Proposed Ballynalacken Windfarm Project

Environmental Impact Assessment Report

Chapter 10: Noise & Vibration

Topic Chapter Authors:

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Glossary of Terms

Term	Definition
A – Weighting	The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing.
Amplitude Modulation	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)
Background Noise	The noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods. The $L_{A90,10min}$ is the parameter that is used to define the background noise level in this instance. L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.
Ballynalacken Windfarm Project	Ballynalacken Windfarm including 12 No. turbines, turbine foundations and hardstanding areas, Windfarm Site Roads, Internal Windfarm Cabling, Windfarm Control Building, Site Entrances, ancillary works at and for the windfarm, along with the Internal Cable Link, Tinnalintan Substation and ancillary works, and Ballynalacken Grid Connection and grid

Term	Definition
	connection works to the Eirgrid Ballyragget Substation. The Project also involves works and activities along the turbine component haul route remote from the site, including the construction of a temporary Blade Transfer Area at HR8.
dB (decibel)	The unit normally employed to measure the magnitude of sound. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 µPa).
dB(A)	An 'A-weighted decibel' – a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. A – Weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Hub Height Wind Speed	The wind speed at the centre of the turbine rotor.
Hertz (Hz)	The unit of sound frequency in cycles per second.
$L_{Aeq,T}$	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).The closer the LAeq value is to either the LAF10 or LAF90 value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.
L_{AF90}	Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.
L_{den}	Refers to the LAeq noise levels over a whole day, but with a penalty of 10 dB(A) for night-time noise (23:00-07:00) and 5 dB(A) for evening noise (19:00-23:00), also known as the day evening night noise indicator.
Low Frequency Noise	LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.
Noise	Sound that evokes a feeling of displeasure in the environment in which it is heard, and is therefore unwelcomed by the receiver
Noise Sensitive Location (NSL)	Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
octave band	A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.
Pascal (Pa)	Pascal is a unit of pressure and so sound pressures are measured in Pascals.
Sound Power Level (L_W)	The sound power level radiated by a source is defined as: $$L_W = 10\log_{10}\left(\frac{W}{W_0}\right) dB$$ where W is the acoustic power of the source in Watts (W) and W0 is a reference sound power chosen in air to be 10^{-12} W.

Term	Definition
Sound Pressure Level (L_p)	The sound pressure level at a point is defined: $$L_P = 20\log_{10}\left(\frac{P}{P_0}\right) dB$$ where P is the sound pressure and P_0 is a reference pressure for propagation of sound in air and has a value of $2x10^{-5}$Pa.
Tonal	Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.
10 Minute Average Wind Speed (m/s)	The wind speed measured by an anemometer at a specified height above ground level, averaged over a 10-minute period.
Wind Shear	The increase of wind speed with height above ground.

List of Abbreviations

Abbreviation	Full Term
EIA	Environmental Impact Assessment
NSL	Noise Sensitive Location

CHAPTER 10 NOISE & VIBRATION

EIAR 10.1 INTRODUCTION

This Chapter 10 (Noise & Vibration) comprises the detailed assessment undertaken of the potential noise and vibration impact on local residential amenity, from the proposed Ballynalacken Wind Farm development. The Proposed Development consists of 12 no. wind turbines with an overall top of foundation level to blade tip height of 155 m, and hub height of 96.5m, (except T4 which has a tip height of 142.5m and a hub height of 84 m) and a rotor diameter of 117m. A full description of the proposed development is provided in Chapter 5 (Description of the Development).

This assessment covers noise, vibration and special characteristics – infrasound and amplitude modulation is discussed in Section EIAR 10.3.1.2. Impact assessments have been prepared for the construction and decommissioning phases and for the operational phase for all houses within 2km of a proposed turbine and 500m from the proposed Tinnalintan Substation – called noise sensitive locations (NSLs) in this report.

EIAR 10.1.1 The Authors of this Chapter (Competent Experts)

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

Mike Simms (Principal Acoustic Consultant) holds a BE and MEngSc in Mechanical Engineering and is a member of the Institute of Acoustics (MIOA) and of the Institution of Engineering and Technology (MIET). Mike has worked in the field of acoustics for over 20 years. He has extensive experience in all aspects of environmental surveying, noise modelling and impact assessment for various sectors including, wind energy, industrial, commercial, and residential.

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

EIAR 10.1.2 Overview of Noise Sensitive Locations

There are 159 No. Noise Sensitive Locations (NSL) assessed for noise and vibration impact from the proposed Ballynalacken Turbines and the 10 No. NSLs assessed for Tinnalintan Substation:

- 54 No. NSLs are within 1km of a proposed turbine
- 50 No. NSLs between 1km and 1.5km of a proposed turbine
- 55 No. NSLs between 1.5km and 2km of a proposed turbine
- 10 No. NSLs within 500m of the proposed Tinnalintan Substation

The locations of these noise sensitive locations are identified on Figure 10.2: Noise Sensitive Locations.

Figures and mapping referenced in this topic chapter can be found in **at the end of this Chapter.**

EIAR 10.1.3 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 (SPLs) 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 250 Hz. To rank the Sound Pressure Level (SPL) of various noise sources, the measured level must be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. The ‘A-weighting’ system defined in the international standard, BS ISO 226:2003 Acoustics. Normal Equal-loudness Level Contours has been found to provide the best correlations with human response to perceived loudness. SPLs measured using ‘A-weighting’ are expressed in terms of dB(A).

An indication of the level of some common sounds on the dB(A) scale is illustrated below. A glossary of acoustic terms used in this chapter is provided at the start of this chapter.

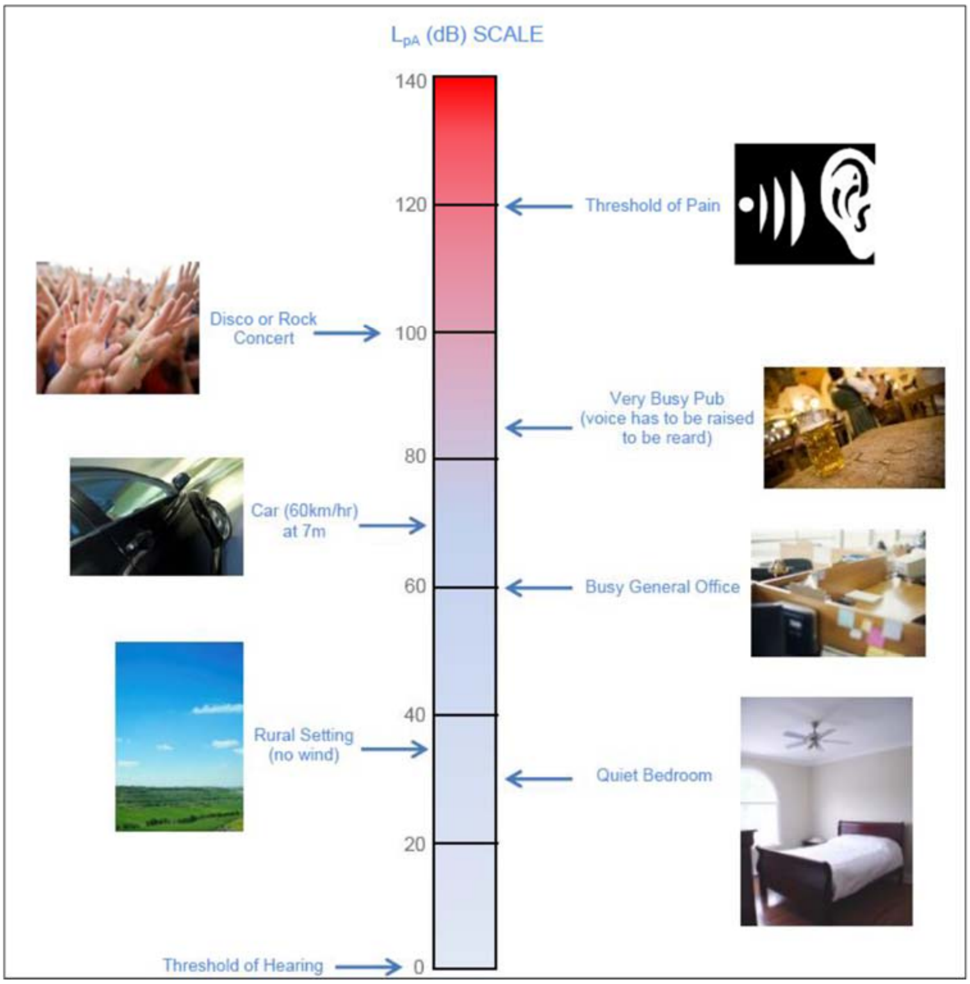


Plate 1: Scale & Indicative Noise Levels – (EPA: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4 – 2016))

EIAR 10.1.4 Sources of Information

Consultation, desktop studies and fieldwork were carried out in order to gather information on the baseline environment.

