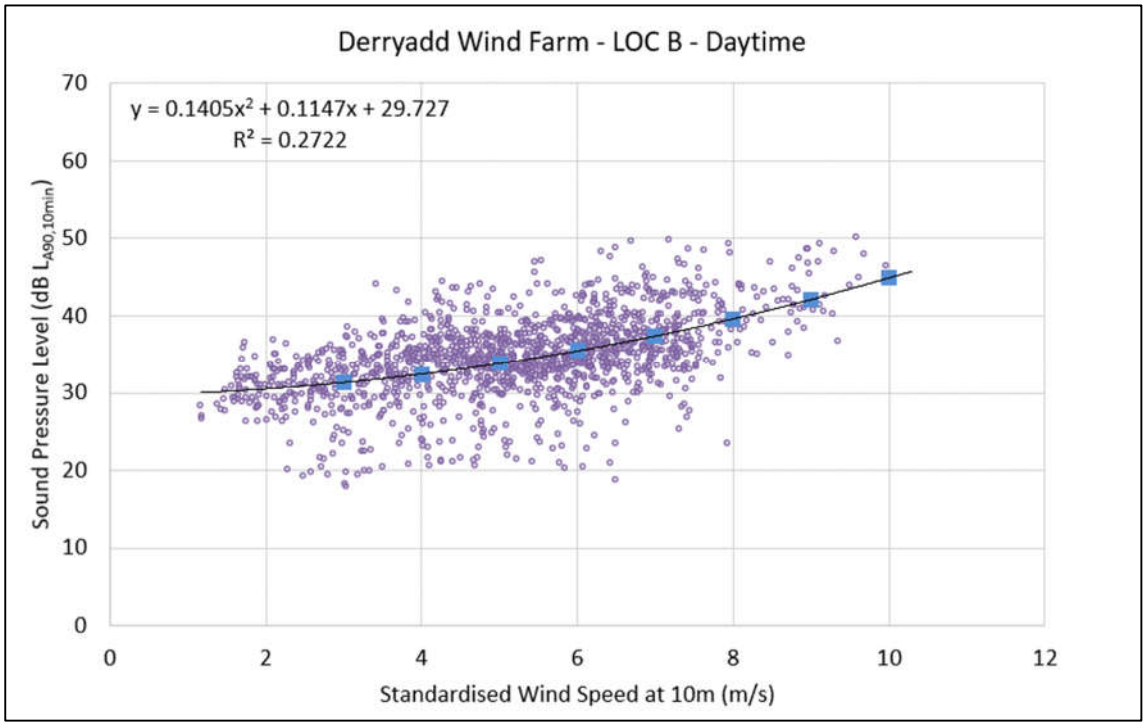

Figure 12-6 Location B – Background Noise – Daytime – 107.5 m Hub Height

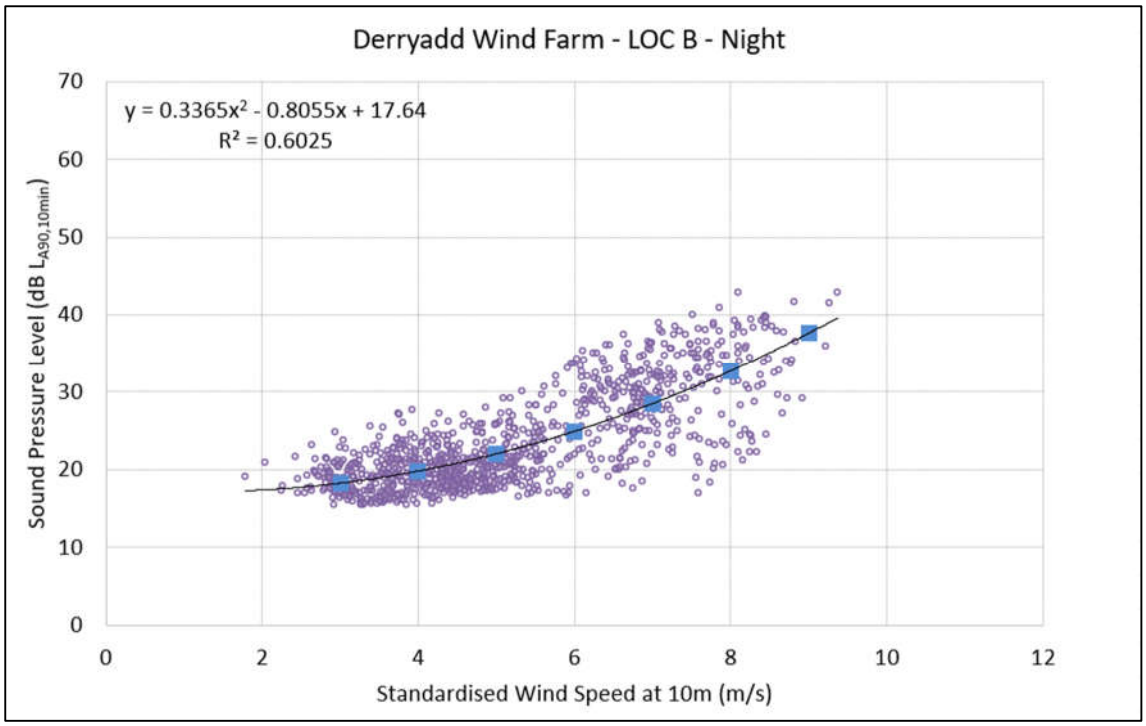

Figure 12-7 Location B – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.3 Location C

Figure 12-8 and Figure 12-9 shows the derived daytime and night-time background noise level for Location C.

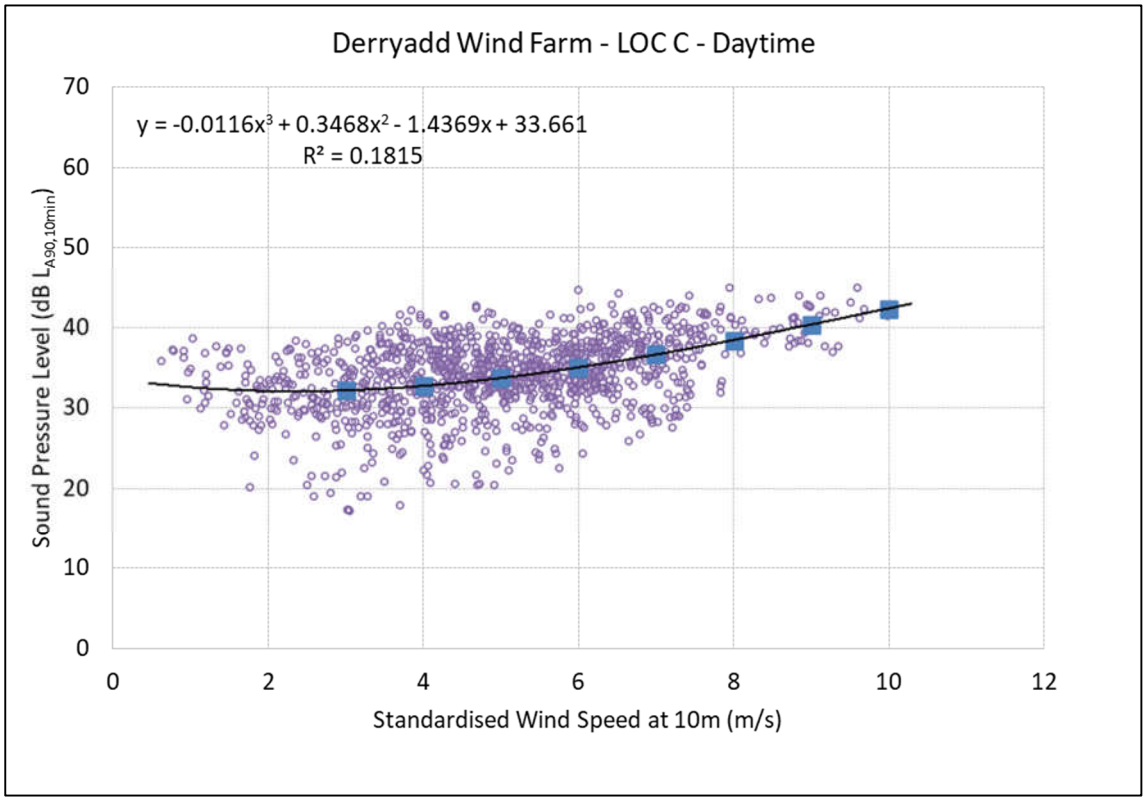

Figure 12-8 Location C – Background Noise – Daytime – 107.5 m Hub Height

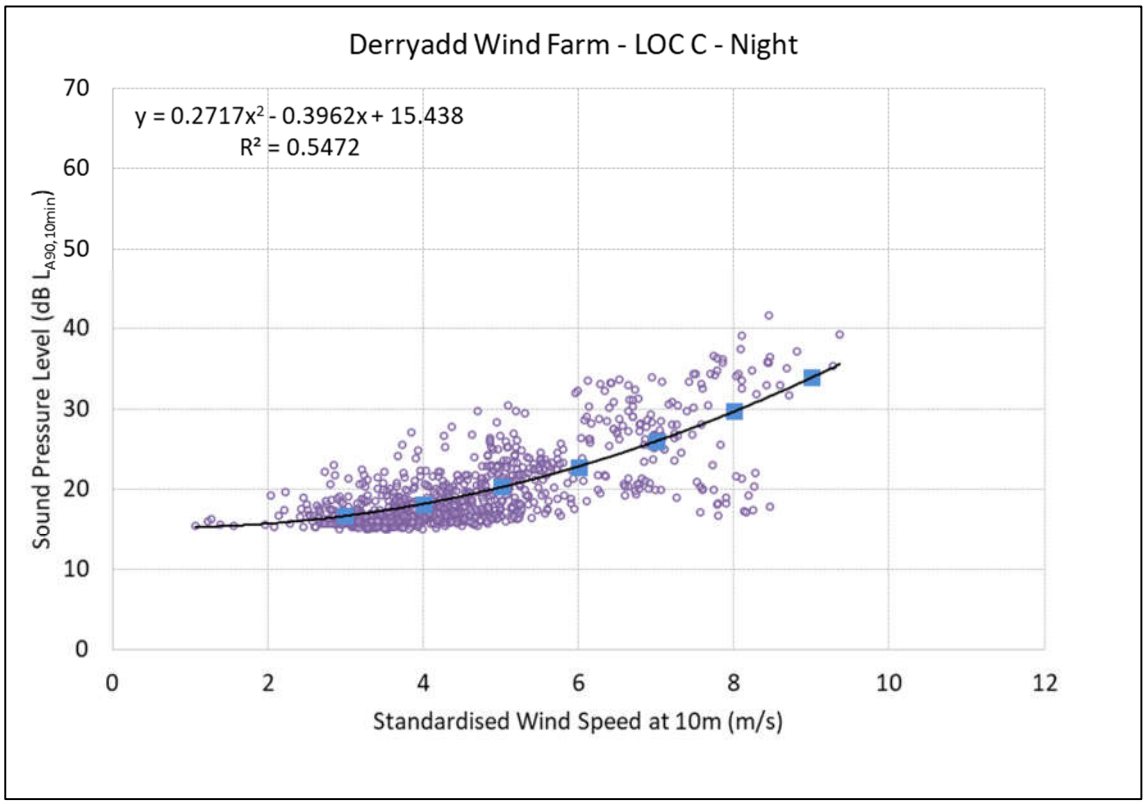

Figure 12-9 Location C – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.4 Location D

Figure 12-10 and Figure 12-11 shows the derived daytime and night-time background noise level for Location D.

