12.0 Noise

12.1 Introduction

Irwin Carr Ltd have been commissioned by ABO Energy Ireland Ltd., to carry out a noise assessment for the proposed Keerglen Wind Farm, Co. Mayo.

It is understood that this report will be submitted for assessment by Mayo County Council, as part of a comprehensive Environmental Impact Assessment Report.

Acoustic terminology used throughout this report is described in Section 12.1.2.

12.1.1 Statement of Competence

Irwin Carr Consulting Ltd is an environmental consultancy based in Ireland. The company has a proven track record in noise impact assessments throughout the UK and Ireland, with extensive knowledge of the issues in relation to noise from wind energy developments.

The assessment was carried out by Mark Burke. Mark is a Consultant in Irwin Carr Consulting, primarily responsible for environmental noise and noise monitoring. He has experience working in both the public and private sectors having previously obtained a BSc (Hons) Degree in Environmental Health.

Shane Carr is a Director in Irwin Carr Consulting, primarily responsible for environmental noise and noise modelling. He has over 25 years' experience working in both the public and private sectors having previously obtained a BSc (Hons) Degree in Environmental Health and a Post-Graduate Diploma in Acoustics. Shane has been responsible for undertaking and reviewing noise impact assessments on numerous large scale wind farms throughout the UK and Ireland. Shane carried out the baseline study.

12.1.2 Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment, is transitory, fluctuates, and is normally localised. Environmental noise is normally assessed in terms of A-weighted decibels, dB (A), when the 'A weighted' filter in the measuring device elicits a response which provides a good correlation with the human ear. The criteria for environmental noise control are of annoyance or nuisance rather than damage. In general, a noise level is liable to provoke a complaint whenever its level exceeds by a certain margin, the pre-existing noise level or when it attains an absolute level. A change in noise level of 3 dB (A) is 'barely perceptible', while an increase in noise level of 10 dB (A) is perceived as a twofold increase in loudness. A noise level in excess of 85 dB (A) gives a significant risk of hearing damage. Construction and industrial noise sources are normally assessed and expressed using equivalent continuous levels, LAeq[1]. Wind turbine source noise is generally expressed in Leq dBA and in sound power levels (LWA dB). Sound power level is a measure of the noise source while sound pressure level is a measurement taken at a distance from the noise source carried out with a noise meter.

[1] L_{Aeq} is defined as being the A-weighted equivalent continuous steady sound level that has the same sound energy as the real fluctuating sound during the sample period and effectively represents a type of average value.

Operational wind turbine noise is assessed using the LA90[2] descriptor, which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources. The LA90 should be used for assessing both the wind energy development noise and background noise as stated in the 2006 and 2019 (draft) Irish wind energy development guidelines. As discussed in ETSU-R-97[3] the LA90 is 1.5-2.5dBA less than the LAeq measured over the same period. In this assessment, the difference between LAeq and LA90 is given as 2dBA which is best practice and the value most commonly applied in wind farm assessments in Ireland. Wind turbine noise levels are given as sound power levels (LWA) dB at integer wind speeds up to maximum LWA levels. Table 12:1 gives a comparison of noise levels in our everyday environment.

[2] LA90, or L90dBA is defined as the noise level equaled or exceeded for 90% of the measurement interval and with wind farm noise the interval used is 10 minutes.

[3] ETSU-R-97, The Assessment & Rating of Noise from Wind Farms, June 1996

Table 12.1: Comparison of sound pressure level in our Environment[4]	
Source/Activity	**Indicative noise level dBA**
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5 km	35-45
Car at 65km/hr at 100m	55
Busy general office	60
Conversation	60
Truck at 50km/hr at 100m	65
Inside a typical shopping centre	70-75
Inside a modern car at around 90km/hr	75-80
Passenger cabin of jet aircraft	85
City Traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35

12.1.3 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria – a description of the methods used in baseline surveys and in the assessment of the significance of effects
- Baseline Description - a description of the baseline noise of the area surrounding the development based on the results of surveys, desk information and consultations, and a summary of any information required for the assessment that could not be obtained
- Assessment of Potential Effects - identifying the ways in which noise receptors could be affected by the development, including a summary of the measures taken during design of the development to minimise noise effects

[4] Fact sheet published by the Australian Government (Greenhouse Office) and the Australian Wind Energy Association

- Mitigation Measures and Residual Effects - a description of measures recommended to off-set potential negative effects and a summary of the significance of the effects of the EIA Development after mitigation measures have been implemented
- Cumulative Effects – identifying the potential for effects of the EIA Development to combine with those from other wind farm developments
- Summary of Effects
- Statement of Significance

12.2 Assessment Methodology and Significance Criteria

12.2.2 Assessment Methodology

This assessment has involved the following elements, further details of which are provided in the following sections:

- Legislation and guidance review
- Desk study, including review of available maps and published information
- Site walkover
- Evaluation of potential effects
- Evaluation of the significance of these effects
- Identification of measures to avoid and mitigate potential effects

12.2.3 Description of Effects

The significance of effects of the proposed development is described in accordance with the EPA guidance document '*Guidelines on the information to be contained in the Environmental Impact Assessment Reports (EIAR), EPA May 2022*'. The details of the methodology for describing the significance of effects are provided in Table 3.4: Section 3.7.3 of the aforementioned EPA 2022 document.

12.2.4 Relevant legislation and guidance

The noise assessment is carried out in accordance with the guidance contained in the following documents:

- Wind Energy Development Guidelines (WEDG)[5] (the 2006 Guidelines)
- Recent 2021 An Bord Pleanála Decisions on Noise Limits
- WHO 2018 Environmental Noise Guidelines for European Region (WHO 2018)
- Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG 2019)
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including Supplementary Guidance Note 4: Wind Shear'[6] (the IOA Good Practice Guide)
- ISO 1996[7] Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures (ISO 1996)
- ETSU-R-97[8]: The Assessment & Rating of Noise from Wind Farms (ETSU-R-97)
- National Roads Authority (NRA) Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2004

12.2.4.1 Wind Energy Development Guidelines 2006

The following are a number of key extracts from the 2006 Guidelines in relation to noise impact:

General Noise Impact

"*Noise impact should be assessed by reference to the nature and character of noise sensitive locations*."

"*Separate noise limits should apply for day-time and for night-time*"

"Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

Measurement Units

"The descriptor [LA90 10min] which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources, should be used for assessing both wind energy development noise and background noise."

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[5] Department of Environment, Heritage and Local Government: Wind Energy Development Guidelines, Guidelines for Planning Authorities 2006 Energy
[6] Institute of Acoustics (2013) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise
[7] ISO 1996/1- Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures
[8] ETSU-R-97: Acoustics-The Assessment & Rating of Noise from Wind Farms: ETSU for the DTI, UK, 1996

Specific Noise Limits

"Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

"In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5 dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours.

However, in very quiet areas, the use of the margin of 5 dB(A) above the background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments. Instead in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of LA90,10min of the wind energy development noise should be limited to an absolute level within the range 35-40 dB(A)".

"During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43 dB(A) will protect sleep inside properties during the night"

The 2006 Guidelines do not specify daytime or night-time hours. However, it is considered good practice to follow the framework given in ETSU-R-97 and IOA Good Practice Guide where daytime and night-time hours are specified. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ETSU-R-97 as:

- Quiet waking hours or quiet day-time periods are defined as:
    - All evenings from 18:00 to 23:00 hrs
    - Saturday afternoon from 13:00 to 18.00 hrs and all-day Sunday 07:00 to 18:00 hrs
- Night-time is defined as 23:00 to 07:00 hrs

12.2.4.2 An Bord Pleanála

2021 An Bord Pleanála Decisions

Recent decision by ABP gave limits (ABP-309306-21, dated 26th September 2022) in accordance with the 2006 Guidelines and were as follows:

(a) between 7am and 11pm:
  (i) the greater of 5 dB(A) L90,10min above background noise levels, or 45 dB(A) L90, 10min, at wind speeds of 5m/s or greater,
  (ii) 40 dB(A) L90, 10min, at all other wind speeds.
(b) 43 dB(A) L90,10min at all other times

where wind speeds are measured at 10 metres above ground level.

12.2.4.3 World Health Guidelines (WHO) 2018

The most recent WHO 2018 Guidelines: 'Environmental Noise Guidelines for the European Region' gives a recommendation limit of 45 dB Lden which is based on low quality evidence. This is an annual average noise level, based on wind speed and direction in the vicinity of the site with no specific limits for night.

12.2.4.4 Draft Revised Wind Energy Development Guidelines 2019 (DRWEDG2019)

There have been a number of draft guidelines over the years with the latest one being in December 2019. The DRWEDG 2019 guidelines, currently in draft format are subject to significant public and stakeholder consultation and liable to change.

A tender to review the DRWEDG19 has been issued. In respect of the noise assessment in this and in line with best practise, the assessment is based on the WEDG06 as outlined in Section 12.2.3.1.

12.2.5 Desk Study

The location for noise monitoring were selected by inspection of Site layout maps and by identifying the nearest receptors surrounding the wind turbines. The Noise Study Area has been defined such that the predicted results have been included for all residential receptors within 3.6km of the wind farm.

The four noise monitoring locations are considered representative of the local noise environment.

12.2.6 Acquisition and Analysis of Background Noise Data

The 2006 Guidelines, ETSU-R-97 and the IOA Good Practice Guide recommend the measurement and use of wind speed data, against which background noise measurements are correlated. The IOA Good Practice Guide Supplementary Guidance Note 4[9].(Appendix 12.2) gives the methodology to account for wind shear, calculation to hub height and to standardise 10m height wind speed.

A LiDAR positioned within the Site during the noise survey was used for wind data measurements over 10-minute intervals.

The 105m hub height wind speed was then standardised to 10m height wind speed with the wind speed plotted against the 10-minute background noise data to derive a best fit polynomial curve. This corresponds with the hub-height of the candidate turbine with the highest sound power level.

[9] IOA, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise-Supplementary Guidance Note 4: Wind Shear

12.2.7 Prediction of Wind Turbine Noise Levels

The predicted noise levels are based on the methodology given in the IOA Good Practice Guide. Noise level calculations are based on ISO 9613-2[10] which provides a prediction of noise levels likely to occur under worst-case down-wind conditions.

There are numerous models for predicting noise from a point source and some of these models are specifically used for the prediction of noise from wind farms. SoundPLAN software package was used to calculate the noise level at the receptors. The propagation model calculates the predicted sound pressure levels by taking the source sound power level for each turbine in their respective octave bands and subtracting a number of attenuation factors according to the following formula:

Predicted Octave Band Noise level = $LW + D – (A_{geo} + A_{atm} + A_{gr} + A_{br} + A_{mis})j$

The predicted octaves from each of the turbines are summed to give the predicted noise level expressed as dBA.

No allowance has been made for the character of noise emitted by the turbines, however in general the emissions from wind turbines are broadband in nature. In the unlikely event of a turbine exhibiting clearly tonal components at any receptor, the turbine would be turned down or stopped until such tonality is ameliorated. A guarantee will be required in the procurements of the turbine to be used onsite, stating that there should be no clearly tonal or impulsive components audible at any noise sensitive receptor location.

A_{geo} –Geometric Spreading

Geometric (spherical) spreading from a simple free-field point source results in attenuation over distance according to:

$$Lp = Lw – (20 \log R + 11)$$

Where:

Lp = sound pressure level

Lw = sound power level

R = distance from the turbine to receiver

D – Directivity Factor

The directivity factor allows for adjustment where the sound radiated in the direction of the receptor is higher than that for which the sound power level is specified. In this case, the sound power levels are predicted as worst case propagation conditions, i.e. all receptors are assumed to be in downwind conditions.

[10] ISO 9613-2 Acoustics -Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation

A_{gr} - Ground Effects

Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from the turbine to receiver. The prediction of ground effects is complex and depends on the source height, receiver height, propagation height between the source and receiver and the intervening ground conditions.

Ground conditions are described according to a variable defined as G, which varies between 0 for hard ground and 1 for soft ground. Although in reality the ground is predominately porous, it has been modelled as mixed 50% hard and 50% porous corresponding to a ground absorption coefficient of 0.5. Our predictions have been carried out using a source height corresponding to the proposed height of the turbine nacelle, a receiver height of 4m and an assumed ground factor of G=0.5 as recommended in the IOA Good Practice Guide.

A_{bar}- Barrier Attenuation

The effect of a barrier (including a natural barrier) between a noise source and receptor is that noise will be reduced according to the path difference (difference between the direct distance between source to receptor and distance between source and receptor over the barrier). The reduction is relative to the frequency spectrum of the sound and may be predicted according to the method given in ISO 9613. In practice, barriers can become less effective in downwind conditions. A barrier can be very effective when it lies within a few metres of the receptor. In the prediction model, zero attenuation is given for barrier effects, which is a worst-case scenario setting.

A_{atm} - Atmospheric Absorption

Sound emergence through the atmosphere is attenuated by conversion of sound energy to heat. This energy is dependent on the temperature and relative humidity of the air, but only weakly on ambient pressure through which the sound is travelling and is frequency dependent, with increasing attenuation towards higher frequencies. The attenuation by atmospheric absorption A_{atm} in decibels during propagation through distance in metres is given by:

$A_{atm} = d \times \alpha$,

α = atmospheric absorption coefficient in dBm^{-1}

d = distance from turbine

Values of α from ISO 9613 Part 1, corresponding to a temperature of $10^{0}C$ and a relative humidity of 70% has been used for these predictions and are given in Table 12:2 below. These values are recommended in the IOA Good Practice Guide.

