12.0 NOISE AND VIBRATION

12.1 INTRODUCTION

This chapter of the Environmental Impact Assessment Report (EIAR) describes the assessment undertaken of the potential noise and vibration impact from the proposed Castlebanny wind farm project on local residential amenity. The proposed development includes 21 no. wind turbines with an overall height from top of foundation level to blade tip of 185 m. A full description of the proposed project is provided in Chapter 2 – *Description of the Proposed Development.*

The nearest properties are located approximately 175 m and 345 m to the nearest proposed turbine location (i.e. Location H056 and H057 from proposed turbine T21 respectively). These properties have been excluded from the assessment in this EIAR chapter due to their close proximity, involvement in the development and that these properties are not currently occupied and will not be occupied during the lifetime of the development.

There are 181 no. noise sensitive locations within 2 km of the proposed turbine locations. The nearest occupied noise sensitive location (NSL) external amenity is H151, which is located approximately 785 m to the nearest proposed turbine location at T1.

Noise and vibration impact assessments have been prepared for the construction and operational phase of the proposed development to the nearest noise sensitive locations. To inform this assessment baseline noise levels have been measured at several NSLs surrounding the proposed development. Noise predictions to the nearest NSLs have been prepared for both the construction and operational phases.

Other wind farm developments (operational, permitted or proposed) with the potential for cumulative impacts were identified and assessed as part of this assessment. Three developments were identified with the potential for cumulative impacts, Ballymartin / Smithstown and Rahora wind farms. In line with Institute of Acoustics (IoA) document, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) (IOA GPG) best practice guidance, the cumulative impact of the other wind farm developments have been included in the operational noise impact assessment of the Castlebanny wind farm development. Further details on all the developments considered for cumulative impacts are provided in Chapter 4 of this EIAR (Policy, Planning and Development Context).

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:

Dr. Aoife Kelly (Acoustic Consultant) holds a BSc (Hons) in Environmental Health, a Diploma in Acoustics and Noise Control, a PhD in Occupational Noise and is a member of the Institute of Acoustics. Aoife has specialised in acoustics since 2014 and has broad experience in the area of windfarm noise monitoring. She has extensive knowledge and experience in environmental and occupational noise surveying and environmental acoustics, including windfarm commissioning and noise nuisance complaints.

Damian Kelly (Director) holds a B.Sc. from DCU and a M.Sc. from QUB. He has over 20 years' experience as an acoustic consultant and is a Member of the Institute of Acoustics. He has extensive knowledge in the field of noise modelling and prediction, having developed many of the largest and most complex examples of proprietary noise models prepared in Ireland to date. He has extensive modelling experience in relation to wind farm, industrial and road infrastructure projects. He is a sitting member of the committee of the Irish Branch of the Institute of Acoustics.

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 doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10 dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3 dB.

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

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 12-1.

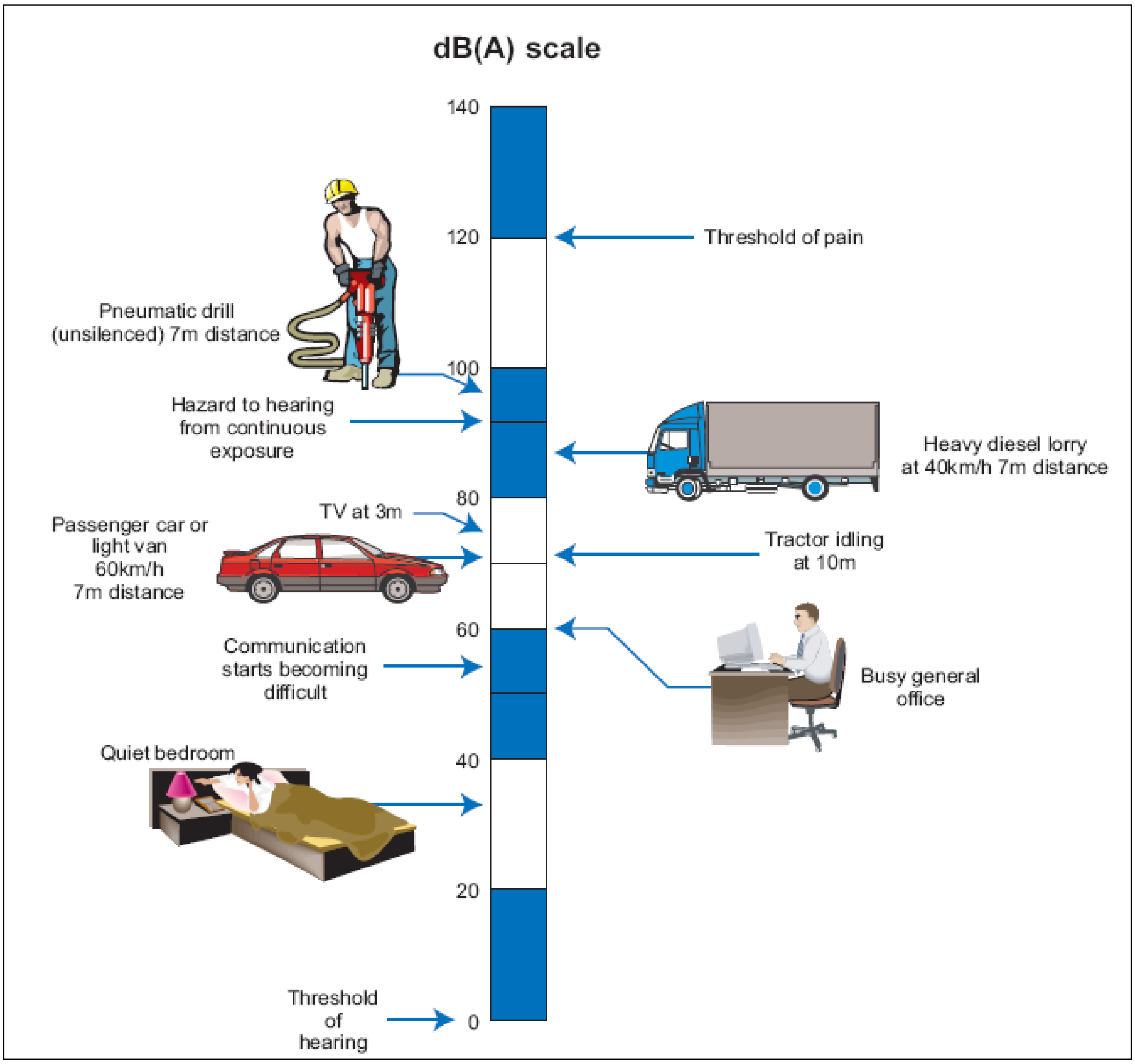

Figure 12-1: The Level of Typical Common Sounds on the dB(A) Scale (NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2004)

12.2 METHODOLOGY

The assessment of impacts for the proposed development have been undertaken with reference to the most appropriate guidance documents relating to environmental noise and vibration which are set out in Section 12.2.3. In addition to these specific guidance documents, the following guidelines were considered and consulted for the purposes of this chapter:

- EPA Guidelines on the Information to be contained in Environmental Impact Statements, (EPA, 2002);
- EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), (EPA, 2003);
- EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports Draft August 2017 (EPA, 2017); and
- EPA Advice Notes for Preparing Environmental Impact Statements, (Draft, September 2015).

The assessment methodology undertaken for this assessment is summarised as follows:

- Review of the most applicable standards and guidelines to set acceptable noise and vibration criteria for the construction and operational phases of the proposed development;
- Characterise the receiving environment through baseline noise surveys at various NSL's surrounding the proposed development;
- Undertake predictive calculations to assess the potential impacts associated with the construction phase of the proposed development at NSL's;
- Undertake predictive calculations to assess the potential impacts associated with the operational phase of the proposed development at NSL's;
- Specify mitigation measures to reduce, where necessary, the identified potential outward impacts relating to noise and vibration from the proposed development; and,
- Describe the significance of the residual noise and vibration effects associated with the proposed development.

12.2.1 Guidance Documents and Assessment Criteria

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

12.2.1.1 Construction 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*.

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 sensitive receptor 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.

Table 12-1: Example Threshold 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 5dB) are less than these values.
Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

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

For the appropriate 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 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 ambient noise levels in the range of 40 to 55 dB $L_{Aeq.T}$. Therefore, for the purposes of this assessment, as a worst case, all properties will be afforded a Category A designation.

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

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

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

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS 5228 recommends that, for a soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above than 15 Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is 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 (NRA, 2004)* also contains information on the permissible construction vibration levels during the construction phase as shown in Table 12-2.

Table 12-2: 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 10 Hz	10 to 50 Hz	50 to 100 Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Following review of the guidance documents set out above, the values in Table 12-2 are considered appropriate for this assessment as they provide more stringent vibration criteria.

12.2.1.3 Additional Vehicular Activity on Public Roads

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the 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 development.

For the assessment of potential noise impacts from construction related traffic along public roads and haul routes it is proposed to adopt guidance from *Design Manual for Roads and Bridges* (DMRB), Highways England, Transport Scotland, The Welsh Government and The Department of Infrastructure 2019.

Table 12-3, taken from Section 13.17 of DMRB presents guidance as to the likely impact associated with any change in the background noise level ($L_{Aeq,T}$) at a noise sensitive receiver as a result of construction traffic.

Section 3.19 of 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;
- A total number of days exceeding 40 in any 6 consecutive months.

Table 12-3: Likely Impacts Associated with Change in Traffic Noise Level (Source DMRB, 2019).

Change in Sound Level (dB L_{A10})	Magnitude of Impact
<1.0	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
5+	Major

The guidance outlined in Table 12-3 will be used to assess the predicted increases in traffic levels on public roads associated with the proposed development and comment on the likely short-term impacts during the construction phase.

12.2.1.4 Operational Phase Noise

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

12.2.1.4.1 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.

The following definition in relation to noise sensitive locations is of note:

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

As can be seen from the calculations presented later in this chapter the various issues identified in this extract have been incorporated into our assessment. Note the noise limits are defined in terms of the $L_{A90,10min}$ parameter.

> *"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.*"

Note again 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.

It is proposed to adopt a lower daytime threshold of 40 dB $L_{A90,10\text{-}min}$ for low noise environments where the background noise is less than 30 dB(A). This follows a review of the prevailing baseline noise survey data contained in this assessment and on-going developments in terms of Irish guidance on the issue of wind turbine noise and is considered appropriate in light of the following:

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

In summary, the operational noise limits proposed for the development are:

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

This set of criteria has been chosen as it is in line with the intent of the relevant Irish guidance and is comparable to noise planning conditions applied to similar sites in the area previously granted planning permission by An Bord Pleanála.

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

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

ETSU-R-97 calls for the control of wind turbine noise by the application of noise limits at the nearest noise sensitive properties. It is considered that absolute noise levels applied at all wind speeds are not suited to wind turbine developments and therefore best practice is to adopt noise limits relative to background noise levels in the vicinity of the noise sensitive locations. Therefore, a critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site noise surveys.

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

12.2.1.4.3 Institute of Acoustics Good Practice Guide

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

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

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

12.2.1.4.4 Future Potential Guidance Changes

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

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

The following statement is of note from the above submission:

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

As the noise provisions contained in the DRWEDG19 as published have drawn a significant number of submissions from a wide range of acousticians and professionals working in this field, the *Wind Energy Development Guidelines for Planning Authorities, 2006* remain widely accepted within the acoustic community. Therefore, in line with best practice, which includes ETSU and IoA Good Practice Guide methodologies as described above the assessment presented in the EIAR is based on the current best practice guidance outlined in Section 5.6 of the *Wind Energy Development Guidelines for Planning Authorities*, 2006. In addition, the following sections of the EIAR chapter also provide a discussion in relation to matters such as low frequency noise, infrasound, amplitude modulation (AM) and noise related impacts on human health. Furthermore, it also describes what would happen if, post-construction, should any issues with special character arise (eg. AM or tones) at any NSL.

12.2.1.4.5 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*".

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. A conditional recommendation, before it becomes folded into any legislative context, would require substantial debate of stakeholders (such as, but not limited to the Public, government bodies, wind farm developers and operators as well as turbine manufacturers). A conditional recommendation is based on low quality evidence that this chosen noise level is effective.

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

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

> *"Even though correlations between noise indicators tend to be high (especially between 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 L_{den} is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes."*

WHO document goes on to state that:

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

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

12.2.1.5 Special Characteristics of Turbine Noise

12.2.1.5.1 Infrasound/Low Frequency Noise

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

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

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

“There is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects.”

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

“Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.

For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects.”

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

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

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

The article concludes that:

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

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[1] found that the level of infrasound from wind turbines is insignificant and no different to any other source of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people.

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

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

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

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

A German report[2], titled "*low frequency noise incl. infrasound from wind turbines and other sources*" presents the details of a measurement project which ran from 2013. The report was published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016 and concluded the following in relation to infrasound from wind turbines:

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

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

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

2 Report available at https://www4.lubw.baden-wuerttemberg.de/servlet/is/262445/low-frequency_noise_incl_infrasound.pdf?command=downloadContent&filename=low-frequency_noise_incl_infrasound.pdf

3 DIN 45680:2013-09 – Draft "Measurement and assessment of low-frequency noise immissions" November 2013

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

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

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

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

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

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

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

The Finnish report concluded that based on their experimental findings:

> *"Infrasound is not causing increased annoyance associated with wind turbine sound. Instead, potential annoyance is more related to intensity and amplitude modulation of turbine sound" 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).

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

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

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

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

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

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

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

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

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

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

Frequency of Occurrence of AM

Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report 'Research into Aerodynamic Modulation of Wind Turbine Noise' (2007). The broad conclusions of this report were that aerodynamic modulation was only considered to be an issue at 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. The research has shown that AM is a rare and unlikely occurrence at operational wind farms.

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

RenewableUK Research Document states the following in relation to matter:

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."*

Assessment of AM

Research and Guidance in the area is ongoing with recent publications being issued by the Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely*, A Method for Rating Amplitude Modulation in Wind Turbine Noise* (August 2016). The 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 AM.

The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work. There has been no adoption of endorsement of an AM 'penalty' scheme by any government. The IOA GPG states in Section 7.2.1 "The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM." Therefore, it is best practice not to provide a condition for AM.

In the absence of published guidance to date, it is considered best practice to adopt the penalty rating and assessment scheme contained in an article published in the Institute of Acoustics publication Acoustics Bulletin (Vol. 42 No. 2 March/April 2017) titled, *Perception and Control of Amplitude Modulation in Wind Turbines Noise.*

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

12.2.1.6 Comments on Human Health Impacts

12.2.1.6.1 The National Health and Medical Research Council

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

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

12.2.1.6.2 Health Canada

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

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

12.2.1.6.3 New South Wales Health Department

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

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

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

12.2.1.6.4 The Australian Medical Association

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

> *"The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."*

12.2.1.6.5 Journal of Occupational and Environmental Medicine

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

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

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

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

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

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

12.2.1.7 Operational Phase Vibration

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

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

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 a vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

Considering that the shortest distance measured from a sensitive receptor external amenity to a turbine hardstanding is greater than 750 m the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria have not been specified for the operational phase of the proposed development.

12.2.1.8 Decommissioning Phase

In relation to the decommissioning phase, the criteria and limits outlined in the Construction Phase of the Proposed Project would be applicable as similar tools and equipment will be used.

12.2.2 EPA Description of Effects

The significance of effects of the proposed development shall be described in accordance with the EPA guidance document Draft Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR), Draft, August 2017. Details of the methodology for describing the 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 with respect to the EPA guidance and description of effects as set out in Chapter 1 (Introduction).

12.2.3 Assessment Methodology

The following guidance documents have been referenced to inform the assessment methodology; further details are presented where relevant in the various sections of this chapter.

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

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

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

12.2.3.2 The Institute of Acoustics Good Practice Guide

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

12.2.3.2.1 Assessment of Cumulative Turbine Noise Impacts

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.

Section 5.1 of the relevant IoA GPG states the following:

> *"5.1.1 ETSU-R-97 states at page 58, "…absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question…"*
>
> *5.1.2 The HMP [7] Report states that "If an existing wind farm has permission to generate noise levels up to ETSU-R-97 limits, planning permission noise limits set at any future neighbouring wind farm would have to be at least 10 dB lower than the limits set for the existing wind farm to ensure there is no potential for cumulative noise impacts to breach ETSU-R-97 limits (except in such cases where a higher fixed limit could be justified)". Such an approach could prevent any further wind farm development in the locality, and a more detailed analysis can be undertaken on a case by case basis.*
>
> *5.1.3 As with the assessment of noise for all wind farm developments, sequential steps need to be taken, but such steps require more detailed attention due to the added complexity of cumulative noise impacts. The advice of the EHO [8] could be invaluable to this part of the assessment."*
>
> *Cumulative impact assessment necessary*
>
> *5.1.4 During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.*
>
> *5.1.5 Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary."*

12.2.3.3 Noise Conditions for Other Wind Farm Developments

The Planning Permission noise conditions relating to the other wind farm developments are considered in this section. It is a requirement that turbine noise emissions from all existing, permitted and proposed wind energy developments are included in the noise impact assessment. As noted previously the cumulative wind farms review identified two wind farms with potential for cumulative impacts to be experienced, namely the nearby Ballymartin / Smithstown and Rahora Wind Farm.

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7 HMP: Hayes McKenzie Partnership Ltd. Report on "Analysis of How Noise Impacts are considered in the Determination of Wind Farm Planning Applications" Ref HM: 2293/R1 dated 6th April 2011.

8 Environmental Health Officer

12.2.3.3.1 Ballymartin / Smithstown Wind Farm

The permissible noise limits for the Ballymartin development are contained in Condition No. 9 of An Bord Pleanála Reference PL10.208178. This planning condition provides that,

"At the critical windspeed (that is, the speed at which the noise of wind turbines and blades is most in excess of ambient noise levels), the noise from the proposed development shall not, when measured externally at the nearest occupied house in the ownership of the existing landowners, exceed 40dB(A)Leq when measured over any 5 minute period."