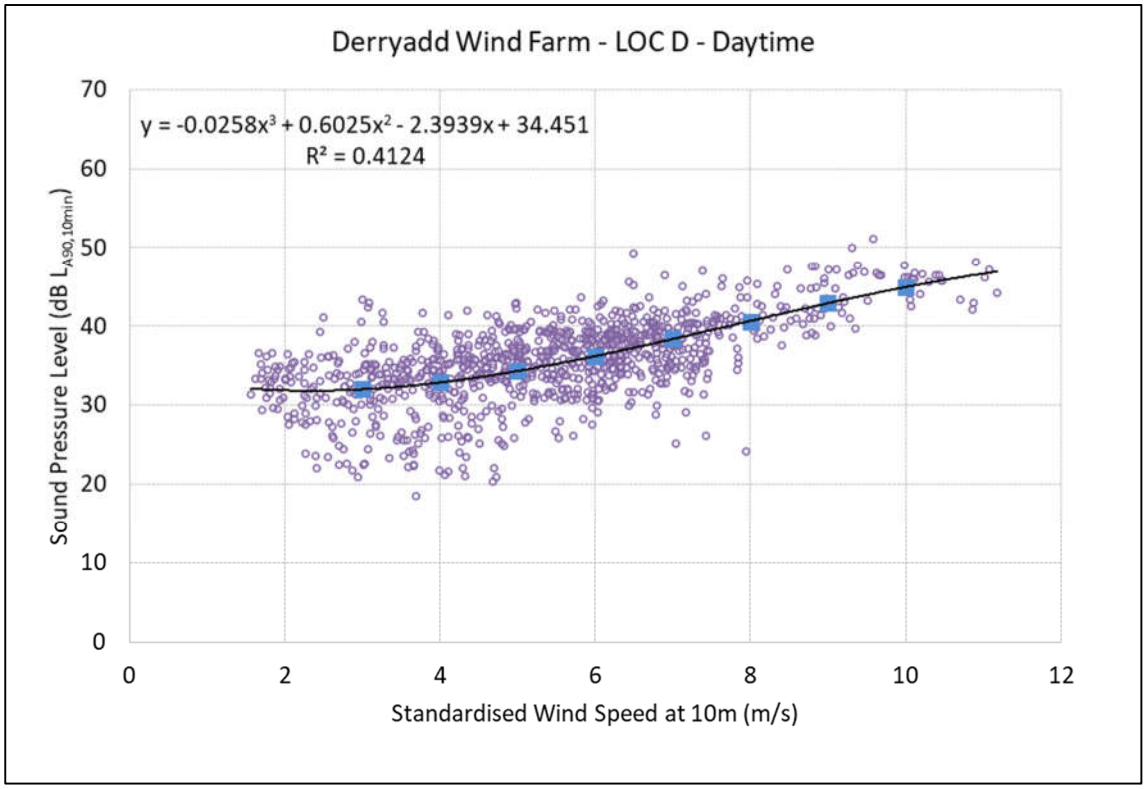

Figure 12-10 Location D – Background Noise – Daytime – 107.5 m Hub Height

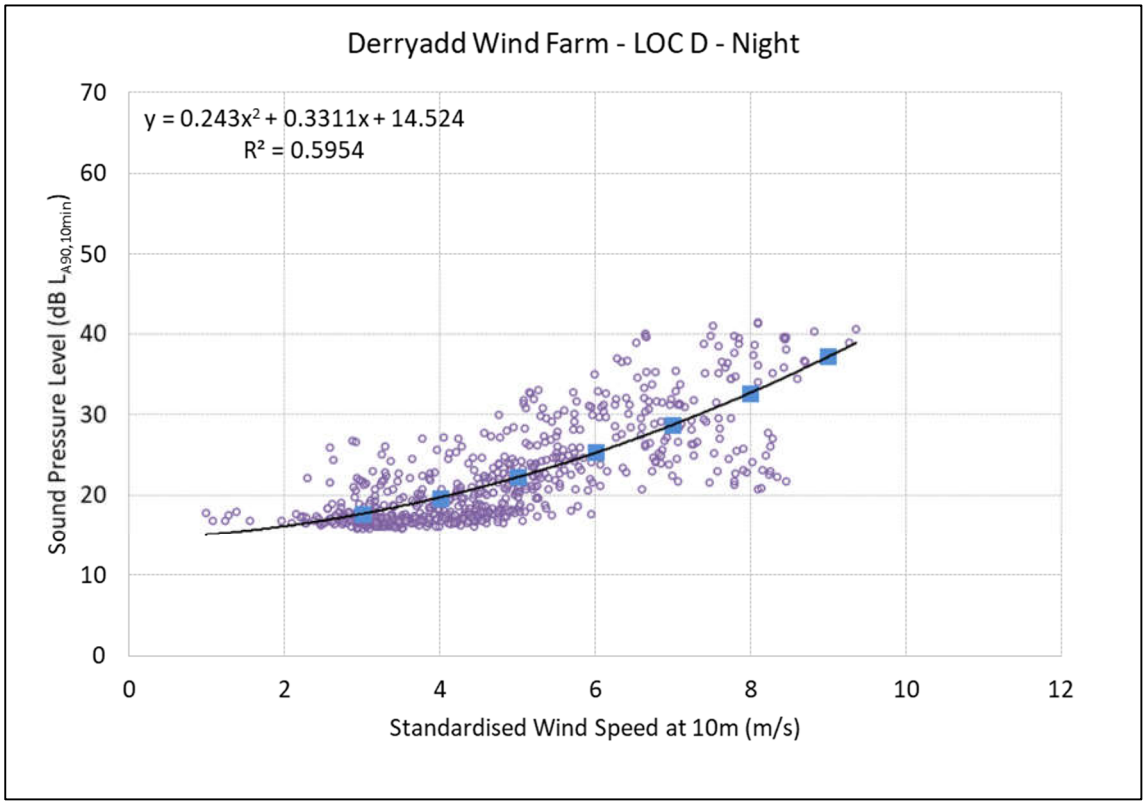

Figure 12-11 Location D – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.5 Location E

Figure 12-12 and Figure 12-13 shows the derived daytime and night-time background noise level for Location E.