Table 12.2: Frequency dependant atmospheric attenuation coefficients (dB/m)

Octave Band Centre Frequency	63	125	250	500	1k	2k	4k	8k	Hz
Air absorption coefficient	0.0001	0.0004	0.001	0.0019	0.0037	0.0097	0.0328	0.117	dB/m

A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

The ISO 9613-2 standard calculates under downwind propagation conditions and therefore predicts the average downwind sound pressure level at each dwelling. The model assumes that the wind is directly downwind from each turbine to each dwelling. The prediction model is calculated as a worst-case scenario.

The predicted noise levels $L_{Aeq\ 10min}$ are converted to the required $L_{A90,10min}$ by subtracting 2 dBA.

12.2.8 Aerodynamic Modulation or Aerodynamic Noise

Aerodynamic noise originates from the flow of air over, under and around the blades and is generally broadband in character. It is directly linked to the movement of the rotors through the air and will occur to varying degrees whenever the turbine blades move. Aerodynamic noise is generally both broadband i.e. it does not contain a distinguishable note or tone, and of random character, although the level is not constant and fluctuates in time with the movement of the blades. The dominant character of such aerodynamic noise is therefore normally a 'swish' type of sound, which is familiar to most people who have stood near to a large wind turbine.

The sound level of aerodynamic noise from wind turbine blades is not completely steady, but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called "*blade swish*", typically occurring in step with the angle of rotation of the blades and so being periodic at the rotor's rotational speed – for typical commercial turbines, this is at a rate of around once or twice per second. This phenomenon is known as Amplitude Modulation of Aerodynamic Noise or more succinctly by the acronym AM. In some situations, however, the modulation characteristics can change in character to the point where it can potentially give rise to increased annoyance.

In early wind turbine designs, where the rotor was positioned downwind of the tower, a pronounced 'beat' was audible as each blade passed through the turbulent wake shed from the tower. However, this effect does not exist for the upwind rotor designs found on the majority of modern wind farms where the air flow to the blades is not interrupted by the tower structure. Instead, it seems that aerodynamic modulation is due to fluctuation of the primary mechanisms of aerodynamic noise generation.

The Temple Group[11] undertook a review of Renewable UK's Research into Amplitude Modulation and concluded the following:

The distinction between normal AM i.e., blade swish (NAM) and other AM (OAM) is important as they are caused by different mechanisms and have separate impacts. Normal AM (NAM) is a commonly occurring typical characteristic of wind turbine noise that occurs persistently for long periods. NAM or "swish" usually disappears at around 3 to 4 rotor lengths from the turbines, except in crosswind conditions.

Based on the evidence available, it was recognised that even at those wind farm sites where OAM has been reported to be an issue, its occurrence may be relatively infrequent.

The study reports that the occurrence and intensity of OAM is dependent on a number of interacting factors that are specific to a location, and it is not feasible to reliably predict the occurrence of OAM at another location simply by cross checking whether similar conditions that arise at a location where OAM has occurred might arise at the new location.

Normal Amplitude Modulation (NAM) is a fundamental component of wind turbine noise and can be heard in proximity to virtually all wind turbine installations. The 2007[12] Salford University Report found instances of "enhanced" AM which occurred at larger distances, but relatively infrequently and at only a small minority of sites. These characteristics are consistent with and can be explained by OAM.

As described previously, many risk factors have been considered for OAM. However, no single item or specific combination of items have been found to be the controlling factors whereby the occurrence, duration and intensity of OAM at a particular location can be reliably predicted in advance of a wind turbine or wind farm being installed.

Salford University in 2007, found that out of 133 operational wind farms investigated, 27 were associated with noise complaints, but OAM was considered to be a factor in noise complaints at only four sites and a possible factor in a further eight locations.

12.2.9 Infrared and Low Frequency Noise and Vibration

There is always low frequency (or infrasound) noise present in the ambient quiet background. It is generated by natural sources such as road traffic, wind effects through air and vegetation, wave motion, water flow in streams and rivers. There are also low frequency emissions from many sources found in modern life, such as household appliances (e.g., washing machines, air conditioners, fridges, heating systems, boilers, burners, heat pumps, extraction systems, electric or battery clocks, sky box, etc.), Other sources include water flowing through pipes within your home and in water flow from municipal water supply. Vibration of

[11] Report for Renewable UK by Temple Group (Dani Fliumicelli). *Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines*, Wind Turbine Amplitude Modulation: *Research to Improve Understanding as to the cause and Effect*, Dec'2013.

[12] Research into Aerodynamic Modulation of Wind Turbine Noise. Report by University of Salford

elements of structures (low frequency, less than 20Hz)) can be generated by local activity in one's home by way of normal routine activity, like climbing stairs, walking on the floor, closing doors etc. When sitting in a moving vehicle very high levels of low frequency vibration/sound is experienced.

The frequency range of audible noise is in the range of 20 to 20,000Hz and low frequency noise is generally from about 2 to 200Hz with infrasound typically of frequencies below 20Hz. There appears to be little or no agreement about the biological effects of low frequency noise on human health and there is evidence to suggest that there are no serious consequences to people's health from infrasound exposure.

A study of low frequency noise (infrasound) and vibration around a modern wind farm was carried out for ETSU and reported in ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'[13]. The results showed levels of infrasound to be below accepted thresholds of perception even on the Site. Furthermore, a document prepared for the World Health Organisation, states that *"there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects"*.

Significant research carried out on low frequency noise has been in the area of blasting (air overpressure) which falls into a very low frequency range (2-20Hz), although with a considerably higher magnitude. Interestingly most microphones recording air-overpressure (low frequency sound) is linear down to 2 Hz with a range that does not go below a level of 88dB, as below that value trigger can occur from relatively low wind speeds (a gust of wind at 9m/s equates to an air overpressure of 133dB).

The level of ground vibration from the operation of the wind farms is below human threshold of 0.2mm/s[14] at the base of a turbine.

<u>South Australian Environment Protection Authority (EPA) Infrasound Study</u>

A report released in January 2013 by the South Australian EPA[15] found that the level of infrasound from wind turbines is insignificant and no different to any other sources 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, houses both adjacent to a wind farm and away from turbines and measured the levels of infrasound with the wind farms operating and also switched off. There were no noticeable differences in the level 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 South Australian study found: '*the contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment*'.

[13] ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'.
[14] Wiss, J. F., and Parmelee, R. A.. (1974) Human Perception of Transient Vibrations, "*Journal of Structural Division*", ASCE, Vol 100, No. S74, PP. 773-787
[15] http://www.epa.sa.gov.au/environmental_info/noise/wind_farms

Massachusetts Institute of Technology (MIT)

A report by an Independent Expert Panel prepared for Massachusetts Department of Health (2012)[16] consisted of a panel that included seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering, all of which were considered independent experts from academic institutions. The report found that *"there is insufficient evidence that the noise from wind turbines is directly (i.e., independent from an effect on annoyance or sleep) causing health problems or disease'* and '*available evidence shows that infrasound levels near wind turbines cannot impact the vestibular system"*.

Technical Research Centre of Finland

A long-term study into so-called "wind turbine syndrome"[17] health problems supposedly caused by low-frequency sound from spinning blades has concluded that this "infrasound" has absolutely no physical impact on the human body.

The study conducted by the Technical Research Centre of Finland (VTT) and others, commissioned by the Finnish government, found that infrasound sound waves with frequencies below the range of human hearing cause no measurable changes in the human body, and cannot in any way be detected by the human ear.

Infrasound measurements were taken inside and outside local dwellings near two Finnish wind farms, as well as inside the facilities and beyond them, for 308 days.

Measurements showed that the infrasound levels in rural areas with wind farms were about the same as levels in a regular urban environment.

"Infrasound samples representing the worst-case scenarios were picked out from the measurement data and used in the listening tests," said VTT.

"The participants in the listening tests were divided into two groups based on how they reported wind turbine infrasound related symptoms: people who suffered from those and people who never had symptoms."

"The participants were unable to make out infrasonic frequencies in wind turbine noise, and the presence of infrasound made no difference to how annoying the participants perceived the noise, and their autonomous nervous system did not respond to it. There were no differences between the results of the two groups."

[16] Infrasound Does Not Explain Symptoms Related to Wind Turbines, Finnish Government, June 2020, https://www.vttresearch.com/en/news-and-ideas/vtt-studied-health-effects-infrasound-wind-turbine-noise-multidisciplinary

[17] Report by Leigh Collins, 21st April 2020 on a study commissioned by the Finnish Government into infrasound and wind turbine syndrome

12.2.10 Field Work

Baseline noise monitoring was undertaken between 15th February and 10th March 2022 at the locations shown in Technical Appendix 12.1. The continuous monitoring period coincided with the wind speed monitoring over the same period at the same 10-minute intervals using a LiDAR located on site. Noise data was recorded for a representative range of wind speeds during the monitoring period.

12.2.11 Consultation

Consultation was carried out with landowners who were familiar with the Site. Access to the nearest dwellings was carried out with permission from the householders / landowners.

12.2.12 Noise Assessment Methodology

In summary, the assessment process comprised:

- Identification of potential receptors, i.e., houses and other potentially noise-sensitive locations;
- Measurement of existing background noise levels at representative locations close to the Site;
- Prediction of the likely noise levels of wind turbines received at each receptor; and
- Comparison of the predicted levels with noise limits.

Potential receptors in the area around the development were initially identified from Ordnance Survey maps, google maps, EPA maps and Site visits. Background measurements were carried out at the shown in Technical Appendix 12.1.

The method of measuring background noise is described in ISO 1996 and ETSU-R-97. In practice, it means carrying out continuous monitoring of background noise levels at receptors for a period that includes a range of wind speeds which correspond to the maximum sound power of the candidate turbines being proposed which is usually 3 to 4 weeks duration. The candidate turbine assessed reaches maximum sound power level at a mean wind speed of 8m/s at 10m height and generates the highest noise level for that turbine specification.

The method of predicting noise levels of wind turbines at receptors is discussed in Section 12.2.6. This method was applied to the calculations for both contour plots and individual receptor predictions.

It is standard practice to predict noise levels for a reference wind speed and to adjust these for other wind speeds, according to the variation in sound power level with wind speed.

12.2.13 Sound Power Levels

The proposal allows consideration of a wider range of models at the site. The potential turbine models currently available on the market, within the proposed geometry range are considered. As the wind turbine to be installed at Keerglen Wind Farm has yet to be selected a number of wind turbine sound power levels have been considered, with the worst-case sound power level at each given wind speed from 4 to 12m/s input to the noise model (i.e. a 'hybrid' wind turbine). In undertaking such a worst-case methodology, this provides the applicant with the freedom to select from a wider range of wind turbine providers without the need for further amendment applications. Wind turbines considered included:

- Nordex
  - N133 – 110m Hub Height
    - 4.8MW

      Warranted Sound Power Level Data relied upon in calculations for the N133 – 4.8MW on the 110m hub height was provided within manufacturer's report Noise level, Power curves, Thrust curves Nordex N133/4.8, dated 31 January 2020 (Document no.:F008_272_A13_EN).
  - N149 – 105m Hub Height
    - 4.5MW
    - 5.7MW
- Vestas
  - V136 – 112m Hub Height
    - 4.2MW
    - 4.5MW
  - V150 – 105m Hub Height
    - 4.2MW
    - 4.5MW

Nordex N133

Warranted Sound Power Level Data relied upon in calculations for the N133 – 4.8MW on the 110m hub height was provided within manufacturer's report Noise level, Power curves, Thrust curves Nordex N133/4.8, dated 31 January 2020 (Document no.:F008_272_A13_EN).

Nordex N149

- 4.5MW
  Sound Power Level Data was not available for the 4.5MW turbine type. To ensure a conservative assessment, Sound Power Level Data from the 5.7MW turbine type was included in this assessment. Warranted Sound Power Level Data relied upon in calculations for the N149 – 5.7MW on the 110m hub height was provided within manufacturer's report Third octave sound power levels Nordex N149/5.X, dated 14 February 2020 (Document no.:F008_275_A17_EN).

- 5.7MW
  Warranted Sound Power Level Data relied upon in calculations for the N149 – 5.7MW on the 110m hub height was provided within manufacturer's report Third octave sound power levels Nordex N149/5.X, dated 14 February 2020 (Document no.:F008_275_A17_EN).

Vestas V136

- 4.2MW
  Warranted Sound Power Level Data relied upon for this turbine type was taken from a previous project completed using this turbine type.

- 4.5MW
  Warranted Sound Power Level Data relied upon for this turbine type was taken from a previous project completed using this turbine type.

Vestas V150

Sound Power Level Data was not available for the 4.2MW and 4.5MW turbine types. To ensure a conservative assessment was undertaken, Sound Power Level Data from the 6.0MW turbine type was included in this assessment. Warranted Sound Power Level Data relied upon in calculations for the V150 – 6.0MW on the 105m hub height was provided within manufacturer's report Performance Specification V150-6.0 MW 50/60 Hz, dated 23 February 2021 (Document no.: 0098-0749 V02).

The sound power levels for these turbines (with serrated trailing edge) are presented in Table 12:3 below.