The permissible noise limits for the Smithstown development are contained in Condition No. 8 of An Bord Pleanála Reference PL10.208178. This planning condition provides that,

"The Developer shall ensure that all activities at the site (construction and operational phase) shall not give rise to noise levels off-site at the nearest inhabited dwellings, which exceed the following sound pressure limits:

- *Day: 45dB(A)* $L_{A90\ (10\ minutes)}$
- *Night: 43dB(A)* $L_{A90\ (10\ minutes)}$

12.2.3.3.2 Rahora Wind Farm

The permissible noise limits for the Rahora development are contained in Condition No. 4 of An Bord Pleanála Reference PL10.206373. This planning condition provides that,

"Noise levels emanating from the proposed development when measured at the nearest inhabited house shall not exceed 40 dBA (15 minutes Leq) at wind speed of 5 metres/second and 45 dBA (15 minutes Leq) at wind speed in excess of 10 metres/second. Measurements shall be made in accordance with ISO recommendations R 1996/1 (Acoustics – Description and Measurement of Environmental Noise, Part 1: Basic Qualities and Procedures)."

For the assessment presented in this report the Ballymartin / Smithstown and Rahora wind farms as built have been included in the cumulative noise model and the total wind turbine noise level of all wind farms is assessed at the houses listed in Table 12-25 against the noise criteria for Castlebanny wind farm.

12.2.3.4 Background Noise Survey

The background noise survey was conducted through installing unattended sound level meters at eight representative locations in the surrounding area.

12.2.3.4.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary cumulative noise model contour at an early stage of the assessment. Any locations that fell inside the predicted 35 dB L_{A90} noise contour were considered for noise monitoring in line with current best practice guidance outlined in the IoA GPG. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g. Google Earth) and verified on the ground.

12.2.3.4.2 Measurement Periods

The survey duration was typically 4 weeks, or until such time that a sufficient number of data point 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."*

AWN conducted an ongoing review of the survey data at regular intervals to establish when adequate data had been captured.

Noise measurements were conducted at relevant monitoring locations over the following periods outlined in Table 12-4.

Table 12-4: Noise Measurement Periods

Location Ref.	Location I.D.	Start Date	End Date
NML1	H025	20 September 2019	31 October 2019
NML2	H045	20 September 2019	31 October 2019
NML3	H020	20 September 2019	31 October 2019
NML4	H068	20 September 2019	31 October 2019
NML5	H074	11 October 2019	15 November 2019
NML6	H080	20 September 2019	15 November 2019
NML7	H099	20 September 2019	20 October 2019
NML8	H147	20 September 2019	29 October 2019

A variety of wind speed and weather conditions were encountered over the survey periods in question. As an indication to this, Figure 12-2 shows the distribution of wind speed and direction recorded at the met mast for all periods of day and night between the 20 September and 15 November 2019. The wind speed data presented below relates to a turbine hub height of 110 m.

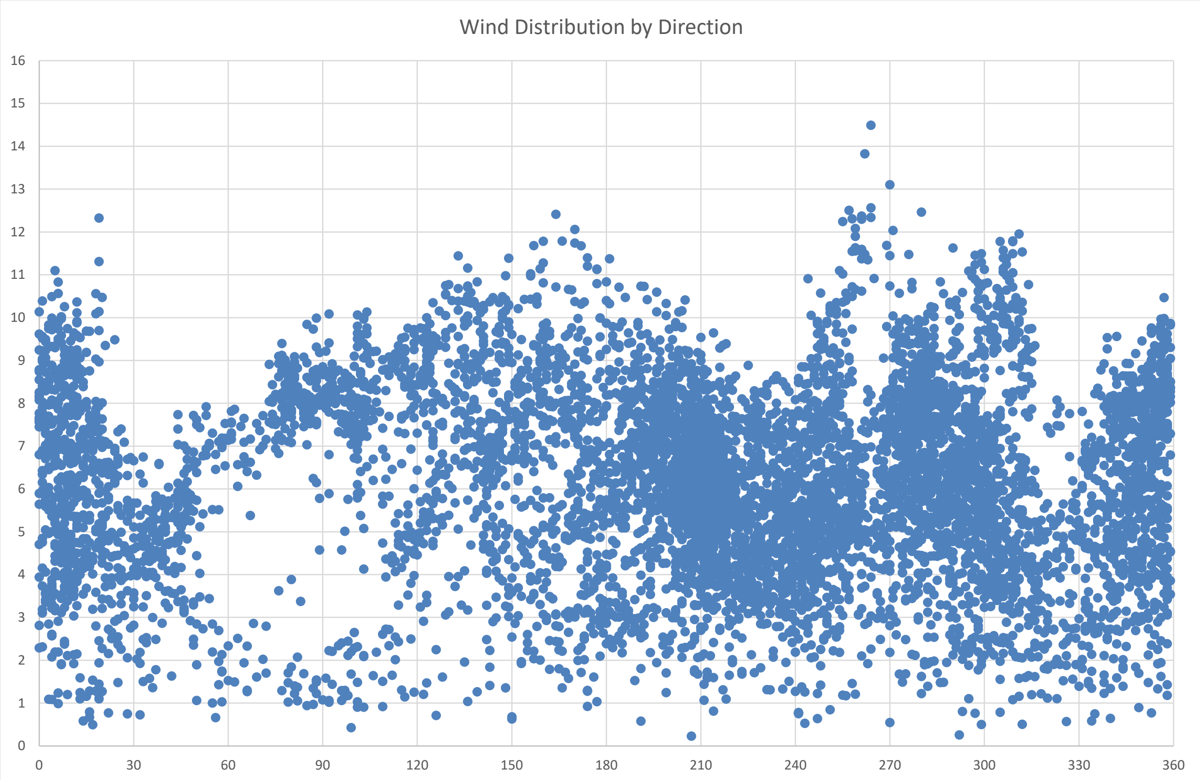

Figure 12-2: Distribution of Wind Speeds and Direction at Castlebanny Met Mast during Survey Period

It is confirmed that survey periods were of sufficient duration to measure adequate data to determine a suitable representation of typical background in accordance with guidance contained within the IoA GPG.

12.2.3.4.3 Instrumentation

The following instrumentation was used at the various locations outlined in Table 12-5.

Table 12-5: Noise Measurement Instrumentation

Location	Equipment	Serial Number	Survey Periods	Calibration Drift over Survey Period
NSL 1 (H025)	Rion NL-52	231668	20/09/2019 to 31/10/2019	0.0 dB
NSL 2 (H045)	Rion NL-52	710288	20/09/2019 to 31/10/2019	0.2 dB
NSL 3 (H020)	Rion NL-52	976162	20/09/2019 to 31/10/2019	0.1 dB
NSL 4 (H068)	Rion NL-52	186672	20/09/2019 to 08/10/2019 Note 1 11/10/2019 to 31/10/2019	0.1 dB
NSL 5 (H074)	Bruel and Kjaer 2238	2638294	11/10/2019 to 15/10/2019 21/10/2019 to 25/10/2019 31/10/2019 to 15/11/2019 Note 2	0.0 dB
NSL 6 (H080a)	Bruel and Kjaer 2238	2562663	20/09/2019 to 08/10/2019 Note 1	0.1 dB
NSL 6 (H080b)			11/10/2019 to 30/10/2019 Note 1,3 31/10/2019 to 15/11/2019	
NSL 7 (H099)	Bruel and Kjaer 2238	2638292	20/09/2019 to 10/10/2019 Note 1 11/10/2019 to 20/10/2019 Note 4	0.1 dB
NSL 8 (H147	Bruel and Kjaer 2238	2562813	20/09/2019 to 09/10/2019 Note 1 11/10/2019 to 29/10/2019 Note 1	0.4 dB

Note 1: Battery power fail on equipment, resolved on subsequent site visit.
Note 2: Logging error on equipment at NSL5, resolved on subsequent site visit 31 October 2019.
Note 3: Meter at NSL6 was moved away from river noise source on 31 October 2019.
Note 4: Cable dislodged by resident – no data logged after 20 October 2019.

Before, after and during each survey period, the measurement instrument was check calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator. The calibration drifts were noted, and the maximum drifts are detailed in the table above. Relevant calibration certificates are presented in Appendix 12-2.

Rainfall was monitored using two rain gauges (Texas Electronics Rainfall Sensor, Model TR 525), one installed at NSL 3 and the other installed at NSL 6. 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 outlined in IOA GPG *Supplementary Guidance Note 2: Data Processing and Derivation of ETSU-R-97 Background Curves,* when calculating the prevailing background noise levels at the various locations.

Wind speed measurements were obtained from a met mast. The location of the system is provided in *Table 12-6* with anemometer heights of 80 m and 64 m.

Table 12-6: Met Mast Locations

Met Mast	Co-ordinates (ITM)	
	Easting	Northing
Met Mast	657,135	632,102

12.2.3.4.4 Measurement Procedure

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

During installation and removal of equipment from each monitoring location, note was made of the primary noise sources contributing to the noise environment in the area (e.g. identified significant noise sources in the area such as local traffic, farm yard activities etc.).

12.2.3.4.5 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 above ground wind speed. The issue of wind shear has been considered in this assessment and followed relevant guidance as outlined in the IoA GPG. This guidance presents the following equations in relation to the derivation of a standardised wind speed at 10m 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.

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

The background noise data has been analysed with respect to a 10m standardised height based on an assessment hub height of 110 m in accordance with the guidance contained in the IoA GPG, Supplementary Guidance Note (SGN) 4: Wind Shear, July 2014.

12.2.3.4.6 Analysis of Background Noise Data

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

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

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

12.2.3.4.7 Measurement Locations

The co-ordinates for selected locations for the noise monitoring are outlined in Table 12-7 and depicted on the map in Figure 12-3.

Table 12-7: Noise Measurement Co-ordinates

Location Ref.	Location I.D.	Co-ordinates (ITM)	
		Easting	Northing
NML1	H025	656822.0	632380.1
NML2	H045	655861.4	634184.0
NML3	H020	656619.2	630386.1
NML4	H068	658737.3	634903.4
NML5	H074	659181.5	633980.9
NML6	H080a	659454.8	632194.9
	H080b	659491.0	632157.6
NML7	H099	660127.6	630186.7
NML8	H147	659741.3	628919.4

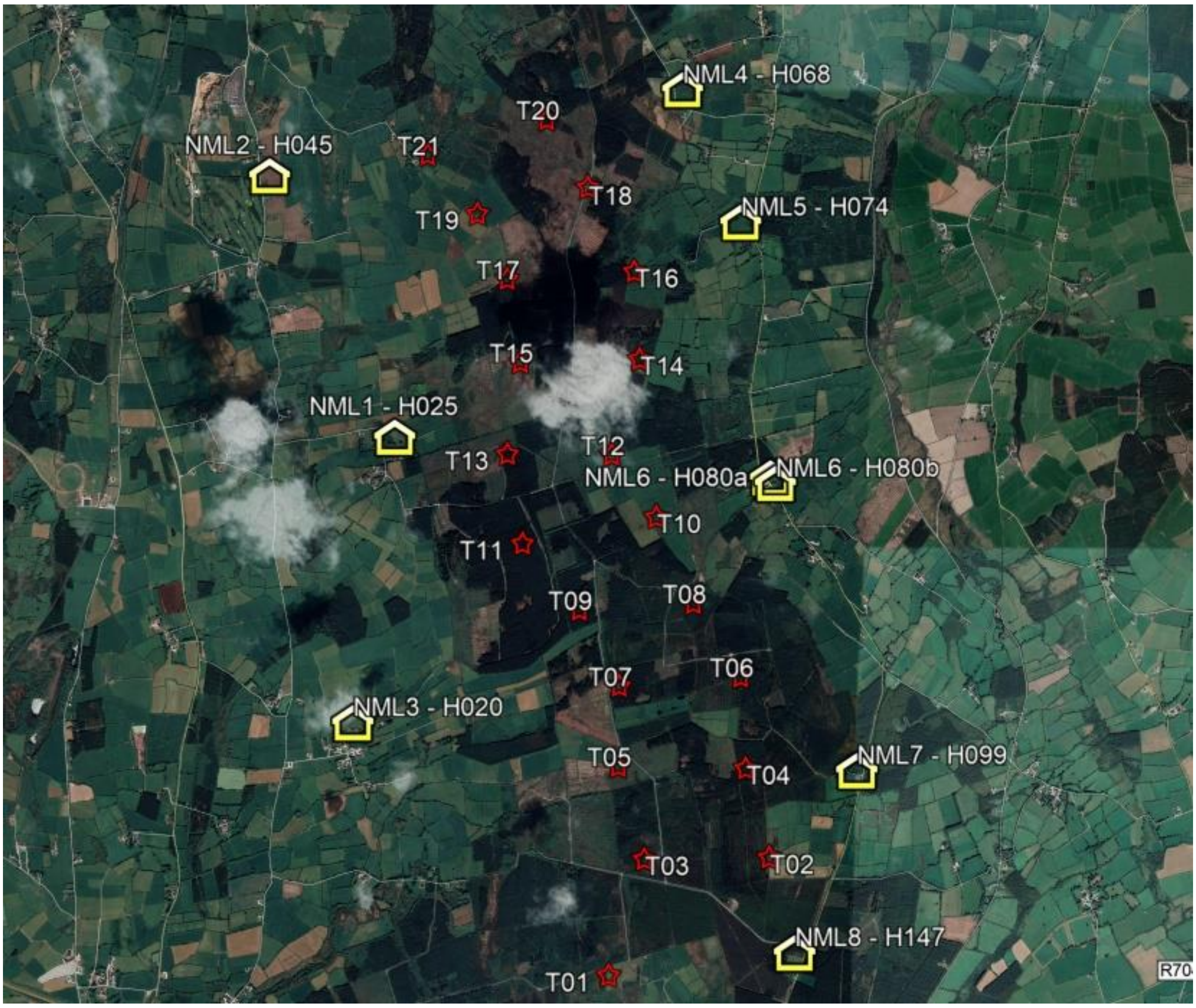

Figure 12-3: Noise Monitoring Locations

Location NML1 (H025) was located in the rear of the garden in open space, at a distance of 10 m to the south of the dwelling. Noise sources were noted as local farm machinery and activity and other anthropological sources.

Location NML2 (H045) was located in the rear of the garden in open space, at a distance of 12 m to the east of the dwelling.

Location NML3 (H020) was located in the rear of the garden in open space, at a distance of 15 m to the north of the dwelling.

Location NML4 (H068) was located in the side garden in open space, at a distance of 12 m to the north of the dwelling.

Location NML5 (H074) was located in the side garden in open space, at a distance of 10 m to the west of the dwelling.

Location NML6 (H080a) was located in the rear garden in open space, at a distance of 10 m to the north of the dwelling. Due to a steady water flow noise from a nearby culverted stream to the north of the property, which was inaudible during installation, the NML6 (H080b) was reinstalled to the south at a distance of 20 m to the south of the dwelling.

Location NML7 (H099) was located in the side garden in open space, at a distance of 12 m to the south of the dwelling.

Location NML8 (H147) was located in the side garden in open space, at a distance of 10 m to the north of the dwelling.

At all locations the noise sources were noted to be primarily from traffic on local roads and other anthropological sources. At NML3 (H020) the other noise source noted was local farm machinery and activity. The existing Ballymartin / Smithstown windfarm development was not visible during installation at NML8 (H147) and during the time of installation and maintenance they were not audible at the location. Site visits were carried out during the morning and afternoon time and therefore no observations were made during night time periods. Wind generated noise in local foliage was noted to be contributing to the background noise at some locations. It is considered that the background noise monitoring locations give a robust picture of background noise levels experienced at typical residential noise sensitive locations surrounding the proposed site.

12.2.3.5 Construction Noise Calculations

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

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

12.2.3.6 Operational Noise Calculations

A series of computer-based prediction models have been prepared to quantify the potential cumulative turbine noise level associated with the operational phase of the proposed development on the receiving environment, together with the nearby Ballymartin / Smithstown and Rahora Wind Farms. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

12.2.3.7 DGMR iNoise V2020 Enterprise

The selected software, DGMR *iNoise Enterprise*, calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 1996).

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

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

12.2.3.8 Input Data and Assumptions

Contour and information available for the site has been inputted into our iNoise noise modelling software using the *ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors: General method of calculation*. The proposal in question considers the construction of 21 no. turbine units on the site as detailed in Chapter 2 of this EIAR (Description of the proposed development).

12.2.3.9 Proposed Turbine Details

Table 12-8 to Table 12-10 detail the co-ordinates of the 21 no. turbines in the proposed Castlebanny Wind Farm development, the 7 no. Ballymartin / Smithstown Wind Farm turbines and the 5 no. Rahora Wind Farm turbines that are being considered as part of this cumulative assessment.

Table 12-8: Proposed Turbine Co-ordinates

Turbine Ref.	Co-ordinates (ITM)	
	Easting	Northing
T1	658,464	628,904
T2	659,458	629,770
T3	658,678	629,701
T4	659,349	630,345
T5	658,475	630,328
T6	659,292	630,971
T7	658,460	630,876
T8	658,948	631,462
T9	658,120	631,359
T10	658,620	631,958
T11	657,754	631,828
T12	658,380	632,457
T13	657,625	632,441
T14	658,512	633,132
T15	657,687	633,081
T16	658,418	633,693
T17	657,571	633,655
T18	658,105	634,316
T19	657,303	634,069
T20	657,800	634,781
T21	657,025	634,541

Table 12-9: Ballymartin / Smithstown As Built Turbine Co-ordinates

Turbine Ref.	Co-ordinates (ITM)		Turbine Model	Hub Height (m)
	Easting	Northing		
TBB1	660,516	626,665	Enercon E82 2.3MW	80
TBB2	660,895	626,702		
TBB3	660,859	626,333		
TBS1	660,871	627,165		
TBS2	660,621	627,356		
TBS3	660,528	627,010		
TBS4	661,028	627,486		

Table 12-10: Rahora As Built Turbine Co-ordinates

Turbine Ref.	Co-ordinates (ITM)		Turbine Model	Hub Height (m)
	Easting	Northing		
TR1	664,348	627,593	Enercon E48	56
TR2	664,532	627,826		
TR3	664,685	628,102		
TR4	664,819	627,925		
TR5	664,951	628,137		

The following sections detail the noise data for the various turbine units under consideration that have been used for modelling purposes.