Table 10-1: Sources of Baseline Information for Noise and Vibration

Type	Source
Consultation	No feedback was received from consultees with regard to Noise or Vibration See Chapter 3: Consultation for further details.
Desktop	• Reviewing or aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps) • Review of peer-reviewed studies on noise and vibration • Review of Pinewood Windfarm planning conditions;
Fieldwork	• Background noise measurements

EIAR 10.1.5 Methodology Used

The evaluation of Noise and Vibration has been carried out in accordance with the following guidelines and codes of practice:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022), and with the following:
- British Standard Institute (BSI) British Standard (BS) 5228-1:2009 +A1:2014 Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise (hereafter referred to as BS 5228–1) (BSI 2014a);
- Department of the Environment, Heritage, and Local Government (DEHLG) Wind Energy Development Guidelines (hereafter referred to as WEDG (DEHLG, 2006);
- Department of Trade, and Industry (UK) Energy Technology Support Unit (ETSU) ETSU-R-97 The Assessment and Rating of Noise from Wind Farms (hereafter referred to as ETSU-R-97) (ETSU, 1996);
- Institute of Acoustics (IOA) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (hereafter referred to as IOA GPG) (IOA, 2013);
- Transport Infrastructure Ireland (TII) (previously National Roads Authority (NRA)) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (hereafter referred to as the TII Noise Guidelines 2014) (NRA 2014);
- United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020);
- International Organization for Standardization (ISO) 9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors - Part 2: Engineering method for the prediction of sound pressure levels outdoors (hereafter referred to as ISO 9613–2) (ISO 2024).

This methodology has been used to evaluate potential impacts and determine appropriate mitigation measures. The methodologies can be found in full in the following methodologies:

- Appendix 10.1: Methodology for the evaluation of Noise – Construction Phase,
- Appendix 10.2: Methodology for the evaluation of Noise – Operational Phase, and
- Appendix 10.3: Methodology for the evaluation of Vibration

EIAR 10.2 PART 1: SCOPING FOR SENSITIVE ASPECTS

The assessment of significant effects (or impacts) is an essential concept of the EIA Directive, and the primary objective of this EIA Report is to identify and evaluate the significant effects of the Project. Scoping has been carried out in accordance with the *Guidance on Scoping* (EC 2017) in order to focus the consideration of the impacts the Ballynalacken Windfarm Project may have on the environment to those which are significant or important enough to merit assessment, review and decision-making.

EIAR 10.2.1 Introduction to Scoping for Sensitive Aspects (Receptors)

The purpose of the scoping exercise, which comprises this Section EIAR 10.2, is to identify the relevant receptors, in relation to noise and vibration effects. In order to identify the relevant receptors, the scoping exercise is carried out as follows:

1. An examination is carried out, in Section EIAR 10.2.2, of the potential sources of impacts resulting from the Project and the pathways for Impacts which link the sources of impacts to the receptors (Sensitive Aspects) of the impacts;

2. The zone of influence of the Project, within which the impacts of the Project could occur, is set out, with justification for same. The zone of influence is also called the 'Study Area' herein. The zones of influence are set out in Section EIAR 10.2.3 for the various Sensitive Aspects which occur in the environment.

3. A scoping examination of Sensitive Aspects which occur within the Study Area(s) is carried out in Section EIAR 10.2.4. The scoping examination results in a Sensitive Aspect being either scoped-in for detailed evaluation in **Part 2: Sensitive Aspect Evaluation Section (i.e. Section EIAR 10.3)** of this chapter or scoped-out from further consideration, the rationale for scoping-out is provided in Section EIAR 10.2.4.

EIAR 10.2.2 Identification of the Sources, Pathways and Receptors of Impacts

The evaluations within the EIAR identify potential impact sources and pathways between the Project and receptors (Sensitive Aspects) of the environment.

EIAR 10.2.2.1 Identification of Impact Sources

The 'source' is an origin of an impact and is associated with the Project. In order to identify the potential 'sources' of impact, the characteristics of the Ballynalacken Windfarm Project, i.e. the size and design, works, activities, use of materials and natural resources, and the emissions and wastes, associated with the construction, operation and decommissioning of the Project, as described in Chapter 5 of this EIA Report, have been examined, and it is considered that the following Project characteristics have potential to act as a 'source' of impact to the sensitive aspects of Noise and Vibration:

Construction Stage Sources of Impact

- Use and movement of plant and heavy machinery;
- Excavation of soils and rock at construction works areas;
- Rockbreaking and excavation at borrow pits;

- Construction of hardstanding areas;
- Delivery vehicles and traffic.

Operational Stage Sources of Impact

- Operational turbines;
- Operational substation.

Decommissioning Stage Sources of Impact

- Use and movement of plant and heavy machinery
- Vehicular traffic;
- Disassembly works at turbines;
- Movement and placement of soils at turbine reinstatement areas.

EIAR 10.2.2.1.1 Identification of Impact Pathways

The 'pathway' is the means by which an impact can reach and affect a receptor. The characteristics of the baseline environment have been examined and it is considered that the following pathways could form a link between the Project (sources of impact) and the Sensitive Aspects (receptors):

- Air
- Ground

EIAR 10.2.2.1.2 Identification of Receptors

Any receptor in the environment which could be affected by a development is referred to as a 'Sensitive Aspect' in this EIA Report. The following Sensitive Aspects are relevant to the receiving environment and are subject to scoping in Section EIAR 10.2.3:

- Local residences and community facilities

The zone of influence in relation to these Sensitive Aspects is examined in Section EIAR 10.2.3 below, with a scoping exercise for each of the Sensitive Aspects presented in Section EIAR 10.2.4.

EIAR 10.2.3 Scoping of the Study Areas (Zone of Influence of the Project)

The scoping and evaluation focuses on the area or zone of influence around the Ballynalacken Windfarm Project within which the impacts of the Project could occur. This area/zone is referred to as the Study Area. The Study Areas for the Sensitive Aspects in relation to Noise and Vibration are set out in the table below.

EIAR 10.2.3.1 Study area for Wind Turbine Noise

The Institute of Acoustics document *Good Practice Guide To The Application Of Etsu-R-97 For The Assessment And Rating Of Wind Turbine Noise* states, in Section 2.2 in relation to the extent of the study area:

> *The 'study area' for background noise surveys (and noise assessment) should, as a minimum, be the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35 dB L_{A90} at up to 10 m/s wind speed. (Note: unless stated, in this document the wind speed reference for noise data is the 10 metre standardised wind speed, derived from the wind speed at turbine hub height as explained in Section 2.6).*

It is noted that for the proposed wind turbine, its maximum sound power level is reached at 9 m/s standardized wind speed, thus the noise contours for 9 m/s and 10 m/s standardised wind speed are the same.

If there were no other wind farms to be considered, the study area could be defined to be simply the 35 dB L_{A90} noise contour at maximum sound power level for the turbine which is 9 m/s, due to the proposed development only. The inclusion of other wind farms in the noise model has the potential to increase noise levels to above 35dB L_{A90} at a wider set of noise-sensitive locations (NSLs).

The cumulative wind farms which were considered in the study area extends to 5 km, though in terms of environmental noise, this extends well beyond the range of potential cumulative impacts.

The only wind farm within 5km is Pinewood wind farm, a permitted development of 11 turbines approximately 4.5 km to the northeast of the proposed Ballynalacken wind farm.