Table 12.3: Warranted sound power data for the potential turbines to be used on the site – with Serrated Trailing Edges

Wind Speed (m/s) @ 10m AGL	Standardised 10m Sound Power Level L_{90} dB(A) (inc 2dB uncertainty)						
	N133 (110m HH)	N149 (105m HH)		V136 (112m HH)		V150 (105m HH)	
	4.8MW	4.5MW	5.7MW	4.2MW	4.5MW	4.2MW	4.5MW
4	97	97.2	97.2	96.7	96.6	94.2	94.2
5	102.6	101.8	101.8	101.5	101.4	96	96
6	106.3	106.2	106.2	105.2	105.2	98.9	98.9
7	106.5	107.6	107.6	105.9	105.9	101.9	101.9
8	106.5	107.6	107.6	105.9	105.9	104.7	104.7
9	106.5	107.6	107.6	105.9	105.9	106.6	106.6
10	106.5	107.6	107.6	105.9	105.9	106.8	106.8
11	106.5	107.6	107.6	105.9	105.9	106.9	106.9
12	106.5	107.6	107.6	105.9	105.9	106.9	106.9

Figure 12:3 below shows the sound power level at each wind speed. It can be seen that the Nordex N149 – 5.7MW with a 105m hub height has the highest sound power level noise level. Therefore, the N149 has been considered the worst-case turbine for assessment on this site. A copy of the manufacturer's performance specification for this turbine type when operating in Mode 0 with STE is given in the Technical Appendix 12.5.

For completeness the predicted noise levels for all other turbine types that fit within the design envelope range applied for as part of the planning application are presented in Technical Appendix 12.6.

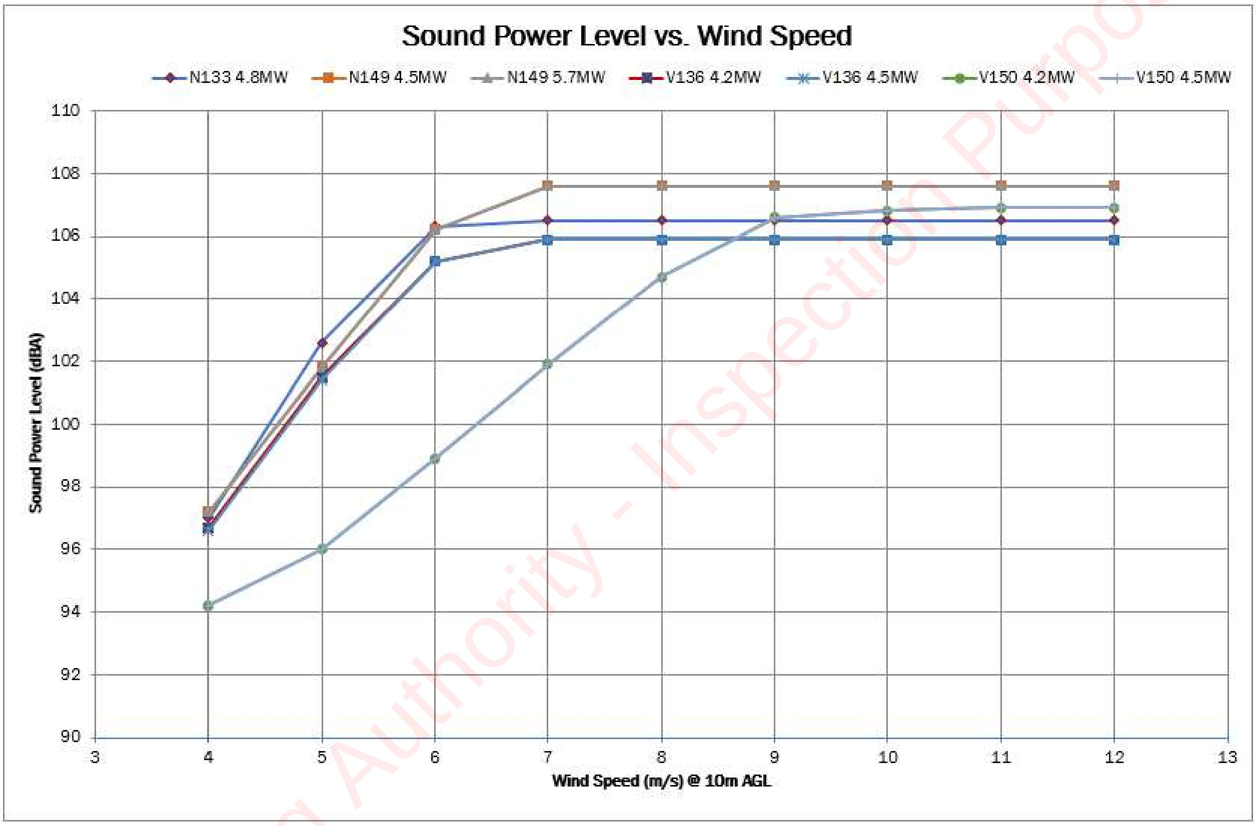

Figure 12: 1 : Warranted sound power data for the potential turbines to be used on the site

The frequency spectrum relied upon in the assessment is presented in Table 12.4 below.

Table 12.4: Frequency Data relied upon for the Nordex N149 4.5/5.7MW – Serrated Edges (ex uc)

Wind Speed (m/s)	Sound Power Level dB(A)							
	63Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Overall
8+	87.3	93.5	97.2	99.8	100.5	98.0	90.4	82.4	105.6

12.2.13.1 Noise Limits

The method of deriving operational noise limits, described in Section 12.2.3.1, is based on the Wind Energy Development Guidelines 2006 and lower limits specified in recent An Bord Pleanála decisions, described in Section 12.2.3.2. The noise limits for the Keerglen Wind Farm are designed to meet:

'Wind turbine noise arising from the proposed development, by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed the greater of:

- *43dB(A)* L90,10min for day and night at wind speeds of 5m/s or greater, and
- 40 dB(A) L90, 10min at all other wind speeds

where wind speeds are measured at 10 metres above ground level. Where properties are financially involved, a 45dB(A) L90,10min limit can be applied.'

12.2.14 Construction Assessment Methodology

12.2.14.1 Relevant Guidance

There is no published national guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. However National Roads Authority (NRA) give limit values which are acceptable (the NRA Guidelines)[18]. Guidance to predict and control noise is also given in BS 5228:2009-1+A12014, *Code of Practice for Noise and Vibration Control on Construction and Open Sites* (two parts) where Part 1 deals with Noise[19].

12.2.14.2 NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes

The NRA Guidelines provide noise limits which are acceptable and states, where it is deemed necessary to predict noise levels associated with construction noise, that this should be done in accordance with BS 5228.

12.2.14.3 BS 5228: 2009-1A;2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites

Part 1 of BS5228 deals with noise prediction and controlOAl. It recommends procedures for noise control in respect of construction operations. The standard stresses the importance of community relations, and states that early establishment and maintenance of the relations throughout the carrying out of Site operations will go some way towards allaying people's concerns. Some of the more relevant factors that are likely to affect the acceptability of construction noise are:

- The attitude of local residents to the Development
- Site location relevant to noise sensitive receptors
- Duration of Site operations
- Hours of work
- The characteristics of the noise produced.

[18] National Roads Authority, *Guidelines for Noise and Vibration in National Road Schemes.*
[19] BS 5228-1: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites: *Code of Practice for Basic Information and Procedures for Noise Control*.

Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the activity. Measures to control noise are described including:

Control of noise at source by, e.g.

- Substitution of plant or activities for less noisy ones
- Modification of plant or equipment by less noisy ones
- Using noise control enclosures
- Siting of equipment and its method of use
- Maintenance of equipment
- Controlling the spread of noise by increasing distance between plant and receptors, or by the provision of acoustic screening

Example criteria for the assessment of the significance of noise effects are also given, although these are not mandatory.

Methods of calculating the levels of noise resulting from construction activities are provided, as are updated source levels for various plant, equipment and construction activities.

12.2.14.4 Construction and Decommissioning Noise Assessment Methodology

The NRA guidelines for construction noise which are considered acceptable are given in Table 12:5.

Table 12.5: Noise Levels considered acceptable based on the NRA Guidelines

Day/Times	Guideline Limits
Monday to Friday 07:00 – 19:00hrs 19:00 – 22:00hrs	 70dB LAeq, (1h) and LAmax 80dB *60dB LAeq, (1h) and LAmax 65dB*
Saturday 08:00 – 16:30hrs	 65dB LAeq,1h and LAmax75dB
Sundays and Bank Holidays 08:00 – 16:00hrs	 *60dB LAeq,1h and LAmax 65dB*

**Construction at these times, other than required by an emergency works, will normally require explicit permission from the relevant local authority, in this case Waterford City and County Council.*

<u>Construction Times for The Development</u>
The construction times for this development are:
Monday to Friday: 07.00 to 19.00hrs, Saturday 08.00 to 13.00hrs with no work on Sunday, or Bank Holidays.

Part 1 of BS 5228 provides several example criteria for the assessment of the significance of noise effects from construction activities. Noise levels generated by construction activities are considered significant if:

- The LAeq, period level of construction noise exceeds lower threshold values of 65dB during daytime, 55dB during evenings and weekends or 45dB at night.
- The total noise level (pre-construction ambient noise plus construction noise) exceeds the pre-construction noise level by 5dB or more for a period of one month or more.

Construction noise from wind farm development, or decommissioning is not considered an intensive activity. The main noise sources will be associated with the construction of the Turbine Foundations and Turbine Hardstands. Lesser noise source activity will be construction of Site Access Tracks, temporary construction compound, turbine erection and the construction of a 38kV electrical substation building.

Decommissioning will likely involve the remediation of Turbine Hardstand Areas and Turbine Foundations, where they will be covered in topsoil and allowed to revegetate. Site Access Tracks will likely be left in-situ for use by the landowners. Underground Internal Wind Farm Cables will be removed, and the ducting left in-situ. Therefore, the decommissioning phase is likely to be shorter and less intrusive than the construction phase with the resultant effects being less.

All workers associated with the development will be subject to the Health and Safety Authority Guidance[20] which states that for noise exposure noise levels likely to exceed 80 dBA (expressed as Lep,d 8 hour dBA) there is the potential of risk of damage to hearing. All workers on site will be given guidance on how to comply with the 'First Action Level'.

12.2.14.5 Evaluation of Potential Effects

The potential impacts of construction are evaluated by comparing the predicted noise levels against the guideline limits given in Table 12:5: Noise levels that are considered acceptable based on the NRA guidelines, and sample criteria in Part 1 of BS 5228 in Section 12.2.13.4.

The potential operational impacts are evaluated by comparing the predicted noise levels against the day and night-time noise limits given in Section 12.5.2. The predicted noise levels are carried out according to the IOA Good Practice Guide as detailed in Section 12.2.8 and potential impacts are assessed against the noise limits at the nearest receptors.

12.2.14.6 Sensitivity

The sensitivity of the development during construction is based on the guideline values in Table 12.5: Noise levels that are considered acceptable based on the NRA guidelines, and sample criteria in Part 1 of BS 5228. The sensitivity of the development during operation is based on the values in Section 12.6.2.1 and Section 12.6.2.2.

[20] Noise - Frequently Asked Questions - Health and Safety Authority (hsa.ie)

12.2.14.7 Magnitude

The magnitude of potential impacts of construction is based on the values in Table 12.10. The magnitude of the development during operation is based on the values in Table 12.15.

12.2.14.8 Significance Criteria

The significance of construction is based on the potential impacts based on the predicted values and compliance with the guideline limits in Table 12.5 and sample criteria in Part 1 of BS 5228.

The significance of the potential impacts of the development have been assessed by taking into account the noise limits at receptors and the degree to which compliance has been met.

12.3 Baseline Description

12.3.2 Identification of Potential Receptors

A number of predictions were prepared for the layout of the wind farm. Based on the initial layout, potential noise-sensitive receptors, including occupied and un-occupied dwellings, were identified from maps. Receptor locations were verified through visits to the area surrounding the development.

12.3.3 Selection of Baseline Noise Survey Locations

Four baseline noise survey locations were selected on the basis of their locations relative to the turbine layout.

12.3.4 Baseline Noise Survey

Background noise monitoring was carried out at four locations in the vicinity of the site over a period of 23 days, as per the requirements of ETSU-R-97.

Simultaneous wind speed monitoring was undertaken using a LiDAR to get the wind speed at hub height. Rainfall monitoring was also carried out at one of the noise monitoring locations for the duration of the survey. Where any periods of rainfall were identified, the associated noise and wind speed data points were removed from the regression analysis.

Baseline monitoring was carried out between Tuesday 15 February 2022 and Thursday 10 March 2022. The noise monitoring locations are described in Table 12:6 below. The noise modelling results showing the monitoring locations can be seen in Figure 12:2-12:5. (Monitoring locations in context of the Proposed development in Technical Appendix 12.1).