For the purposes of this assessment, the turbine type assumed for the development site is the Vestas V150 5.6MW. The turbine is a pitch regulated upwind turbine with a three-blade rotor. For the purposes of this assessment predictions have assumed the source of noise at a hub height of 110m with serrated trailing edges[9]. Each wind turbine is secured to a circular-shaped reinforced concrete foundation. A worst-case assessment of the Vestas V150 has been used for modelling purposes e.g. operating mode with the highest noise level for unit with serrated trailing edges.

While the noise profiles of the Vestas V150[10] wind turbine has been used for the purposes of this assessment, the actual turbine to be installed on the site will be the subject of a competitive tender process and could include turbines not amongst the turbine models currently available. The 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 Vestas turbines in this assessment must be considered in the context of the above and should not be construed as meaning it is the only make or model of wind turbine that could be used on the site.

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

Table 12-11 details the noise data used for noise modelling purposes for Castlebanny wind farm.

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9 Serrations are thin, zig-zagged components attached to the rotor blade for sound reduction. They influence the turbulent trailing edge sound by replacing the straight edge of the rotor blade with a serrated one. This has the potential to reduce the sound power level associated with the wind turbine.

10 Vestas Technical Report – Third Octave Noise Emission EnVestus V150-5.6MW Date Version 2 Document no: 0079-5099_02, Issued 2019_05_20. Data has been corrected from hub height to a standardised 10m above ground wind speed for an assumed hub height of 110m. This manufacturer's data has been used, including details of noise spectra. The detailed noise spectra are not presented here for commercial reasons and associated non-disclosure agreements with the manufacturer.

Table 12-11: L_{wA} Levels Used for Prediction Model – Nordex V150 5.6MW (with Serrated Trailing Edges)

Standardised 10m Height Wind Speed (m/s)	Octave Band (Hz) Sound Power Levels (dB re 10^{-12}W)								dB(A)
	63	125	63	500	63	2k	63	8k	
3	73.6	81.3	86.0	87.8	86.5	82.4	75.2	65.1	92.6
4	77.4	85.1	89.8	91.5	90.4	86.2	79.1	69.0	96.4
5	81.7	89.4	94.1	95.8	94.7	90.5	83.5	73.4	100.7
6	84.1	92.0	96.9	98.8	97.7	93.5	86.5	76.3	103.6
7	84.7	92.6	97.5	99.4	98.3	94.1	87.1	76.9	104.2
8	85.6	93.4	98.2	100.1	98.9	94.8	87.7	77.6	104.9
9	86.3	93.7	98.2	100.0	98.9	94.9	88.1	78.4	104.9

Moreover, as explained below in Section 12.2.1.4, appropriate guidance is couched in terms of a L_{A90} criterion. Best practice guidance in the IoA GPG states that "L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB". Therefore, a 2dB reduction has been applied to the noise model output. All predicted noise levels in this chapter are presented in terms of L_{A90}, i.e. this reduction of 2dB is included the values presented.

Finally, best practice specifies that should any tonal component be present, a penalty shall be added to the predicted noise levels. The level of this penalty is described in ETSU-R-97, 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 ETSU-R-97 best practice guidance.

A number of other existing and proposed windfarm developments have been identified in the vicinity of the development as follows:

- Ballymartin / Smithstown Wind Farm (planning ref. PL 10.208178) – operating development consisting of 7 turbines.
- Rahora Wind Farm (planning ref. PL 10.206373) - operating development consisting of 5 turbines.

The noise emission data in Table 12-12 has been assumed at 80 m for the Ballymartin / Smithstown Turbines based on the Enercon Document Sound Power Level of the ENERCON E82 E2 Operational Mode 1 Data Sheet (SIAS-04-SPL E82 OM 1 Rev 3.1 Issued 01-2013.)

Table 12-12: Assumed Noise Emission Data for Ballymartin / Smithstown Wind Farm Used for Prediction Model

Standardised 10m Height Wind Speed (m/s)	Octave Band (Hz) Sound Power Levels (dB re 10^{-12}W)								dB(A)
	63	125	63	500	63	2k	63	8k	
5	77.2	83.8	88.2	89.1	91.3	90.0	84.2	71.3	96.4
6	81.5	88.1	92.5	93.4	95.6	94.3	88.5	75.6	100.7
7	84.1	90.7	95.1	96.0	98.2	96.9	91.1	78.2	103.3
8	84.8	91.4	95.8	96.7	98.9	97.6	91.8	78.9	104.0
9	84.8	91.4	95.8	96.7	98.9	97.6	91.8	78.9	104.0

The noise emission data in Table 12-13 has been assumed at 56 m for the Rahora Turbines based on the Enercon Document Sound Power Level of the ENERCON E48 Operational Mode 1 Data Sheet (SIAS-04-SPL E48 OM 1 Rev 3.1 Issued 14-07-2012.)

Table 12-13: Assumed Noise Emission Data for Rahora Wind Farm Used for Prediction Model

Standardised 10m Height Wind Speed (m/s)	Octave Band (Hz) Sound Power Levels (dB re 10^{-12}W)								dB(A)
	63	125	63	500	63	2k	63	8k	
5	74.5	81.1	85.5	86.4	88.6	87.3	81.5	68.6	93.7
6	78.7	85.3	89.7	90.6	92.8	91.5	85.7	72.8	97.9
7	81.5	88.1	92.5	93.4	95.6	94.3	88.5	75.6	100.7
8	82.5	89.1	93.5	94.4	96.6	95.3	89.5	76.6	101.7
9	83.3	89.9	94.3	95.2	97.4	96.1	90.3	77.4	102.5

For the purposes of all predictions presented in this report to account for various uncertainties in the measurement of turbine source levels, a value of 2 dB has been added to the manufacturer's values in line with best practice wind turbine noise assessment.

12.2.3.9.1 Modelling Calculation Parameters

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, 1996.

In terms of calculation a ground attenuation factor (general method) of 0.5 and no metrological correction were assumed for all calculations. The atmospheric attenuation outlined in Table 12-14 were used for all calculations in accordance with the guidance outlined in the IOA GPG.

Table 12-14: Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88

Additional information relating to the noise model inputs and calculation settings is provided in Appendix 12-3.

12.2.3.10 Additional Information

Table 12-15 details the co-ordinates of the 181 no. NSLs being considered in this assessment. The information has been taken from a list of receptors generated by TOBIN Consulting Engineers within 2 km from the edge of study area. Noise predictions were prepared in respect of the various operational turbine wind speeds at these locations. Figures identifying all NSLs are provided in Appendix 12-4.

Table 12-15: NSL Co-ordinates Within 2 km of Proposed Development

NSL Ref.	Co-ordinates (ITM)		NSL Ref.	Co-ordinates (ITM)		NSL Ref.	Co-ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H001	658,486	627,593	H073	659,201	634,581	H201	657,910	636,727
H002	657,962	627,403	H074	659,200	633,980	H202	658,017	636,704
H003	657,896	627,456	H075	659,331	633,980	H203	659,045	636,108
H012	656,696	629,497	H076	659,346	633,288	H204	659,210	636,101
H013	657,143	629,440	H077	659,364	633,225	H205	659,273	636,055
H014	657,338	629,431	H078	659,307	632,926	H206	659,290	635,755
H015	657,383	629,446	H079	659,414	632,287	H207	659,452	635,641
H016	657,432	629,472	H080	659,467	632,182	H208	659,240	635,557
H017	656,734	630,101	H081	659,515	632,144	H209	659,286	635,501
H018	656,615	630,137	H082	659,518	632,105	H210	659,465	635,513
H019	656,592	630,271	H083	659,739	631,864	H211	659,427	635,408
H020	656,615	630,366	H084	659,749	631,789	H212	661,119	631,308
H021	656,686	632,204	H085	659,851	631,794	H213	662,037	627,760
H022	656,746	632,219	H086	659,928	631,770	H214	662,007	627,693
H023	656,726	632,272	H087	659,957	631,733	H215	661,789	627,313
H024	656,691	632,304	H088	660,282	631,745	H216	661,772	627,278
H025	656,805	632,388	H089	660,534	631,662	H217	661,510	627,266
H026	656,696	632,474	H090	660,132	631,495	H218	661,453	627,086
H027	656,584	632,539	H091	660,134	631,280	H219	661,367	626,954
H028	656,277	632,519	H092	660,851	631,390	H220	661,251	626,676
H029	656,519	632,688	H093	660,304	631,087	H221	660,537	625,958
H030	656,033	632,639	H094	660,339	631,045	H222	660,509	625,929
H031	655,951	632,970	H095	660,360	630,930	H223	658,605	627,296
H032	655,942	633,213	H096	660,523	630,990	H224	658,120	627,198
H033	655,885	633,215	H097	660,896	630,951	H225	658,041	627,245
H034	656,015	633,428	H098	660,658	630,816	H226	658,001	627,099
H035	655,797	633,480	H099	660,124	630,207	H227	657,961	627,102
H036	655,803	633,511	H100	660,676	630,864	H228	656,548	630,340
H037	655,815	633,576	H101	661,183	630,752	H229	656,245	630,666
H039	655,813	633,693	H102	661,340	630,381	H230	655,981	631,812
H040	655,849	633,716	H103	661,280	630,735	H231	655,944	632,093
H041	655,845	633,883	H104	661,215	630,514	H232	655,945	632,130
H042	655,876	634,041	H105	661,247	630,338	H233	655,771	632,224
H043	655,906	633,876	H106	661,075	630,251	H234	655,641	632,270
H044	655,852	634,153	H108	661,390	630,239	H235	655,756	632,286
H045	655,841	634,187	H109	661,083	630,157	H236	655,672	632,335

NSL Ref.	Co-ordinates (ITM)		NSL Ref.	Co-ordinates (ITM)		NSL Ref.	Co-ordinates (ITM)	
	Easting	Northing		Easting	Northing		Easting	Northing
H046	655,826	634,225	H110	661,090	630,099	H237	655,754	632,381
H047	655,833	634,249	H111	660,747	629,836	H238	655,509	633,504
H048	655,619	634,351	H112	660,842	629,723	H239	655,484	633,606
H049	655,686	634,437	H113	661,173	629,865	H240	655,427	633,634
H050	655,808	634,450	H114	661,123	629,777	H241	655,401	633,625
H051	655,712	634,580	H115	661,174	629,718	H242	655,621	633,646
H052	655,569	634,830	H116	661,101	629,698	H243	655,757	633,641
H053	655,450	634,798	H117	661,147	629,638	H244	655,747	633,683
H054	655,620	635,136	H118	661,070	629,573	H245	655,275	634,290
H055	655,703	635,226	H119	661,153	629,530	H246	655,695	635,529
H058	658,188	635,881	H120	661,056	629,479	H247	655,765	635,595
H059	658,158	635,848	H121	661,027	629,404	H248	655,644	635,579
H060	658,596	635,268	H122	660,981	629,362	H249	655,637	635,623
H061	658,587	635,160	H143	659,505	627,706	H250	655,573	635,693
H062	658,772	635,431	H145	659,568	628,212	H251	655,564	635,777
H063	658,820	635,325	H146	659,593	628,238	H252	655,560	635,837
H064	658,765	635,292	H147	659,739	628,901	H253	655,284	634,061
H065	658,805	635,283	H148	659,732	629,019	H255	655,910	632,853
H066	658,793	635,260	H149	659,328	628,403	H256	655,947	632,557
H067	658,770	635,230	H150	659,316	628,498	H257	655,871	633,288
H068	658,737	634,884	H151	659,172	628,561	H258	661,246	628,346
H069	659,344	635,139	H152	656,559	630,359	H259	659,489	632,294
H070	659,355	635,063	H153	655,942	632,516	H260	656,020	632,827
H071	659,366	634,916	H154	655,733	634,289			
H072	659,324	634,716	H200	656,125	633,124			

12.3 EXISTING ENVIRONMENT

This section documents the typical background noise levels measured in the vicinity of the noise sensitive locations in closest proximity to the proposed development site.

12.3.1 Background Noise Levels

The following sections present an overview and results of the noise monitoring data obtained from the background noise survey in accordance with the methodology discussed in Section 12.2.3.3. An examination of the potential for noise contribution from the existing Ballymartin / Smithstown and Rahora Wind Farms to the measured noise levels at the noise survey locations concluded that it was not required to filter the data by wind direction. Details are presented in Appendix 12-5.

Location NML6 was found to have been impacted from steady water flow noise from a nearby culverted stream to the north of the property, which was inaudible during installation. The SLM was relocated to area south of the property on 11 October 2019 but stream was still audible. The results from this location have been analysed and are presented in the following sections.

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.