Figure 10.1 below shows the 35 dB L_{A90} contours for:

1. the proposed Ballynalacken wind farm only *(orange line),*
2. the permitted Pinewood wind farm only *(light blue line)*, and
3. both wind farm operating together – i.e. the cumulative 35 dB L_{A90} contour *(red line).*

As can be seen, the cumulative 35 dB L_{A90} contour around each wind farm individually is slightly larger than the 35 dB L_{A90} contour for each wind farm on its own.

The NSLs included in noise assessment presented in this EIAR are those at distances up to 2 km from the proposed Ballynalacken wind farm. This covers a larger area than the cumulative 35 dB L_{A90} contour around the proposed Ballynalacken wind farm, therefore **the distance of 2 km represents a conservative extent for the study area**.

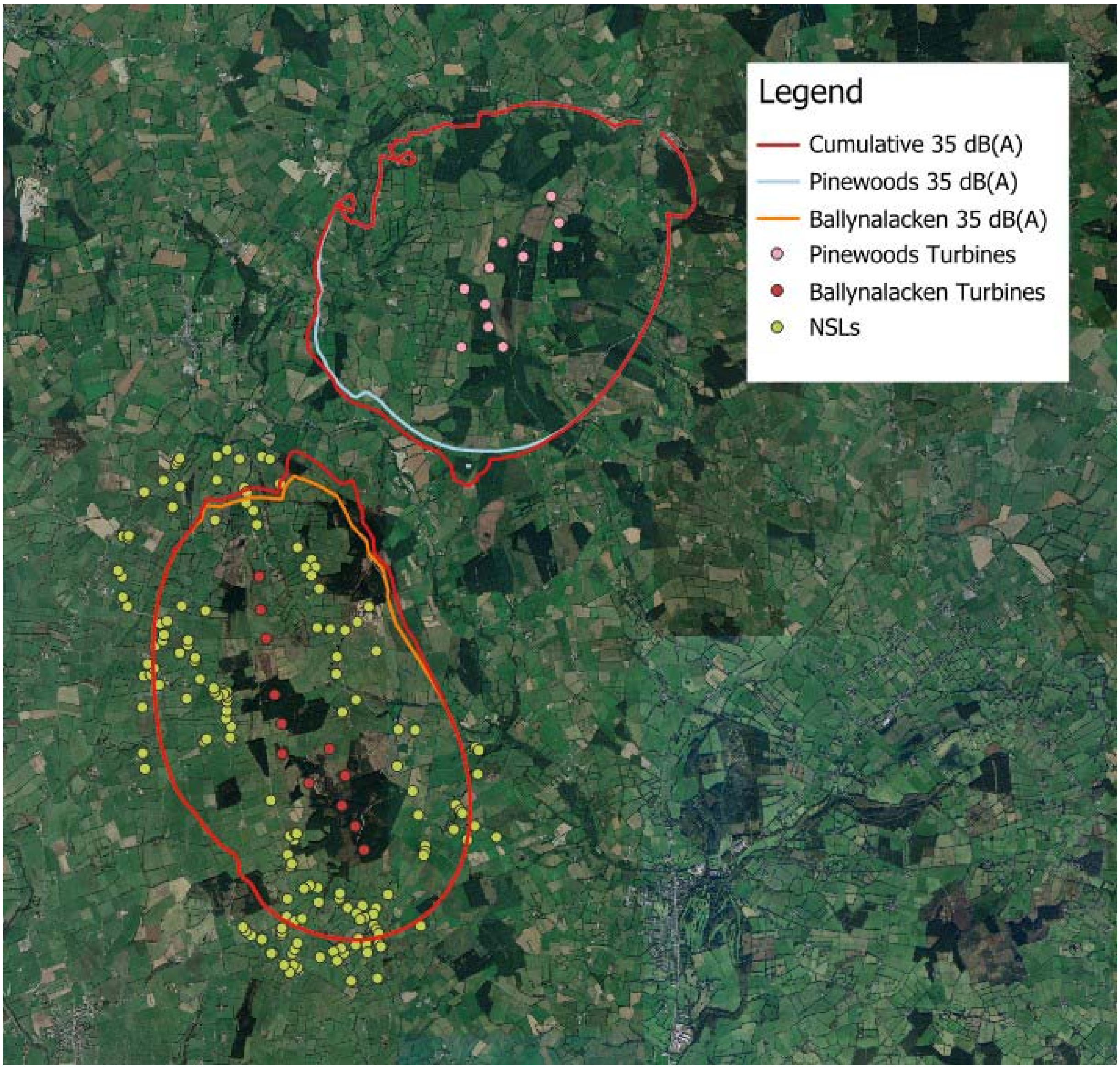


Figure 10.1: Determining the Study Area for Operational Noise - 35 dB L_{A90} contours for the Ballynalacken and Pinewoods, individually and cumulatively

Table 10-2: Study Area of the Project in relation to Noise & Vibration

Sensitive Aspect	Ballynalacken Windfarm Project Zone of Influence/Study Area	Justification
Local Residences **Community Facilities**	2km from turbines 500m from Tinnalintan Substation Public roads subject to cable works Residences along local roads subject to concentrated material haulage routes	As detailed in in Section 10.2.3 above, a 2km study area covers a larger area than the cumulative 35 dB L_{A90} contour around the proposed Ballynalacken wind farm, therefore the distance of 2 km represents a conservative extent for the study area. This area also extends around the main construction works which will occur at the windfarm site. In relation to the substation, cable routes and materials haulage routes - this study area incorporates the nearest houses to these noise sources.

EIAR 10.2.4 Scoping of Sensitive Aspects

Any receptor in the local environment which could be affected by a development is a Sensitive Aspect. The various sensitive aspects of the Noise and Vibration environment are scoped in the table below for potential to be affected by the Ballynalacken Windfarm Project. The scoping examination results in a Sensitive Aspect being either scoped-in for detailed evaluation in **Part 2: Sensitive Aspect Evaluation Section (i.e. Section EIAR 10.3)** of this chapter or scoped-out from further consideration, for the following reasons:

a) Where it is considered that a Sensitive Aspect is likely, or has potential, to be significantly affected by the Project, that Sensitive Aspect has been scoped in for detailed evaluation in Part 2 (Section EIAR 10.3).
b) Where it is considered that there is no potential for a Sensitive Aspect to be affected, or where the likely/potential impacts to that Sensitive Aspect will be Neutral (i.e. No impact/imperceptible impact) then that Sensitive Aspect has been scoped out from further consideration, and the rationale for scoping-out is provided in the table.
c) An exception is made for Sensitive Aspects which are not likely to be significantly affected but may be of particular or local concern and merit a detailed examination, these Sensitive Aspects are also scoped in for detailed evaluation in Part 2 (Section EIAR 10.3).

Table 10-3: Scoping of Sensitive Aspects

Sensitive Aspect	Is there a Pathway between the Project and the Sensitive Aspect?	Likely (or have potential) to be Significant?	Scope In/ Out	Scoping Result & Rationale *(scoped out only)*
Local Residences	Yes	Potential	Scope In	See Section EIAR 10.3.1 Part 2 Evaluation
Community Facilities	Yes	No	Scope Out	Scoped Out: There is a soccer pitch (Brookville AFC) located on private lands in Tinnalintan, adjacent to the public road along which the Grid Connection cabling is routed. While this soccer pitch is within the study area, due to the separation distance from the substation compound (>200m), and the infrequent use of this facilities, in addition to the nature of the use of this facility, significant noise impacts will not occur, and it is considered that the construction or operation of the substation will have no effect on the use or enjoyment of the pitch. There are no other community facilities or other public recreational amenity areas within the study areas.

EIAR 10.3 NOISE & VIBRATION PART 2: EVALUATION SECTION

This Evaluation Section examines the scoped-in Sensitive Aspect – Local Residents. in greater detail, and comprises a baseline description and impact evaluation for each of the Sensitive Aspects.