Table 12.6: Noise Monitoring Locations

Noise Monitoring Location	Grid Reference
NML1	109789, 331282
NML2	109829, 332953
NML3	108813, 333130
NML4	108415, 333453

The noise monitoring equipment used during the survey was:

- 4 x Larson Davis LxT Sound Level Meter with environmental protection kit including a large 30ppi foam windscreen which complies with the ETSU W/13/00386/REP
- 1no. onset HOBO data logging rain gauge

All sound level meters have been calibrated within the 24 months of the survey date. Calibration certificates of the acoustic instruments are included in Technical Appendix 12.4. The measurement microphone was located at least 1.2m above ground height and at least 3.5m from any building facade. The measurement locations were selected to minimise the effects of reflections from buildings and are representative of the existing background noise levels in the vicinity of the proposed windfarm.
The Sound Level Meters were set to record L_{A90} over synchronised ten-minute intervals to the rain gauge and anemometer, as specified in ETSU-R-97.

Figures 12:2-12:5 below shows the correlation between the measured wind speed and noise level at each of the four noise monitoring locations, including periods of rainfall. The background noise and wind speed vs. time for the monitoring period indicated a good correlation between the measured noise level data and the wind speed data at both locations.

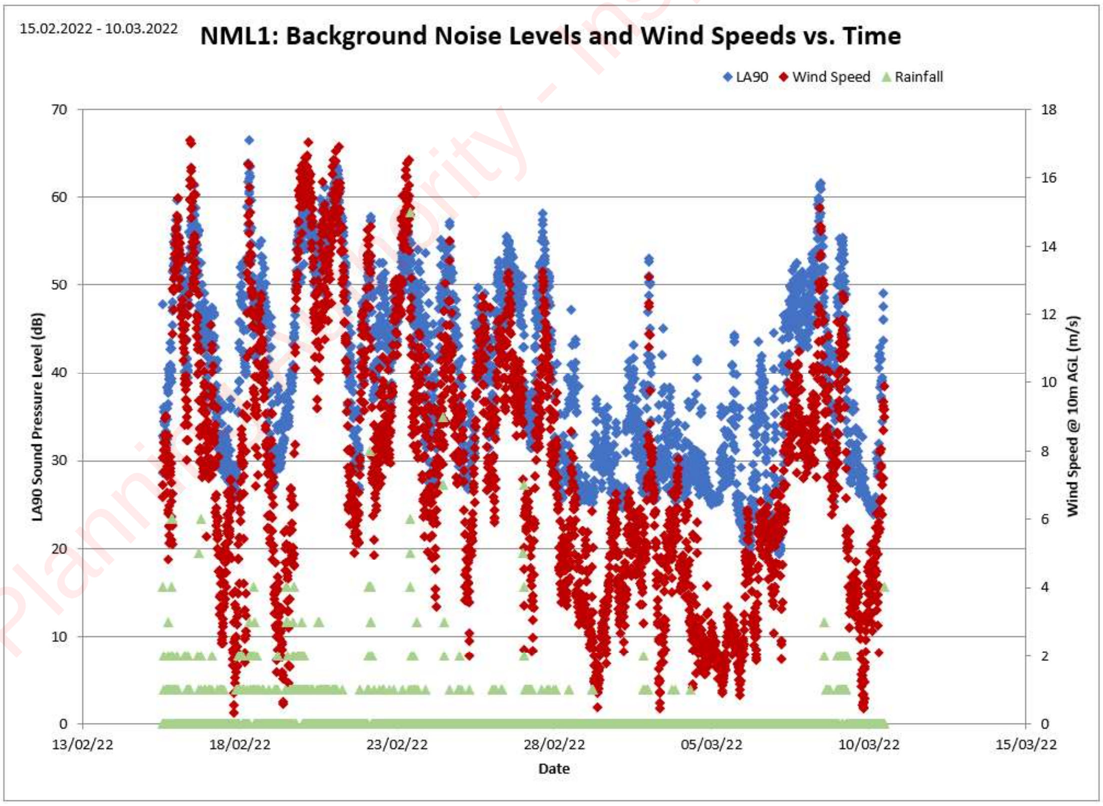

Figure 12: 2: Background noise and wind vs. time at Noise Monitoring Location 1

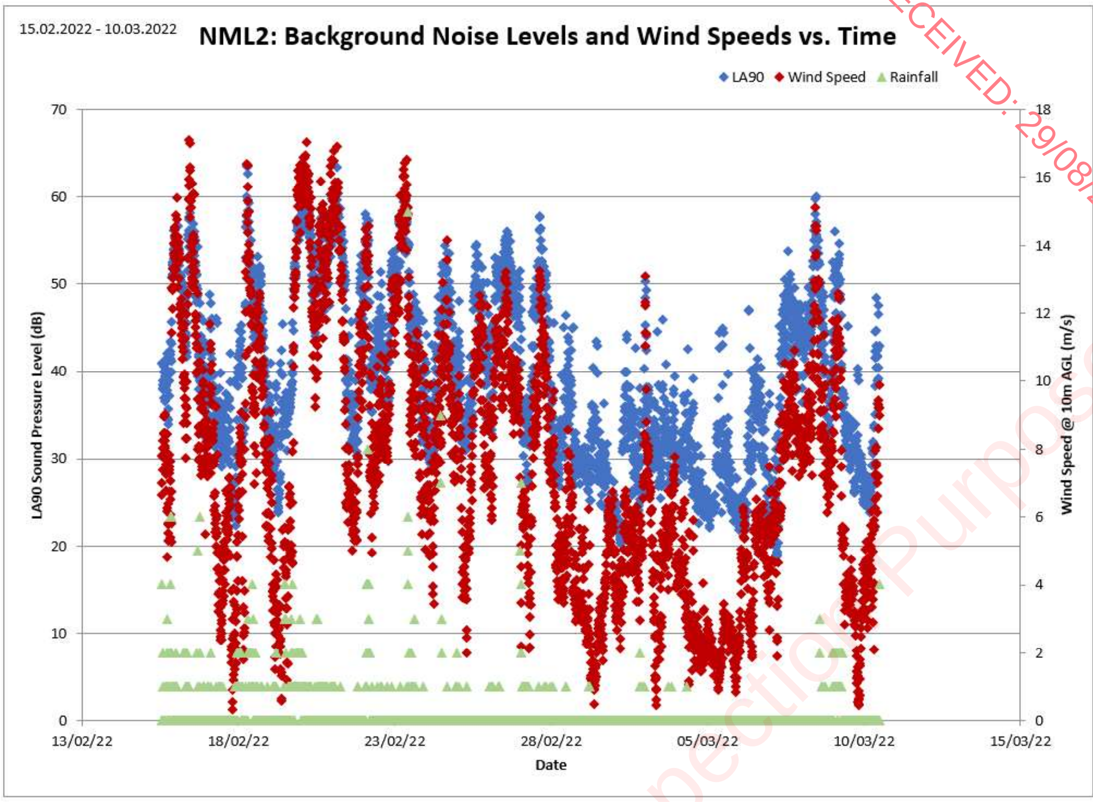

Figure 12: 3: Background noise and wind vs. time at Noise Monitoring Location 2

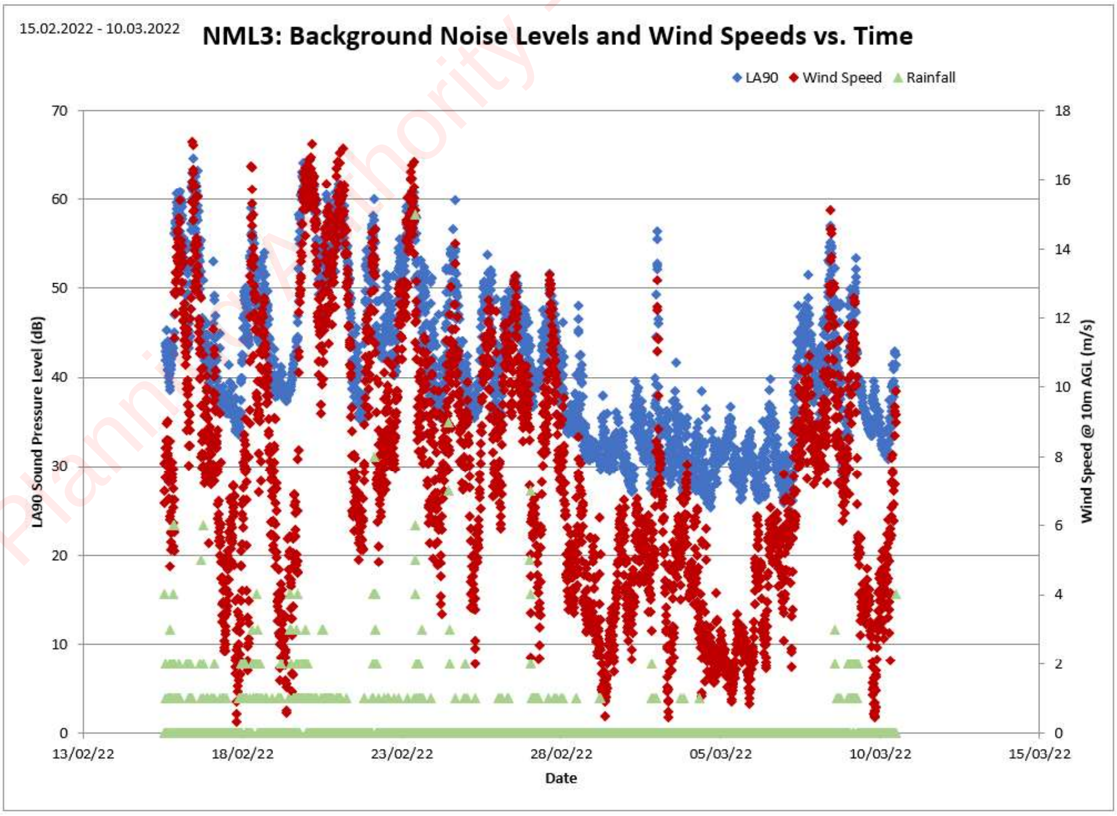

Figure 12: 4: Background noise and wind vs. time at Noise Monitoring Location 3

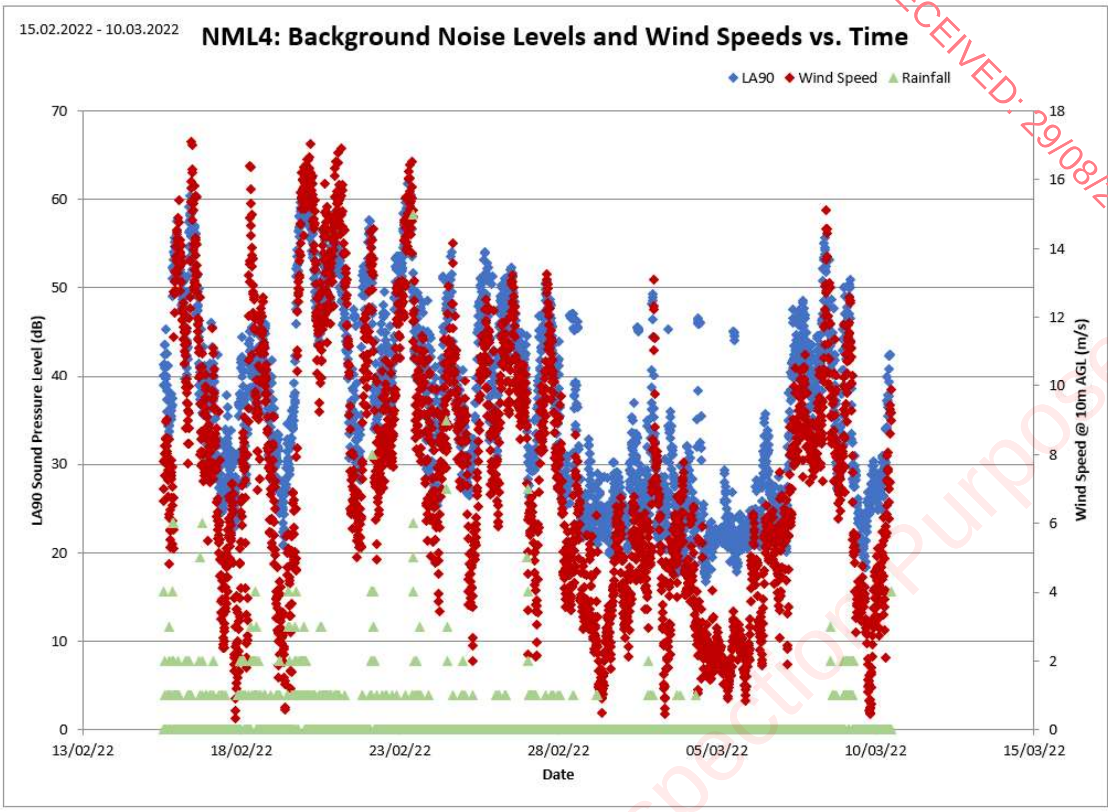

Figure 12: 5: Background noise and wind vs. time at Noise Monitoring Location 4

12.4 Wind Speed

In order to establish the existing background sound pressure level across all operational wind speeds, wind speeds were measured throughout the background noise survey using a met mast close to the proposed location of turbines.

The mast captured wind speeds at the proposed hub-height 91.5m, logged for the duration of the survey over 10-minute averaging time periods, then standardised down to 10m height using the equation below:

$$V_{10std} = V_{hh} [L_n(H_{10}/z_0) / Ln(H_{hh}/z_0)] \quad [1]$$

Where:

V_{10std} = derived wind speed at height 10m in m/s

V_{hh} = wind speed at hub height in m/s

H_{10} = 10m

H_{hh} = hub height (91.5m)

Z_0 = the surface roughness length (m).