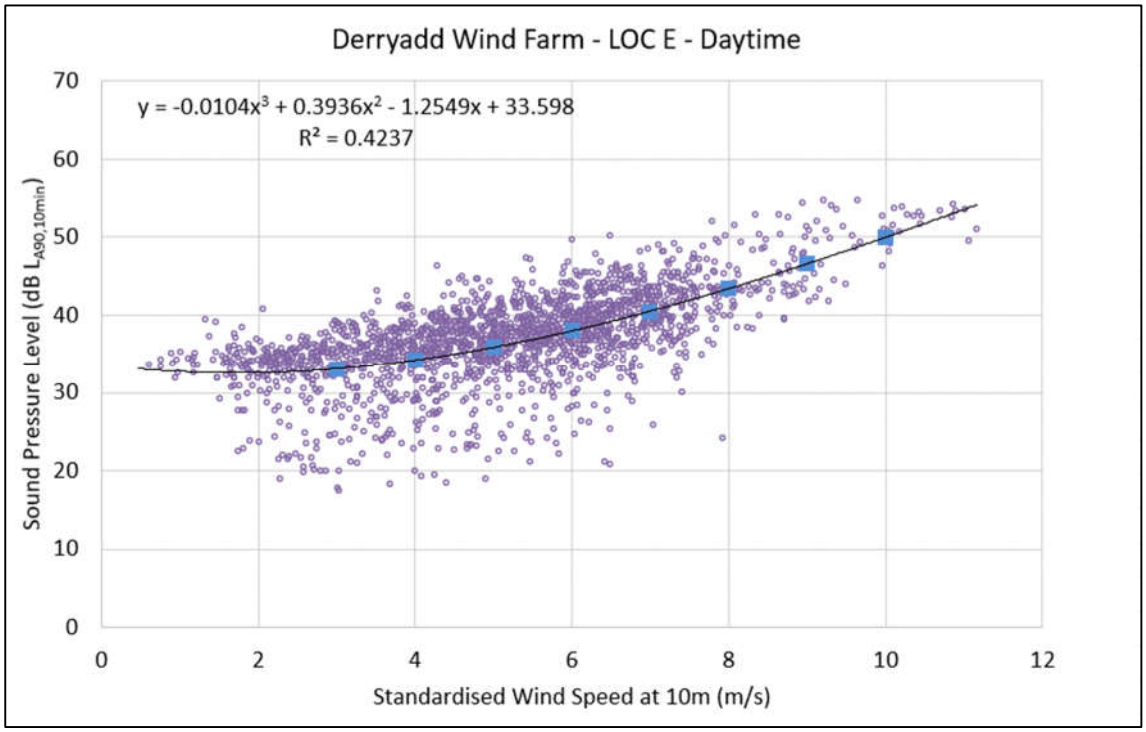

Figure 12-12 Location E – Background Noise – Daytime – 107.5 m Hub Height

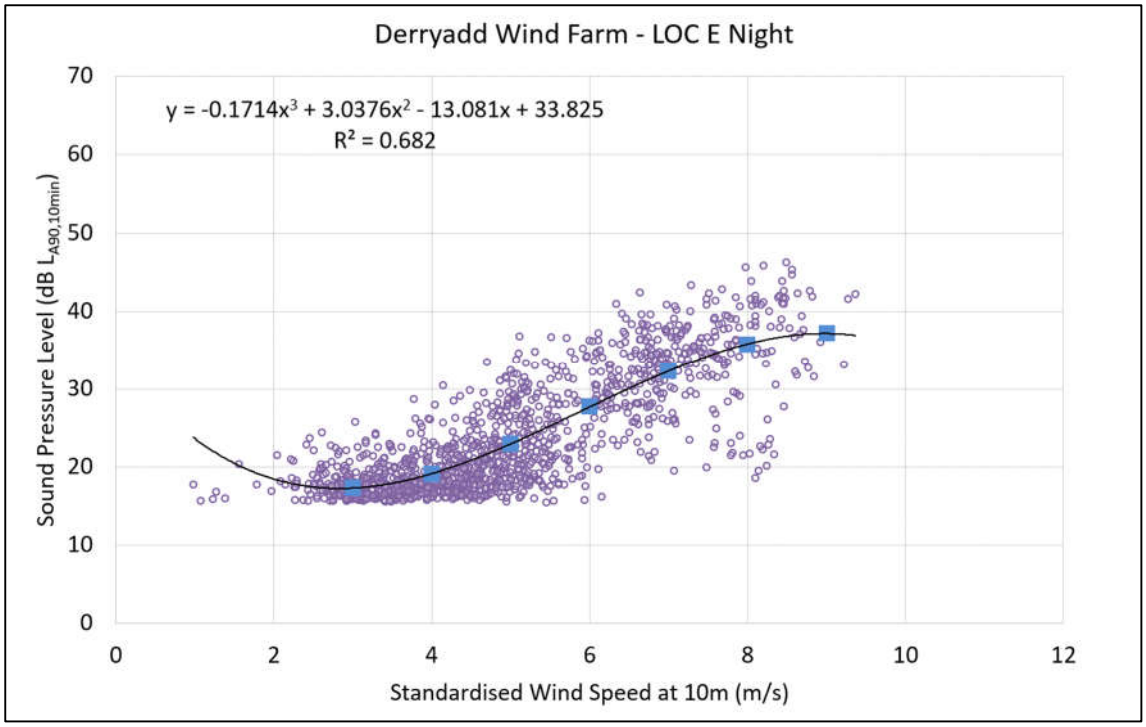

Figure 12-13 Location E – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.6 Location F

Figure 12-12 and Figure 12-13 shows the derived daytime and night-time background noise level for Location F. As mentioned previously, the background noise data for this location is dominated by noise from a nearby lock in a canal. As a result, the data shows a clear steady noise

level in the measured background noise and is not representative of the noise environment in the wider area, rather these noise levels are specific to Location F and may be variable depending on how the lock functions. It is noted that no evidence of variability was observed in the measured data.

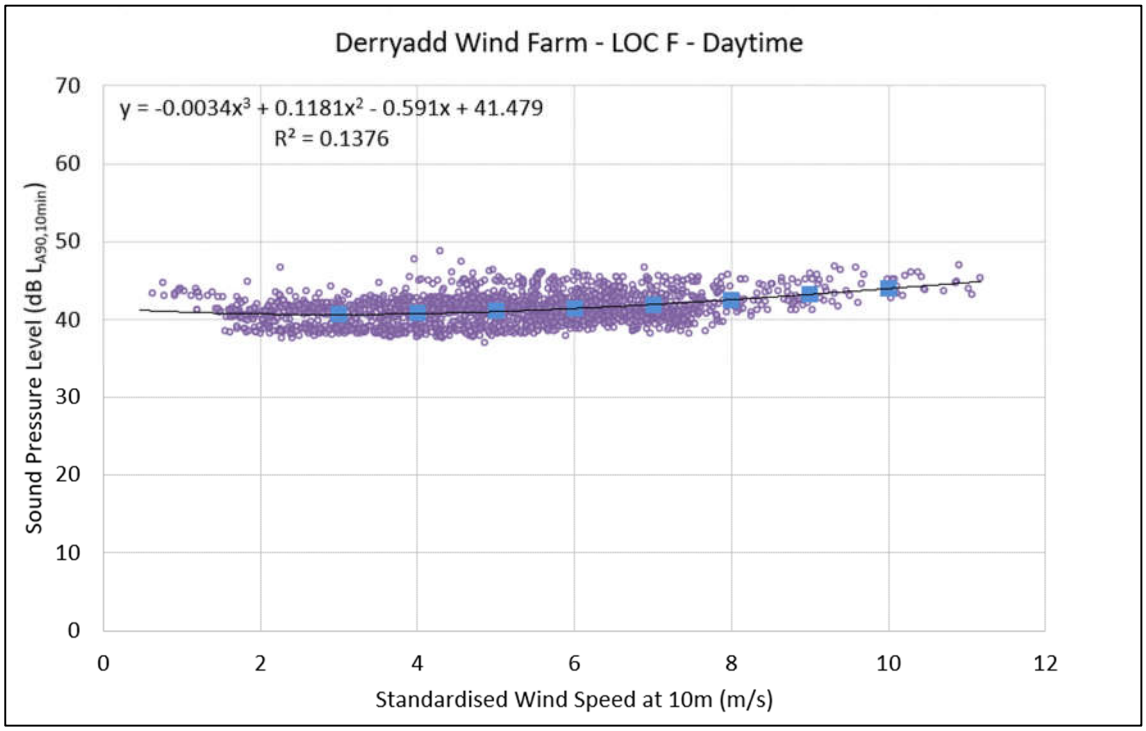

Figure 12-12 Location F – Background Noise – Daytime – 107.5 m Hub Height

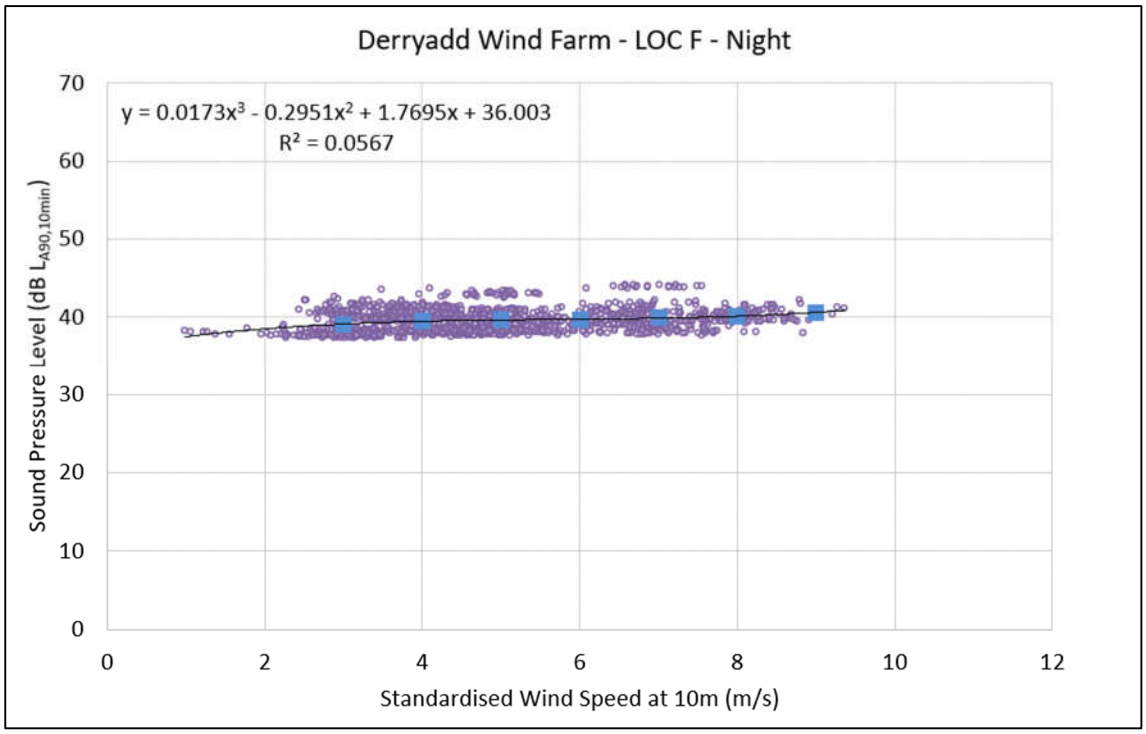

Figure 12-13 Location F – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.7 Location G

Figure 12-14 and Figure 12-15 shows the derived daytime and night-time background noise level for Location G.