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

12.3.1.1 Location NML1

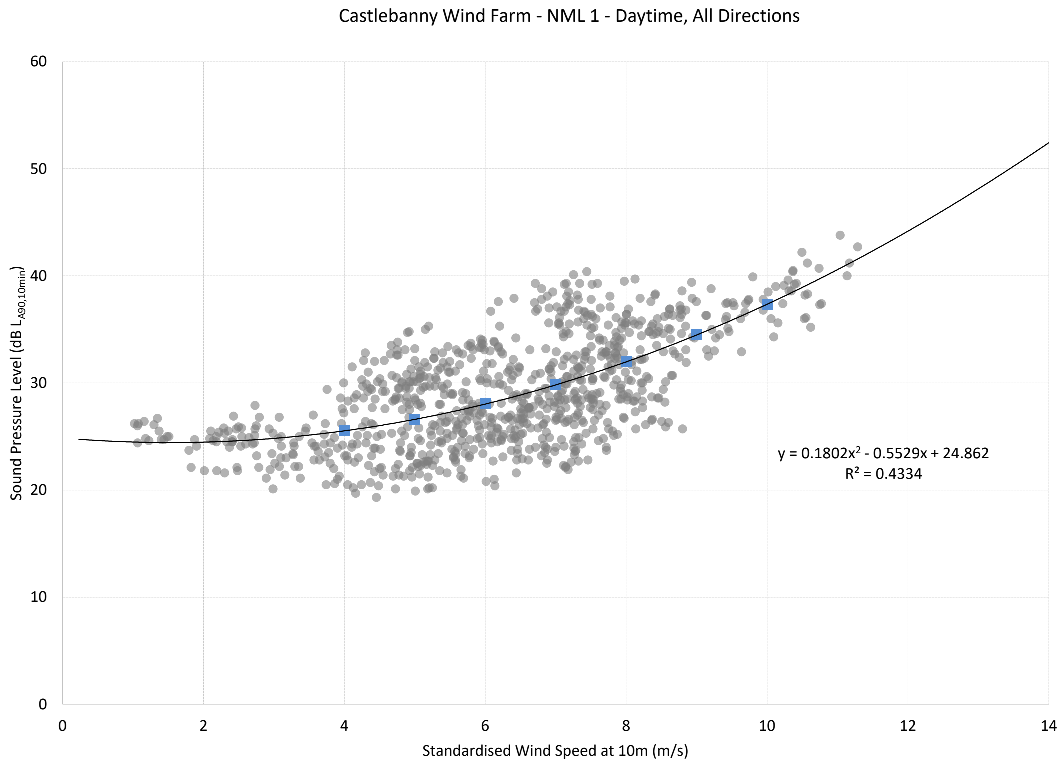

Figure 12-4: Location NML1 (H025) – Background Noise – Daytime Period

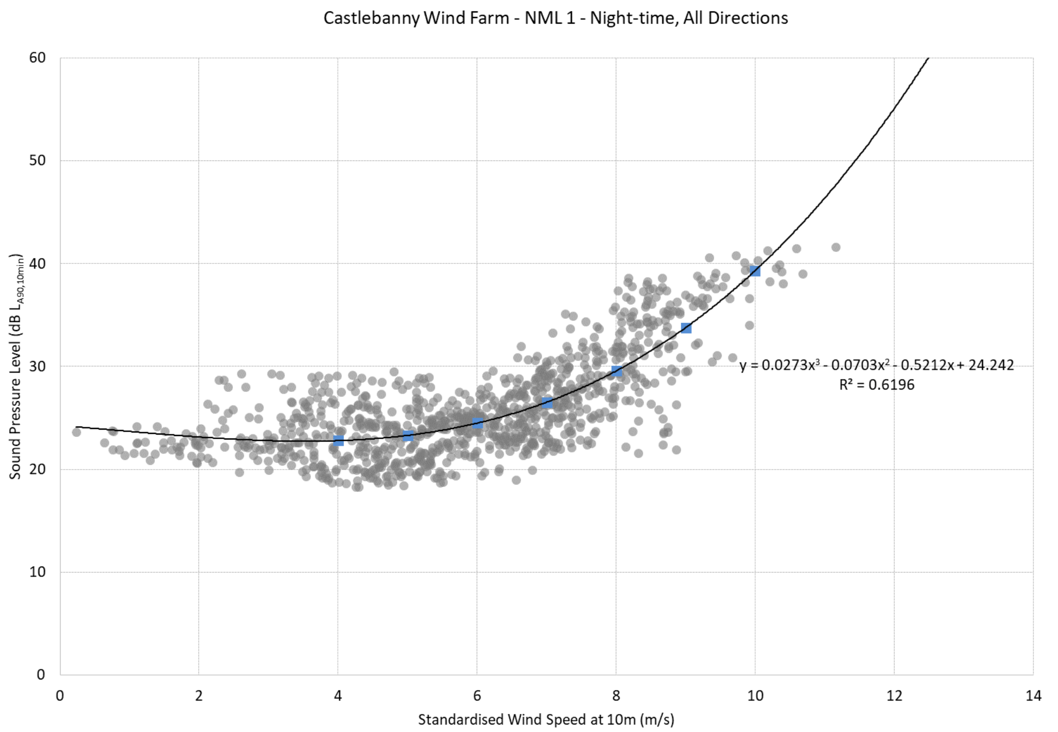

Figure 12-5: Location NML1 (H025) – Background Noise – Night-time Period

12.3.1.2 Location NML2

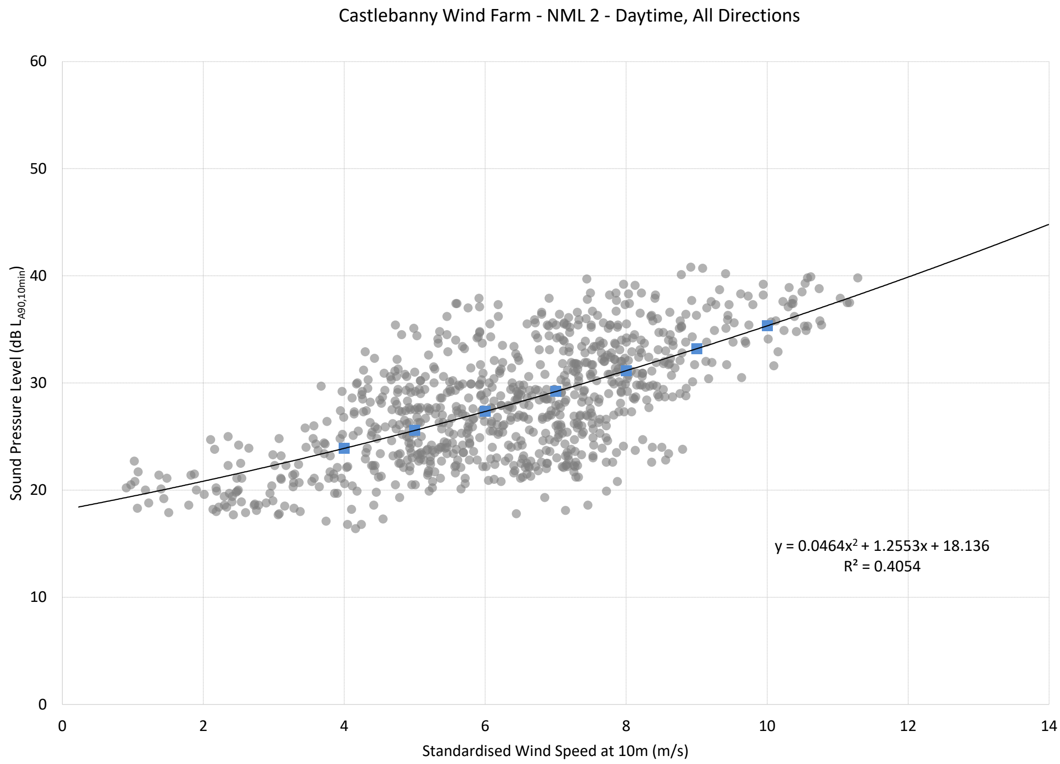

Figure 12-6: Location NML2 (H045) – Background Noise – Daytime Period

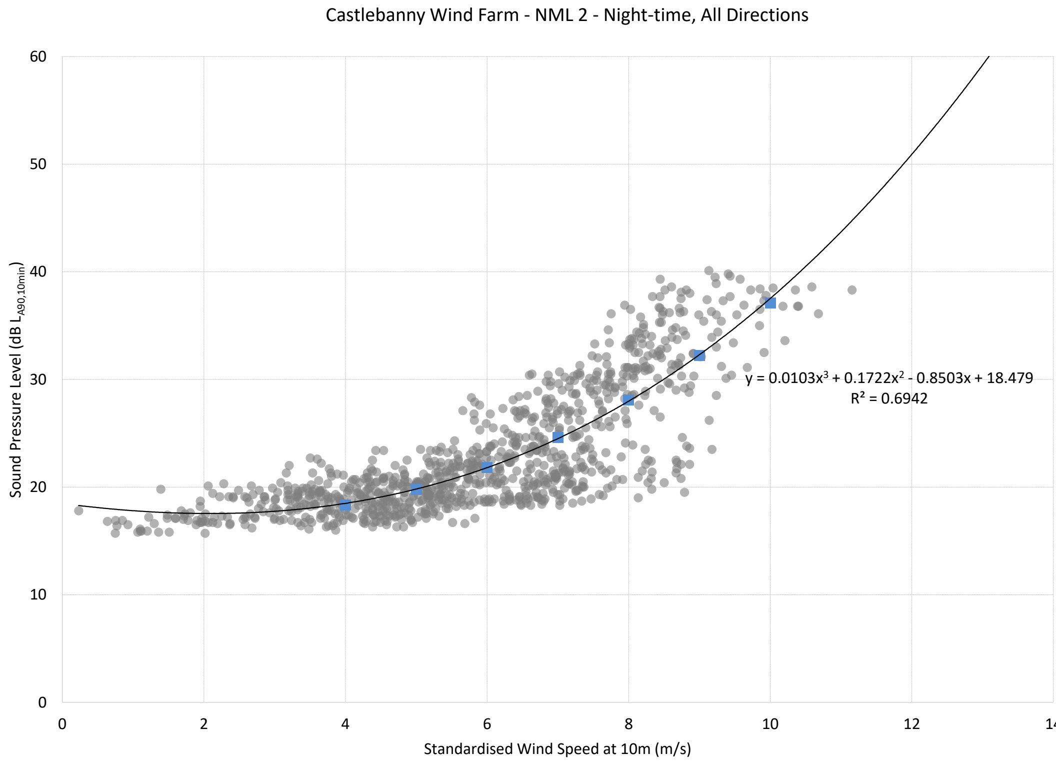

Figure 12-7: Location NML2 (H045) – Background Noise – Night-time Period

12.3.1.3 Location NML3

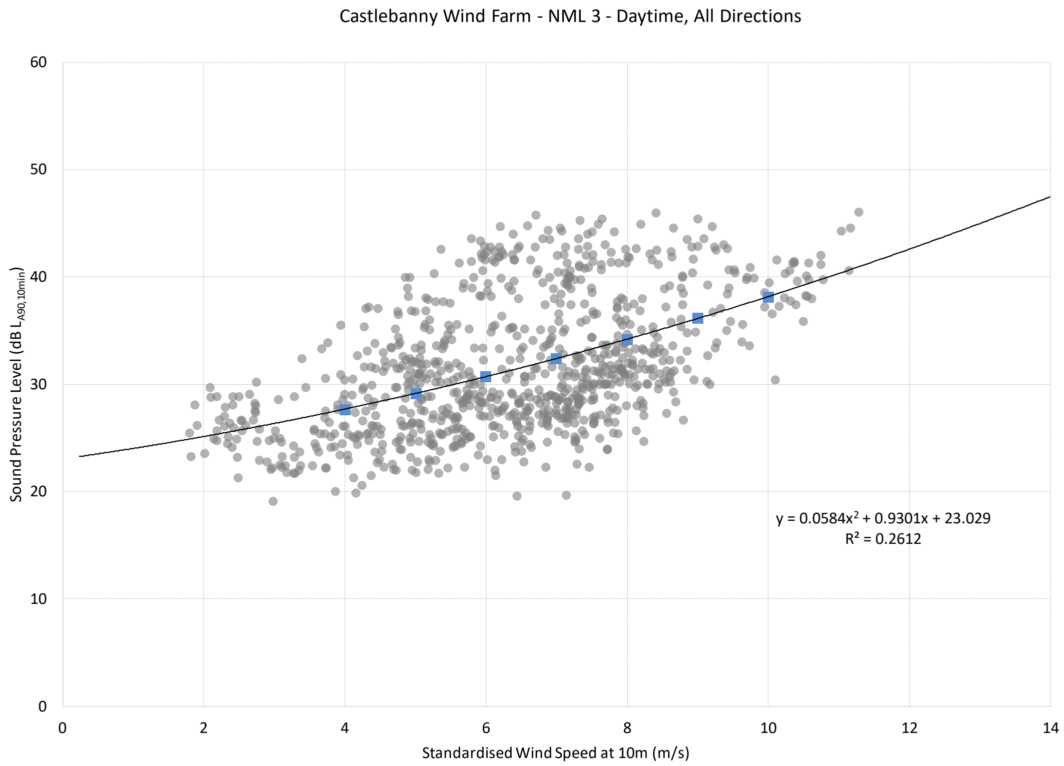

Figure 12-8: Location NML3 (H020) – Background Noise – Daytime Period

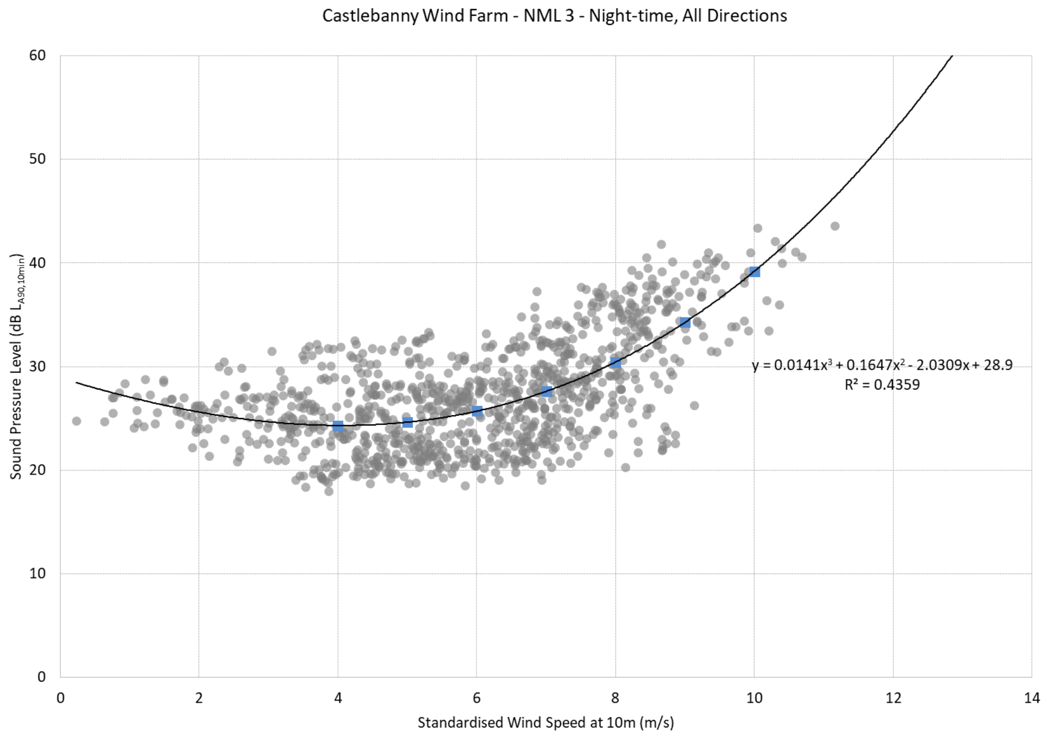

Figure 12-9: Location NML3 (H020) – Background Noise – Night-time Period

12.3.1.4 Location NML4

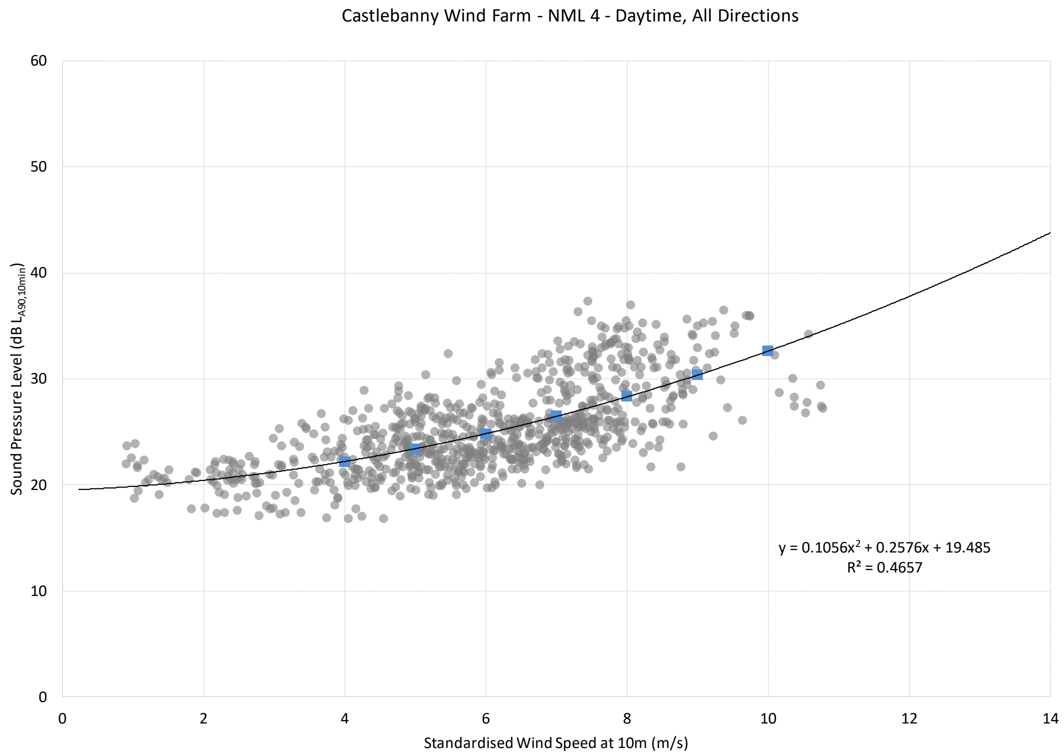

Figure 12-10: Location NML4 (H068) – Background Noise – Daytime Period

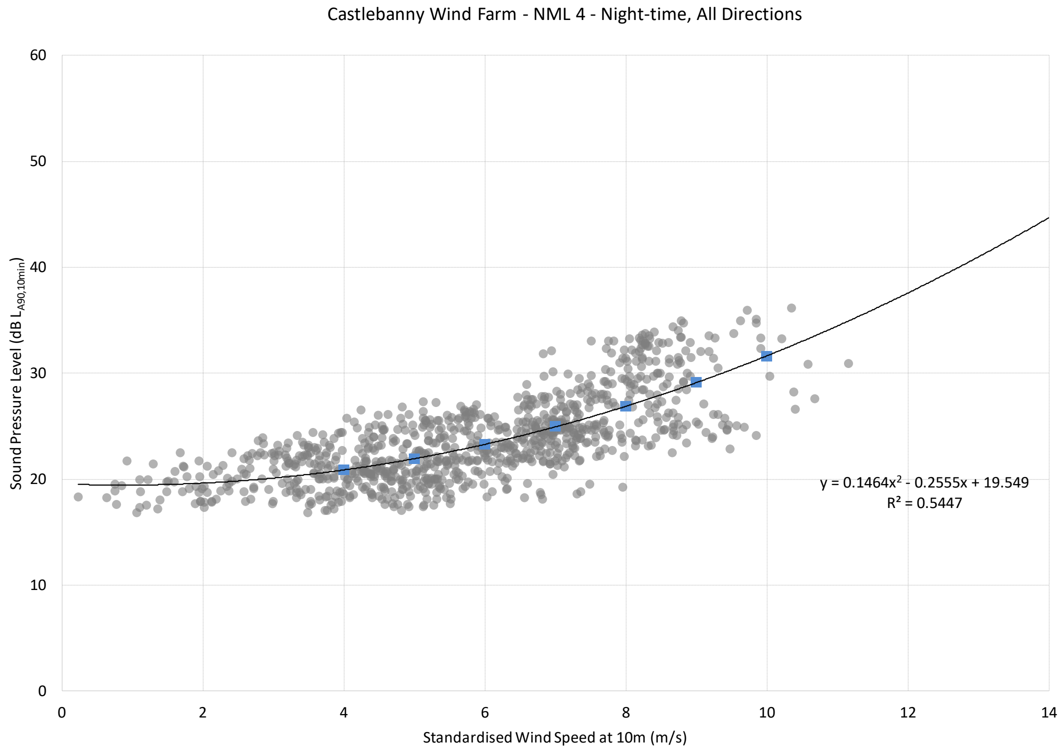

Figure 12-11: Location NML4 (H068) – Background Noise – Night-time Period

12.3.1.5 Location NML5

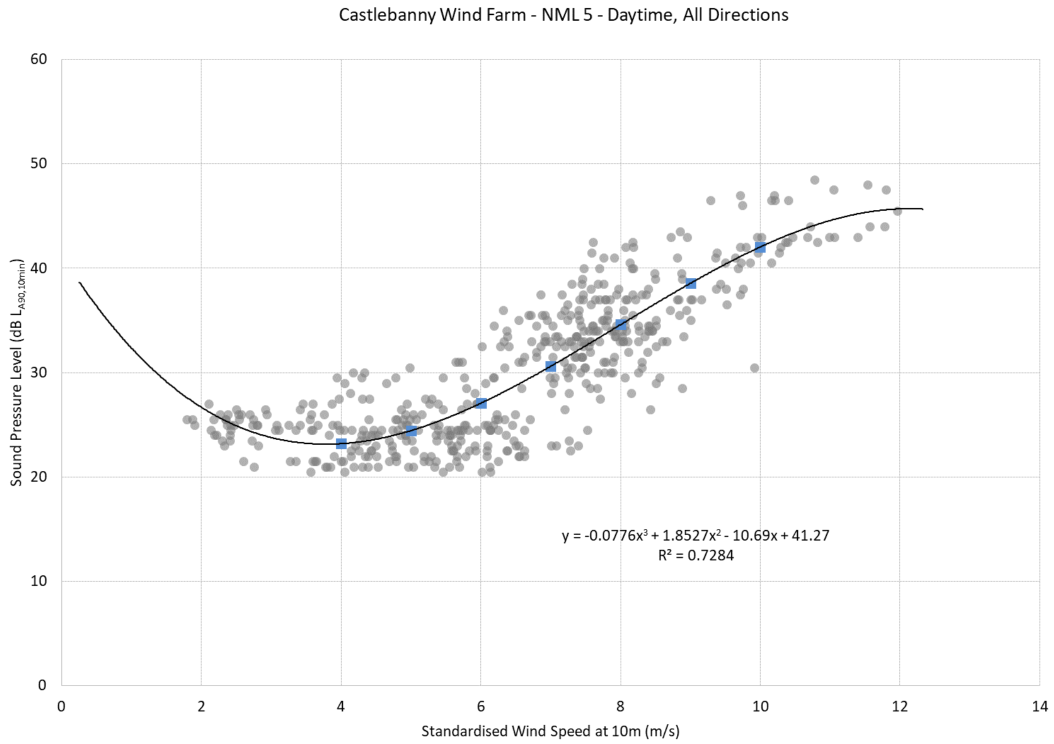

Figure 12-12: Location NML5 (H074) – Background Noise – Daytime Period