A reference roughness factor of 0.05m is used to calculate wind speeds in accordance with IEC 61400-11.

The derived wind speeds were calculated using equation [1], for each ten-minute period, with the derived values compared to the background noise levels as per ETSU-R-97.

12.5 Noise Monitoring Results

The L_{A90} values where rainfall was recorded, as required in ETSU-R-97, were omitted from any part of this assessment process.

For each noise monitoring location, wind speed and recorded $L_{A90,10}$ min during quiet daytime were plotted on a scatter graph with polynomial best fit line applied. This was also repeated for the night-time periods. These wind speed and noise levels recorded correspond with times over the survey period where rainfall was not recorded. These graphs are shown below as Figures 12:6-12:13.

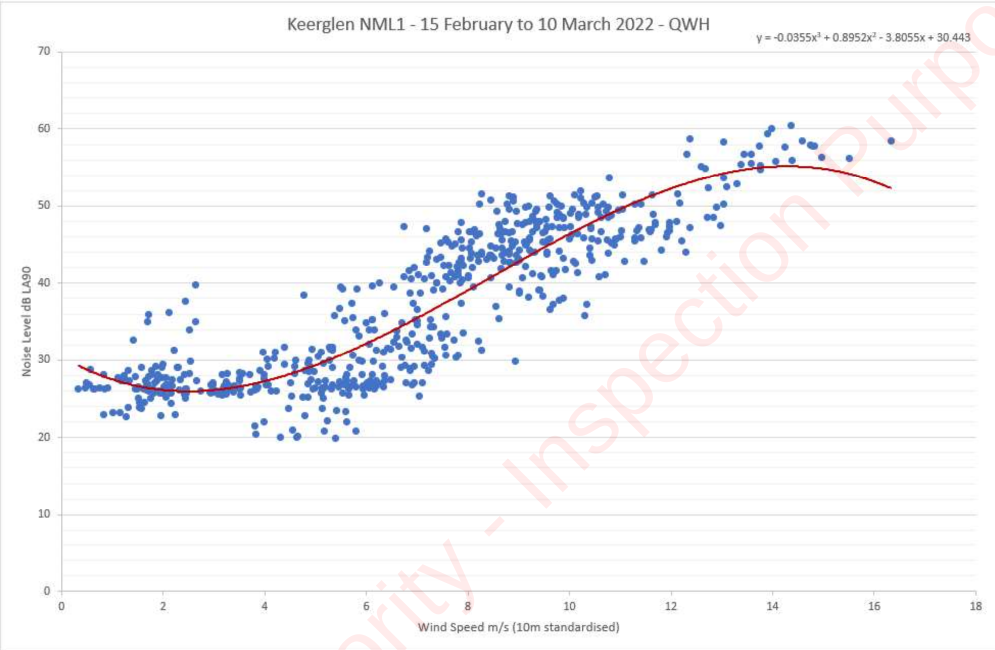

Figure 12: 6: Quiet Daytime – NML1

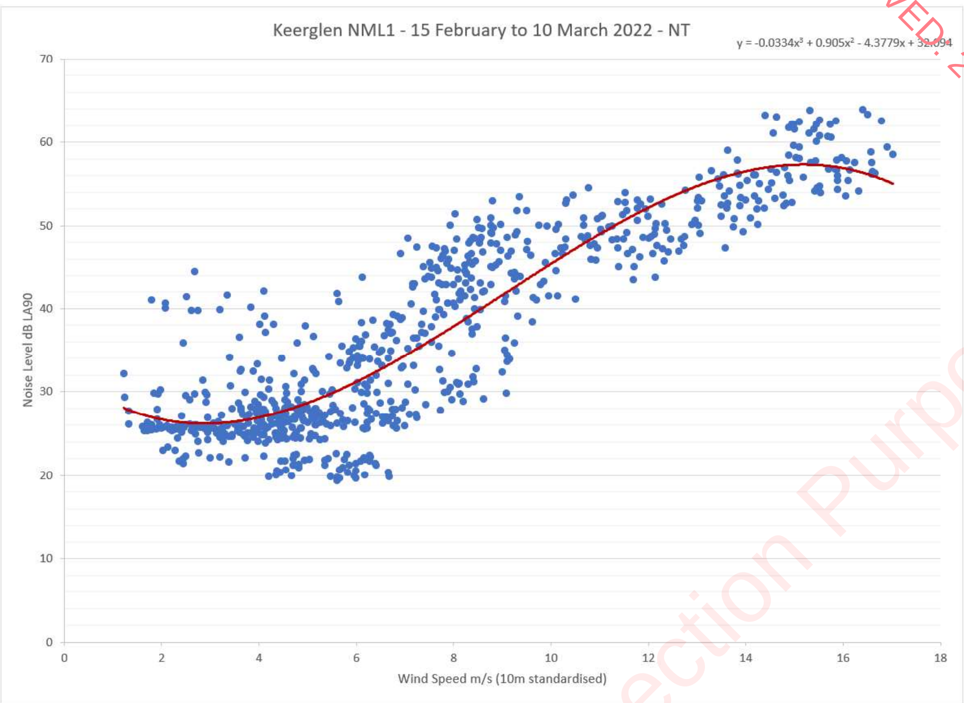

Figure 12: 7: Night-time – NML1

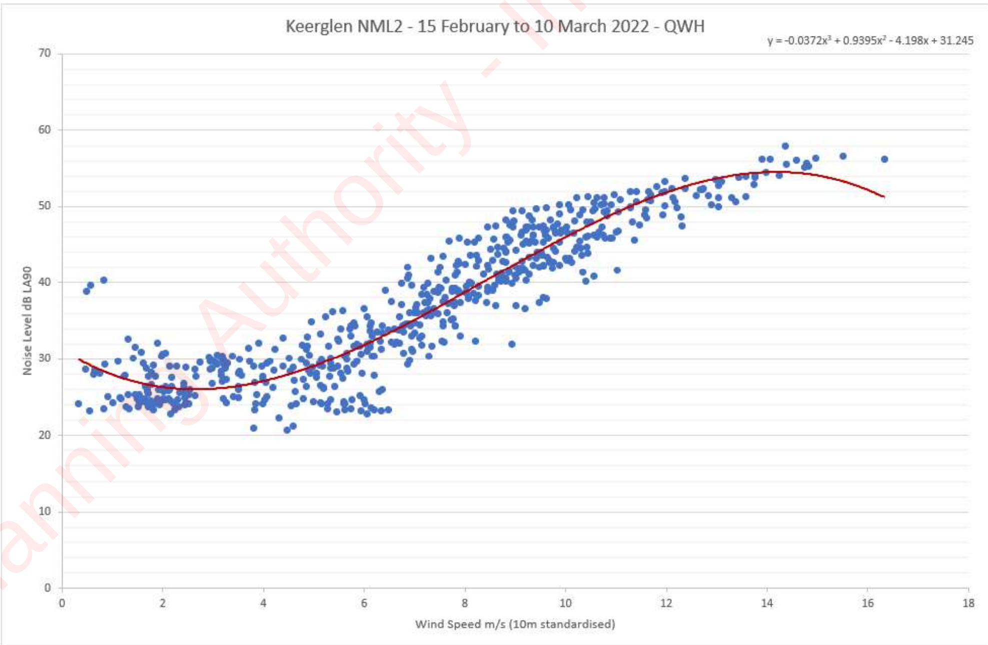

Figure 12: 8: Quiet Daytime – NML2

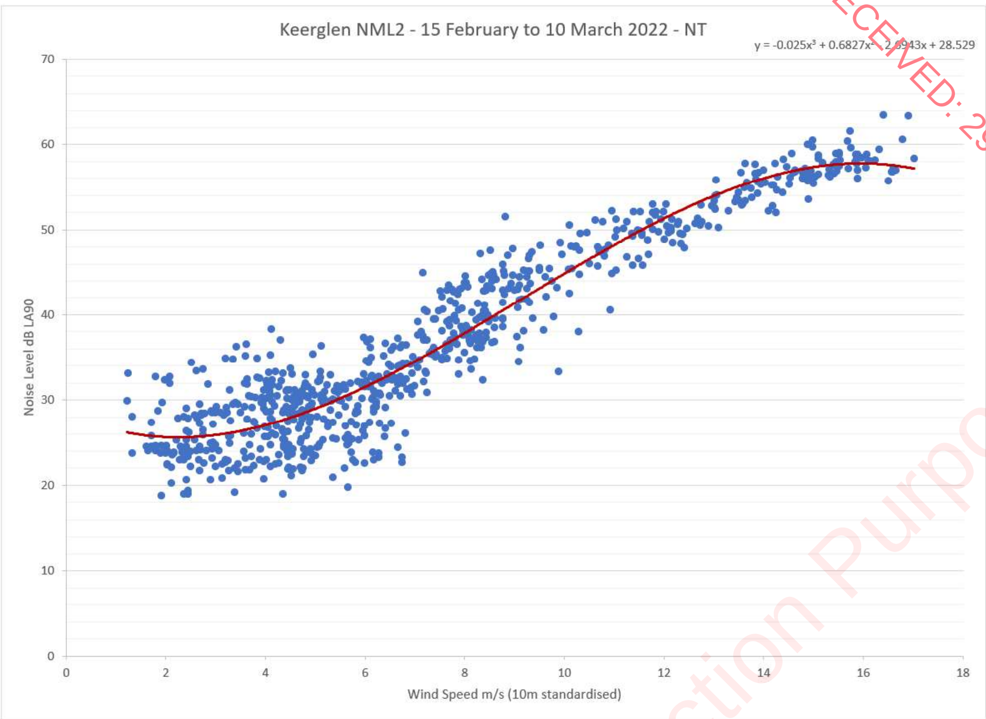

Figure 12: 9: Night-time – NML2

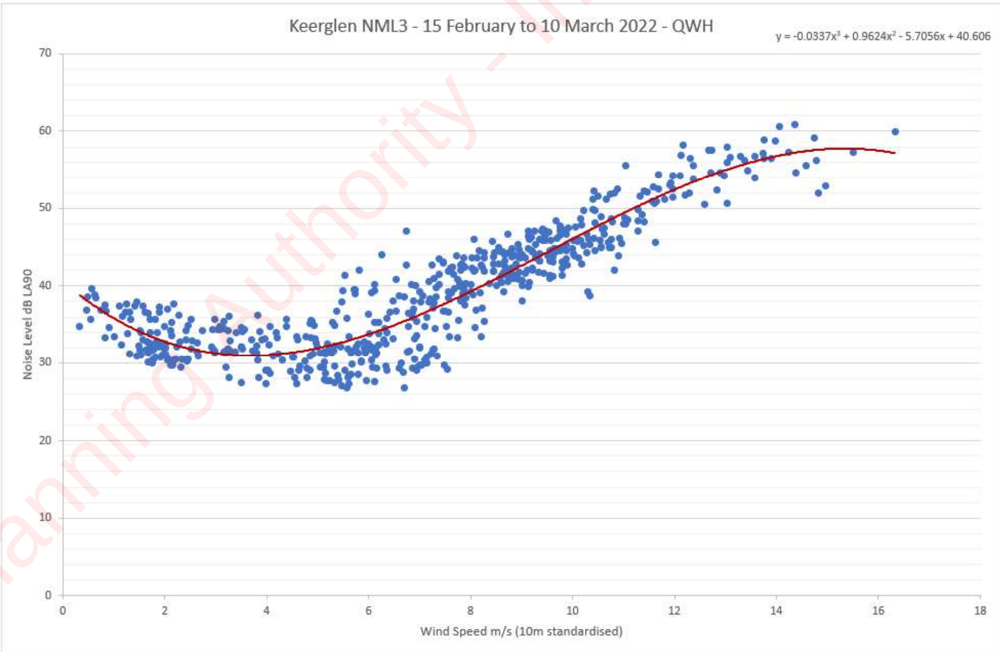

Figure 12: 10: Quiet Daytime – NML3

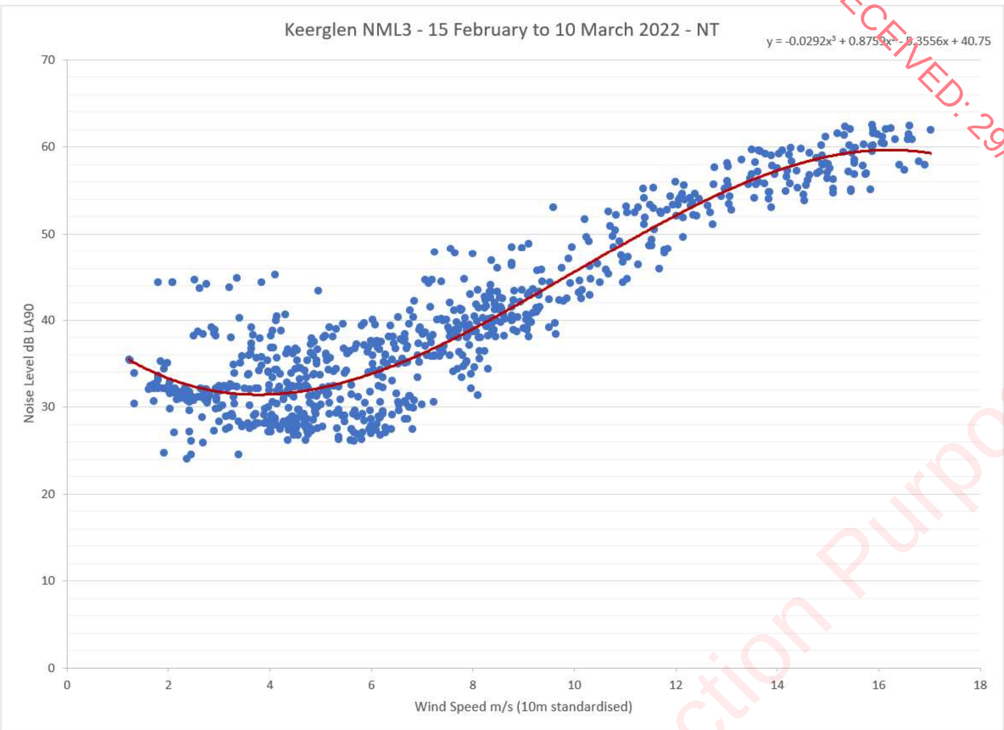

Figure 12: 11: Night-time – NML3

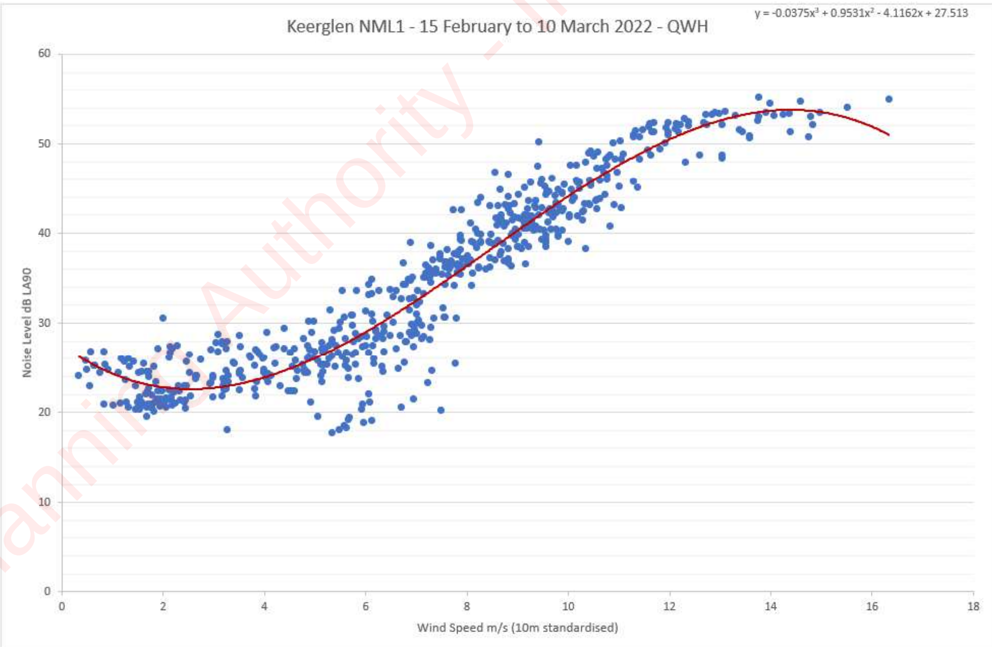

Figure 12: 12: Quiet Daytime – NML4

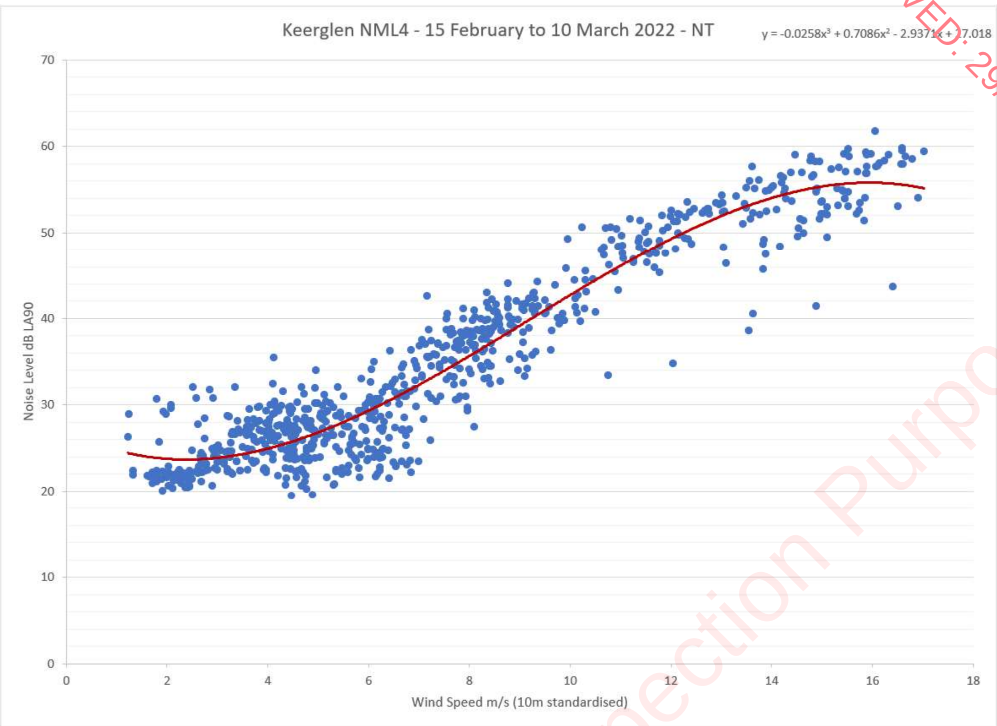

Figure 12: 13: Night-time – NML4

From these polynomial best fit lines, the average L_{A90} sound pressure levels were derived for the wind speeds between 4m/s and 12m/s during the quiet daytime and nighttime at each monitoring location. The results are shown in Table 12.7 below with the limit values of also shown:

12.5.2 Noise Assessment Locations

The monitoring locations were chosen so that the distance was sufficient to ensure no noise contribution from any other operating wind turbines.

Should the predicted operational noise levels from the development comply with the requirements of the 2006 Guidelines at the closest receptors, it may be assumed that the predicted noise levels at receptors further away from the development will also comply, due to the attenuation of turbine noise levels with distance. The locations of the closest receptors are given in Table 12.14.

12.5.3 Prevailing Background Noise Levels

Table 12.7 gives the background noise levels obtained from quiet daytime and night-time measurement periods at the baseline measurement locations. The area is not defined as a low noise environment as the background is above 30dB L_{A90} for most locations at all wind speeds, with the exception of some levels below 30dB at low wind speeds.

Table 12.7: Prevailing Background Noise Level

Monitoring Location	Prevailing Background (B/G) Noise Levels LA90Db, 10min Standardised Mean 10m Height Wind Speed (m/s)									
		4	5	6	7	8	9	10	11	12+
NML1	Day	27.3	29.4	32.2	35.5	39.1	42.8	46.4	49.6	52.3
	B/G+5	32.3	34.4	37.2	40.5	44.1	47.8	51.4	54.6	57.3
Noise Limit		**43**	**43**	**43**	**43**	**44.1**	**47.8**	**51.4**	**54.6**	**57.3**
NML1	Night	26.9	28.7	31.2	34.3	37.9	41.6	45.4	49.0	52.2
	B/G+5	31.9	33.7	36.2	39.3	42.9	46.6	50.4	54.0	57.2
Noise Limit		**43**	**43**	**43**	**43**	**43**	**46.6**	**50.4**	**54**	**57.2**
NML2	Day	27.1	29.1	31.8	35.1	38.7	42.4	46.0	49.2	51.9
	B/G+5	32.1	34.1	36.8	40.1	43.7	47.4	51.0	54.2	56.9
Noise Limit		**43**	**43**	**43**	**43**	**43.7**	**47.7**	**51**	**54.2**	**56.9**
NML2	Night	27.1	29.0	31.5	34.5	37.9	41.4	44.9	48.2	51.3
	B/G+5	32.1	34.0	36.5	39.5	42.9	46.4	49.9	53.2	56.3
Noise Limit		**43**	**43**	**43**	**43**	**43**	**46.4**	**49.9**	**53.2**	**56.3**
NML3	Day	31.0	31.9	33.7	36.3	39.3	42.6	46.1	49.4	52.5
	B/G+5	36.0	36.9	38.7	41.3	44.3	47.6	51.1	54.4	57.5
Noise Limit		**43**	**43**	**43**	**43**	**44.3**	**47.6**	**51.1**	**54.4**	**57.5**
NML3	Night	31.5	32.2	33.8	36.2	39.0	42.2	45.6	49.0	52.2
	B/G+5	36.5	37.2	38.8	41.2	44.0	47.2	50.6	54.0	57.2
Noise Limit		**43**	**43**	**43**	**43**	**44**	**47.2**	**50.6**	**54**	**57.2**