EIAR 10.3.1 SENSITIVE ASPECT: LOCAL RESIDENCES – NOISE & VIBRATION

This detailed evaluation section for Noise and Vibration is presented as follows:

- Section EIAR 10.3.1.1 – description of the baseline environment;
- Section EIAR 10.3.1.3 – evaluation of potential impacts

EIAR 10.3.1.1 Baseline Environment – Local Residences – Noise & Vibration

EIAR 10.3.1.1.1 Noise Sensitive Locations

There are 159 No. noise-sensitive locations (NSLs) within 2km of the proposed turbines and 10 NSLs within 500m of Tinnalintan Substation, this distance range being representative of the closest NSLs:

- 54 No. NSLs are within 1km of a proposed turbine
- 50 No. NSLs between 1km and 1.5km of a proposed turbine
- 55 No. NSLs between 1.5km and 2km of a proposed turbine
- 10 No. NSLs within 500m of the proposed Tinnalintan Substation

These 169 No. NSLs are assessed for noise impact.

See Table below showing the distance from the nearest turbine to all NSLs. The table also shows the distance from Tinnalintan Substation to the relevant NSLs for the Substation.

Mapping of these NSLs in relation to the proposed turbines and Tinnalintan Substation follows the table.

Table 10-4: Noise Sensitive Locations

House ID	Stakeholder ?	Distance to nearest turbine (m)		House ID	Stakeholder ?	Distance to nearest turbine (m)
H1		922		H86		1368
H2		878		H87		1272
H3		840		H88		951
H4		835		H89		1251
H5		820		H90		983
H6		695		H91		1035
H7		817		H92		1010
H8		770		H93	Stakeholder	1894
H9	Stakeholder	829		H94	Stakeholder	1914
H10		752		H95		1085
H11		684		H96		1050
H12		822		H97		1825
H13		891		H98		1208
H14		991		H99		1045
H15		769		H100		1592
H16	Stakeholder	734		H101		1756
H17	Stakeholder	684		H102		1659
H18	Stakeholder	681		H103		1593
H19		574		H104		1033

House ID	Stakeholder ?	Distance to nearest turbine (m)		House ID	Stakeholder ?	Distance to nearest turbine (m)
H20		717		H105		1010
H21		729		H106	Stakeholder	1203
H22		693		H107		1078
H23		745		H108		1073
H24		689		H109		1525
H25		657		H110		1410
H26		652		H111		1372
H27		655		H112		1391
H28		699		H113	Stakeholder	1293
H29		782		H114		1085
H30		830		H115		1831
H31		842		H116		1893
H32		757		H117		1884
H33		985		H118		1950
H34		910		H119		1866
H35	Stakeholder	713		H120		1872
H36	Stakeholder	663		H121		1548
H37	Stakeholder	757		H122		1524
H38		785		H123		1521
H39		648		H124		1956
H40		720		H125		1859
H41		844		H126		1644
H42		890		H127		1918
H43		719		H128		1932
H44	Stakeholder	1003		H129		1954
H45	Stakeholder	894		H130		1752
H46	Stakeholder	766		H131		1791
H47	Stakeholder	535		H132		1636
H48		968		H133	Stakeholder	1444
H49		727		H134		1234
H50		1402		H135		1164
H51		1427		H136		1025
H52		1439		H137		1645
H53		1422		H138		1617
H54		1555		H139		1306
H55		1823		H140		1476
H56		1305		H141		1273
H57		895		H142		1088
H58		882		H143		1491
H59		934		H144		1146
H60		960		H145		1836
H61		1050		H146		1868
H62		1110		H147		1819
H63		1169		H148	Stakeholder	1264
H64		1298		H149		1412

House ID	Stakeholder ?	Distance to nearest turbine (m)		House ID	Stakeholder ?	Distance to nearest turbine (m)
H65		1301		H150		1662
H66		1350		H151		1573
H67		1294		H152		1972
H68		1221		H153		1925
H69		1313		H154		1892
H70		1448		H155		1909
H71		1388		H156		1945
H72		1459		H157		1970
H73		1775		H158		1975
H74		1809		H159		1938
H75		1569				
H76		1593		SubH1		253
H77		1857		SubH2		234
H78		1859		SubH3		340
H79		1730		SubH4		279
H80		1664		SubH5		270
H81		1867		SubH6		377
H82		1627		SubH7		370
H83		1601		SubH8		350
H84		1558		SubH9	Stakeholder	375
H85		1403		SubH10		432

Noise predictions were prepared at these NSLs in respect of turbines operating at various wind speeds. See Section EIAR 10.3.1.3.1 assessment of Noise from Operating Wind Turbines which includes a noise contour map. Noise predictions were also prepared at the NSLs proximate to Tinnalintan Substation, see Section EIAR 10.3.1.3.4.

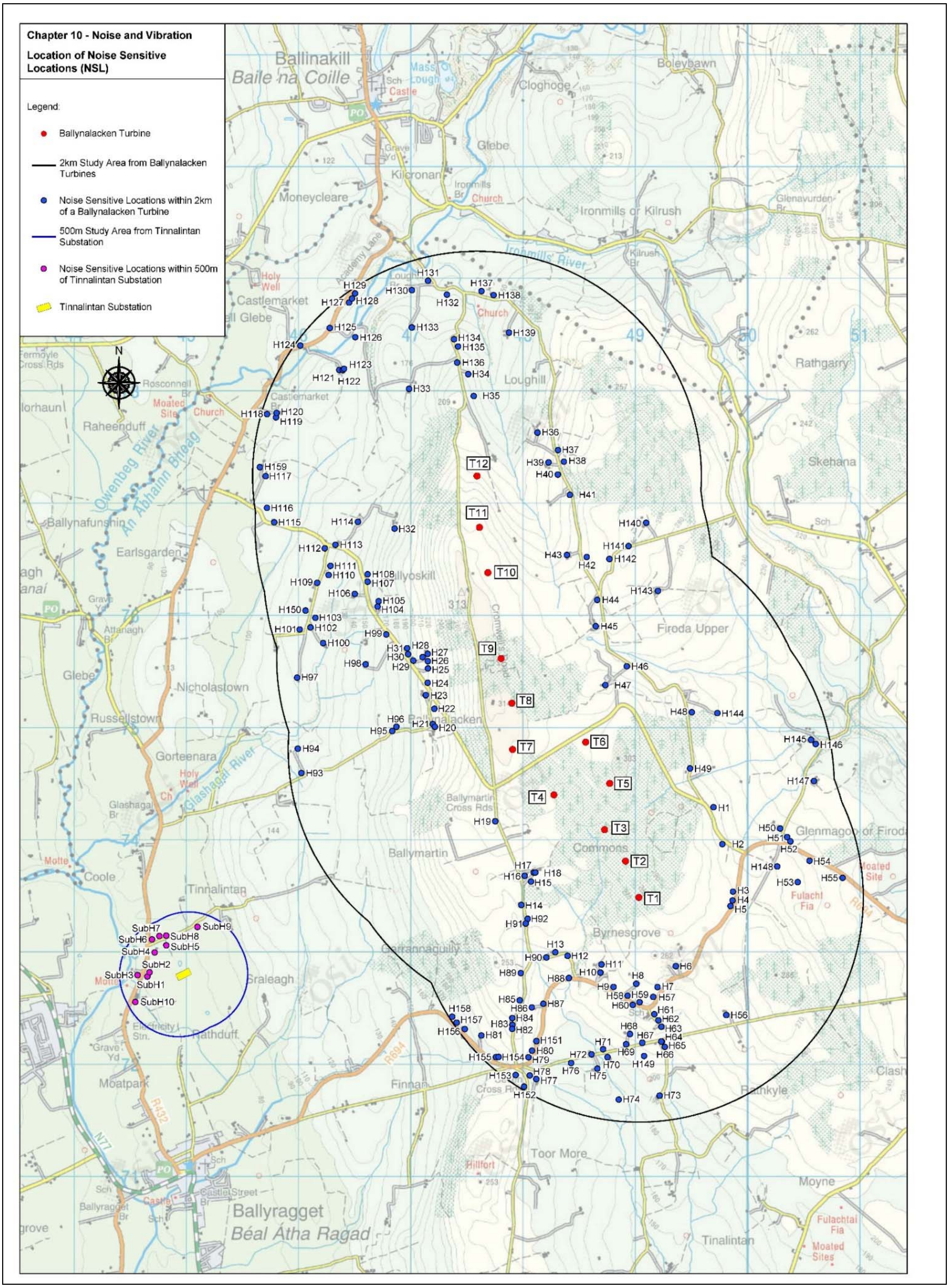


Figure 10.2 Location of Noise Sensitive Locations (NSL) in relation to Ballynalacken Turbines and Tinnalintan Substation

EIAR 10.3.1.1.2 Baseline Noise Measurements

To inform this assessment, baseline noise levels have been measured at six representative NSLs surrounding the proposed development site. Details of the Background Noise Measurements are detailed in Appendix 10.4: Background Noise Measurements.