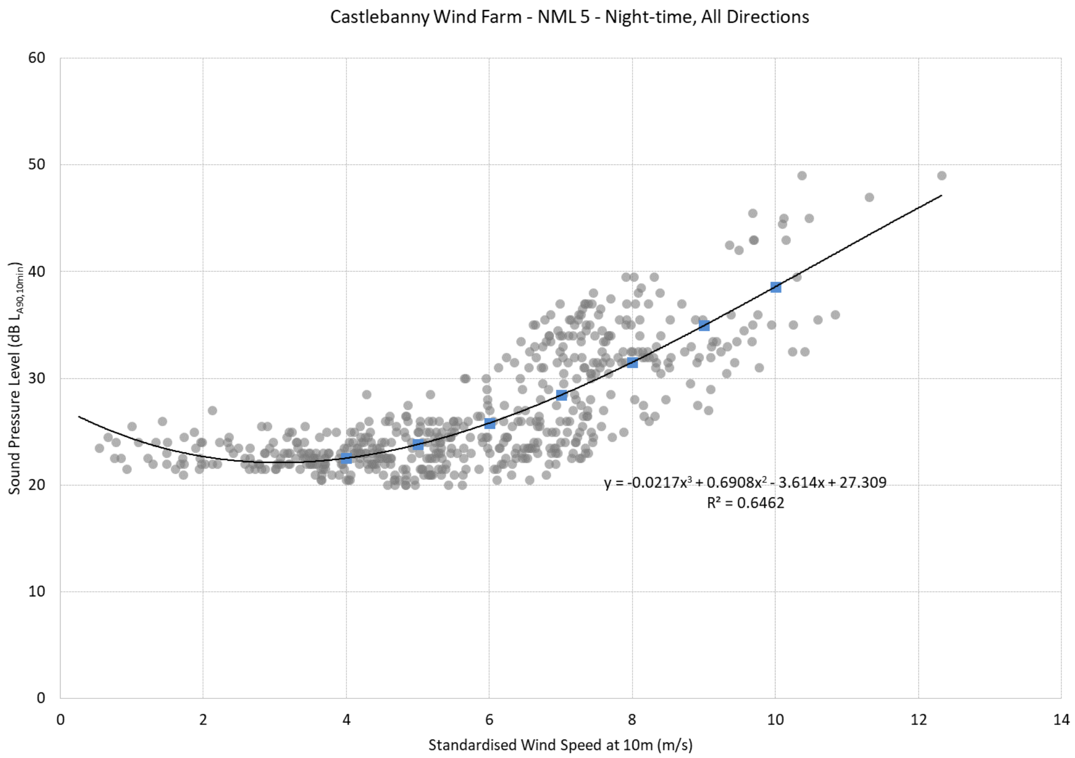

Figure 12-13: Location NML5 (H074) – Background Noise – Night-time Period

12.3.1.6 Location NML6

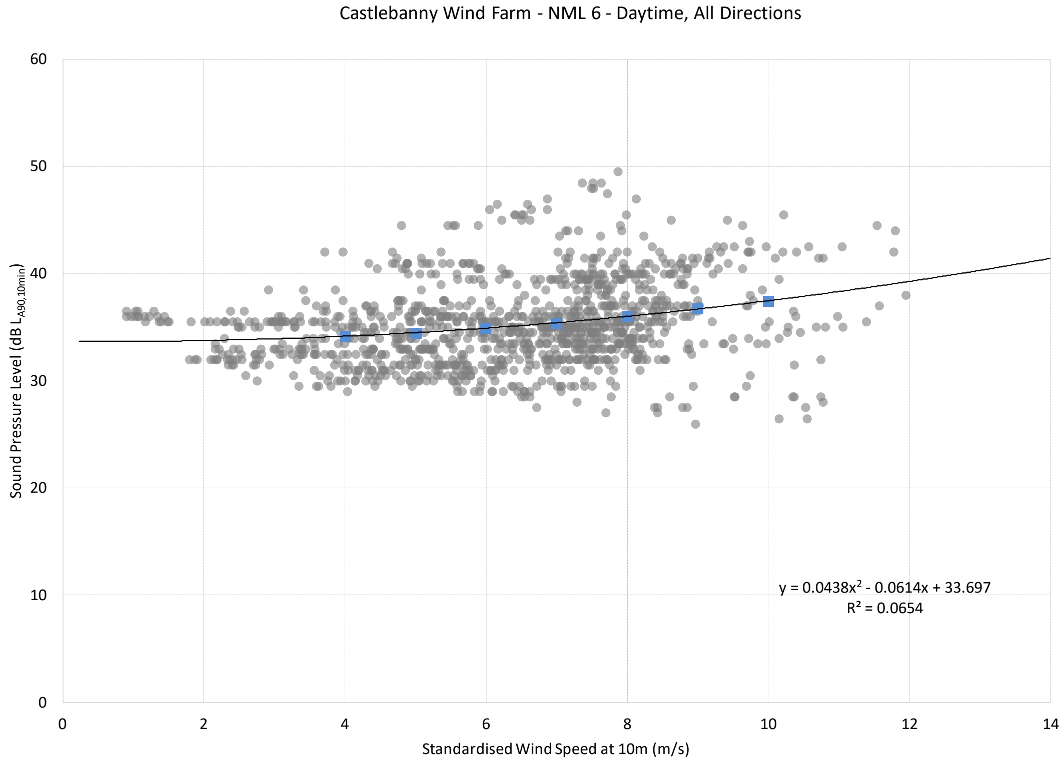

Figure 12-14: Location NML6 (H080) – Background Noise – Daytime Period

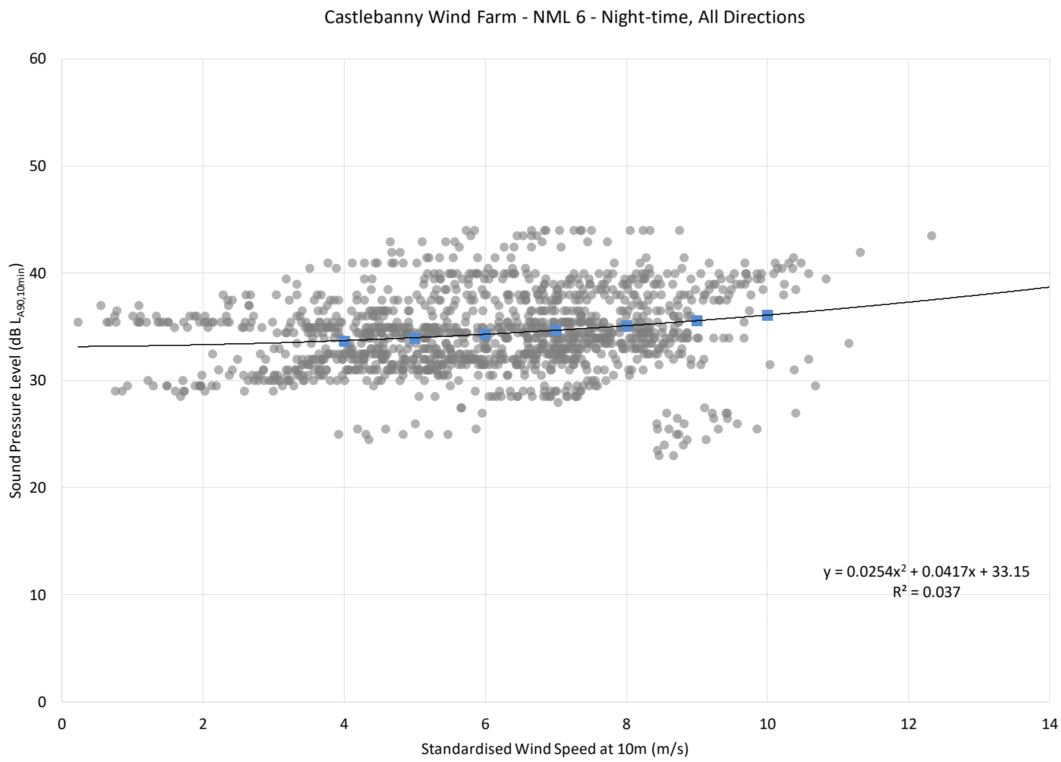

Figure 12-15: Location NML6 (H080) – Background Noise – Night-time Period

12.3.1.7 Location NML7

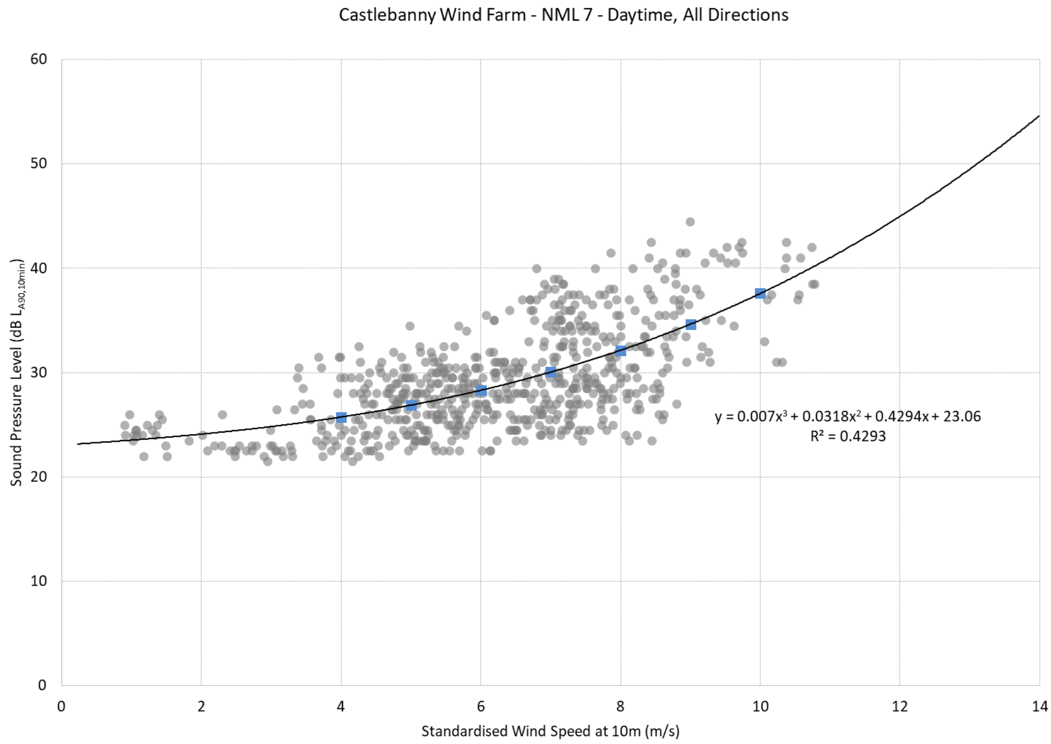

Figure 12-16: Location NML7 (H099) – Background Noise – Daytime Period

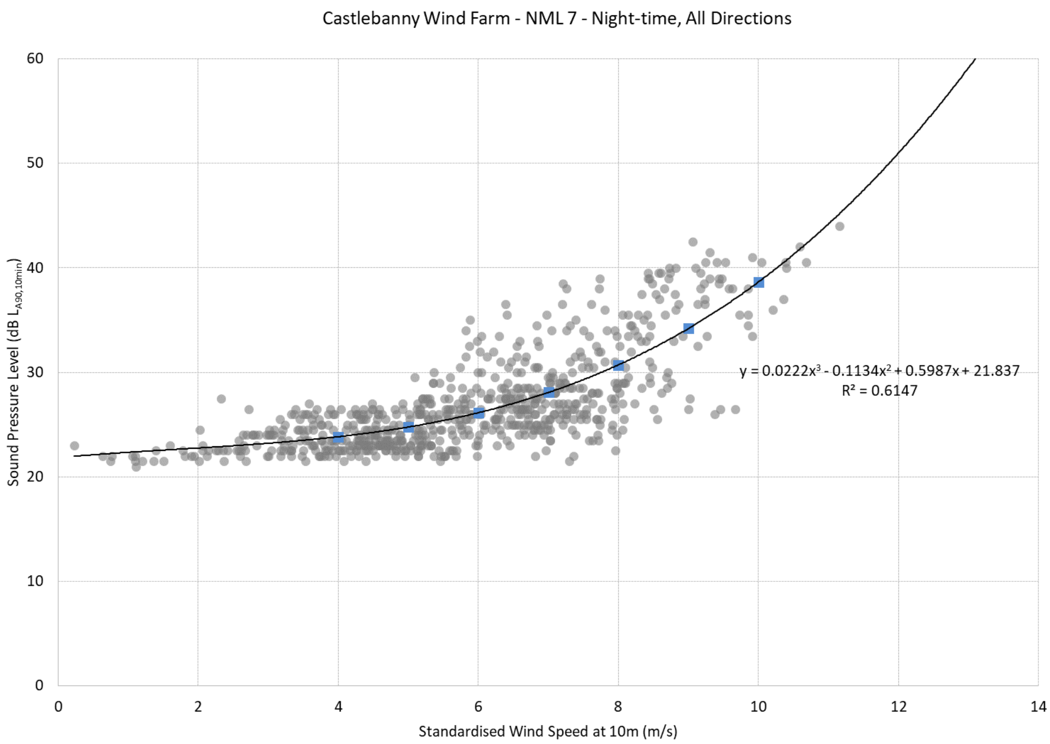

Figure 12-17: Location NML7 (H099) – Background Noise – Night-time Period

12.3.1.8 Location NML8

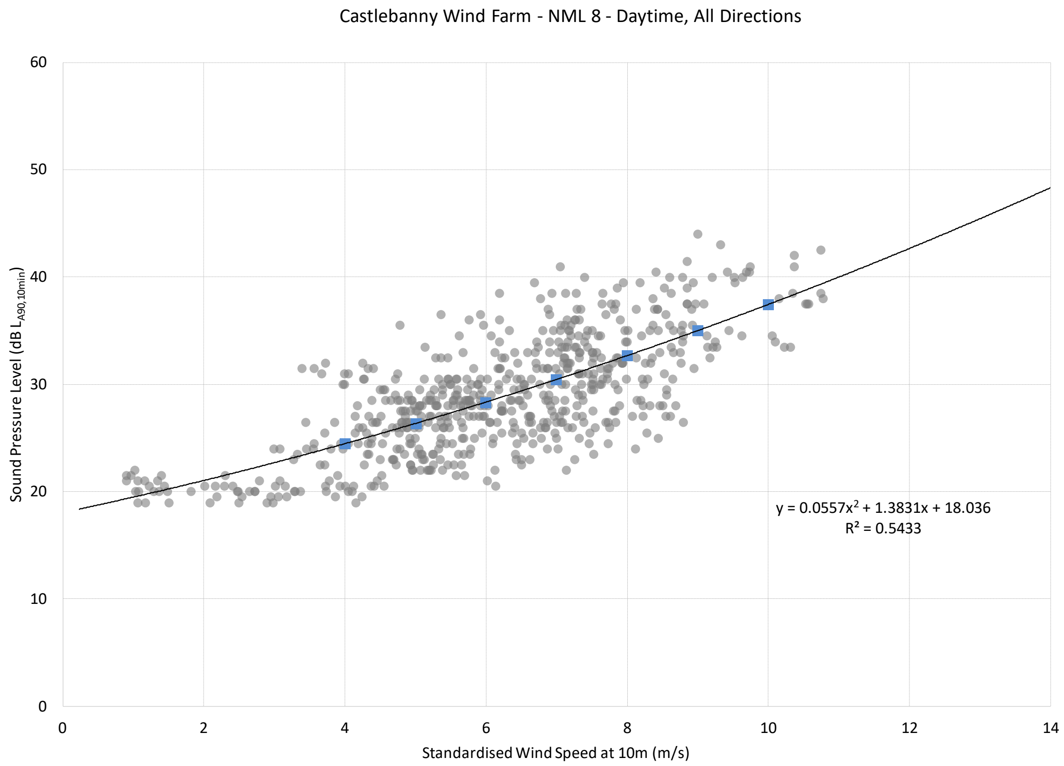

Figure 12-18: Location NML8 (H147) – Background Noise – Daytime Period

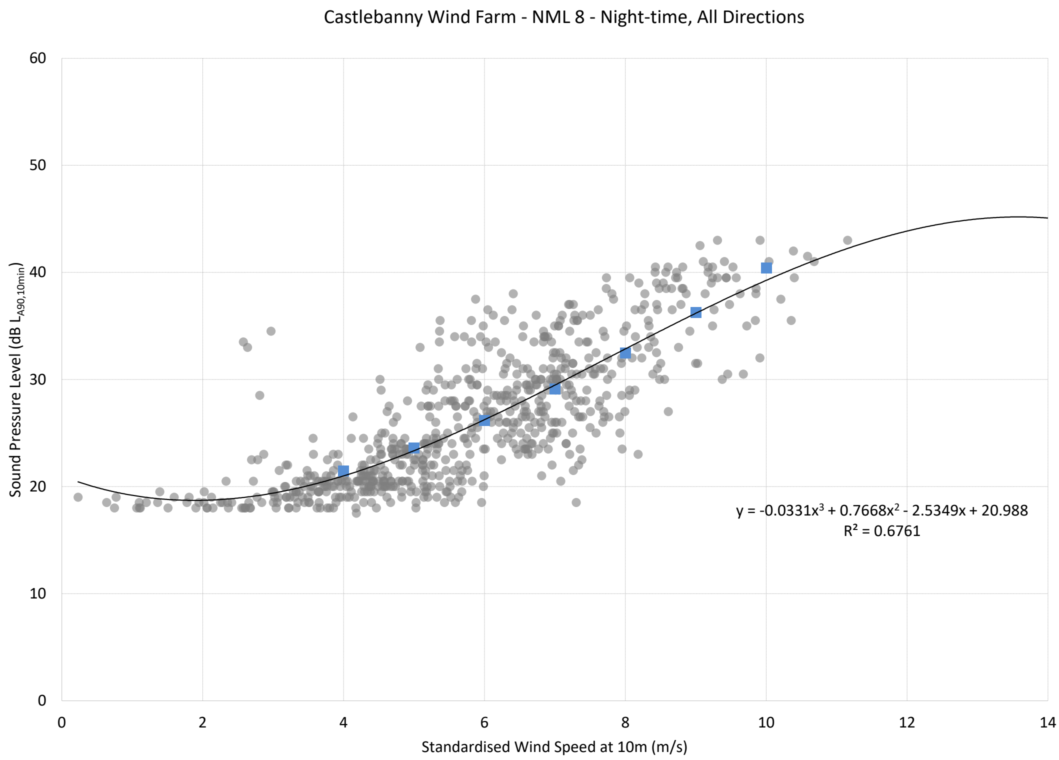

Figure 12-19: Location NML8 (H147) – Background Noise – Night-time Period

12.3.1.9 Summary

Table 12-16 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night time periods. These levels have been derived using regression analysis carried out on the data sets in line with best practice guidance contained the IoA GPG and its SGN No. 2 *Data Collection.*