NML4	Day	23.9	26.1	29.0	32.5	36.4	40.3	44.2	47.6	50.6
	B/G+5	28.9	31.1	34.0	37.5	41.4	45.3	49.2	52.6	55.6
Noise Limit		**43**	**43**	**43**	**43**	**43**	**45.3**	**49.2**	**52.6**	**55.6**
NML4	Night	27.0	28.8	31.3	34.3	37.7	41.2	44.7	48.1	51.2
	B/G+5	32.0	33.8	36.3	39.3	42.7	46.2	49.7	53.1	56.2
Noise Limit		**43**	**43**	**43**	**43**	**43**	**46.2**	**49.7**	**53.1**	**56.2**

12.5.4 Noise Limits

The noise limits for the development are based on the limits contained within the Wind Energy Development Guidelines 2006 and on the background levels obtained in Table 12.8 A lower fixed limit of 45dBA for daytime could be applied, however a more stringent limit is applied with the lowest background noise levels obtained at location NML3 used as the basis for the assessment at all receptors with a limit of 43dBA being applied for day and night. Where receptors are financially involved, a 45dBA limit can be applied.

Table 12. 8: Derived Background Day and Night Noise Levels used in Assessment – NML1

Monitoring Location		Prevailing Background (B/G) Noise Levels LA90Db, 10min Standardised Mean 10m Height Wind Speed (m/s)								
		4	5	6	7	8	9	10	11	12+
NML3	Day	31.0	31.9	33.7	36.3	39.3	42.6	46.1	49.4	52.5
	B/G+5	36.0	36.9	38.7	41.3	44.3	47.6	51.1	54.4	57.5
Noise Limit		**43**	**43**	**43**	**43**	**44.3**	**47.6**	**51.1**	**54.4**	**57.5**
NML3	Night	31.5	32.2	33.8	36.2	39.0	42.2	45.6	49.0	52.2
	B/G+5	36.5	37.2	38.8	41.2	44.0	47.2	50.6	54.0	57.2
Noise Limit		**43**	**43**	**43**	**43**	**44**	**47.2**	**50.6**	**54**	**57.2**

12.5.5 Development Design Mitigation

The selected turbine will be fitted with STE as standard which is best practice. A serrated extension of the trailing edge to the rotor blades mitigates noise emissions by effectively breaking up the turbulence on the tooth flanks into smaller eddies. The intensity of the pressure fluctuations is reduced which mitigates the noise emissions. Since the intensity of the noise emissions is largely dependent on the flow speed, STE are only installed on the outer rotor blade area where the rotary speed is the highest. Typically, STE reduces the noise levels by 2 to 3dBA depending on specific turbine used.

12.6 Assessment of Potential Effects

12.6.2 Construction Noise

12.6.2.1 Construction and Decommissioning Noise Levels

As has been previously stated, the construction process associated with wind farms is not considered intensive and is temporary works most of which is carried out a considerable distance from receptors. The main noise sources will be associated with the construction of the Turbine Foundations, Turbine Hardstands, Underground Electricity Export Connection and compound, with lesser sources being the construction of the on Site 38kV Electrical Substation. The main construction traffic to the Site will be during a very short period where ready-mix trucks deliver concrete for the turbine bases. While delivery of material from local quarries for upgrade of Site Access Tracks, Turbine Hardstands, Temporary Storage Compound and 38kV Electrical Substation will be for longer periods but will be of less intensity, generating lower levels of noise along the routes. During delivery of materials, trucks will access the site from a different route than leaving the Site, thereby reducing traffic noise at receptors along the local road network. The delivery of turbines by large trucks travelling at very low speed will generate very low levels of noise at receptors along the Turbine Delivery Route.

It is not possible to specify the precise noise levels of emissions from the construction equipment until such time as a contractor is chosen and construction plant has been selected. However, Table 12.9 indicates typical construction range of noise levels for this type of activity (levels from author's database and BS 5228). Predictions are made for receptors nearest to the turbine bases / hardstands activity, compound development and for receptors at varying distance from the Underground Electricity Export Connection route.