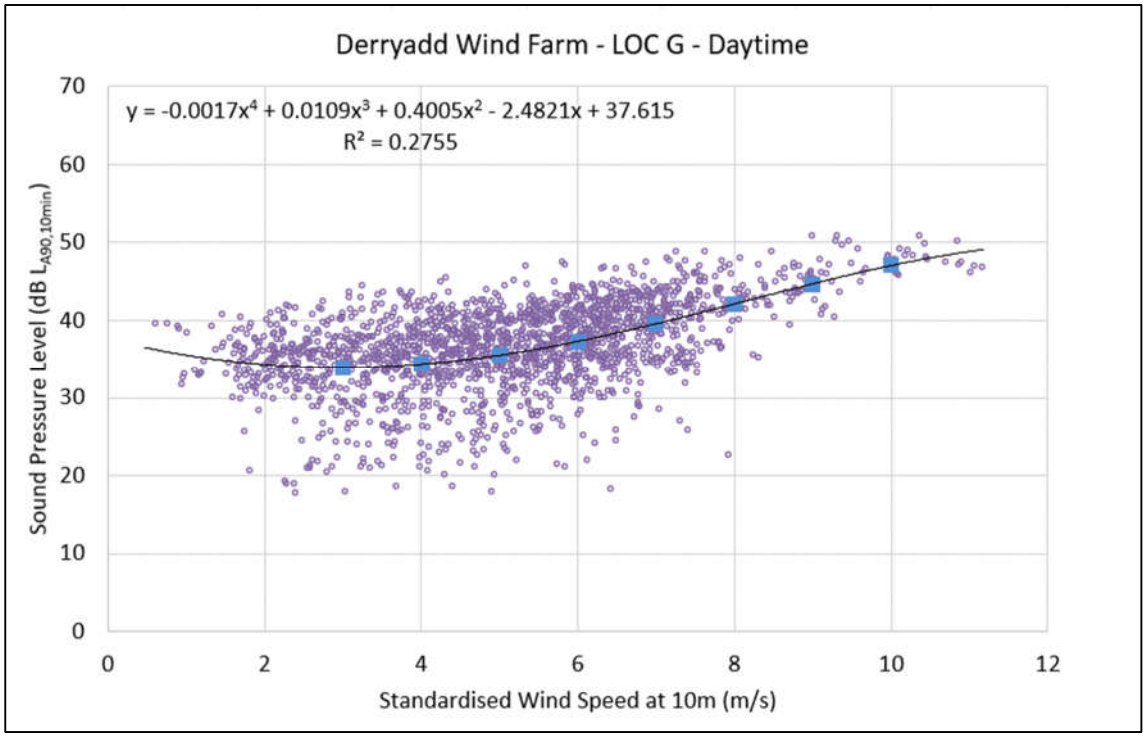

Figure 12-14 Location G – Background Noise – Daytime – 107.5 m Hub Height

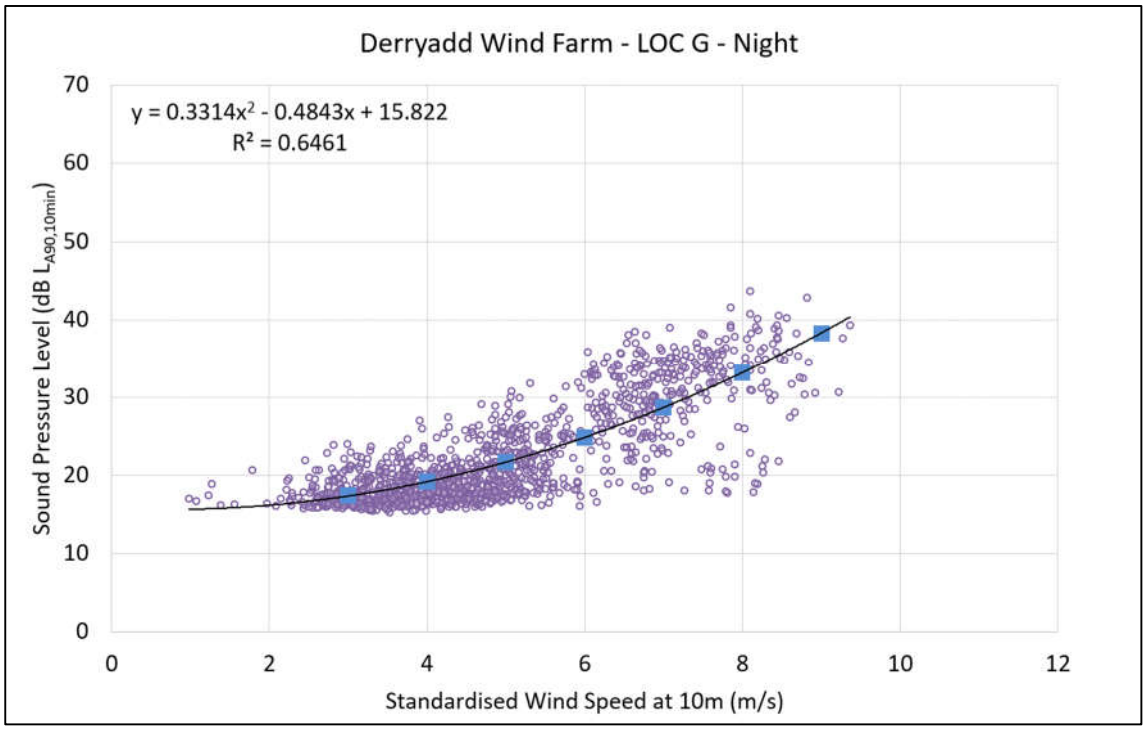

Figure 12-15 Location G – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.8 Location H

Figure 12-16 and Figure 12-17 shows the derived daytime and night-time background noise level for Location H.

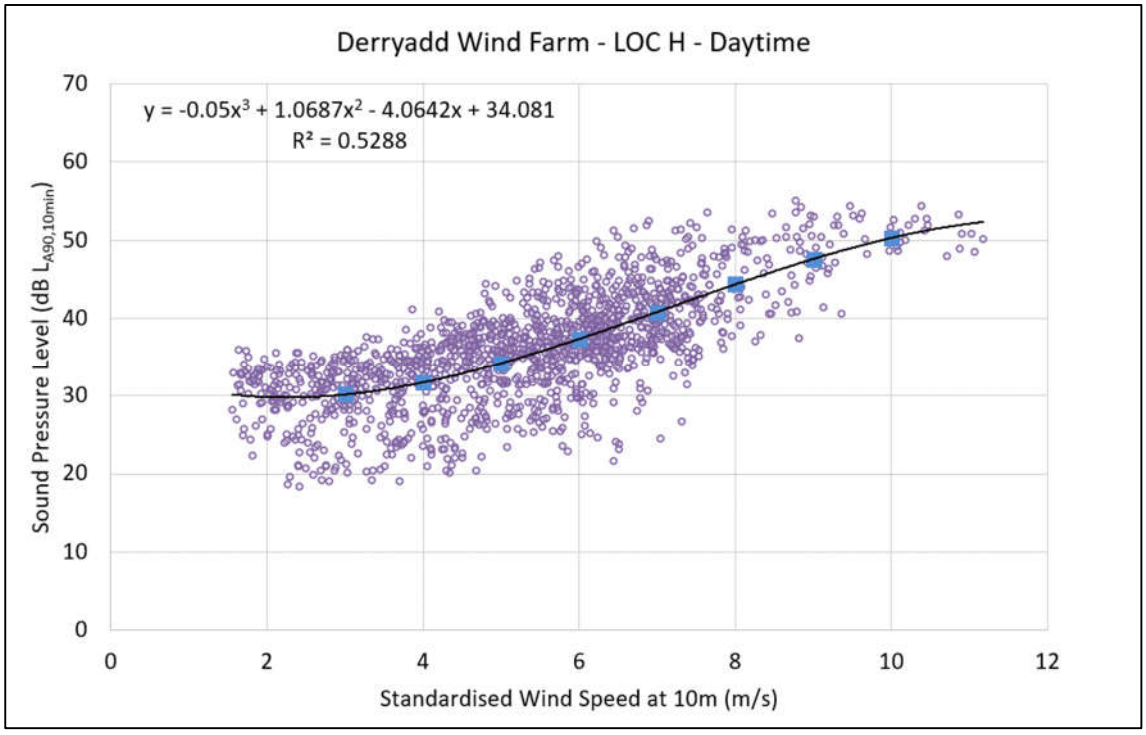

Figure 12-16 Location H – Background Noise – Daytime – 107.5 m Hub Height

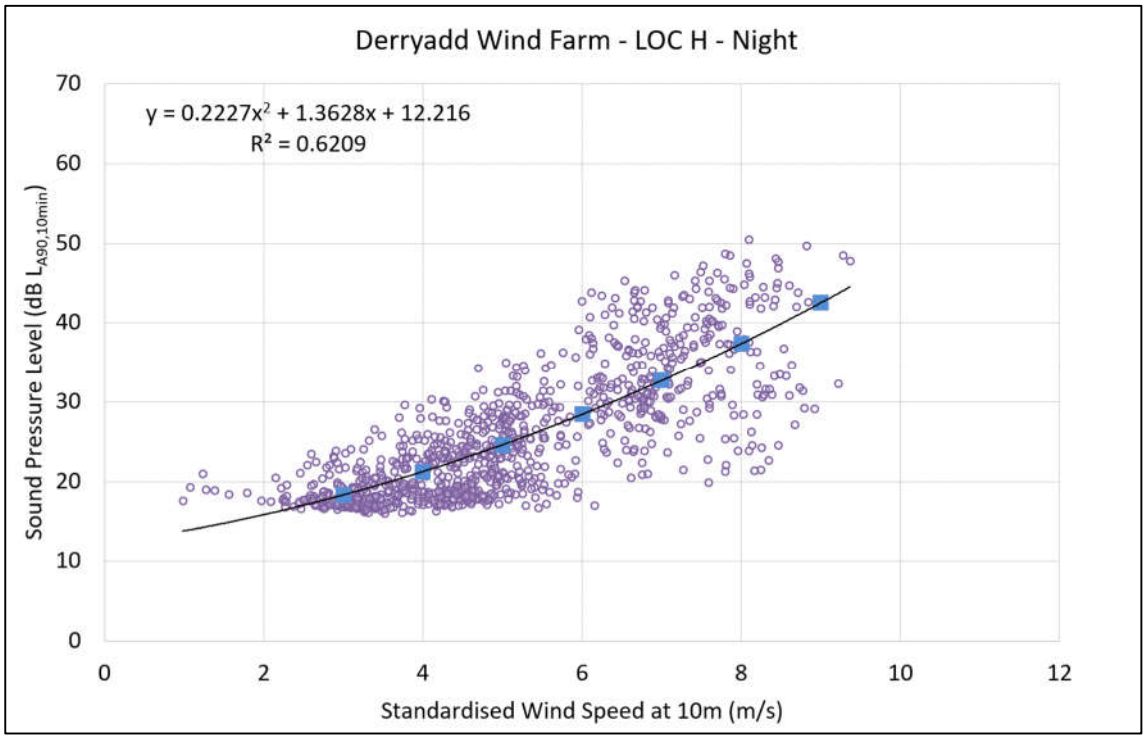

Figure 12-17 Location H – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.9 Location I

Figure 12-18 and Figure 12-19 shows the derived daytime and night-time background noise level for Location I.