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Locations were selected generally on proximity to the proposed wind turbines. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps). The selected locations for the noise monitoring are outlined in the table below and depicted on the map in **Figure 10.3**.

Table 10-5 Noise Measurement Co-ordinates (ITM)

Name	Distance to nearest Ballynalacken Turbine	Easting	Northing
H35	713	647,494	677,996
H41	844	648,350	677,116
H47	535	648,666	675,421
H2	878	649,710	674,006
H18	681	648,042	673,750
H106	1203	646,429	676,228

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

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

Table 10-6 presents a summary of the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime 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 in the Institute of Acoustics *Good Practice Guide Supplementary Guidance No. 2: Data Processing & Derivation of ETSU-R-97 Background Curves*.

The 'envelope' values in Table 10-6 are, for each wind speed, obtained by using the lowest value measured across the noise survey locations for the same wind speed. The resulting values are used to derive wind turbine noise criteria at locations where no noise survey was carried out.

Table 10-6 Derived Levels of $L_{A90,10-min}$ for Various Wind Speeds

House	Period	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	9
H35	Day	28.8	29.6	30.8	32.6	35.0	37.9	41.4
	Night	22.3	23.0	24.0	25.8	28.6	32.7	38.6
H41	Day	24.9	27.6	31.0	34.9	38.8	42.5	45.7
	Night	16.8	19.5	23.3	27.9	32.9	38.1	43.1
H47	Day	28.4	29.6	32.0	35.4	39.8	44.3	48.2
	Night	19.0	22.3	25.9	29.9	34.6	41.0	50.6
H2	Day	26.9	27.0	28.2	30.3	33.0	36.1	39.5
	Night	17.0	18.0	19.5	21.7	24.6	28.4	33.1
H18	Day	24.0	25.1	27.1	29.7	32.7	35.9	39.1
	Night	19.7	21.0	22.6	24.7	27.1	29.9	33.1
H106	Day	27.6	28.1	29.4	31.7	35.1	39.6	--
	Night	19.1	20.3	21.6	23.1	24.8	26.9	--

House	Period	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	9
Envelope	Day	24.0	25.1	27.1	29.7	32.7	35.9	39.1
	Night	16.8	18.0	19.5	21.7	24.6	26.9	33.1

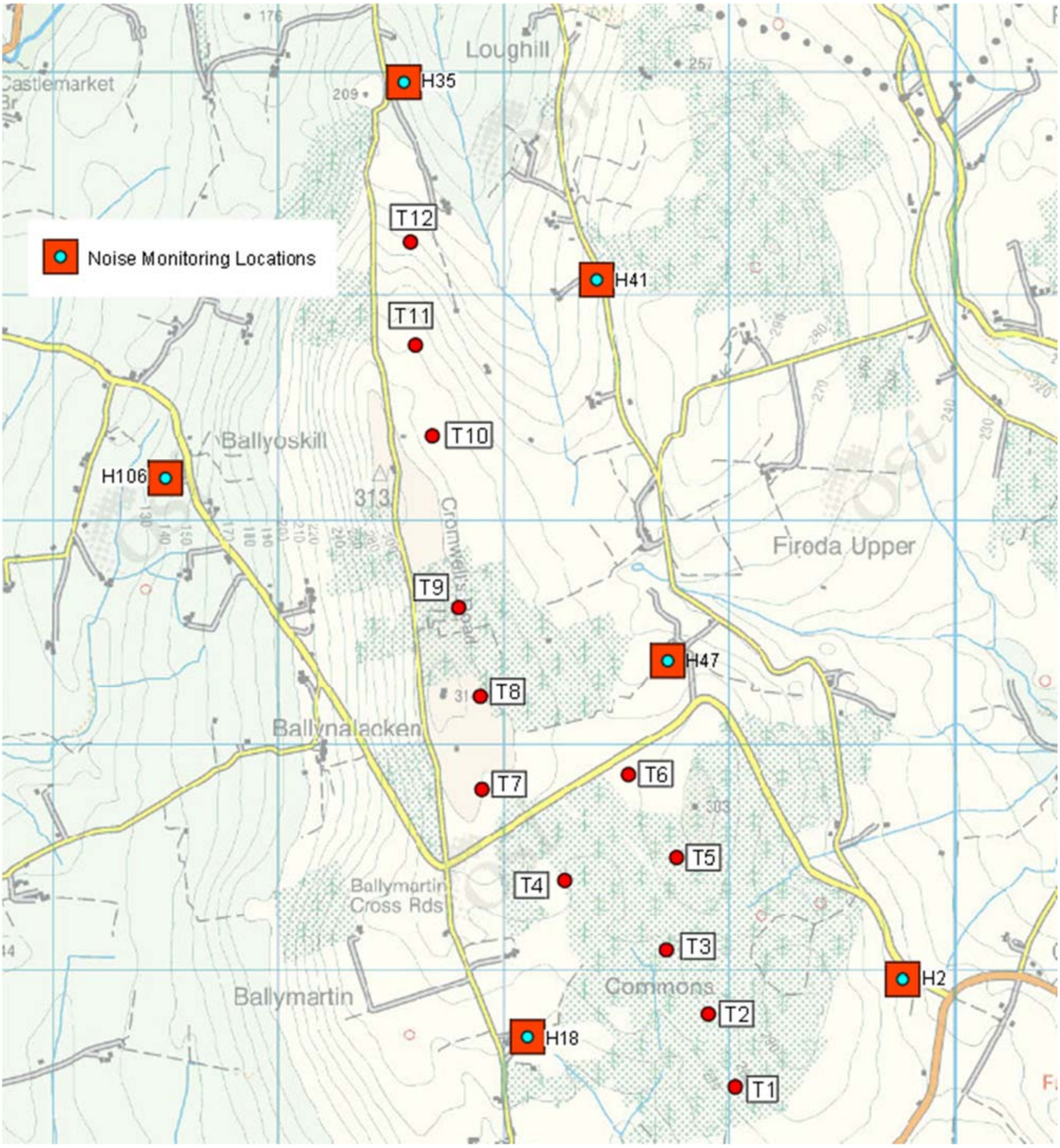


Figure 10.3: Noise Monitoring Locations

EIAR 10.3.1.1.3	Evolution of the Baseline Environment (the 'Do-Nothing' scenario)

If the development is not progressed the existing noise environment will remain largely unchanged.

EIAR 10.3.1.2 Irish and International Noise Limit Criteria and Guidance

The operational noise assessment documented in this chapter (*Section 10.3.1.3.1 below*) is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines for Planning Authorities* 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.

EIAR 10.3.1.2.1.1 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 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 operational wind turbine noise by the application of noise limits at the nearest noise sensitive locations (NSLs). ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind turbine developments and recommends that operational noise limits should be set relative to the existing background noise levels at NSLs. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site baseline noise surveys.

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

The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB L_{A90} and/or a higher level above the prevailing background noise level.

EIAR 10.3.1.2.1.2 Wind Energy Development Guidelines for Planning Authorities

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

The following extracts from this document should be considered:

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

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

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

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.

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

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

> *"However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of the $L_{A90,\ 10min}$ of the wind energy development be limited to an absolute level within the range of 35 – 40dB(A)."*

In relation to night time periods the following guidance is given:

> *"A fixed limit of 43dB(A) will protect sleep inside properties during the night."*

This limit is defined in terms of the $L_{A90,10}$min parameter. This represents the commonly adopted night-time noise criterion curve in relation to wind farm developments.