Table 12.9: Typical Noise Levels from Construction Works

Activity	L_{Aeq} at 10m
General Construction (pile driving, ready-mix trucks pouring concrete)	70-84dBA
Tracked excavator removing topsoil, subsoil for foundation	80- 87dBA
Rock breaker and excavator loading	82-89dBA
Vibrating rollers including tipping material	76-86dBA
Underground Electricity Export Connection: Trenching Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	71-74dBA
Excavator loading / tipping, excavator and Vibratory roller	80- 87dBA

The difference in noise levels between two locations can be calculated as:

$$\mathbf{L}_{p2} - \mathbf{L}_{p1} = 10 \log (R_2 / R_1)^2 - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$

$$= 20 \log (R_2 / R_1) - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$

where:

L_{p1} = sound pressure level at location 1

L_{p2} = sound pressure level at location 2

R_1 = distance from source to location 1

R_2 = distance from source to location 2

and where:

A_{atm} = Attenuation due to air absorption

A_{gr} = Attenuation due to ground absorption

A_{br} = Attenuation provided by a barrier

A_{mis} = Attenuation provided by miscellaneous other effects

In the calculations attenuation by A_{atm}, A_{gr} and A_{mis} is taken as 3dBA where distances are more than 200m from a source and as zero within 200m - amelioration by barriers is not accounted for.

Table 12.10 gives the noise levels predicted from construction activity at varying distances. The main noise sources are assumed to be the construction of the Turbine Foundations, Turbine Hardstands and Underground Electricity Export Connection. The development of the Site Access Tracks, construction of the new on site 38kV Electrical Substation, works on the Substation and Site Control Building will also take place, however the noise levels associated with this activity will be lower and of shorter duration than other works. The main road traffic noise will be associated with the delivery of ready-mix concrete for Turbine Foundations.

Road traffic is dealt with under a sub-heading 'Traffic and Transport' in Chapter 14.

The maximum construction noise levels associated with the Development and Underground Electricity Export Connection are listed in Table 12.10. At receptor locations further away, noise levels will be less than that predicted. Works associated with Decommissioning will be no more than the levels predicted in Table 12.10.

Table 12.10: Predicted Construction Noise Levels

Activity taken as 100% per hour	Distance of Activity (m)	L_{Aeq} dB 1hr range
General Construction (pile driving, ready-mix trucks pouring concrete)	1217m to H1	25-39dBA
Tracked excavator removing topsoil, subsoil for foundation	1217m to H1	35-42dBA
Rock breaker and excavator loading	1217m to H1	37-44dBA
Vibrating rollers including tipping material	1217m to H1	31-41dBA
Underground Electricity Export Connection: Trenching Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	At varying distances along route: 15m 20m 40m 80m	67.5-70.5dBA 65-68dBA 59-62dBA 53-56dBA
Construction of compound (loading / tipping, excavator and Vibratory roller)	2503m to nearest receptor	29-36dBA

<u>Construction Traffic</u>

The delivery of turbines to the Site will generate low level traffic noise as the vehicles carrying the turbines will move slowly along the local roads where impact is expected to be greatest. The main construction noise generated by traffic to and from the Site will be due to ready-mix trucks delivering concrete with trucking of spoil being carried out at the same time. The concrete pour for each individual turbine will be required to be completed in a short a period as possible (usually within 10 hours).

The construction of 8 turbines shall require 949 loads of concrete and 949 truck movements, while each ready-mix truck has a capacity of 8m³. This results in 119 loads of concrete and 238 truck movements for each turbine. For delivery of concrete the timeframe envisaged for each turbine concrete pour is taken as 10 hrs. This equates to an average of 23.8 movements per hour.

The general expression for predicting the 1 hr LAeq alongside a haul road used by single engine items of mobile plant is:

$L_{Aeq} = L_{WA} - 33 + 10\log_{10}Q - 10\log_{10}V - 10\log_{10}d$

where:

L_{WA} = the sound power level of the truck, in decibels (dB);

Q = 23.8, the number of vehicles per hour;

V = 60, the average vehicle speed, in kilometres per hour (km/h);

d = the distance of receiving position from the centre of haul road, in metres (m).

LAeq = 105-33 +10log23.8 – 10log60 – 10log20 = 55 LAeq 1hr.

At 10m from the roadside the noise levels equate to 58 LAeq 1hr. The trucking for the concrete pour will extend for a total of 8 days (1 day for each turbine). In practice the levels generated by truck movement should be lower than predicted due to the smooth surface on the local roads.

Underground Electricity Export Connection -Cable laying along road by trenching

Cable laying and trenching will occur along the Underground Electricity Export Connection route from the proposed on-site 38kV Electrical Substation to existing Tawnaghmore ESB Substation or a Large Energy User at Killala Business Park which means maximum levels will pertain no more than 0.5 days equivalent (4 hours) at any single receptor.

Construction noise levels are based on continuous operation. In practice, most plant will operate at a maximum level for short intervals.

12.6.2.2 Assessment of Construction Noise

The higher levels predicted are from the Underground Electricity Export Connection and delivery of concrete for Turbine Foundations. These maximum noise levels will persist for no more than 4 hours at any receptor. All predicted noise levels are well within NRA guidelines given as acceptable and are considered slight. Construction noise is a temporary activity.

All activity is predicted without additional mufflers, or without topographic screening. The maximum road traffic noise which is generated by ready-mix trucks delivering concrete for Turbine Foundations will be short term and of 8 days' duration. The predicted noise levels are well within the NRA guidelines given as acceptable and are therefore considered as not significant.

Ground vibration from rock breaking will be below the threshold of sensitivity to humans of 0.2mm/s peak particle velocity at all receptors[21]. The effects of noise and vibration from onsite construction activities are therefore considered not significant.

12.6.2.3 Description of Effects

The criteria for description of effects for all construction noise activity and the potential worst-case effects, at the nearest receptors is given below.

Table 12.11: Description of Effects - Construction		
Quality	**Significance**	**Duration**
Negative	Not Significant	Temporary

12.6.2.4 Decommissioning

Noise effects during the Decommissioning phase of the development are likely to be of a similar nature to that during construction but of shorter duration. It is likely that Site Access Tracks and Turbine Foundations (excluding plinths) will be left in place and covered over with topsoil unless there are environmental reasons to remove. It is likely that the duration of the Decommissioning phase will be of shorter duration than that during construction. Any legislation, guidance, or best practice relevant at the time of decommissioning will be complied with.

12.6.2.5 Description of Effects – Decommissioning

The criteria for description of effects for all decommissioning noise activity and the potential worst-case effect at the nearest receptors is given below.

Table 12.12: Description of Effects - Construction		
Quality	**Significance**	**Duration**
Negative	Not Significant	Temporary

12.6.3 Operational Noise

Noise emissions from the proposed Windfarm site at the residential properties in the closest proximity to the site have been assessed. The turbine locations are referenced in Table 12:13 with the receptor location in Table 12:14.

Table 12.13: Turbine Locations		
Location	**Grid Reference**	
Wind Turbine Location (T1)	105593	332354
Wind Turbine Location (T2)	105498	331903
Wind Turbine Location (T3)	106013	331772
Wind Turbine Location (T4)	105948	332208

[21] Wiss, J. F., and Parmelee, R. A. (1974) Human Perception of Transient Vibrations, "*Journal of Structural Division*", ASCE, Vol 100, No. S74, PP. 773-787

Wind Turbine Location (T5)	106412	332265
Wind Turbine Location (T6)	106373	331811
Wind Turbine Location (T7)	107006	331962
Wind Turbine Location (T8)	107353	332397

Table 12.14: Receptor Locations

Dwelling No	Irish National Grid (ING) Co-ordinates	
	X	Y
H1	108446	333422
H2	108527	333483
H3	108819	333128
H4	108830	333093
H5	108932	333585
H6	109099	333493
H7	109144	333519
H8	109195	333564
H9	109332	333811
H10	109555	334055
H11	109699	334090
H12	109827	334270
H13	109933	334138
H14	110104	334294
H15	110137	334141
H16	110254	333479
H17	110146	333433
H18	109852	332949
H19	109801	332863
H20	110165	332195
H21	110227	332106
H22	110432	331996
H23	110568	331833
H24	109959	331567
H25	109807	331292
H26	109789	331257
H27	110342	331149
H28	110512	330774
H29	109908	330713
H30	109866	330532
H31	109650	330643
H32	109532	330367
H33	109645	330015
H34	109634	329770
H35	109698	329517

The height of the noise receptor was set at 4m to represent an upstairs bedroom window, deemed appropriate as WEDG06 specifically addresses the concerns of potential noise disturbance during the night.

The SoundPLAN noise model predicts the noise level as L_{Aeq} dB values. WEDG19 guidance advises that the L_{Aeq} values are likely to be in the region of of 1.5-2.5dB above the L_{A90} levels, therefore a 2dB reduction has been made from the L_{Aeq} levels to covert to L_{A90}.

12.6.3.1 Predicted Operational Noise Levels

Table 12.15 gives the predicted noise levels at the nearest receptors to the development at varying wind speeds for each receptor location. The turbine type included in this assessment is the Nordex N149 5.7MW with a hub height of 105m.

A noise contour map of the 8no. turbine development at maximum sound power output at a wind speed of 7ms-1 at 10m height is presented in Technical Appendix 12.3. The contour map in Technical Appendix 12.**3** assumes that all turbines are simultaneously downwind to each location all of the time (continuously) which results in an overprediction of the noise levels.

Table 12.15: Predicted LA90 Noise Levels at varying wind speeds from Keerglen WF Only

Wind Speed,	Predicted LA90 Noise Level (dB)						
m/s	4	5	6	7	8	9	10+
H1	21.5	26.1	30.5	31.9	31.9	31.9	31.9
H2	20.8	25.4	29.8	31.2	31.2	31.2	31.2
H3	20.7	25.3	29.7	31.1	31.1	31.1	31.1
H4	20.7	25.3	29.7	31.1	31.1	31.1	31.1
H5	18.8	23.4	27.8	29.2	29.2	29.2	29.2
H6	18.4	23	27.4	28.8	28.8	28.8	28.8
H7	18.2	22.8	27.2	28.6	28.6	28.6	28.6
H8	17.9	22.5	26.9	28.3	28.3	28.3	28.3
H9	16.7	21.3	25.7	27.1	27.1	27.1	27.1
H10	14.7	19.3	23.7	25.1	25.1	25.1	25.1
H11	14.8	19.4	23.8	25.2	25.2	25.2	25.2
H12	14.1	18.7	23.1	24.5	24.5	24.5	24.5
H13	14	18.6	23	24.4	24.4	24.4	24.4
H14	13.1	17.7	22.1	23.5	23.5	23.5	23.5
H15	13.4	18	22.4	23.8	23.8	23.8	23.8
H16	14.1	18.7	23.1	24.5	24.5	24.5	24.5
H17	14.8	19.4	23.8	25.2	25.2	25.2	25.2
H18	16.4	21	25.4	26.8	26.8	26.8	26.8
H19	16.7	21.3	25.7	27.1	27.1	27.1	27.1
H20	15.6	20.2	24.6	26	26	26	26
H21	15.3	19.9	24.3	25.7	25.7	25.7	25.7
H22	14.6	19.2	23.6	25	25	25	25
H23	13.5	18.1	22.5	23.9	23.9	23.9	23.9
H24	16.1	20.7	25.1	26.5	26.5	26.5	26.5
H25	16.5	21.1	25.5	26.9	26.9	26.9	26.9
H26	16.5	21.1	25.5	26.9	26.9	26.9	26.9
H27	14.5	19.1	23.5	24.9	24.9	24.9	24.9
H28	13	17.6	22	23.4	23.4	23.4	23.4
H29	15.4	20	24.4	25.8	25.8	25.8	25.8

H30	15.2	19.8	24.2	25.6	25.6	25.6	25.6
H31	16.1	20.7	25.1	26.5	26.5	26.5	26.5
H32	16	20.6	25	26.4	26.4	26.4	26.4
H33	15	19.6	24	25.4	25.4	25.4	25.4
H34	14.6	19.2	23.6	25	25	25	25
H35	13.9	18.5	22.9	24.3	24.3	24.3	24.3

12.6.3.2 Operational Noise Assessment

The assessment was made of the predicted operational noise levels from the development based on the limits described in Section 12.2.3.1 in the 2006 Guidelines and taking into consideration the recent 2021 An Bord Pleanála decision described in Section 12.2.3.2.

As can be seen from Table 12.16 the predicted noise levels at all receptors are lower than the noise limits in all cases, at all wind speeds, and are therefore compliant with the noise limits and are not significant in terms of EIA.

The predicted noise levels assume that all turbines are directly down-wind to nearest receptors.