Table 12-16: Derived Levels of LA90,10-min for Various Wind Speeds

Location	Period	Derived $L_{A90, 10-min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
NML1 (H025)	Day	25.5	26.6	28.0	29.8	32.0	34.5	37.4
	Night	22.8	23.3	24.5	26.5	29.6	33.8	39.3
NML2 (H045)	Day	23.9	25.6	27.3	29.2	31.1	33.2	35.3
	Night	18.5	19.8	21.8	24.5	28.0	32.3	37.5
NML3 (H020)	Day	27.7	29.1	30.7	32.4	34.2	36.1	38.2
	Night	24.3	24.6	25.7	27.6	30.4	34.2	39.2
NML4 (H068)	Day	22.2	23.4	24.8	26.5	28.3	30.4	32.6
	Night	20.9	21.9	23.3	24.9	26.9	29.1	31.6
NML5 (H074)	Day	23.2	24.4	27.1	30.6	34.6	38.6	42.0
	Night	22.5	23.8	25.8	28.4	31.5	34.9	38.6
NML6 (H080)	Day	34.2	34.5	34.9	35.4	36.0	36.7	37.5
	Night	33.7	34.0	34.3	34.7	35.1	35.6	36.1
NML7 (H099)	Day	25.7	26.9	28.3	30.0	32.1	34.6	37.6
	Night	23.8	24.8	26.1	28.1	30.7	34.2	38.6
NML8 (H147)	Day	24.5	26.3	28.3	30.4	32.7	35.0	37.4
	Night	21.0	23.3	26.2	29.5	32.9	36.2	39.3
Envelop	Day	22.2	23.4	24.8	26.5	28.3	30.4	32.6
	Night	18.5	19.8	21.8	24.5	26.9	29.1	31.6

Review of the background noise levels confirms they are in the order of magnitude expected considering the location of the meters and the existing soundscapes in the areas. In order to provide a worst case assessment, a worst-case envelop based on the lowest average levels measured at the 8 no. locations at the various wind speeds for both day and night time is also presented in Table 12-16.

It is proposed to adopt this envelop limit to derive turbine noise thresholds for the initial screening phase of the assessment.

The background noise data shall be used to derive appropriate noise limits for each of the noise sensitive locations.

12.4 POTENTIAL EFFECTS

12.4.1 Do Nothing Effects

If the development is not progressed the existing noise environment will remain largely unchanged. Traffic noise is currently a significant noise source in the vicinity of some road networks in the area. In the absence of the proposed development increases in traffic volumes on the local road network would be expected over time and would likely result in slight increases in the overall ambient and background noise levels in the area.

12.4.2 Potential Effects – Construction Phase

Construction noise prediction calculations have been conducted using the methodology outlined in Section 12.2.3.5. The noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. The predicted "worst case" levels are expected to occur for only short periods of time at a very limited number of properties. Construction noise levels will be lower than these levels for most of the time at most properties in the vicinity of the proposed development.

12.4.2.1 General Construction – Turbines and Hardstandings and Met Mast

12.4.2.1.1 Noise

A number of noise sources that would be expected on a construction site of this nature have been identified and predictions of the potential noise emissions calculated at the closest sensitive receptor. In this instance the nearest third-party noise sensitive receptor is Location H151, the external amenity which is situated approximately 785 m from proposed turbine T1.

Table 12-17: Typical Wind Farm Turbine Construction Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[11]	Predicted Noise Level at 785 m (dB $L_{Aeq,T}$)
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	31
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	29
Piling Operations (C.12.14)	Standard pile driving.	88	40
General Construction (Various)	All general activities plus deliveries of materials and plant	84	33
Dewatering Pumps (D.7.70)	If required.	80	32
JCB (D.8.13)	For services, drainage and landscaping.	82	34
Vibrating Rollers (D.8.29)	Road surfacing.	77	29
Rock Breaking (C.9.11)	If required at some locations	90	42
Total		--	45

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

Calculations have assumed an on time 66% for each item of plant i.e. 8-hours over a 12 hours assessment period. There are no areas that are known to require piling, but if sheet piles are required, the cumulative noise levels outlined in Table 12-17 are comparable.

At the nearest noise sensitive location, the predicted noise levels from construction activities are in the range of 29 to 42 dB $L_{Aeq,T}$ with a total worst-case cumulative construction level of the order of 45 dB $L_{Aeq,T}$. In all instances the predicted noise levels at the nearest NSLs are below the appropriate criteria outlined in Table 12-1(Category A - 65 dB $L_{Aeq,T}$ during daytime periods).

This assessment is considered representative of worst-case and construction noise levels will be lower at properties located further than 785 m from the works.

There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Table 12-1Table 12-1 and this finding is valid should all items of plant operate simultaneously.

12.4.2.1.2 Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

12.4.2.1.3 Description of Effects

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 this aspect of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Short-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.

12.4.2.2 Construction of Access Tracks (including Tree Felling)

It is proposed to fell trees in order to construct new access tracks and temporary roads to access selected borrow pit areas as part of the development. Review of the road layout has identified that the nearest occupied NSL to any point along the proposed roads is 250 m to location H148 (659732E, 629020N). All other locations are at greater distances with the majority at significantly greater distances. The full description of the new roads is outlined in Chapter 2 of the EIAR.

12.4.2.2.1 Noise

Table 12-18 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on time 66% for each item of plant i.e. 8-hours over a 12 hour assessment period.

Table 12-18: Indicative Noise Levels from Construction Plant at Various Distances from the New Access Tracks Works

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[12]	Highest Predicted Noise Level at Stated Distance from Edge of Works(dB $L_{Aeq,T}$)	
		250 m	700 m
Petrol-driven chainsaw (D2.14)	86	52	42
HGV Movement (C2.30)	79	45	35
Excavator Mounted Rock Breaker (C9.12)	85	51	41
Vibration Rollers (D8.29)	77	43	33
Total	--	52	42

The table shows that within a distance of 250 m, noise levels are below the construction noise criteria in Table 12-1. It is also of note that as these works will progress along the route the worst-case predicted impacts will reduce. It is envisioned that they would be at the closest position to the nearest NSL for no more than 3 to 4 weeks.

It is concluded that while there were moderate noise impacts predicted at some NSLs nearest the access tracks, the impact was brief and therefore no specific mitigation measures were required beyond the best practice measures in Section Construction and Decommissioning Phase12.5.1.

12.4.2.2.2 Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

12.4.2.2.3 Description of Effects

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 this aspect of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Moderate	Temporary

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.

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

12.4.2.3 Borrow Pits

12.4.2.3.1 Noise

To inform this aspect of the proposal a comparative noise assessment has been prepared and is outlined in the following paragraphs. Two situations have been considered as follows:

- Scenario A Blasting operation[13]
- Scenario B Rock breaking operation

In terms of these activities please note the following:

- A mobile crusher will operate on site for both options.
- In Scenario B that two rock breakers will be in use on site during daytime periods for an estimated three-month period.
- For the purposes of this assessment we have assumed the plant is working in the vicinity of the potential borrow pits the location of which are indicated in Table 12-19.
- Table 12-20 outlines the assumed noise levels for the plant items as extracted from *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.*
- If the blasting option is undertaken it is estimated that some 8 to 12 blasts will be required over a 4-week period. It is expected that no more than 1 blast would occur in a single working day.

Table 12-19: Proposed Borrow Pit Locations

Borrow Pit ID	Co-ordinates (ITM)	
	Easting	Northing
BOR 1	657,714	633,258
BOR 2	659,220	631,173
BOR 3	658,663	629,485

Table 12-20: Typical Plant Noise Levels

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

A construction noise model has been prepared to consider the expected noise emissions from the proposed construction works for the two scenarios outlined above. A percentage on-time of 66% has been assumed for the noise calculations. The predicted levels are detailed in Table 12-21 at the 10 no. closest NSLs to borrow pit, BOR 1, to the north of the development.

13 Note that blasting may be required at some turbine base locations. If this is the case the mitigation measures detailed in the relevant section of this chapter will be applicable to these activities. The assessment presented here for borrow pit activities will be comparable to those expected in relation to works associated with turbine foundations.

Table 12-21: Typical Plant Noise Levels Borrow Pit to North (BOR 1)

Loc.	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario A	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario B	Diff. dB(A)
H025	33	48	-15
H026	33	47	-14
H029	33	47	-14
H027	33	47	-14
H023	32	46	-14
H024	32	46	-14
H022	32	46	-14
H021	32	46	-14
H200	32	45	-13
H028	32	45	-13

The predicted levels are detailed in Table 12-22 at the 10 closest NSLs to the borrow pit, BOR 2, to the east of the development.

Table 12-22: Typical Plant Noise Levels Borrow Pit to East (BOR 2)

Loc.	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario A	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario B	Diff. dB(A)
H084	37	50	-13
H083	36	50	-14
H085	36	49	-13
H086	36	49	-13
H087	36	49	-13
H091	36	49	-13
H082	35	48	-13
H090	35	48	-13
H081	35	48	-13
H080	35	48	-13

The predicted levels are detailed in Table 12-23 at the 10 closest NSLs to the borrow pit, BOR 3, to the south of the development.

Table 12-23: Typical Plant Noise Levels Borrow Pit to South (BOR 3)

Loc.	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario A	Predicted Construction Noise Level $L_{Aeq,1hr}$ Scenario B	Diff. dB(A)
H016	35	48	-13
H151	35	48	-13
H015	34	47	-13
H014	34	47	-13

Loc.	Predicted Construction Noise Level $L_{Aeq,1hr}$		Diff. dB(A)
	Scenario		
	A	B	
H148	33	46	-13
H150	33	46	-13
H147	33	46	-13
H149	32	45	-13
H013	30	43	-13
H146	30	43	-13

Review of the data contained in Table 12-18 to Table 12-20 confirms the following:

- Predicted construction noise levels for both Scenario A (30 to 37 dB (A)) and B (43 to 50 dB (A)) at all borrow pits are well within the best practice construction noise criteria outlined in Table 12-1. It is assumed that construction works at the borrow pits will only occur during daytime periods only (07:00 to 19:00hrs).
- The blasting proposal results in lower levels of construction noise since the use of the rock breaking plant is not required in this instance. Predicted noise levels are lower at all assessed locations for Scenario A.
- It is accepted that the individual blast events will be audible at some locations. Blast events will be designed and controlled such that the best practice noise and vibration limit values outlined in the mitigation section of this chapter are not exceeded.

Blasting

If required, blasting may be carried out at the borrow pit areas or some turbine base locations. In a worst case scenario the closest distance would be more than 700 m. The extent of blasting will depend on the rock type and depth in the area.

Whilst drill and blast methods generate intermittent high noise levels when taking place, the time period over which impacts are experienced are significantly shorter compared to other extraction methods. Where a significant portion of hard rock is required to be excavated, the use of drill and blast would enable extraction works to be undertaken at a significantly faster rate compared to traditional rock breaking techniques.

Blasting impacts relate to both ground vibration and air overpressure, the magnitude of which depends on a variety of factors.

Noise - Air Overpressure (AOP)

Air overpressure is energy transmitted from the blast site within the atmosphere in the form of pressure waves. As such a wave passes a given position, the pressure of the air at this point rises very rapidly to a value above the ambient pressure, and then falls more slowly to a value below, before returning to the ambient value after a series of oscillations. The maximum excess pressure in this wave is known as the peak air overpressure. This value is typically measured in terms of dB (L_{in}).

These pressure waves will consist of energy over a wide range of frequencies, some of which are audible and known as sound waves or noise, but most of the energy is inaudible at frequencies of less than 20 Hz which is not heard by the human ear but is sensed as pressure.

The main sources of air overpressure from blasting relate to blast design and set up (e.g. detonating cord, stemming release and gas venting) and physical properties of the site (movement of rock and reflection of stress waves). The intensity of air overpressure levels at a receiver location is highly dependent on meteorological conditions which affect ambient air pressure including temperature, cloud cover, humidity, wind speed and direction etc. Due to the large variability in these conditions, it is not possible to reliably calculate AOP. The control of its intensity is therefore undertaken at source through careful blast design.

It is important to note that routine open-pit blasting operations regularly generate air overpressures up to a magnitude of 120dB (L_{in}), with levels in excess of 125dB (L_{in}) being relatively rare. Damage levels are rarely approached let alone exceeded. BS 5228-2 notes that there is no known evidence of structural damage to structures from excessive air overpressure levels from quarry blasting in the UK.

<u>Ground Vibration</u>

The level of vibration at a receiver location from a blast depends predominately on the distance from the blast, the maximum instantaneous charge (MIC), sequencing of charges and ground conditions between the blast area and the receiver location.

In the case of the proposed development, blast events will be minor at the nearest NSLs due to ground vibration and air overpressure levels, however the duration of the effects are intermittent. The closest sensitive properties to the identified likely blast sites are at distances of greater than 700 m. These potential impacts will be appropriately mitigated through the implementation of best practice blasting control measures which are outlined in Section 12.5.1.2.

<u>Rock Breaking</u>

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

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

Vibration measurements were conducted during various staged activities and at various distances.

Peak vibration levels during staged activities using the 3 Tonne Breaker ranged from 0.48 to 0.25 PPV (mm/s) at distances of 10 m to 50 m respectively from the breaking activities. Using a 6 Tonne Breaker, measured vibration levels ranged between 1.49 to 0.24 PPV (mm/s) at distances of 10 m to 50m respectively.

Whilst these measurements relate to a solid concrete slab, the range of values recorded provides some context in relation typical ranges of vibration generated by construction rock breaking activity.

Referring to the vibration magnitudes greater than 500 m distance to the nearest NSL, vibration impacts due to rock breaking construction works (if required) will be not significant and temporary.

Notwithstanding the above, any construction activities undertaken on the site will be required to operate below the recommended vibration criteria set out in Table 12-2.

12.4.2.3.2 Description of Effects

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 this aspect of the construction of Borrow Pits are described below.

Noise Assessment

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

Vibration Assessment – Blasting

Quality	*Significance*	*Duration*
Negative	Slight	Momentary

Vibration Assessment – Rock Breaking

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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.

12.4.2.4 Substation Construction

12.4.2.4.1 Noise

A variety of items of plant will be used for construction of the substation compound. As previously stated, due to the fact that the construction programme has been established in outline form only, it is difficult to calculate the actual magnitude of noise emissions to the local environment. However, it is possible to predict typical noise levels 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 substation is to be located at coordinates 658,200E 631,859N. The nearest NSL to the proposed substation site is H079 at approximately 1.2 km to the east. As a worst-case example assuming the same construction activities as outlined in Section 12.4.2.1, it is predicted that the likely worst-case potential noise levels from construction activities associated with the substation will be in the order of 38 dB $L_{Aeq,T}$ at Location H079. This level of noise is considerably within the construction noise criterion outlined in Table 12-1

12.4.2.4.2 Vibration

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

12.4.2.4.3 Description of Effects

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 this aspect of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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.

12.4.2.5 Grid Connection Construction

12.4.2.5.1 Noise

The grid connection for the substation location requires the connection route to pass from within the site boundary, across private lands and connects to an existing overhead line to the east of the development via an underground cable loop-in connection. The full description of the proposed grid connection arrangements for the Proposed Development is outlined in Chapter 2 of the EIAR.

Construction activities will be carried out during normal daytime working hours (i.e. weekdays 0700 – 1900hrs and Saturdays 0700 – 1400hrs).

The grid connection route passes by houses along local roads. Indicative noise levels for the types of machinery that will be used on site have been identified. To provide an indication of the potential noise impact, the noise levels due to the grid connection construction machinery have been calculated at a number of distances as shown in Table 12-24.

Table 12-24: Indicative Noise Levels from Construction Plant at Various Distances from the Grid Connection Works

Item (BS 5228 Ref.)	Plant Noise Level at reference 10 m Distance (dB $L_{Aeq,T}$)	Highest Predicted Plant Noise Level (dB $L_{Aeq,T}$)			
		15 m	20 m	40 m	80 m
HGV Movement (C.2.30)	79	72	69	63	56
Tracked Excavator (C2.14)	79	72	69	63	56
Vibrating Rollers (D.8.29)	77	70	67	61	54
Total Construction Noise		76	74	67	60

At the nearest NSL to the east at Ballyvool (661032E, 633685N) the distance between grid works and property is 15 m and the predicted cumulative noise levels from construction activities are 76 dB $L_{Aeq,1hr}$, which are above the threshold of 65 dB $L_{Aeq,1hr}$. Noise mitigation will therefore be required to reduce construction noise levels from this type of activity during all periods at the closest properties.

Given the variations of grid connection activities, the number of plant items operating at any one time and the location of upgrading 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.

At NSLs at a distance of greater than 50 m, which accounts for the majority of properties in the area, the predicted cumulative noise levels from construction activities are below 65 dB $L_{Aeq,1hr}$.

12.4.2.5.2 Vibration

Due to the distance of the proposed works from sensitive locations, and the duration of any potential impact on any single dwelling significant vibration effects are not expected.

12.4.2.5.3 Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the small number of nearest NSLs associated with this aspect of the construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Significant	Temporary

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.

At the majority of properties, the grid construction effects are described below.

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

12.4.2.6 Construction Traffic

This section has been prepared in order to review potential noise impacts associated with construction traffic on the local road network. Chapter 16 of this EIAR presents an assessment of traffic and transportation and reference has been made to this chapter to inform the following discussion. The following situations are commented upon here:

- Stage 1a – Site preparation and Groundworks;
- Stage 1b – Concrete Pouring;
- Stage 2a – Extended Artic Deliveries;
- Stage 2b – Turbine Deliveries; and
- Stage 2c – Other Deliveries.