In summary, the Wind Energy Development Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- An appropriate absolute limit level in the range of 35 – 40 dB L_{A90} for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels of not less than 30 dB $L_{A90,10min}$ and;
- 43 dB $L_{A90,10min}$ for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála.

EIAR 10.3.1.2.1.3 Future Potential Wind Energy Development Guidance Changes

In December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 (Draft WEDG) were published for consultation and therefore have yet to be finalised. It is important to note that as part of the public consultation several concerns in relation to the proposed approach to operational noise assessment have been expressed by various parties and it is the opinion of the authors of this assessment that the Draft WEDG 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"

Therefore, in line with best practice, the assessment presented in this EIAR is based on the current guidance outlined in the 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 (SGNs).

If updated Wind Energy Guidelines are published during the application process for the Proposed Development it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information. It should be noted, modern wind turbines can be controlled to within permitted operational noise levels should the noise criteria change materially in the new Wind Energy Guidelines.

EIAR 10.3.1.2.1.4 World Health Organization (WHO) Noise Guidelines for the European Region

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'. A strong recommendation, *"can be adopted as policy in most situations" whereas a conditional recommendation, "requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply".*

The objective of the WHO Environmental Noise Guidelines for the European Region is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is risk of adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB L_{den}, as wind turbine noise above this level is associated with adverse health effects.
No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.
To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."

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

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

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

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

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

EIAR 10.3.1.2.1.5 Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics (IOA) publication of A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) including 6 Supplementary Guidance Notes. These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG, and its Supplementary Guidance Notes (SGNs) are considered to represent best practice and have been adopted for this assessment.

EIAR 10.3.1.2.1.6 Good Practice for Baseline Noise Measurements

The IOA GPG states, that at a minimum continuous baseline noise monitoring should be carried out at the nearest noise sensitive locations 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 collated at the site of the wind turbine development. Regression analysis is then conducted on the data sets to derive background noise levels at various wind speeds to establish the appropriate day and night time noise criterion curves.

EIAR 10.3.1.2.1.7 Good Practice for Operational Noise Predictions

Operational noise emissions associated with the wind turbines can be predicted in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors (2024). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

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

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

The Institute of Acoustics Good Practice Guide (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…"*

Also:

> *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."*

EIAR 10.3.1.3 Impact Evaluation – Local Residences – Noise and Vibration

This Section comprises an evaluation of the likely significant impacts of the proposed Ballynalacken Windfarm Project on the receiving environment. Moderate, Slight, Imperceptible and Neutral Impacts are also taken into consideration.

a) Significant Impacts which are likely or have potential to occur, are subject to detailed evaluation;

b) Moderate or Slight Impacts, which are likely or have potential to occur, are subject to detailed evaluation;

c) Non-significant impacts of local concern or considered important enough to merit detailed evaluation;

d) Neutral or Imperceptible Impacts are scoped out from detailed evaluation, and a short evaluation is provided in the table below. Unlikely Impacts are also scoped out.

Table 10-7: Noise & Vibration Impacts

Likely/Potential Impact	**Evaluation**
Significant Impacts which are likely or have potential to occur – see detailed evaluation	
Operational Phase: Increase in Ambient Noise Levels – Noise from Operating Turbines	*See Section EIAR 10.3.1.3.1 to Section EIAR 10.3.1.3.3*
Non-significant or Not Likely impacts considered important enough (or of local concern) – see detailed evaluation	
Operational Phase: Increase in Ambient Noise Levels – Noise from the operational Tinnalintan Substation	*See Section EIAR 10.3.1.3.4*
Construction Phase: Increase in Ambient Noise Levels – Noise from Construction Works	*See Section EIAR 10.3.1.3.5*
Construction Phase: Vibration from construction works	*See Section EIAR 10.3.1.3.6*
Operational Phase: Vibrations during the Operational Phase	*See Section EIAR 10.3.1.3.7*
Neutral or Imperceptible Impacts, or where no impact is likely to occur – evaluation below	
Decommissioning Phase Increases in ambient noise	Not Significant: Although similar (*to the construction phase*) works and equipment will be used, decommissioning phase will be lower overall. And lower noise levels to those calculated for the construction phase would be expected. In any case, based on the construction noise levels (see Section 10.3.1.3.5), the predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB LAeq,1hr) at all NSLs for the decommissioning phase. Therefore, the potential noise effects at nearest noise sensitive locations is considered to be negative, not significant and temporary.
Decommissioning Phase Vibrations	There are no expected significant sources of vibration associated with the decommissioning phase and effect remains are predicted to **be** neutral, imperceptible and temporary and therefore not significant.

EIAR 10.3.1.3.1 Noise from Operating Turbines

Noise Modelling software used for the calculations

Operating noise prediction calculations have been conducted using the methodology outlined in Appendix 10.2 Methodology for the evaluation of Noise – Operational Phase. The software, DGMR iNoise Enterprise, was selected to calculate noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors*, (ISO, 2024).

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

- the magnitude of the noise source in terms of A-weighted sound power levels (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 impacts at distances greater than approximately 400 m).

Turbine Details

In terms of predicting noise levels at noise-sensitive locations however, the turbine technology is described by two parameters:

- The hub height, and
- The sound power level.

The turbine type assessed is the Vestas V117 4.2MW. The turbine is a pitch regulated upwind turbine with a three-blade rotor with a hub height of 96.5m (except T4 which has a hub height of 84 m) and a rotor diameter of 117m.

The sound power levels for the V117 4.2MW referenced to windspeeds at standardised 10m height are presented in Table 10-8. Note that although T4 has a lower hub height the same sound power levels have been used.

Wind Speed (m/s)	Sound Power Level, dB(A) at Octave Band Centre Frequency (Hz)								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
3	71.1	79.7	85.3	88.0	87.8	84.6	78.5	69.4	93.1
4	74.8	83.0	88.4	91.0	90.7	87.6	81.6	72.8	96.1
5	79.7	87.6	92.7	95.2	94.9	91.9	86.3	77.9	100.4
6	84.3	91.6	96.4	98.7	98.5	95.8	90.7	83.0	104.1
7	86.3	93.5	98.3	100.6	100.4	97.7	92.5	84.8	106.0
8	86.3	93.5	98.2	100.5	100.4	97.7	92.7	85.1	106.0
≥9	86.4	93.5	98.2	100.5	100.4	97.8	92.9	85.5	106.0

Table 10-8 Sound Power Levels for the V117 4.2MW turbine (Proposed Development)

Other Wind Farm Included in Cumulative Assessment

An appraisal of the wider study area around the site to identify wind farms either operating or consented and which could potentially cause cumulative operating noise impacts, was carried out – Section EIAR 10.2.3. The results of this exercise identified one wind farm in the wider area - the **consented Pinewoods Wind Farm** (Planning Reference 22507) an 11-turbine wind farm 4.2km to the northeast, with sound power levels as in Table 10-9 below and identified on **Figure 10.1**.

Wind Speed (m/s)	Sound Power Level, dB(A) at Octave Band Centre Frequency (Hz)								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
3	71.0	79.6	85.2	87.9	87.7	84.5	78.4	69.3	93.0
4	74.5	82.6	87.9	90.5	90.3	87.3	81.6	73.0	95.7
5	79.2	86.9	92.0	94.5	94.3	91.5	86.1	77.9	99.8
6	83.9	91.1	95.8	98.1	98.0	95.4	90.4	82.9	103.6
7	86.1	93.2	97.9	100.2	100.1	97.5	92.6	85.1	105.7
8	86.4	93.5	98.2	100.5	100.4	97.8	92.9	85.5	106.0
≥9	86.5	93.5	98.1	100.4	100.4	98.0	93.3	86.2	106.0

Table 10-9 Sound Power Levels for the V117 4.2 MW turbine for 78 m hub height (Pinewoods Wind Farm)

Operational Wind Turbine Noise Criteria

With respect to the relevant guidance documents described in Section EIAR 10.3.1.2, noise criteria curves have been identified for the proposed development. The noise criteria curves for the NSLs have been derived following a detailed review of the background noise data conducted at the nearest NSLs.