Table 12.16: Margin Between Predicted Noise Levels and Noise Limits

Wind Speed, m/s	Predicted LA90 Noise Level (dB)						
	4	5	6	7	8	9	10+
H1	-21.5	-16.9	-12.5	-11.1	-11.1	-11.1	-11.1
H2	-22.2	-17.6	-13.2	-11.8	-11.8	-11.8	-11.8
H3	-22.3	-17.7	-13.3	-11.9	-11.9	-11.9	-11.9
H4	-22.3	-17.7	-13.3	-11.9	-11.9	-11.9	-11.9
H5	-24.2	-19.6	-15.2	-13.8	-13.8	-13.8	-13.8
H6	-24.6	-20	-15.6	-14.2	-14.2	-14.2	-14.2
H7	-24.8	-20.2	-15.8	-14.4	-14.4	-14.4	-14.4
H8	-25.1	-20.5	-16.1	-14.7	-14.7	-14.7	-14.7
H9	-26.3	-21.7	-17.3	-15.9	-15.9	-15.9	-15.9
H10	-28.3	-23.7	-19.3	-17.9	-17.9	-17.9	-17.9
H11	-28.2	-23.6	-19.2	-17.8	-17.8	-17.8	-17.8
H12	-28.9	-24.3	-19.9	-18.5	-18.5	-18.5	-18.5
H13	-29	-24.4	-20	-18.6	-18.6	-18.6	-18.6
H14	-29.9	-25.3	-20.9	-19.5	-19.5	-19.5	-19.5
H15	-29.6	-25	-20.6	-19.2	-19.2	-19.2	-19.2
H16	-28.9	-24.3	-19.9	-18.5	-18.5	-18.5	-18.5
H17	-28.2	-23.6	-19.2	-17.8	-17.8	-17.8	-17.8
H18	-26.6	-22	-17.6	-16.2	-16.2	-16.2	-16.2
H19	-26.3	-21.7	-17.3	-15.9	-15.9	-15.9	-15.9
H20	-27.4	-22.8	-18.4	-17	-17	-17	-17
H21	-27.7	-23.1	-18.7	-17.3	-17.3	-17.3	-17.3
H22	-28.4	-23.8	-19.4	-18	-18	-18	-18
H23	-29.5	-24.9	-20.5	-19.1	-19.1	-19.1	-19.1
H24	-26.9	-22.3	-17.9	-16.5	-16.5	-16.5	-16.5
H25	-26.5	-21.9	-17.5	-16.1	-16.1	-16.1	-16.1
H26	-26.5	-21.9	-17.5	-16.1	-16.1	-16.1	-16.1
H27	-28.5	-23.9	-19.5	-18.1	-18.1	-18.1	-18.1

H28	-30	-25.4	-21	-19.6	-19.6	-19.6	-19.6
H29	-27.6	-23	-18.6	-17.2	-17.2	-17.2	-17.2
H30	-27.8	-23.2	-18.8	-17.4	-17.4	-17.4	-17.4
H31	-26.9	-22.3	-17.9	-16.5	-16.5	-16.5	-16.5
H32	-27	-22.4	-18	-16.6	-16.6	-16.6	-16.6
H33	-28	-23.4	-19	-17.6	-17.6	-17.6	-17.6
H34	-28.4	-23.8	-19.4	-18	-18	-18	-18
H35	-29.1	-24.5	-20.1	-18.7	-18.7	-18.7	-18.7

12.6.4 Cumulative Effects Assessment

An assessment of the cumulative effects of noise from the development together with the nearby Glenora Wind Farm, located west/northwest of the development has been undertaken. The Glenora Wind Farm is currently at the Planning stage having submitted a Strategic Infrastructure Development planning application to An Bord Pleanála (ABP Reg. Ref. 318701) seeking permission for the construction of 22 no. wind turbines and all associated works. This case is due to be decided by 16/09/24. A Noise Contour Map which illustrates the location of Glenora Wind Farm in the context of the residential houses which form part of the assessment is included at Appendix 12.3.

12.6.4.1 Cumulative Assessment Locations

The same receptor locations used for the proposed development are also used in the cumulative assessment. The assessment is a worst-case scenario with the assumption made that the predicted noise levels to receptors are downwind from both wind farms and individual turbines at the same time, a scenario that cannot occur in practise.

12.6.4.2 Noise Limits

The noise limits are the same as that used in Table 12.7.

12.6.4.3 Cumulative Noise Levels

Table 12.14 gives details of the predicted cumulative noise levels for the nearest receptors to the development.

Table 12.17: Predicted Cumulative Noise Levels for each Receptor

Wind Speed, m/s	Predicted LA90 Noise Level (dB)						
	4	5	6	7	8	9	10+
H1	23.8	28.8	33.1	34.4	34.4	34.4	34.4
H2	23.2	28.2	32.5	33.9	33.9	33.9	33.9
H3	22.6	27.5	31.9	33.2	33.2	33.2	33.2
H4	22.6	27.5	31.8	33.2	33.2	33.2	33.2
H5	21.2	26.2	30.5	31.9	31.9	31.9	31.9
H6	20.6	25.6	29.9	31.3	31.3	31.3	31.3
H7	20.4	25.4	29.7	31.1	31.1	31.1	31.1
H8	20.2	25.2	29.5	30.8	30.8	30.8	30.8
H9	19.2	24.2	28.5	29.9	29.9	29.9	29.9
H10	17.6	22.6	26.9	28.3	28.3	28.3	28.3

H11	17.4	22.4	26.7	28.1	28.1	28.1	28.1
H12	16.8	21.8	26.1	27.5	27.5	27.5	27.5
H13	16.5	21.5	25.8	27.1	27.1	27.1	27.1
H14	15.5	20.5	24.8	26.2	26.2	26.2	26.2
H15	15.7	20.7	25.0	26.3	26.3	26.3	26.3
H16	15.8	20.7	25.1	26.4	26.4	26.4	26.4
H17	16.4	21.3	25.7	27.0	27.0	27.0	27.0
H18	18.1	23.0	27.3	28.7	28.7	28.7	28.7
H19	18.3	23.2	27.6	28.9	28.9	28.9	28.9
H20	16.9	21.7	26.1	27.4	27.4	27.4	27.4
H21	16.6	21.4	25.8	27.1	27.1	27.1	27.1
H22	15.9	20.7	25.1	26.5	26.5	26.5	26.5
H23	14.4	19.2	23.6	25.0	25.0	25.0	25.0
H24	17.2	22.0	26.4	27.8	27.8	27.8	27.8
H25	17.6	22.4	26.7	28.1	28.1	28.1	28.1
H26	17.6	22.4	26.7	28.1	28.1	28.1	28.1
H27	15.2	20.0	24.3	25.7	25.7	25.7	25.7
H28	13.8	18.6	23.0	24.3	24.3	24.3	24.3
H29	16.5	21.3	25.6	27.0	27.0	27.0	27.0
H30	16.1	20.9	25.2	26.6	26.6	26.6	26.6
H31	17.1	21.9	26.3	27.6	27.6	27.6	27.6
H32	17.0	21.8	26.1	27.5	27.5	27.5	27.5
H33	15.6	20.3	24.7	26.1	26.1	26.1	26.1
H34	15.2	19.9	24.3	25.7	25.7	25.7	25.7
H35	14.2	18.9	23.3	24.7	24.7	24.7	24.7

A noise contour map of the cumulative effects of all turbines is presented with a maximum sound power output at a wind speed of 7m/s at 10m height in Technical Appendix 12.3. The contour map assumes that all turbines are simultaneously downwind at the same time to each location which results in an overprediction of the noise levels.

12.6.4.4 Cumulative Noise Assessment

The assessment was made with predicted operational noise levels from the development against noise limits in the Wind Energy Development Guidelines 2006. All predicted noise levels are within the noise limits. Table 12.18 gives the difference between the predicted cumulative noise levels in Table 12.17 and noise limits for each receptor. A negative margin indicates that the predicted noise levels are within the lower fixed 43dBA limit (45dBA for financially involved properties), which means the levels are within the day and night limits.

Table 12.18: Margin Between Predicted Cumulative Noise Levels and Lower Fixed Limit of 43dBA

Wind Speed, m/s	Predicted LA90 Noise Level (dB)						
	4	5	6	7	8	9	10+
H1	-14.8	-10.1	-5.7	-4.3	-4.3	-4.3	-4.3
H2	-15.8	-11.0	-6.7	-5.3	-5.3	-5.3	-5.3
H3	-16.9	-12.1	-7.7	-6.4	-6.4	-6.4	-6.4
H4	-16.9	-12.1	-7.8	-6.4	-6.4	-6.4	-6.4

H5	-18.9	-14.1	-9.8	-8.4	-8.4	-8.4	-8.4
H6	-19.6	-14.8	-10.5	-9.1	-9.1	-9.1	-9.1
H7	-19.9	-15.1	-10.8	-9.4	-9.4	-9.4	-9.4
H8	-20.4	-15.5	-11.2	-9.8	-9.8	-9.8	-9.8
H9	-21.6	-16.7	-12.4	-11.0	-11.0	-11.0	-11.0
H10	-23.1	-18.2	-13.9	-12.5	-12.5	-12.5	-12.5
H11	-23.7	-18.8	-14.5	-13.1	-13.1	-13.1	-13.1
H12	-24.5	-19.6	-15.3	-13.9	-13.9	-13.9	-13.9
H13	-24.7	-19.8	-15.5	-14.1	-14.1	-14.1	-14.1
H14	-25.7	-20.9	-16.5	-15.2	-15.2	-15.2	-15.2
H15	-25.5	-20.7	-16.3	-15.0	-15.0	-15.0	-15.0
H16	-25.3	-20.5	-16.1	-14.7	-14.7	-14.7	-14.7
H17	-24.8	-20.0	-15.6	-14.3	-14.3	-14.3	-14.3
H18	-23.0	-18.2	-13.8	-12.5	-12.5	-12.5	-12.5
H19	-22.7	-17.9	-13.6	-12.2	-12.2	-12.2	-12.2
H20	-24.6	-19.9	-15.5	-14.1	-14.1	-14.1	-14.1
H21	-24.9	-20.2	-15.8	-14.4	-14.4	-14.4	-14.4
H22	-25.8	-21.0	-16.6	-15.3	-15.3	-15.3	-15.3
H23	-26.7	-22.0	-17.6	-16.2	-16.2	-16.2	-16.2
H24	-24.5	-19.7	-15.4	-14.0	-14.0	-14.0	-14.0
H25	-24.3	-19.5	-15.2	-13.8	-13.8	-13.8	-13.8
H26	-24.3	-19.5	-15.2	-13.8	-13.8	-13.8	-13.8
H27	-26.7	-21.9	-17.6	-16.2	-16.2	-16.2	-16.2
H28	-27.8	-23.1	-18.7	-17.3	-17.3	-17.3	-17.3
H29	-25.7	-20.9	-16.5	-15.1	-15.1	-15.1	-15.1
H30	-26.0	-21.3	-16.9	-15.5	-15.5	-15.5	-15.5
H31	-25.0	-20.2	-15.9	-14.5	-14.5	-14.5	-14.5
H32	-25.2	-20.4	-16.1	-14.7	-14.7	-14.7	-14.7
H33	-26.7	-22.0	-17.6	-16.2	-16.2	-16.2	-16.2
H34	-27.2	-22.5	-18.1	-16.7	-16.7	-16.7	-16.7
H35	-28.0	-23.3	-19.0	-17.6	-17.6	-17.6	-17.6

12.6.5 Description of Effects

The criteria for description of effects for all operational noise activity and the potential worst-case effects, at the nearest receptors is given below.

Table 12.19: Description of Effects - Operational

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.7 Mitigation Measures and Residual Effects

12.7.2 Construction and Decommissioning Noise Mitigation

No significant construction noise effects have been identified. Therefore, no specific mitigation measures are required. However, general guidance for controlling construction noise through the use of good practice given in BS 5228 will be followed. Construction and Decommissioning of the development shall be limited to working times given and any controls incorporated in any planning permission.

During the Decommissioning phase of the development, noise levels are likely be no more than predicted in Table 12.10, however, it is envisaged that decommissioning will be of shorter duration. Any legislation, guidance or best practice relevant at the time of decommissioning will be complied with. Construction and decommissioning are a temporary day time activity.

12.7.2.1 Residual Construction and Decommissioning Effects

The residual effects are the same as the construction and Decommissioning effects identified in this assessment.

12.7.3 Operational Noise Mitigation

The development has been designed to comply with the 2006 noise Guidelines and noise limits attached as conditions to recent 2021 An Bord Pleanála decisions. The operational noise emissions are predicted to be compliant and well within these guidelines with no special mitigation required apart from fitting rotors with STE which is now considered best practice.

All turbines will have STE fitted as standard to reduce noise emission levels. Further mitigation is not considered necessary.

12.7.3.1 Residual Operational Effects

The residual effects are the same as the operational effects identified in this assessment.

12.7.4 Cumulative Effects

The cumulative effects of all nearby wind turbines have been assessed and found to be in compliance with the noise limits set in the Wind Energy Development Guidelines 2006.

12.8 Summary of Effects

Table 12.20 below summarises the effects.

Table 12.20: Summary of Effects

	Quality	Significance	Duration
Construction Noise	Negative	Not Significant	Temporary
Operational Noise	Negative	Not Significant	Long Term

Decommissioning Noise	Negative	Not Significant	Temporary

12.9 Statement of Significance

This Section has assessed the significance of the potential effects of the proposed development during operation, construction and decommissioning.

The effects of noise from the operation of the development has been assessed using 2006 Guidelines with the methodology described in ETSU-R-97 and the IOA Good Practice Guide. Noise levels during operation of the proposed development have been predicted using the best practice of calculation technique. They have been compared with the noise limits in the 2006 Guidelines and recent 2021 An Bord Pleanála limits and found to be compliant.

There has been a consultation process in relation to the revision of the 2019 Wind Energy Development Guidelines. This document provided the basis for a discussion on amendments of the noise limits applicable to wind turbine developments. It is understood that there will be revisions to the draft consultation documents, however a mitigation strategy to incorporate a reduction in sound power level outputs with respect to directionality can be put in place to comply with any specific variation in noise limit levels if new more restrictive guidelines are adopted. All turbines have software incorporated so that the sound power levels can be reduced by direction and energy output.

The noise levels predicted at the nearest receptors are orders of magnitude below the level at which risk of hearing damage, or indeed negative health effects are possible.

Noise during construction of the development and decommissioning will be managed to comply with best practice, legislation and guidelines current at that time so that effects are not significant.