Changes in traffic noise levels associated with the additional traffic for each of the construction stages listed above have been calculated for several routes. Table 12-25Table 12-25 presents a summary of the data on which the calculations have been based.

Table 12-25: Information for Construction Traffic Noise Assessment

Route	Stage	Traffic Units	%HGV	Estimated Number of Days
M9 North	Existing	13,320	9.3	365
	1a	13,438	9.6	77
	1b	13,608	10.5	21
	2a	13,334	9.3	113
	2b[Note 1]	n/a	n/a	n/a
	2c	13,386	9.3	24
M9 South	Existing	12,805	9.2	365
	1a	12,923	9.6	77
	1b	13,093	10.4	21
	2a	12,819	9.2	113
	2b	12,880	9.6	39
	2c	12,871	9.2	24
N29	Existing	2,785	36.2	365
	1a	2,903	36.7	77
	1b	3,073	38.9	21
	2a	2,799	36.1	113
	2b	2,860	37.1	39
	2c	2,851	35.5	24
N25	Existing	13,389	9.3	365
	1a	13,507	9.6	77
	1b	13,677	10.5	21
	2a	13,403	9.3	113
	2b	13,464	9.7	39
	2c	13,455	9.3	24
R704	Existing	1,468	6.0	365
	1a	1,586	9.2	77
	1b	1,756	15.7	21
	2a	1,482	6.2	113
	2b	1,543	9.3	39
	2c	1,534	6.1	24

[Note 1] This location is not on the AIL delivery route.

Based on the data presented above the changes in noise level relative to the noise from existing traffic flows have be calculated and are outlined in Table 12-26.

Table 12-26: Estimated Changed to Traffic Noise Levels

Route	Stage	Change In Traffic Noise Level, dB(A)	Estimated Number of Days
1. M9 North	1a	0.2	77
	1b	0.5	21
	2a	0.0	113
	2b	n/a	n/a
	2c	0.0	24
2. M9 South	1a	0.2	77
	1b	0.5	21
	2a	0.0	113
	2b	0.2	39
	2c	0.0	24
3. N29	1a	0.2	77
	1b	0.7	21
	2a	0.0	113
	2b	0.2	39
	2c	0.0	24
4. N25	1a	0.2	77
	1b	0.5	21
	2a	0.0	113
	2b	0.1	39
	2c	0.0	24
5. R704	1a	1.6	77
	1b	3.9	21
	2a	0.1	113
	2b	1.5	39
	2c	0.3	24

With the exception of Stage 1b on Route 5, the predicted increases in traffic noise levels during each of the construction stages of the proposed development are less than 3 dB along all routes. With reference to the criteria set out in Section 13.4.1.2 the potential impacts are negligible to minor. With reference to the DMRB criteria, the increase calculated for Stage 1b on Routes 5 is potentially moderate however, the estimated durations of the corresponding phases are only 21 days. No additional mitigation measures are proposed.

12.4.2.6.1 Cumulative Assessment

Cumulative changes in traffic noise levels associated with the peak additional traffic have also been calculated for several routes. Table 12-25Table 12-25 presents a summary of the data on which the calculations have been based.

Table 12-27: Information for Cumulative Construction Traffic Noise Assessment

Route	Stage	Traffic Units	%HGV	Change In Traffic Noise Level, dB(A)
1. M9 North	Existing	13,320	9.3	0.3
	Peak	13,660	9.9	
2. M9 South	Existing	12,805	9.2	0.3
	Peak	13,145	9.8	
3. N29	Existing	2,785	36.2	0.5
	Peak	3,125	35.9	
4. N25	Existing	13,389	9.3	0.3
	Peak	13,729	9.9	
5. R704	Existing	1,468	6.0	2.9
	Peak	1,808	11.3	

As shown in Table 12-27 the predicted increases in cumulative traffic noise levels during peak construction stages of the proposed development are less than 3 dB along all routes. With reference to the criteria set out in Section 13.4.1.2 the potential impacts are imperceptible. No additional mitigation measures are proposed.

It is concluded that there will be no significant noise impacts associated with the additional traffic generated during the construction phase of the proposed development and therefore no specific mitigation measures will be required.

12.4.2.6.2 Vibration

Along the Turbine Delivery Route the trucks will use National / Regional roads as much as possible. The vehicle movements are not expected as a significant source of vibration, due to the modest speeds passing by the nearest NSLs along the route.

12.4.2.6.3 Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations along the R704 route, particularly associated with the Stage 1b construction phase are described below.

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

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.

At the majority of noise sensitive locations along the R704 during Stage 1a and Stage 2b, the construction traffic effects are described below.

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

At the majority of properties the construction traffic effects, apart from those mentioned above, are described as:

Quality	*Significance*	*Duration*
Negative	Imperceptible	Temporary

12.4.3 Potential Effects – Operational Phase

12.4.3.1 Assessment of Wind Turbine Noise

With respect to the relevant guidance documents outlined in Section 12.2.1, the following noise criteria curves have been identified for the proposed development. The criteria curves have been derived following a detailed review of the background noise data conducted at the nearest noise sensitive locations.

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

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

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

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

This set of criteria has been chosen as it is in line with the intent of the relevant Irish guidance and is comparable to noise planning conditions applied to similar sites in the area previously granted planning permission by An Bord Pleanála.

Based on the statistical analysis of wind speed data and baseline noise level information, day and night time noise criteria curves have been developed and are presented in the relevant sections of this Chapter. Table 12-24 outlines the operational noise criteria that are applicable to this assessment.

The lowest baseline noise levels measured at each of the various monitoring locations as part of the baseline noise survey have been used in this process in order to adopt a worst-case approach in the derivation of the noise criteria curves.

Table 12-28: Noise Criteria Curves

Location	Period	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
NML1 (H025)	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.3
NML2 (H045)	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML3 (H020)	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.2
NML4 (H068)	Day	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML5 (H074)	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.6
NML6 (H080)	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML7 (H099)	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.7
NML8 (H147)	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.3
Envelop	Day	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0

A worst-case assessment has been carried out for the nearest 181 NSLs surrounding the proposed development site, basing the turbine noise criteria on the envelop of the lowest background noise levels measured at the 8 no. NSLs, and assuming all receptors are downwind of all turbines at the same time.

Table 12-29 presents the omnidirectional results of the exercise at all locations considering the cumulative impact of the proposed Castlebanny turbines and the previously stated existing and proposed wind farms already in the area. The predicted levels have been compared against the adopted noise criteria curves.

Table 12-29: Review of Cumulative Predicted Turbine Noise Levels against Relevant Criteria

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
H001	Predicted	26.1	29.4	32.5	33.6	34.3	34.3	34.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H002	Predicted	24.4	27.8	30.9	31.9	32.6	32.7	32.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H003	Predicted	24.4	27.9	31.0	32.0	32.7	32.7	32.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H012	Predicted	25.5	29.7	32.6	33.2	34.0	34.0	34.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H013	Predicted	27.3	31.5	34.4	35.0	35.7	35.8	35.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H014	Predicted	28.4	32.5	35.4	36.1	36.8	36.8	36.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H015	Predicted	28.6	32.8	35.7	36.4	37.1	37.1	37.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H016	Predicted	28.9	33.1	36.0	36.7	37.4	37.4	37.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H017	Predicted	26.8	31.0	33.9	34.5	35.2	35.2	35.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H018	Predicted	26.3	30.5	33.4	34.1	34.8	34.8	34.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H019	Predicted	26.5	30.7	33.6	34.2	34.9	35.0	35.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H020	Predicted	26.8	31.0	33.8	34.5	35.2	35.2	35.2
	Daytime Criterion	40.0	40.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.6
	Night-time Excess	--	--	--	--	--	--	--
H021	Predicted	30.5	34.8	37.7	38.3	39.0	39.0	39.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H022	Predicted	31.0	35.3	38.1	38.8	39.5	39.5	39.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H023	Predicted	30.9	35.2	38.1	38.7	39.4	39.4	39.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H024	Predicted	30.7	35.0	37.9	38.5	39.2	39.2	39.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H025	Predicted	31.6	35.9	38.8	39.4	40.1	40.1	40.1
	Daytime Criterion	40.0	40.0	40.0	40.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.2
	Night-time Excess	--	--	--	--	--	--	--
H026	Predicted	30.9	35.2	38.1	38.7	39.4	39.4	39.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H027	Predicted	30.2	34.5	37.4	38.0	38.7	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H028	Predicted	28.4	32.7	35.6	36.2	36.9	36.9	36.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H029	Predicted	29.9	34.2	37.1	37.7	38.4	38.4	38.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H030	Predicted	27.3	31.5	34.4	35.0	35.7	35.8	35.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H031	Predicted	27.1	31.4	34.3	34.9	35.6	35.6	35.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H032	Predicted	27.3	31.6	34.4	35.0	35.7	35.8	35.8

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H033	Predicted	27.0	31.3	34.1	34.7	35.5	35.5	35.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H034	Predicted	27.8	32.1	35.0	35.6	36.3	36.3	36.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H035	Predicted	26.7	31.0	33.9	34.5	35.2	35.2	35.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H036	Predicted	26.8	31.1	33.9	34.5	35.2	35.3	35.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H037	Predicted	26.9	31.2	34.0	34.6	35.4	35.4	35.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H039	Predicted	26.9	31.2	34.1	34.7	35.4	35.4	35.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H040	Predicted	27.1	31.4	34.3	34.9	35.6	35.6	35.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-min}}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
H041	Predicted	27.2	31.5	34.4	35.0	35.7	35.7	35.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H042	Predicted	27.4	31.7	34.6	35.2	35.9	35.9	35.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H043	Predicted	27.6	31.9	34.7	35.3	36.0	36.1	36.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H044	Predicted	27.3	31.6	34.5	35.1	35.8	35.8	35.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H045	Predicted	27.2	31.5	34.4	35.0	35.7	35.7	35.7
	Daytime Criterion	40.0	40.0	40.0	40.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H046	Predicted	27.1	31.4	34.3	34.9	35.6	35.6	35.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H047	Predicted	27.2	31.5	34.3	34.9	35.6	35.7	35.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H048	Predicted	25.9	30.1	33.0	33.6	34.3	34.4	34.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Excess	--	--	--	--	--	--	--
H049	Predicted	26.2	30.4	33.3	33.9	34.6	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H050	Predicted	26.9	31.2	34.0	34.6	35.4	35.4	35.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H051	Predicted	26.2	30.4	33.3	33.9	34.6	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H052	Predicted	25.0	29.3	32.1	32.7	33.4	33.5	33.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H053	Predicted	24.4	28.7	31.6	32.2	32.9	32.9	32.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H054	Predicted	23.8	28.1	31.0	31.6	32.3	32.3	32.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H055	Predicted	24.2	28.5	31.4	32.0	32.7	32.7	32.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H058	Predicted	26.8	31.1	34.0	34.6	35.3	35.3	35.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H059	Predicted	27.0	31.3	34.2	34.8	35.5	35.5	35.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H060	Predicted	29.3	33.6	36.5	37.1	37.8	37.8	37.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H061	Predicted	30.2	34.5	37.4	38.0	38.7	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H062	Predicted	27.6	31.9	34.8	35.4	36.1	36.1	36.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H063	Predicted	28.0	32.3	35.1	35.7	36.4	36.5	36.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H064	Predicted	28.5	32.8	35.7	36.3	37.0	37.0	37.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H065	Predicted	28.3	32.6	35.5	36.1	36.8	36.8	36.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H066	Predicted	28.5	32.8	35.7	36.3	37.0	37.0	37.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H067	Predicted	28.8	33.1	36.0	36.6	37.3	37.3	37.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H068	Predicted	30.8	35.1	37.9	38.5	39.2	39.3	39.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H069	Predicted	26.2	30.5	33.4	34.0	34.7	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H070	Predicted	26.4	30.7	33.6	34.2	34.9	34.9	34.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H071	Predicted	26.9	31.2	34.1	34.7	35.4	35.4	35.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H072	Predicted	27.8	32.1	34.9	35.5	36.3	36.3	36.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H073	Predicted	28.9	33.2	36.1	36.7	37.4	37.4	37.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H074	Predicted	30.6	34.9	37.8	38.4	39.1	39.1	39.1

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Criterion	40.0	40.0	40.0	45.0	45.0	45.0	46.9
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	44.0
	Night-time Excess	--	--	--	--	--	--	--
H075	Predicted	29.7	33.9	36.8	37.4	38.1	38.2	38.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H076	Predicted	30.6	34.9	37.8	38.4	39.1	39.1	39.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H077	Predicted	30.6	34.9	37.8	38.4	39.1	39.1	39.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H078	Predicted	31.3	35.6	38.5	39.1	39.8	39.8	39.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H079	Predicted	31.6	35.9	38.8	39.4	40.1	40.1	40.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	0.1	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H080	Predicted	31.5	35.8	38.7	39.3	40.0	40.0	40.0
	Daytime Criterion	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H081	Predicted	31.4	35.7	38.6	39.2	39.9	39.9	39.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
H082	Predicted	31.5	35.8	38.7	39.3	40.0	40.0	40.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H083	Predicted	30.2	34.5	37.4	38.0	38.7	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H084	Predicted	30.9	35.2	38.1	38.7	39.4	39.4	39.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H085	Predicted	30.2	34.4	37.3	37.9	38.6	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H086	Predicted	29.7	34.0	36.9	37.5	38.2	38.2	38.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H087	Predicted	29.6	33.9	36.8	37.4	38.1	38.1	38.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H088	Predicted	27.4	31.7	34.6	35.2	35.9	35.9	35.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H089	Predicted	26.2	30.5	33.3	34.0	34.7	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Excess	--	--	--	--	--	--	--
H090	Predicted	28.2	32.4	35.3	35.9	36.6	36.7	36.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H091	Predicted	29.2	33.5	36.4	37.0	37.7	37.7	37.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H092	Predicted	24.5	28.6	31.5	32.2	32.9	33.0	33.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H093	Predicted	27.8	32.0	34.9	35.6	36.3	36.3	36.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H094	Predicted	27.9	32.0	35.0	35.6	36.3	36.4	36.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H095	Predicted	27.7	31.9	34.8	35.5	36.2	36.2	36.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H096	Predicted	27.9	32.0	34.9	35.6	36.3	36.3	36.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H097	Predicted	24.9	28.9	31.8	32.6	33.3	33.4	33.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived $L_{A90, 10-min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H098	Predicted	26.4	30.4	33.4	34.1	34.8	34.9	34.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H099	Predicted	30.6	34.7	37.7	38.3	39.0	39.1	39.1
	Daytime Criterion	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H100	Predicted	26.7	30.8	33.7	34.5	35.2	35.2	35.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H101	Predicted	24.1	28.0	30.9	31.8	32.5	32.6	32.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H102	Predicted	23.4	27.1	30.1	31.1	31.8	31.9	31.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H103	Predicted	23.9	27.8	30.7	31.6	32.3	32.4	32.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H104	Predicted	23.8	27.6	30.6	31.5	32.3	32.3	32.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H105	Predicted	23.8	27.5	30.6	31.5	32.3	32.3	32.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H106	Predicted	24.7	28.5	31.5	32.4	33.1	33.2	33.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H108	Predicted	23.2	26.9	29.9	30.9	31.6	31.7	31.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H109	Predicted	24.8	28.5	31.5	32.4	33.2	33.2	33.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H110	Predicted	24.8	28.4	31.5	32.4	33.1	33.2	33.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H111	Predicted	26.6	30.3	33.4	34.2	34.9	35.0	35.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H112	Predicted	26.3	29.9	33.0	33.9	34.6	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H113	Predicted	24.8	28.3	31.3	32.4	33.1	33.2	33.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H114	Predicted	25.0	28.5	31.6	32.6	33.3	33.4	33.4

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H115	Predicted	24.8	28.2	31.3	32.4	33.2	33.2	33.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H116	Predicted	25.1	28.5	31.6	32.7	33.4	33.5	33.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H117	Predicted	25.0	28.3	31.4	32.6	33.3	33.4	33.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H118	Predicted	25.3	28.6	31.7	32.9	33.6	33.6	33.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H119	Predicted	24.7	27.9	31.1	32.3	33.0	33.1	33.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H120	Predicted	25.4	28.5	31.7	32.9	33.6	33.7	33.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H121	Predicted	25.5	28.6	31.8	33.0	33.7	33.8	33.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived $L_{A90, 10-min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
H122	Predicted	25.7	28.8	32.0	33.2	33.9	34.0	34.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H143	Predicted	28.9	30.7	34.3	36.1	36.8	36.8	36.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H145	Predicted	28.8	31.6	34.9	36.2	36.9	37.0	37.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H146	Predicted	28.9	31.6	34.9	36.3	37.0	37.0	37.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H147	Predicted	30.1	33.9	36.9	37.8	38.5	38.5	38.5
	Daytime Criterion	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	45.4
	Night-time Excess	--	--	--	--	--	--	--
H148	Predicted	30.7	34.6	37.6	38.4	39.1	39.1	39.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H149	Predicted	29.4	33.0	36.0	37.0	37.7	37.7	37.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H150	Predicted	29.8	33.5	36.5	37.4	38.1	38.1	38.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Excess	--	--	--	--	--	--	--
H151	Predicted	30.3	34.3	37.3	38.0	38.7	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H152	Predicted	26.5	30.7	33.6	34.2	35.0	35.0	35.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H153	Predicted	26.7	31.0	33.9	34.5	35.2	35.2	35.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H154	Predicted	26.5	30.8	33.7	34.3	35.0	35.0	35.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H200	Predicted	28.1	32.4	35.3	35.9	36.6	36.6	36.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H201	Predicted	22.4	26.7	29.5	30.1	30.8	30.9	30.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H202	Predicted	22.5	26.8	29.6	30.2	31.0	31.0	31.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H203	Predicted	23.7	28.0	30.9	31.5	32.2	32.2	32.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H204	Predicted	23.2	27.4	30.3	30.9	31.6	31.7	31.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H205	Predicted	23.0	27.2	30.1	30.7	31.4	31.5	31.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H206	Predicted	24.4	28.7	31.5	32.2	32.9	32.9	32.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H207	Predicted	24.1	28.4	31.2	31.8	32.6	32.6	32.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H208	Predicted	25.3	29.6	32.5	33.1	33.8	33.8	33.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H209	Predicted	25.4	29.7	32.5	33.1	33.8	33.9	33.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H210	Predicted	24.5	28.8	31.6	32.2	33.0	33.0	33.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H211	Predicted	25.0	29.3	32.1	32.8	33.5	33.5	33.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H212	Predicted	23.6	27.7	30.6	31.4	32.1	32.1	32.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H213	Predicted	27.6	28.3	32.4	34.8	35.5	35.6	35.6
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H214	Predicted	28.2	28.9	32.9	35.4	36.1	36.2	36.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H215	Predicted	31.0	31.3	35.5	38.0	38.7	38.7	38.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H216	Predicted	31.2	31.4	35.6	38.2	38.9	38.9	38.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H217	Predicted	34.3	34.4	38.6	41.2	41.9	41.9	41.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	1.2	1.9	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H218	Predicted	34.8	34.9	39.2	41.8	42.5	42.5	42.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	1.8	2.5	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H219	Predicted	35.8	35.9	40.1	42.7	43.4	43.4	43.4