This set of criteria has been derived in line with the intent of the relevant Irish guidance and best practice guidance (as described in Section EIAR 10.3.1.2). It is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála and local planning authorities in Ireland.

The planning condition for Pinewood Wind farm is also presented here for reference (PL11.248518):

19 The operation of the proposed development, by itself or in combination with any other permitted wind energy development, shall not result in noise levels, when measured externally at nearby noise sensitive locations, which exceed:
(a) Between the hours of 7am and 11pm:
i. the greater of 5 dB(A) $L_{90,10min}$ above background noise levels, or 45 dB(A) $L_{90,10min}$, at wind speeds of 7 metres per second or greater
ii. 40 dB(A) $L_{90,10min}$ at all other wind speeds
(b) 43 dB(A) $L_{90,10min}$ at all other times
where wind speeds are measured at 10 metres above ground level.

The following points were also taken into consideration when setting the noise criteria curves for the NSLs:

- 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'. Accounting for the difference in the noise parameters, the proposed lower threshold here, this is more than 3 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 (i.e. EPA NG4) 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.

Therefore, in summary, it is considered that the operational noise limits, as set out in Table 10-10 below, for the development cumulatively with other permitted windfarms in the area are appropriate:

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 or equal to 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).

Table 10-10 Proposed Noise Criteria Curves for the Ballynalacken Windfarm

Day and night time noise criteria curves have been determined and are presented in Table 10-11. These are the operational noise criteria that are applicable to this assessment.

House	Period	Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	9
H35	Day	40.0	40.0	45.0	45.0	45.0	45.0	46.4
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.6
H41	Day	40.0	40.0	45.0	45.0	45.0	47.5	50.7
	Night	43.0	43.0	43.0	43.0	43.0	43.1	48.1
H47	Day	40.0	40.0	45.0	45.0	45.0	49.3	53.2
	Night	43.0	43.0	43.0	43.0	43.0	46.0	55.6
H2	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	43.0
H18	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
H106	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	43.0
Worst Case Envelope	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

Table 10-11 Proposed Noise Criteria Curves for the Ballynalacken Windfarm

Assessment of Operating Wind Turbine Noise

The predicted noise levels for the Proposed Development have been calculated for all 159 No. noise sensitive locations (NSLs) identified within the 2km study area.

Predicted noise levels have been calculated using the ISO 9613-2 standard which represents worst-case conditions favourable to noise propagation (typically downwind propagation from source to receiver and/or downward refraction under temperature inversions).

A worst case 'omni-directional' assessment has been completed; this assumes that all noise sensitive locations are downwind of all turbines at the same time which is not possible because the NSLs surround the site but nevertheless the assessment considers the worst-case scenario. The predicted noise levels include predicted noise from consented Pinewood Windfarm which is not yet constructed.

The results of the noise prediction models have been compared against the turbine noise criteria that have been assigned to each of the NSLs in accordance with the criteria set out in Table 10-10 above.

The predicted noise levels at various wind speeds are compared against the noise criteria curves in Table 10-12 below.

Exceedances of the noise criteria are noted at 10 no. locations; in the Table 10-12, additional rows for these locations show the wind turbine noise criteria and the exceedances.

Figure 10.4 (found at the end of this chapter) shows the cumulative noise contours the wind speed of 9 m/s at standardised 10 m height, this being the wind speed at which the wind turbine reaches its maximum sound power level (See Section EIAR 10.2.3.1.).

Table 10-12 Cumulative Noise Prediction Model for all 159 No. NSLs and comparison with assigned Noise Criteria

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H001	Predicted	27.9	31.0	35.2	38.9	40.8	40.8	40.8
H002	Predicted	27.6	30.7	35.0	38.6	40.5	40.5	40.4
H003	Predicted	26.5	29.5	33.8	37.5	39.4	39.4	39.3
H004	Predicted	26.4	29.4	33.7	37.3	39.2	39.2	39.2
H005	Predicted	26.4	29.4	33.7	37.4	39.3	39.2	39.2
H006	Predicted	26.9	29.9	34.2	37.9	39.8	39.8	39.7
H007	Predicted	25.6	28.6	32.9	36.6	38.5	38.5	38.4
H008	Predicted	26.2	29.2	33.5	37.2	39.1	39.0	39.0
H009	Predicted	25.8	28.8	33.1	36.8	38.7	38.6	38.6
H010	Predicted	26.8	29.8	34.1	37.8	39.7	39.6	39.6
H011	Predicted	27.6	30.6	34.9	38.6	40.5	40.4	40.4
H012	Predicted	26.9	29.9	34.2	37.9	39.8	39.8	39.7
H013	Predicted	26.6	29.6	33.9	37.6	39.5	39.4	39.4
H014	Predicted	27.7	30.7	35.0	38.6	40.5	40.5	40.5
H015	Predicted	29.6	32.6	36.8	40.5	42.4	42.4	42.4
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.5	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H016	Predicted	29.5	32.5	36.8	40.4	42.4	42.3	42.3
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H017	Predicted	30.3	33.3	37.6	41.2	43.1	43.1	43.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	0.1	0.1
H018	Predicted	30.4	33.4	37.7	41.3	43.2	43.2	43.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.2	0.2	0.2

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H019	Predicted	31.0	34.1	38.4	42.0	43.9	43.9	43.8
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	2.0	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.9	0.9	0.8
H020	Predicted	29.2	32.2	36.5	40.2	42.1	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H021	Predicted	29.1	32.1	36.4	40.0	41.9	41.9	41.9
H022	Predicted	29.4	32.4	36.7	40.4	42.3	42.2	42.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H023	Predicted	28.8	31.8	36.1	39.7	41.6	41.6	41.6
H024	Predicted	29.0	32.0	36.3	40.0	41.9	41.8	41.8
H025	Predicted	29.1	32.1	36.4	40.0	42.0	41.9	41.9
H026	Predicted	29.1	32.1	36.4	40.0	42.0	41.9	41.9
H027	Predicted	29.1	32.1	36.4	40.0	41.9	41.9	41.9
H028	Predicted	28.6	31.7	36.0	39.6	41.5	41.5	41.4
H029	Predicted	27.9	30.9	35.2	38.8	40.7	40.7	40.7
H030	Predicted	27.5	30.5	34.8	38.4	40.4	40.3	40.3
H031	Predicted	27.4	30.5	34.8	38.4	40.3	40.3	40.2
H032	Predicted	27.5	30.5	34.8	38.5	40.4	40.4	40.3
H033	Predicted	24.9	26.4	32.1	34.4	36.3	36.3	36.2
H034	Predicted	25.9	27.2	33.0	35.1	37.0	37.0	37.0
H035	Predicted	27.3	29.1	34.4	37.0	39.0	39.0	38.9
H036	Predicted	27.5	30.1	34.8	38.0	40.0	39.9	39.9
H037	Predicted	29.5	32.3	36.8	40.2	42.1	42.1	42.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H038	Predicted	29.6	32.3	36.8	40.3	42.2	42.2	42.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H039	Predicted	29.2	32.0	36.5	39.9	41.8	41.8	41.8
H040	Predicted	29.0	31.8	36.2	39.7	41.6	41.6	41.6
H041	Predicted	28.7	31.4	35.9	39.4	41.3	41.3	41.2
H042	Predicted	28.3	31.1	35.6	39.1	41.0	40.9	40.9
H043	Predicted	28.8	31.7	36.1	39.6	41.6	41.5	41.5