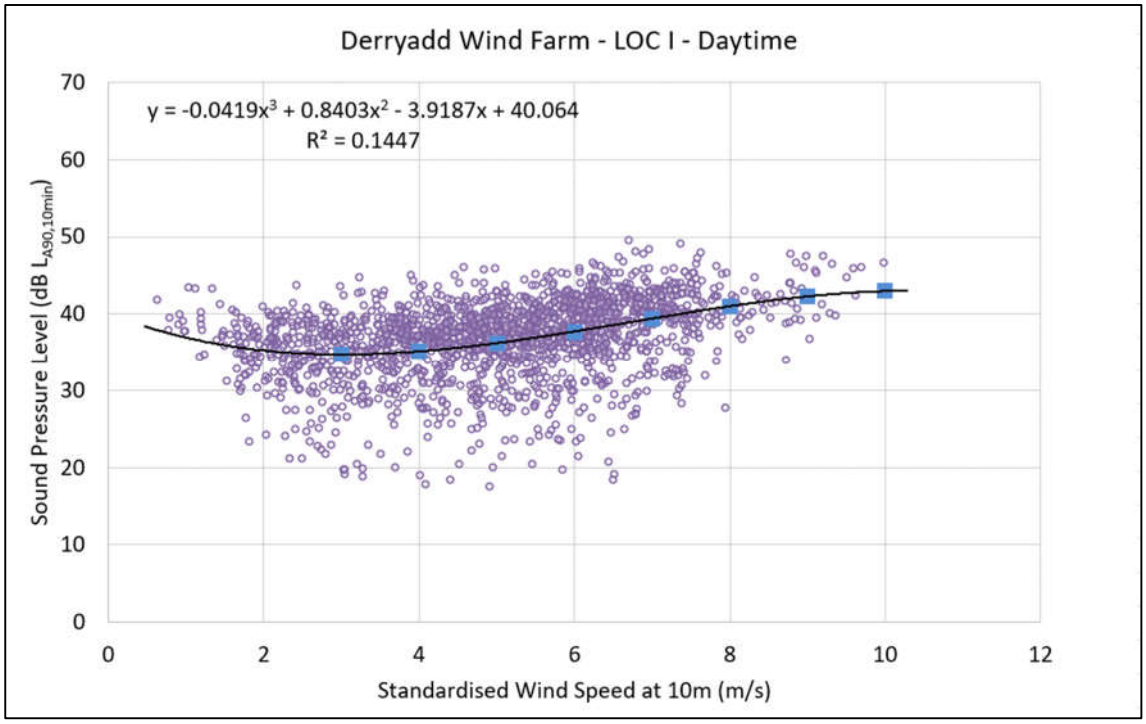

Figure 12-18 Location I – Background Noise – Daytime – 107.5 m Hub Height

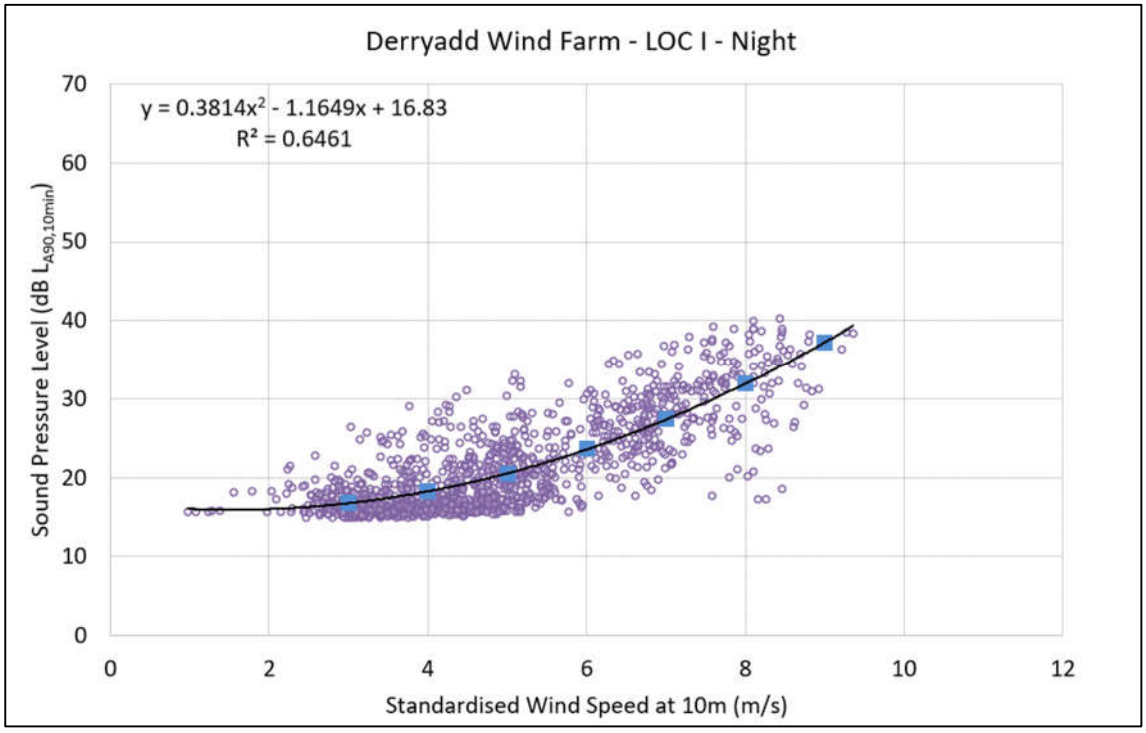

Figure 12-19 Location I – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.10 Location J

Figure 12-20 and Figure 12-21 shows the derived daytime and night-time background noise level for Location J.

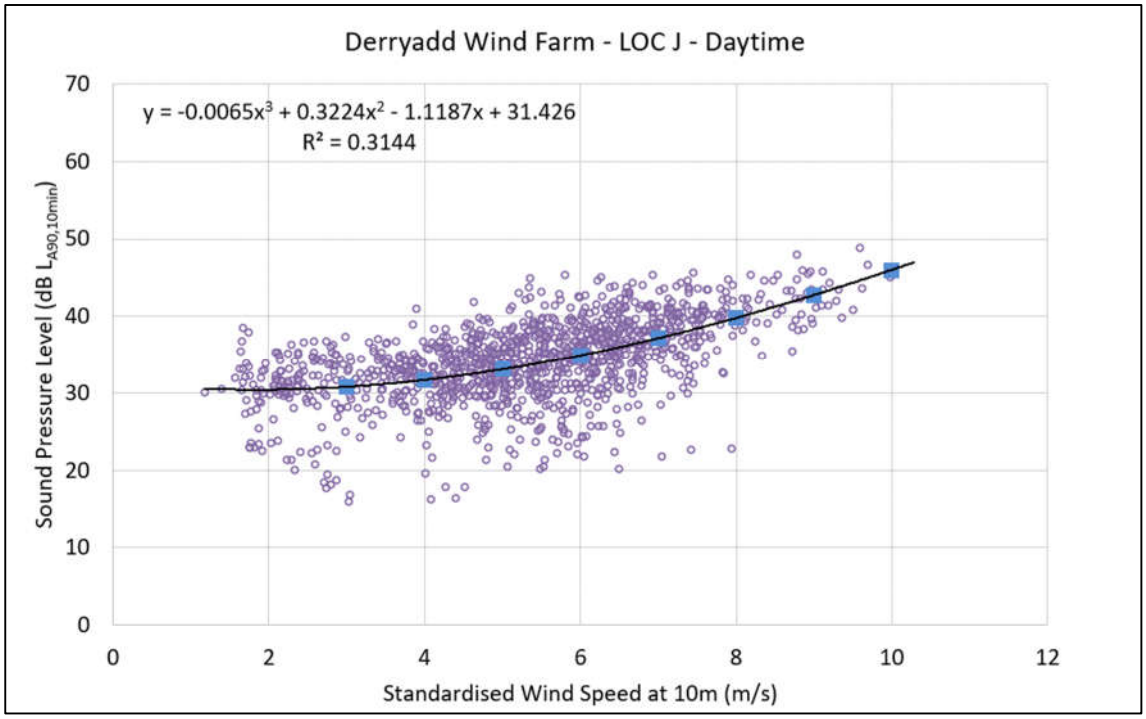

Figure 12-20 Location J – Background Noise – Daytime – 107.5 m Hub Height

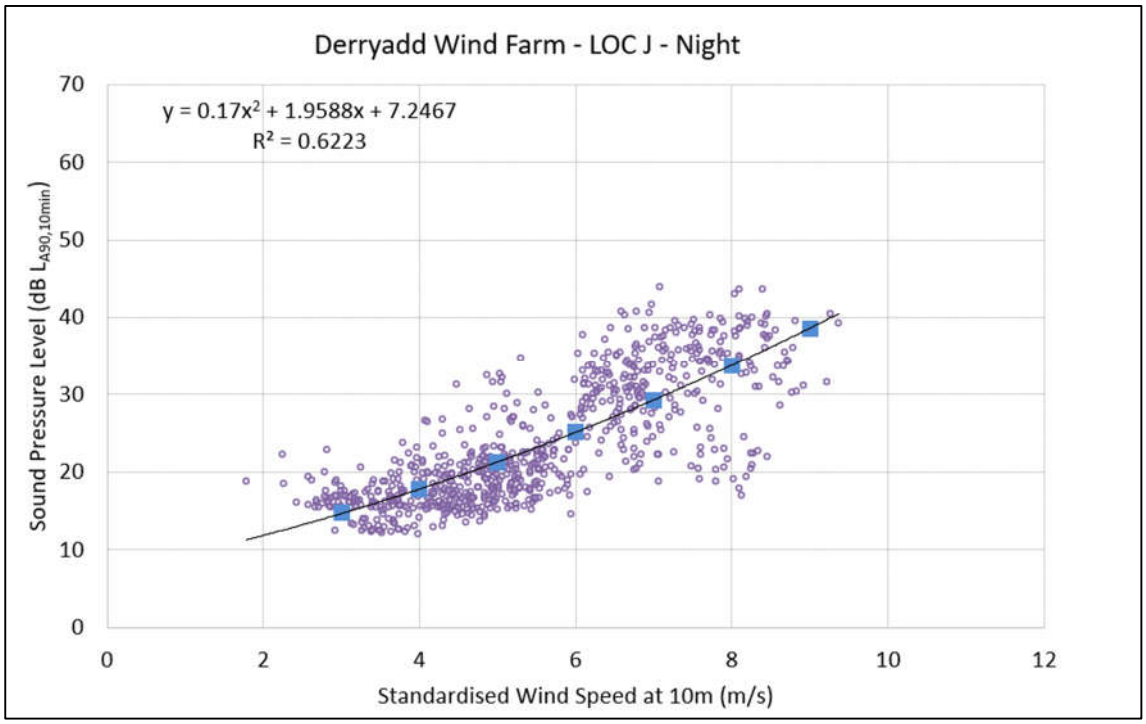

Figure 12-21 Location J – Background Noise – Night-time – 107.5 m Hub Height

12.5.1.11 Summary of Derived Background Noise Levels

Table 12-10 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night-time periods. These levels have been derived using regression analysis carried out on the data sets measured in line with best practice guidance contained in the IOA GPG and its SGN No. 2 Data Collection.