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	0.1	2.7	3.4	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	0.4	0.4	0.4
H220	Predicted	37.4	37.5	41.8	44.3	45.0	45.0	45.0
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	1.8	4.3	5.0	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	1.3	2.0	2.0	2.0
H221	Predicted	33.9	34.0	38.2	40.8	41.5	41.5	41.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	0.8	1.5	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H222	Predicted	33.3	33.4	37.7	40.2	40.9	40.9	40.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	0.2	0.9	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H223	Predicted	25.4	28.1	31.4	32.8	33.5	33.5	33.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H224	Predicted	24.2	27.3	30.4	31.6	32.3	32.4	32.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H225	Predicted	24.1	27.3	30.4	31.6	32.3	32.3	32.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H226	Predicted	23.6	26.7	29.9	31.1	31.8	31.8	31.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
H227	Predicted	23.5	26.7	29.8	31.0	31.7	31.7	31.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H228	Predicted	26.4	30.6	33.5	34.2	34.9	34.9	34.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H229	Predicted	25.7	30.0	32.8	33.5	34.2	34.2	34.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H230	Predicted	26.2	30.5	33.4	34.0	34.7	34.7	34.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H231	Predicted	26.4	30.6	33.5	34.1	34.8	34.9	34.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H232	Predicted	26.4	30.7	33.5	34.2	34.9	34.9	34.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H233	Predicted	25.7	30.0	32.8	33.5	34.2	34.2	34.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H234	Predicted	25.2	29.5	32.3	32.9	33.6	33.7	33.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0

NSL Ref.	Parameter	Derived $L_{A90, 10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Excess	--	--	--	--	--	--	--
H235	Predicted	25.7	30.0	32.8	33.4	34.2	34.2	34.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H236	Predicted	25.4	29.6	32.5	33.1	33.8	33.9	33.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H237	Predicted	25.8	30.0	32.9	33.5	34.2	34.3	34.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H238	Predicted	24.6	28.9	31.8	32.4	33.1	33.1	33.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H239	Predicted	24.5	28.8	31.7	32.3	33.0	33.1	33.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H240	Predicted	24.4	28.7	31.5	32.1	32.9	32.9	32.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H241	Predicted	24.3	28.6	31.4	32.0	32.7	32.8	32.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H242	Predicted	25.4	29.7	32.5	33.2	33.9	33.9	33.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H243	Predicted	26.6	30.9	33.7	34.3	35.1	35.1	35.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H244	Predicted	26.6	30.8	33.7	34.3	35.0	35.1	35.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H245	Predicted	22.2	26.5	29.4	30.0	30.7	30.7	30.7
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H246	Predicted	23.3	27.6	30.4	31.0	31.7	31.8	31.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H247	Predicted	23.4	27.7	30.6	31.2	31.9	31.9	31.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H248	Predicted	22.9	27.2	30.0	30.6	31.3	31.4	31.4
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H249	Predicted	22.7	27.0	29.9	30.5	31.2	31.2	31.2
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H250	Predicted	22.3	26.5	29.4	30.0	30.7	30.8	30.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H251	Predicted	22.0	26.3	29.1	29.7	30.4	30.5	30.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H252	Predicted	21.8	26.1	28.9	29.5	30.2	30.3	30.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H253	Predicted	24.3	28.6	31.4	32.0	32.7	32.8	32.8
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H255	Predicted	26.8	31.1	34.0	34.6	35.3	35.3	35.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H256	Predicted	26.8	31.1	33.9	34.5	35.2	35.3	35.3
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H257	Predicted	27.0	31.3	34.1	34.7	35.4	35.5	35.5
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H258	Predicted	29.3	30.3	34.2	36.4	37.1	37.1	37.1
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H259	Predicted	31.0	35.3	38.2	38.8	39.5	39.5	39.5

NSL Ref.	Parameter	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		4	5	6	7	8	9	10
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--
H260	Predicted	27.4	31.6	34.5	35.1	35.8	35.9	35.9
	Daytime Criterion	40.0	40.0	40.0	40.0	40.0	45.0	45.0
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	--	--	--	--	--	--	--

A noise contour for standard mode operation rated power at 9 m/s wind speed (i.e. highest cumulative noise emission) has been presented in Appendix 12-6.

The cumulative predicted noise levels at various wind speeds have been compared against the noise criteria curves outlined in Table 12-28.

The predicted omni-directional noise levels for all turbines operating in standard mode (with serrated trailing edges) has identified some exceedances at a small number of NSLs (7 no.) at certain windspeeds.

Six NSLs (H217 to H222) cumulatively exceed the predicted omni-directional daytime noise levels. Of these six locations, H219 and H220 also cumulatively exceed the predicted omni-directional night-time noise levels. The six NSL's are located to the south of the proposed development and Ballymartin / Smithstown Wind Farm. As presented in Appendix 12-5, the contribution from the proposed Castlebanny development is more than 10 dB below the noise contribution from the other wind farm (Ballymartin / Smithstown) at the 6 no. NSLs during the day time and 2 no. NSLs during the night-time periods respectively. In addition, the noise limits set by Castlebanny Wind Farm are lower than the noise limits set by the planning conditions at the Ballymartin / Smithstown Wind Farm. The IOA GPG states that *"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."*. As the predicted day time noise contribution from Castlebanny Wind Farm is more than 10 dB below the contribution from the Ballymartin / Smithstown Wind Farm, the requirement of the IOA GPG is met at the 6 no. NSLs. The same principle applies for the same 2 no. NSLs, where the predicted cumulative predicted night-time noise levels were also exceeded.

Based on the exclusions above, the number of locations with cumulative exceedances of the noise criteria is just 1 no. property of the 181 no. properties assessed. At H079 the exceedance was 0.1 dB during day-time at 8 m/s. Directional noise predictions models have been developed to identify the number and magnitude of exceedances to the noise criteria at the various NSLs with the proposed turbines operating in standard mode. The full tabulated results of this assessment are shown in Appendix 12-7. When cumulative directionality is considered there are no NSLs that exceed the noise criteria.

It is reiterated that this initial review has considered a cumulative predicted noise level at various wind speeds, compared against the noise criteria curves outlined in Table 12-28. The cumulative predicted omni-directional noise levels for all turbines operating in standard mode indicates that there will be no exceedances of the noise criteria curves at 174 no. properties. When directionality is considered, there will be no exceedances of the criteria at the remaining 1 no. property as a direct result of the proposed Castlebanny wind farm.

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

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

Description of Effects

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 the wind farm is described below.

Quality	*Significance*	*Duration*
Negative	Moderate	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 in addition to assuming the lowest background noise level envelope, measured at 8 no. noise monitoring locations.

For the majority of locations assessed here the effect of the operational turbines can be considered to be as follows:

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

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

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

12.4.3.2 Substation Noise

Details of the proposed substation options are described in Chapter 2 of the EIAR. The substation will typically be operational 24/7.

The following extract from the *EirGrid Evidence Based Environmental Studies Study 8: Noise – Literature review and evidence-based field study on the noise effects of high voltage transmission development* (May 2016) states the following in relation to noise effects associated with 110 kV substation installations: -

> *"The survey on the 110kV substation at Dunfirth indicated that measured noise levels (L_{Aeq}) were less than 40 dB(A) at 5 m from each of the boundaries of the substation. This is below the WHO night-time free-field threshold limit of 42 dB for preventing effects on sleep and well below the WHO daytime threshold limits for serious and moderate annoyance in outdoor living areas (i.e. 55 dB and 50 dB respectively). Spectral analysis of the data recorded at this site demonstrated that there were no distinct tonal elements to the recorded noise level. To avoid any noise impacts from 110 kV substations at sensitive receptors, it is recommended that a minimum distance of 5 m is maintained between 110 kV substations and the land boundary of any noise sensitive property."*

The proposed development has comparable noise emissions to the 110 kV unit discussed above and considering the distance between the proposed development and the nearest noise sensitive location (i.e. greater than 1 km), noise from the proposed substation is not assessed as likely to result in significant adverse noise effects. It is predicted, therefore, that the expected noise levels experienced at the nearest dwelling will be less than 20 dB(A).

It is concluded, therefore, that there will be no significant noise emissions from the operation of the proposed development.

Description of Effects

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 the substation is described below.

Quality	*Significance*	*Duration*
Negative	Imperceptible	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.

12.4.3.3 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.

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

12.4.3.4 Cumulative Impacts

A review of the planning register identified the following developments within the vicinity of the proposed development:

- Ballymartin / Smithstown Wind Farm located approximately 2 km south of the proposed development; and,
- Rahora Wind Farm located approximately 4 km southeast of the proposed development.

Based on review of the planning searches, it is understood that there are no other developments (other than those listed above) that could give rise to cumulative noise impacts with the proposed development.

During the construction and decommissioning phases of the proposed project all calculations have presented a worst-case scenario and summarised the cumulative impact of all predicted machinery operating simultaneously.

The operational phase of the proposed project has considered the potential cumulative impacts of the Proposed Development in combination with other wind energy developments in the area as required by best practice guidance discussed in Section 12.2.3.2.

12.5 MITIGATION MEASURES

The assessment of potential impact has demonstrated that the proposed development is expected to comply with the identified criteria for both the construction, operational and decommissioning phases. However, to ameliorate any noise and vibration effects, a schedule of noise control measures has been formulated for both construction/decommissioning and operational phases.

12.5.1 Construction and Decommissioning Phases

The comments in this section relate primarily to the construction phase, but are apply equally to the decommissioning phase:

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

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

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

- selection of plant with low inherent potential for generation of noise and/ or vibration;

- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- regular maintenance and servicing of plant items.

12.5.1.1 Noise

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

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models, fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 12-1 using methods outlined in BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs weekdays and between 7:00hrs and 19:00hrs on Saturdays. However, to ensure that optimal use is made of good weather period or at critical periods within the programme (i.e. concrete pours) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the local Planning Authority.

In addition to the mitigation measures outlined above, where grid connection works are taking place within 50m of the nearest NSL, screening will be used as an effective method to reduce the noise level at the nearest receivers. The effectiveness of a noise screen will depend on the height and length of the screen, its mass, and its position relative to both the source and receiver.

The length of the screen should in practice be at least five times the height, however, if shorter sections are necessary then the ends of the screen will be wrapped around the source.

BS 5228-1:2009+A1:2014 states that on level sites the screen should be placed as close as possible to either the source or the receiver. The construction of the barrier will be such that there are no gaps or openings at joints in the screen material. In most practical situations the effectiveness of the screen is limited by the sound transmission over the top of the barrier rather than the transmission through the barrier itself. In practice, screens constructed of materials with a mass per unit of surface area greater than 10kg/m^2 will give adequate sound insulation performance. As an example, the use of a standard 2.4m high construction site hoarding will provide a sufficient level of noise screening once it is installed at a suitable position between the source and receiver. Annex B of *BS 5228-1:2009+A1:2014* (Figures B1, B2 and B3) provide typical details for temporary and mobile acoustic screens, sheds and enclosures that can be constructed on site from standard materials.

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

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

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

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

The methods used to minimise effects will consist of some or all the following:

- Restriction of hours within which blasting can be conducted.
- A publicity campaign undertaken before any work and blasting starts (e.g. 48 hours written notification).
- The firing of blasts at similar times to reduce the ‘startle’ effect.
- On-going circulars informing people of the progress of the works.
- The implementation of an onsite documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.
- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

12.5.1.2 Vibration

Vibration associated with construction activities will be limited to the values set out in Table 12-2. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage.

Site investigations have indicated that no piling activities are anticipated. Therefore, no mitigation measures are proposed.

On review of the likely vibration levels associated with construction activities, it is concluded that the construction of the proposed development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings.

In the unlikely event of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period:

- A clear communication programme will be established to inform closest building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars.
- Alternative less intensive working methods and/or plant items shall be employed, where feasible.
- Appropriate vibration isolation shall be applied to plant, where feasible.
- Cut off trenches to isolate the vibration transmission path shall be installed where required.
- Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values.

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

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

12.5.2 Operational Phase

An assessment of the operation noise levels has been undertaken in accordance with best practice guidelines and procedure as outlined in Section 12.2.1.4. The findings of the assessment confirmed that the predicted operational noise levels will be within the relevant best practice noise criteria curves for wind farms. Therefore, noise mitigation measures are not required for the operational phase of this development.

If alternative turbine technologies are considered for the site the turbine selected will comply with the noise limits set out in this assessment.

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

In the unlikely event that an issue of AM is associated with the proposed development, an appropriate investigation shall be undertaken in accordance with the guidance outlined in the

Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *A Method for Rating Amplitude Modulation in Wind Turbine Noise* (August 2016) or subsequent revisions.

12.5.3 Decommissioning Phase

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

The mitigation measures that will be considered in relation to any decommissioning of the site are the same as those proposed for the construction phase of the development, i.e. as per Section 12.5.1.

12.5.4 Monitoring

12.5.4.1 Construction Phase

Noise and vibration monitoring is proposed in accordance with the guidance contained in *British Standard BS5528* during the construction phase.

12.5.4.2 Operational Phase

A post commissioning noise monitoring survey will be conducted to ensure compliance with any noise conditions applied to the development. In the unlikely instance that an exceedance of these noise criteria is identified, the assessment guidance outlined in the IoA GPG and Supplementary Guidance Note 5: *Post Completion Measurements* (July 2014) will be followed and relevant corrective actions will be taken, if required. For example, implementation of Noise operational modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure predicted noise levels are within the relevant noise criterion curves/planning conditions. Such curtailment can be applied using the wind farm SCADA system without undue effect on the wind farm operations.

For post-commissioning of the proposed turbine units, it is proposed that the noise monitoring methodology detailed in the relevant section of this report will be repeated with consideration of the guidance outlined in the IoA GPG and Supplementary Guidance Note 5.

12.6 RESIDUAL EFFECTS

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

12.6.1 Construction / Decommissioning Phases

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

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

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

12.6.1.1 Construction of Access Tracks (including Tree Felling)

Quality	*Significance*	*Duration*
Negative	Moderate	Temporary

12.6.1.2 Borrow Pits

Noise Assessment

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

Vibration Assessment – Blasting

Quality	*Significance*	*Duration*
Negative	Slight	Momentary

12.6.1.3 Grid Connection Construction

The predicted residual grid connection construction effects are summarised as follows at the small number of closest noise sensitive locations to the site:

Quality	*Significance*	*Duration*
Negative	Moderate	Temporary

For most of the locations assessed here the effect of the grid connection construction are as follows:

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

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

12.6.1.4 Construction Traffic

The predicted residual construction traffic effects during Phase 1b along the R704 are summarised as follows at the small number of closest noise sensitive locations to the site:

Quality	*Significance*	*Duration*
Negative	Slight	Temporary

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.

12.6.2 Operational Phase

12.6.2.1 Wind Turbine Operation

The predicted noise levels associated with the proposed development will be within best practice noise criteria curves recommended in Irish guidance 'Wind Energy Development Guidelines for Planning Authorities, 2006', and has been supplemented with guidance from ESTU-R-97 and the IOA GPG and its supplementary guidance notes. It is not considered that a significant effect is associated with the development.

Therefore, in line with best practice the assessment presented in the EIAR is based on the current guidance outlined in the *Wind Energy Development Guidelines for Planning Authorities (*2006),

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

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

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

The above effects should be considered in terms that the effect is variable and that this assessment considers the locations of the greatest potential impact in addition to assuming the lowest background noise level envelope, measured at 8 no. noise monitoring locations.

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

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

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

12.6.3 Cumulative Effects

Cumulative assessment has been considered here with due consideration of the proposed development in combination with any existing permitted and proposed wind turbine developments in the wider study area as noted in Section 12.4.3.1. It has been predicted that the cumulative effects do not exceed the adopted criteria.

12.7 CONCLUSION

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

The assessment of construction noise and vibration and has been conducted in accordance 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*. Subject to good working practice as recommended in the EIAR, noise associated with the construction phase is not expected to exceed the recommended limit values. The associated noise and vibration are not expected to cause any significant effects.

Based on detailed information on the site layout, turbine noise emission levels and turbine height, worst-case cumulative turbine noise levels have been predicted at NSL's for a range of operational wind speeds. The predicted operational noise levels will be within best practice noise limits; therefore, it is not considered that a significant effect is associated with the development.

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

12.8 REFERENCES

- EPA Guidelines on the Information to be contained in Environmental Impact Statements, (EPA, 2002);
- EPA Advice Notes on Current Practice (in the preparation of Environmental Impact Statements), (EPA, 2003);
- EPA Guidelines on the Information to be contained in Environmental Impact Assessment Reports Draft August 2017 (EPA, 2017); and
- EPA Advice Notes for Preparing Environmental Impact Statements, (Draft, September 2015).
- ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, (ISO, 1996). Reference No. 1
- Institute of Acoustics: A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013)
- Wind Energy Development Guidelines" published by the Department of the Environment, Heritage and Local Government 2006
- Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) "The Assessment and Rating of Noise from Wind Farms" (1996).
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.