Table 12-10 Derived Background Noise Levels of $L_{A90,10-min}$ for Various Wind Speeds

Location	Period	Derived $L_{A90,10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds							
		3	4	5	6	7	8	9	≥10
A	Day	33.2	33.7	34.8	36.6	39.1	42.2	46.0	50.4
	Night	17.9	20.4	23.2	26.3	29.6	33.3	37.2	*37.2*
B	Day	31.3	32.4	33.8	35.5	37.4	39.6	42.1	44.9
	Night	18.3	19.8	22.0	24.9	28.5	32.7	37.7	*37.7*
C	Day	32.2	32.7	33.7	35.0	36.6	38.4	40.3	42.3
	Night	16.7	18.2	20.3	22.8	26.0	29.7	33.9	*33.9*
D	Day	32.0	32.9	34.3	36.2	38.4	40.6	42.9	44.9
	Night	17.7	19.7	22.3	25.3	28.7	32.7	37.2	*37.2*
E	Day	33.1	34.2	35.9	38.0	40.5	43.4	46.6	50.0
	Night	17.3	19.1	22.9	27.7	32.3	35.8	37.2	*37.2*
F	Day	40.7	40.8	41.1	41.5	42.0	42.6	43.2	44.0
	Night	39.1	39.5	39.6	39.7	39.9	40.1	40.6	*40.6*
G	Day	33.9	34.4	35.5	37.3	39.6	42.1	44.7	47.1
	Night	17.4	19.2	21.7	24.8	28.7	33.2	38.3	*38.3*
H	Day	30.2	31.7	34.2	37.4	40.8	44.4	47.6	50.3
	Night	18.3	21.2	24.6	28.4	32.7	37.4	42.5	*42.5*
I	Day	34.7	35.2	36.2	37.7	39.4	41	42.3	43.0
	Night	16.8	18.3	20.5	23.6	27.4	31.9	37.2	*37.2*
J	Day	30.8	31.7	33.1	34.9	37.2	39.8	42.8	46
	Night	14.7	17.8	21.3	25.1	29.3	33.8	38.6	*38.6*
Envelope	Day	30.2	31.7	33.1	34.9	36.6	38.4	40.3	42.3
	Night	14.7	17.8	20.3	22.8	26.0	29.7	33.9	*33.9*

A conservative envelope based on the lowest derived background levels at the various wind speeds for both day and night-time is presented in Table 12-10.

12.5.2 Wind Turbine Noise Limits

With respect to the relevant guidance documents outlined in Section 12.3.2.55, noise criteria curves have been established for the proposed development. The criteria curves have been derived following a detailed review of the background noise data conducted at representative NSLs described in Section 12.4.2.

This set of criteria adopted is in line with the intent of the applicable WEDGs and is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála and local planning authorities in Ireland. For the proposed development, 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) is 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 infers a 3 dB difference when accounting for difference parameters between the NG4 limits and the WEDG06 limits. The proposed lower threshold daytime criterion 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.
- The planning condition issued by ABP (Planning Ref PL20.239743) for the Sliabh Bawn wind farm development imposed an effective lower threshold of 43 dB $L_{A90,T}$. The proposed lower threshold here is more than 3 dB more stringent than this level.
- 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) Derryadd Wind Farm (ABP Ref: PL14.303592), Coole Wind Farm (ABP Ref: PL25M.300686) Cloncreen (ABP Ref: PA0047), Meenbog (ABP Ref: PL05E.300460), Borrisbeg (ABP-318704-23) and Ballivor (ABP-316212-23).

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

In summary, the operational noise limits proposed for the wind farm are:

- 40 dB LA90,10min for daytime in quiet environments with typical background noise of less than 30 dB LA90,10min.
- 45 dB LA90,10min for daytime in environments with typical background noise greater than or equal to 30 dB LA90,10min or a maximum increase of 5 dB(A) above background noise (whichever is the higher); and
- 43 dB LA90,10min for night-time periods or a maximum increase of 5 dB(A) above background noise (whichever is the higher).

Day and nighttime noise criteria curves have been determined from review of the derived background noise levels at 10 no. NSLs surrounding the proposed wind farm site and are presented in the relevant sections of this chapter.

12.5.2.1 *Assigning Turbine Noise Limits*

The derived turbine noise limits have been assigned to the various NSLs where noise monitoring has been undertaken. Where background noise measurements have been conducted in the vicinity and/or are judged to be typical/indicative of the background noise levels at other locations, these can be assigned to the nearby representative location for the purposes of setting appropriate turbine noise limits for the assessment. That approach is in line with best practice guidance set out in the IOA GPG.

For the purpose of this assessment, a conservative 'envelope review' will be applied to all non-surveyed locations. The envelope review is a conservative approach that adopts the lowest noise criteria derived from the measured background noise levels and applies it to all non-surveyed locations. This is not to say that this is the actual background noise at these locations.

Table 12-11 outlines the operational noise criteria that will apply to this assessment. The derived criteria at 9m/s have been applied to higher wind speeds for the purpose of this assessment. It should be noted that as wind speed increases so too will the background noise levels, this approach to the assessment is therefore conservative.

Table 12-11 Proposed Noise Criteria Curves

Location	Period	Turbine Noise Limits $L_{A90, 10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds)						
		3	4	5	6	7	8	≥9
A	Day	45.0	45.0	45.0	45.0	45.0	47.2	51.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
B	Day	45.0	45.0	45.0	45.0	45.0	45.0	47.1
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
C	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
D	Day	45.0	45.0	45.0	45.0	45.0	45.6	47.9
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
E	Day	45.0	45.0	45.0	45.0	45.5	48.4	51.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
F	Day	45.7	45.8	46.1	46.5	47.0	47.6	48.2
	Night	44.1	44.5	44.6	44.7	44.9	45.1	45.6
G	Day	45.0	45.0	45.0	45.0	45.0	47.1	49.7
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.3
H	Day	45.0	45.0	45.0	45.0	45.8	49.4	52.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	47.5
I	Day	45.0	45.0	45.0	45.0	45.0	46.0	47.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
J	Day	45.0	45.0	45.0	45.0	45.0	45.0	47.8
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.6
Envelope	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0

12.5.3 Noise Limits for Fixed Plant

Based on a review of the measured noise from the background noise survey (Section 12.5.112.4.2), the NSLs in the vicinity of the site are defined as areas of low background noise as per the NG4 guidance. As the proposed substation and battery storage facility will operate on a 24-hour basis, the potential impact during night-time periods governs the assessment. A night time criterion of 35 dB $L_{Aeq,T}$ is considered appropriate for the operation of the substation. The substation design will ensure that the noise emissions do not contain audible tones or impulsive characteristics at the nearest NSLs. 35 dB $L_{Aeq,T}$ is considered a low level of noise.

In accordance with to the guidance from the BS4142 standard, discussed in Section 12.3.2.6, it is considered that the proposed absolute criterion of 35 dB $L_{Aeq,T}$ for noise from the substation is robust and should prevent adverse impacts at NSLs.

12.6 POTENTIAL EFFECTS

12.6.1 Do-nothing Scenario

If the proposed development is not progressed, the existing noise environment is expected to remain unchanged. Any increases in traffic volumes on the local road network would not be expected to result in a significant change to the overall ambient and background noise levels within the study area.

12.6.2 Construction Phase

Construction noise prediction calculations have been conducted using the assessment methodology outlined and discussed in Sections 12.3.2 and 12.4.44. The source noise levels referred to in this section are indicative of the type of plant items and activities associated with the construction of the proposed development.

The highest predicted noise levels are expected to occur for short periods of time at a limited number of properties. Construction noise levels will be lower than these levels for most of the time at most properties in the vicinity of the proposed development.

There are several stages and elements associated with the construction phase of the proposed development which will include but are not limited to the following:

- Construction of new entrance(s) and hardcore existing entrance, construction of internal site roads;
- Open and operation of borrow pits;
- Construction of turbines and hardstand areas;
- Construction of substation;
- Construction of Battery Storage Facility; and
- Cabling and grid connections.

Chapter 3 (Description of the Proposed Development) has detailed information on each of these elements.

In general, the distances between the construction activities associated with the proposed development and the nearest NSLs are such that there will be no significant noise, and vibration impacts at the NSLs. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration effects, all other stages and elements are considered unlikely to have any significant noise and vibration effects namely, construction compounds, amenity tracks, car parks, met mast, security cabins and temporary accommodating works for the Turbine Delivery Route.

Construction activities will be carried out during normal daytime working hours (i.e., weekdays 08:00hrs – 20:00hrs and Saturdays 08:00hrs – 13:00hrs). However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (e.g., concrete pours) or to accommodate delivery of large turbine components along public routes it could

be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the Local Authority.

12.6.2.1 General Construction of Turbines and Hardstand Areas

Noise

Several noise sources that would be expected on a construction site of this nature have been identified and predictions of the potential noise emissions have been calculated at the nearest NSL. In this instance the closest noise sensitive receptor is Location P1133 which is situated approximately 780 m from the proposed turbine T01.

Table 12-12 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 12-12 Typical Wind Farm Turbine Construction Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[4]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)
			780 m
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	28
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	26
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	34
Piling Operations (C.12.14)	Piling Foundations (if required).	89	38
General Construction (Various)	All general activities plus deliveries of materials and plant	78	27
Dewatering Pumps (D.7.70)	If required.	80	29
JCB (D.8.13)	For services, drainage and landscaping.	82	31

[4] All plant noise levels are derived from BS5228: Part 1

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[4]	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m)
			780 m
Vibrating Rollers (D.8.29)	Road surfacing.	77	26
Cumulative Construction Noise Level		--	41

At 780 m from the works the predicted noise levels from construction activities are in the range of 26 to 38 dB $L_{Aeq,T}$ with a total 'worst-case' cumulative construction level of the order of 41 dB $L_{Aeq,T}$. In all instances the predicted noise levels at the nearest NSLs are below the adopted significance threshold outlined in Table 12-1 (Category A – 65 dB $L_{Aeq,T}$ during daytime periods). This assessment is considered representative of worst-case construction noise levels at NSLs.

There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the thresholds outlined in Table 12-1 and this finding is valid should all items of plant operate simultaneously. 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 effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case associated effects at the nearest noise sensitive locations associated with construction of turbines and hardstanding areas are described as follows:

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

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

12.6.2.2 Construction of Site Roads

It is proposed to construct new site access roads and amenity access tracks to access the various parts of the development. Review of the site access road and amenity access track layout has identified that the nearest NSL to any point along the proposed layout is approximately 118 m to P1121. All other locations are at greater distances with the majority at significantly greater distances. The full description of the new road is outlined in Chapter 3 (Description of the Proposed Development).

Noise

Table 12-13 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 12-13 Indicative Noise Levels from Construction Plant at Various Distances from Site Roads

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[5]	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,T}$) at 118 m
HGV (C.2.30)	79	48
Excavator Mounted Rock Breaker (C9.12)	85	54
Vibration Rollers (D.8.29)	77	46
Cumulative Total	--	55

The table shows that at 118 m, noise levels 10 dB below the construction noise thresholds in Table 12-1 and therefore the impact is not significant. As these works will progress along the road the worst-case predicted impacts will reduce. Works will therefore be in proximity to the closest NSL's for limited period.

There are no items of plant or construction activities that are likely to give rise to noise levels that would be considered out of the ordinary or in exceedance of the thresholds outlined in Table 12-1. 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 effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of site roads are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

[5] All plant noise levels are taken from BS5228: Part 1

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

12.6.2.3 Borrow Pits

Noise

To inform this aspect of the proposal, a noise assessment has been based on the following assumptions:

- 1 mobile crusher and 1 rock breaker will be used at each borrow pit location;
- The plant will operate simultaneously in the vicinity of all proposed borrow pit location indicated in Table 12-14; and,
- 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.

Table 12-14 Proposed Borrow Pit Locations

Borrow Pit Ref	Co-ordinates (ITM)	
	Easting	Northing
BP-01	605,840	768,550
BP-02	606,825	766242
BP-03	606,175	766,420
BP-04	606,270	765,964

Table 12-15 Plant Noise Emissions

Item	dB(A) L_w Levels per Octave Band (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Crusher	95	98	98	106	103	100	95	86	110
Rock Breaker	93	101	104	114	115	116	113	106	121
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	69	82	96	99	103	101	99	88	107
Tracked Excavator (3 no. in each pit)	77	88	95	93	93	92	86	76	99

A noise model prediction model has been prepared to consider the expected noise emissions from the proposed construction works at borrow pits as outlined above. A percentage on-time of 66% has been used for the noise calculations.

The nearest NSL to any of the borrow pit locations is at a distance of over 600 m from any borrow pit area. Consequently, the resulting noise levels at the NSLs are low. The predicted levels at the ten NSLs with the highest predicted noise levels assuming all borrow pits operate simultaneously are presented in Table 12-16.

Table 12-16 Prediction Noise Levels from Borrow Pit Activity at Nearest NSLs

Location Ref.	dB $L_{Aeq,T}$
P0852	44
P1516	44
P1524	44
P1519	44
P1517	44
P1526	43
P1521	43
P0886	43
P1515	43
P1527	43

Review of the results contained in Table 12-16 confirms that the predicted construction noise levels are more than 20 dB below the relevant daytime construction noise criteria (65 dB $L_{Aeq,T}$). It is expected that construction works at the borrow pits will only occur during daytime periods.

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 noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with operation of borrow pits are described follows:

Quality	Significance	Duration
Negative	Not Significant	Short Term

12.6.2.4 Substation Construction

Noise

The nearest NSL to the proposed substation is P0589, which is approximately 375 m to the closest point of the substation. As a worst-case example assuming the same construction activities as outlined in

Table 12-12 , it is predicted that the likely worst-case potential noise levels from construction activities associated with the substation will be in the order of 49 dB $L_{Aeq,T}$ at the nearest NSL. This level of noise is well below the significance threshold of 65 dB $L_{Aeq,T}$, 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 effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of substation are described below.

Quality	Significance	Duration
Negative	Not Significant	Short Term

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

12.6.2.5 Battery Storage Compound

The battery storage compound is to be sited at ITM coordinates 604957, 769339. The nearest NSL is P0589, which is approximately 375 m to the closest point to the proposed battery storage compound.

Noise

As a worst-case, assuming the same construction activities as outlined in Table 12-12 , it is predicted that the likely worst-case potential noise levels from construction activities associated with the substation will be in the order of 49 dB $L_{Aeq,T}$ at the nearest NSL. This level is well below the significance threshold of 65 dB $L_{Aeq,T}$.

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 effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of the battery storage compound are described below.

Quality	Significance	Duration
Negative	Not Significant	Short Term

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

12.6.2.6 Grid Connection and Underground Cabling Construction

The proposed grid connection route is within the site boundary, an underground 110 kV cable will run from the proposed onsite electrical substation to the existing Landsborough-Richmond 110 kV OHL. The proposed underground cables will cross under the N63 National Road, via HDD, which is located between the substation and Lanesborough-Richmond OHL. The proposed development requires approximately 460 m of 110kV underground cable (UGC) installation from the 110kV onsite substation to the existing OHL to the south. The full description of the cable route is outlined in Chapter 3 (Description of the Proposed Development) of this EIAR. Review of the cable layout has identified that the nearest NSL to any point is 385 m P0589.

Noise

Table 12-17 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period. Note the plant items and activities are indicative and based on conservative assumption to be representative of a reasonable worst case.

Table 12-17 Indicative Noise Levels for Typical Construction Plant at Various Distances from the Grid Connection Works

Item (BS 5228 Ref.)	Highest Predicted Plant Noise Level (dB $L_{Aeq,T}$) at 385 m
Tracked Excavator (C.2.5)	34
Hydraulic vibratory compactor (tracked excavator) (C.2.42)	42
Wheeled Loader (C.2.8)	46
HGV (C.6.19)	36
HDD (Directional drilling under N63) (C.4.96)	43
Cumulative Construction Noise Level	49

At the closest NSL, the predicted cumulative noise levels from construction activities are between 34 and 46 dB $L_{Aeq,T}$. The total noise level associated with this element of the works is 49 dB $L_{Aeq,T}$ which is below the significance threshold of 65 dB $L_{Aeq,T}$. Given the variations of grid connection activities, the number of plant items operating at any one time and the location of road works only operating along the closest boundaries for a limited duration of the overall development, the calculated noise levels presented are considered to present a worst-case scenario. As these works will progress along the route the worst-case predicted effects will reduce. 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 effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of the grid connection and underground cabling are described below.

Quality	Significance	Duration
Negative	Not Significant	Temporary

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

12.6.2.7 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 (Traffic and Transportation) has been used to inform the assessment presented in this chapter.

Changes in the traffic noise levels associated with the construction traffic for 'peak' and 'average' construction have been calculated on based on information in Chapter 15 (Traffic and Transportation).

The peak percentage increase along any of the construction haul routes due to construction generated traffic is 3%. Assuming 5% of the baseline traffic flows are heavy goods vehicles (HV) and 100% of construction traffic are HV (worst case) the calculated maximum increase based on the peak construction traffic flow would be 1.5 dB. With reference to the DMRB magnitude of impact set out in Table 12-2, the potential impacts are classified as a minor impact change. It is concluded that there will be no significant noise impacts associated with the additional traffic generated during the construction phase.

Description of Effects

The likely predicted effects are below the limits and/or thresholds identified for a significant effect to occur. With respect to the EPA's criteria for description of effects, the potential associated effects at the nearest NSLs associated with additional traffic generated during the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Slight	Short Term

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

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 development can be considered comparable to those outlined in relation to the construction phase (as per Section 12.6.2) albeit less works will be required as only above ground structures will be removed. Turbine and mast foundations will remain underground, and cable ducting will remain in situ. The underground cabling to the OHL and on-site substation will remain in place. Refer to Chapter 3 (Description of Proposed Development) for full details. The predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB $L_{Aeq,T}$) at all NSLs 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 below.

Quality	*Significance*	*Duration*
Negative	Not significant	Short Term

12.6.4 Operational Phase

12.6.4.1 Assessment of Wind Turbine Noise

Using the assessment methodology described in Section 12.4.5 the predicted turbine noise levels have been calculated at all NSLs within the study area of the proposed development. A worst-case 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 'worst-case' 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 12.5.212.5.2, which have been derived in accordance with the criteria set out in Section 12.3.2.5.

At all NSLs the worst omni-directional cumulative turbine noise levels are below the noise criterion curves.

Appendix 12-4 presents the predicted omni-directional turbine results at all NSLs in tabulated form. Table 12-18 presents the result of the turbine noise predictions and assessment review at 12 no. locations with the highest levels of wind turbine noise predicted, at all other location the maximum turbine noise levels are predicted to be <40 dB L_{A90}. Noise contours for the omni-

directional rated power wind speed (i.e., highest noise emission) are presented in Appendix 12-5.

Table 12-18 Review of Predicted Turbine Noise Levels against Relevant Criteria

NSL	Details	Derived $L_{A90,\ 10\text{-}min}$ Levels (dB) at Various Standardised 10 m Height Wind Speeds							
		4	5	6	7	8	9	10	11
P1527	Predicted	29.7	34.0	38.2	39.5	39.7	39.8	40.2	40.2
	Daytime Criterion	45.0	45.0	45.0	45.5	48.4	51.6	51.6	51.6
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1526	Predicted	29.7	34.0	38.2	39.5	39.7	39.9	40.2	40.2
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1524	Predicted	29.9	34.2	38.4	39.7	39.9	40.1	40.4	40.4
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1521	Predicted	30.1	34.4	38.6	39.9	40.0	40.2	40.5	40.6
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1519	Predicted	30.1	34.4	38.6	39.9	40.1	40.3	40.6	40.6
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--

NSL	Details	Derived $L_{A90,\ 10\text{-}min}$ Levels (dB) at Various Standardised 10 m Height Wind Speeds							
		4	5	6	7	8	9	10	11
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1517	Predicted	30.2	34.5	38.7	40.0	40.2	40.3	40.6	40.7
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1516	Predicted	30.2	34.5	38.7	40.0	40.2	40.4	40.7	40.7
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1515	Predicted	30.2	34.5	38.7	40.0	40.2	40.3	40.7	40.7
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1512	Predicted	30.0	34.3	38.6	39.9	40.0	40.2	40.5	40.6
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	47.8	47.8	47.8
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.6	43.6	43.6
	Night Time Excess	--	--	--	--	--	--	--	--
P1508	Predicted	30.0	34.3	38.5	39.8	40.0	40.2	40.5	40.5
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--

NSL	Details	Derived $L_{A90,\ 10\text{-}min}$ Levels (dB) at Various Standardised 10 m Height Wind Speeds							
		4	5	6	7	8	9	10	11
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P1504	Predicted	29.5	33.8	38.0	39.3	39.5	39.7	40.0	40.0
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--
P0211	Predicted	29.7	34.0	38.2	39.5	39.7	39.9	40.2	40.2
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.3	45.3	45.3
	Daytime Excess	--	--	--	--	--	--	--	--
	Night Time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night Time Excess	--	--	--	--	--	--	--	--

Description of Effects

The predicted noise levels associated with the proposed wind farm are within best practice noise criteria recommended in the Irish guidance '*Wind Energy Development Guidelines for Planning Authorities*' (2006), therefore it is not considered that a significant effect is associated with turbine noise from the proposed development.

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

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the most impacted noise sensitive locations associated with operation of the wind turbine of the proposed development are described as follows:

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 the locations of the greatest potential impact.

12.6.4.2 Fixed Plant Noise

Substation

Details of the proposed 110kV substation are described in Chapter 3 (Description of the Proposed Development). The substation is likely to be operating continuously, and the noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the substation at the nearest NSL.

The noise emission level associated with a typical substation that would support a development of this nature is the order of 92 dB(A) L_w.

Noise prediction model calculations for the operation of the substation have been undertaken in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (2024)*. The predicted noise level from the operation of the substation at the nearest NSL P0589 at approximately 400 m) is 23 dB $L_{Aeq,T}$. This level of noise is low, and it is concluded that there will be no significant noise emissions from the operation of the substation at any NSL. Furthermore, the predicted noise level is well below the criterion for fixed mechanical plant outlined in Section 12.3.2.6 and will not result in any adverse impacts at nearby NSLs. At the detailed design stage, substation plant will be selected to ensure that there are no tonal or impulsive characteristics from the plant audible at any NSLs during night time periods.

Battery Storage Facility

Details of the proposed battery storage facility are described in Chapter 3 of the EIAR (Description of the Proposed Development). The battery storage facility is likely to operating continuously, 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 development, it is proposed that up to 20 no. containerised units will operate at the battery storage facility. Typically noise emission levels associated with the operation of a battery storage containerised unit is presented in Table 12-19.

Table 12-19 Battery Storage Sound Power Levels Used in Noise Assessment

Item	dB(A) L_w Levels per Octave Band (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Battery Storage Unit	65	73	83	82	83	82	85	78	90

Noise prediction model calculations have been undertaken in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation* (2024). The predicted noise levels from the operation of the proposed battery storage facility have been calculated using the noise emission data in Table 12-19. Prediction calculations assume the proposed 20 no. units will operate simultaneously. The precited noise levels at the nearest NSL (P0589) at approximately 400 m) is 34 dB $L_{Aeq,T}$.

The predicted noise level from the battery storage facility is within the criterion for fixed machinal plant outlined in Section 12.3.2.6 and are therefore unlikely to result in any adverse impacts at nearby NSLs. At the detailed design stage of the proposed development, the selection and location of mechanical and electrical plant will be undertaken to ensure that noise emissions are within the proposed criteria and that there are no tonal or impulsive characteristics from the plant operation audible at any NSL during night time periods.

Cumulative Levels

The cumulative noise level at the nearest NSL from the operation of the substation and the battery storage facility is 34 dB $L_{Aeq,T}$ at the nearest noise sensitive location. The predicted noise cumulative noise levels are within the criterion for fixed machinal plant outlined in Section 12.3.2.6 and unlikely to result in any adverse impacts at nearby NSLs. The predicted levels at the 10 no. NSLs with the highest predicted noise levels from the operation of fixed mechanical and electrical plant are presented in Table 12-20.

Table 12-20 Prediction Noise Levels from Fixed Plant at Nearest NSLs

Location Ref.	dB $L_{Aeq,T}$
P0589	34
P0525	33
P1121	29
P1149	26
P1173	26
P1133	25
P0232	24
P1261	24
P1272	23
P1278	23

Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the fixed mechanical and electrical plant at the proposed substation and battery storage facility is described below.

Quality	Significance	Duration
Negative	Not Significant	Long-term

12.7 MITIGATION MEASURES

The assessment of potential effects has demonstrated that the proposed development is expected to comply with the identified criteria for the construction, operational and decommissioning phases of the proposed development and therefore no specific mitigation measures are required.

12.7.1 Construction and Decommissioning Phases

The contract documents will specify that the Contractor undertaking the construction works will be obliged to adopt best practice noise abatement measures contained in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise and BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration.

12.7.2 Operational Phase

12.7.2.1 Wind Turbine Noise

An assessment of the operational turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 12.3.2.5 of this Chapter. A review of other wind turbine developments in accordance with the IOA GPG guidance has confirmed that the cumulative contribution of turbine noise from other sites could be scoped out of the cumulative assessment as they are not significant.

The findings of the assessment confirmed that the predicted operational noise levels from the proposed development will be within the relevant best practice noise criteria. Therefore, no specific mitigation measures are required.

If alternative turbine models within the proposed specifications are considered for the proposed development, an updated noise assessment will be prepared to confirm that the noise emissions will comply with the noise criteria outlined in Section 12.5.2 and/or the relevant operational criteria associated with the grant of planning for the proposed development.

12.7.2.2 Amplitude Modulation

In the event of 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 (AMWG) namely, Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016) or subsequent revisions.

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

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

12.7.2.3 Fixed Plant

The assessment of noise from the operation of fixed plant at the substation and battery storage facility is predicted to comply with the proposed criteria in Section 12.3.2.6. Therefore, no

specific mitigation measures are required. However, at the detailed design stage the following measures will be employed to ensure the noise levels at NSL are within the proposed criterion and the potential for noise disturbance is minimised:

- the selection and location of mechanical and electrical plant will be undertaken in order to ensure the noise emission limits set out above are not exceeded.
- all mechanical plant items e.g. fans, pumps etc. shall be regularly maintained to ensure that excessive noise generated any worn or rattling components is minimised.
- any new or replacement mechanical plant items, including plant located inside, shall be designed so that all noise emissions from site do not exceed the noise limits.
- there are no tonal or impulsive characteristics from the plant operation audible at any NSL during night time periods.

12.7.3 Monitoring

Commissioning noise surveys will be undertaken to ensure compliance with any noise conditions applied to the proposed development. It is common practice to commence surveys within six months of a proposed development being commissioned.

12.7.3.1 Wind Turbine Noise

If an exceedance of the noise criteria is identified as part of the commissioning assessment, the guidance outlined in the IOA GPG and 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 turbine 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.

12.8 RESIDUAL EFFECTS

This section summarises the likely residual noise and vibration effects associated with the proposed development following the implementation of mitigation measures.

12.8.1 Construction Phase

During the construction phase of the proposed development, there will be some impacts on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and the NSLs, the short-term duration of the construction phase, and the assessment's findings that the expected noise and vibration emissions will be below the identified threshold and limit values, the impacts will not be significant.

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

12.8.1.1 General Construction – Turbines and Hardstand Areas

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.2 Construction of Site Roads

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.3 Borrow Pits

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.4 Substation Construction

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.5 Battery Storage Facility

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.6 Grid Connection and Underground Cabling Construction

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

The likely predicted noise and vibration effects are below the limits and/or thresholds 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.

12.8.1.7 Construction Traffic

Quality	*Significance*	*Duration*
Negative	Slight	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds identified for a significant effect to occur. 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.

12.8.2 Operational Phase

12.8.2.1 Wind Turbine Noise

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

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

The predicted residual operational turbine noise effects are summarised as follows at the nearest NSLs.

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

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

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

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

12.8.2.2 Substation Operation

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

The above effects consider the locations of the greatest potential impact.

12.8.2.3 Battery Storage Compound

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

The above effects consider the locations of the greatest potential impact.

12.9 CUMULATIVE EFFECTS

12.9.1 Wind Turbine Noise

Existing permitted and proposed wind farm developments with the potential for cumulative impacts have been considered as part of the turbine noise impact assessment. A review of existing, proposed and permitted wind turbine developments in the wider study area has been undertaken in accordance with the guidance contained in the IOA GPG. The nearest other wind turbine development is located at a distance of approximately 8 km to the Northwest of the proposed development. A full cumulative wind turbine assessment has been scoped out of the assessment as the noise contribution from the other wind farm turbines was confirmed during preliminary noise modelling to be more than 10 dB below the lowest turbine noise limit value.

12.9.2 Noise from Fixed Plant Operation

There are no other industrial noise sources of fixed mechanical and electrical plant in the vicinity of the nearest NSLs to the proposed substation and battery storage facility that are expected to have any cumulative noise impacts at NSLs. The background noise survey (refer to Section

12.4.2 and 12.5 that was undertaken in the vicinity of the proposed wind farm site did not identify any steady industrial plant noise sources in the receiving environment. Therefore, the potential for any cumulative noise effects is not significant.

12.9.3 Construction and Decommissioning

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

The predicted noise levels from construction activity would need to be well in excess of 55 dB $L_{Aeq,T}$ at an NSL in order for a potential cumulative construction noise increase to exceed the noise thresholds. The assessment in Section 12.8.112.6.2 and 12.6.3 confirms that the predicted noise levels from activities at any NSL are ≤55 dB $L_{Aeq,T}$ and therefore the potential for any cumulative noise effect from all of the proposed activities occurring simultaneously or with construction activities from other developments is unlikely and not significant.

12.10 DIFFICULTIES ENCOUNTERED DURING PREPARATION OF THIS CHAPTER

There were no difficulties or limitations encountered when undertaking this assessment.

12.11 SUMMARY

When considering a development of this nature, the potential noise and vibration effects on the surroundings must be considered for three stages: the short-term construction phase and decommissioning phases, and the long-term operational phase.

The assessment of construction noise and vibration and has been conducted in accordance with best practice guidance contained in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration*.

Residual noise associated with the construction and decommissioned phases have been predicted to be below the proposed threshold values. The associated noise and vibration levels are not likely to cause significant effect at any NSL.

Based on detailed information on the site layout, turbine noise emission levels and turbine hub height, turbine noise levels have been predicted at NSLs for a range of operational wind speeds. The predicted noise levels associated with the proposed development will be within the best practice noise limits recommended in WEDGs. Therefore, it is not considered that a significant effect is associated with the proposed development.

Operational noise from the proposed substation and battery storage facility has been assessed and found to be within the adopted criteria.

No significant vibration effects are associated with the operation of the site.

Therefore, it is not considered that a significant effect is associated with the proposed development.

12.12 REFERENCES

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022)
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise. (BS5228-1)
- Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004)
- Design Manual for Roads and Bridges, Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (National England (now National Highways) 2020) (DMRB)
- BS 7385 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (1993) (BS77385)
- BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. (BS5528-2)
- Department of the Environment, Heritage and Local Government Wind Energy Development Guidelines 2006 (WEDGs)
- Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) publication The Assessment and Rating of Noise from Wind Farms (1996) (ETSU-R-97)
- Institute of Acoustics (IOA) document A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) including six Supplementary Guidance Notes (IOA GPG)
- World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018)
- ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (2024)
- EPA Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) (2011)
- EPA Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4), 2016 (NG4)
- Draft Revised Wind Energy Development Guidelines 2019 Department of Housing, Local Government and Heritage (2019 draft WEDGs)
- World Health Organisation (WHO) document Community Noise (WHO, 1995)
- South Australian Environment Protection Authority namely, Infrasound levels near windfarms and in other environments (EPA, 2013)
- State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources (2016)
- 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)
- RenewableUK AM project (RenewableUK 2013)
- 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) Research into Aerodynamic Modulation of Wind Turbine Noise (2007)
- Wind turbine AM review: Phase 2 report. 3514482A Issue 3. Department for Business, Energy & Industrial Strategy (2016)

- ISO 1996: 2017: Acoustics — Description, measurement, and assessment of environmental noise.