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H044	Predicted	27.6	30.5	34.9	38.5	40.4	40.4	40.3
H045	Predicted	28.4	31.4	35.7	39.3	41.2	41.2	41.2
H046	Predicted	28.6	31.6	35.9	39.5	41.4	41.4	41.4
H047	Predicted	31.1	34.1	38.4	42.0	44.0	43.9	43.9
	Daytime Criterion	40	40	45	45	45	49.3	53.2
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	46	55.6
	Night-time Excess	--	--	--	--	1.0	--	--
H048	Predicted	27.0	30.0	34.3	38.0	39.9	39.9	39.8
H049	Predicted	29.0	32.1	36.4	40.0	41.9	41.9	41.9
H050	Predicted	23.4	26.5	30.8	34.4	36.4	36.3	36.3
H051	Predicted	23.0	26.1	30.4	34.0	36.0	35.9	35.9
H052	Predicted	22.8	25.9	30.2	33.8	35.8	35.7	35.7
H053	Predicted	22.2	25.2	29.5	33.2	35.1	35.0	35.0
H054	Predicted	21.7	24.7	29.0	32.7	34.6	34.6	34.5
H055	Predicted	19.8	22.9	27.2	30.9	32.8	32.8	32.8
H056	Predicted	21.5	24.6	28.9	32.5	34.4	34.4	34.4
H057	Predicted	24.9	27.9	32.2	35.8	37.8	37.7	37.7
H058	Predicted	25.1	28.2	32.5	36.1	38.0	38.0	38.0
H059	Predicted	24.6	27.6	31.9	35.6	37.5	37.4	37.4
H060	Predicted	24.4	27.4	31.7	35.4	37.3	37.2	37.2
H061	Predicted	23.5	26.5	30.8	34.5	36.4	36.4	36.3
H062	Predicted	23.0	26.0	30.3	34.0	35.9	35.8	35.8
H063	Predicted	22.5	25.5	29.8	33.5	35.4	35.4	35.3
H064	Predicted	21.6	24.6	28.9	32.6	34.5	34.4	34.4
H065	Predicted	21.5	24.6	28.9	32.5	34.4	34.4	34.4
H066	Predicted	21.2	24.2	28.5	32.2	34.1	34.1	34.1
H067	Predicted	21.7	24.7	29.0	32.7	34.6	34.6	34.6
H068	Predicted	22.3	25.3	29.6	33.3	35.2	35.2	35.1
H069	Predicted	21.6	24.7	29.0	32.7	34.6	34.5	34.5
H070	Predicted	20.9	23.9	28.2	31.9	33.8	33.8	33.8
H071	Predicted	21.3	24.3	28.6	32.3	34.2	34.2	34.2
H072	Predicted	20.9	24.0	28.3	32.0	33.9	33.8	33.8
H073	Predicted	18.7	21.7	26.0	29.7	31.6	31.6	31.6
H074	Predicted	18.6	21.7	26.0	29.7	31.6	31.6	31.6
H075	Predicted	20.2	23.2	27.6	31.2	33.2	33.1	33.1
H076	Predicted	20.3	23.3	27.6	31.3	33.2	33.2	33.2
H077	Predicted	19.1	22.1	26.5	30.1	32.1	32.0	32.0
H078	Predicted	19.2	22.2	26.5	30.2	32.1	32.1	32.1
H079	Predicted	20.0	23.0	27.3	31.0	32.9	32.9	32.8
H080	Predicted	20.3	23.4	27.7	31.4	33.3	33.2	33.2
H081	Predicted	20.0	23.0	27.3	31.0	32.9	32.9	32.8
H082	Predicted	21.0	24.0	28.4	32.0	33.9	33.9	33.9
H083	Predicted	21.2	24.2	28.5	32.2	34.1	34.1	34.1
H084	Predicted	21.5	24.6	28.9	32.5	34.4	34.4	34.4
H085	Predicted	22.6	25.6	29.9	33.6	35.5	35.5	35.4
H086	Predicted	22.5	25.6	29.9	33.5	35.4	35.4	35.4
H087	Predicted	23.0	26.1	30.4	34.0	36.0	35.9	35.9
H088	Predicted	25.4	28.4	32.7	36.3	38.2	38.2	38.2

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H089	Predicted	24.0	27.0	31.3	35.0	36.9	36.9	36.8
H090	Predicted	25.9	28.9	33.2	36.8	38.8	38.7	38.7
H091	Predicted	26.9	29.9	34.2	37.8	39.8	39.7	39.7
H092	Predicted	27.2	30.3	34.6	38.2	40.1	40.1	40.0
H093	Predicted	20.6	23.6	27.9	31.6	33.5	33.5	33.4
H094	Predicted	20.7	23.7	28.0	31.7	33.6	33.6	33.6
H095	Predicted	26.0	29.0	33.3	36.9	38.8	38.8	38.8
H096	Predicted	26.3	29.3	33.6	37.3	39.2	39.2	39.1
H097	Predicted	21.2	24.2	28.5	32.2	34.1	34.1	34.0
H098	Predicted	24.7	27.7	32.0	35.7	37.6	37.6	37.5
H099	Predicted	26.0	29.1	33.4	37.0	38.9	38.9	38.9
H100	Predicted	22.5	25.6	29.9	33.6	35.5	35.4	35.4
H101	Predicted	21.4	24.5	28.8	32.4	34.4	34.3	34.3
H102	Predicted	21.9	25.0	29.3	33.0	34.9	34.8	34.8
H103	Predicted	22.2	25.2	29.6	33.2	35.1	35.1	35.1
H104	Predicted	25.7	28.7	33.0	36.6	38.6	38.5	38.5
H105	Predicted	25.8	28.8	33.1	36.8	38.7	38.6	38.6
H106	Predicted	24.4	27.4	31.7	35.3	37.2	37.2	37.2
H107	Predicted	25.2	28.2	32.5	36.2	38.1	38.0	38.0
H108	Predicted	25.2	28.2	32.5	36.2	38.1	38.0	38.0
H109	Predicted	22.3	25.3	29.6	33.3	35.2	35.2	35.2
H110	Predicted	22.9	25.9	30.2	33.9	35.8	35.8	35.7
H111	Predicted	23.0	26.0	30.3	34.0	35.9	35.8	35.8
H112	Predicted	22.6	25.6	30.0	33.6	35.5	35.5	35.5
H113	Predicted	23.2	26.2	30.5	34.2	36.1	36.1	36.0
H114	Predicted	24.5	27.5	31.8	35.4	37.4	37.3	37.3
H115	Predicted	19.8	22.9	27.2	30.9	32.8	32.7	32.7
H116	Predicted	20.2	23.3	27.6	31.3	33.2	33.2	33.1
H117	Predicted	20.6	23.6	27.9	31.6	33.5	33.5	33.5
H118	Predicted	18.6	21.7	26.0	29.7	31.6	31.6	31.5
H119	Predicted	19.0	22.1	26.4	30.1	32.0	32.0	32.0
H120	Predicted	19.0	22.0	26.4	30.0	32.0	31.9	31.9
H121	Predicted	20.4	23.2	27.7	31.1	33.1	33.0	33.0
H122	Predicted	20.5	23.3	27.8	31.3	33.2	33.2	33.1
H123	Predicted	20.7	23.3	28.0	31.3	33.2	33.2	33.2
H124	Predicted	19.0	21.0	26.3	29.0	31.0	30.9	30.9
H125	Predicted	20.9	21.6	28.1	29.6	31.6	31.6	31.5
H126	Predicted	20.0	21.6	27.2	29.6	31.6	31.6	31.5
H127	Predicted	21.8	20.9	28.8	28.9	30.9	30.9	30.9
H128	Predicted	21.9	20.8	28.9	28.9	30.8	30.9	30.8
H129	Predicted	22.4	20.9	29.3	29.0	30.9	31.0	30.9
H130	Predicted	23.6	22.1	30.6	30.2	32.1	32.2	32.2
H131	Predicted	23.8	22.1	30.7	30.2	32.1	32.2	32.2
H132	Predicted	24.3	22.9	31.2	30.9	32.9	33.0	32.9
H133	Predicted	23.7	23.4	30.7	31.4	33.4	33.4	33.4
H134	Predicted	25.1	24.9	32.1	32.9	34.8	34.8	34.8
H135	Predicted	25.3	25.3	32.3	33.3	35.2	35.3	35.2
H136	Predicted	25.3	26.2	32.4	34.1	36.0	36.1	36.0
H137	Predicted	24.7	23.3	31.6	31.3	33.3	33.4	33.4
H138	Predicted	25.2	24.1	32.2	32.1	34.1	34.2	34.1

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H139	Predicted	24.6	25.2	31.6	33.1	35.1	35.1	35.1
H140	Predicted	26.4	28.0	33.6	35.9	37.9	37.9	37.8
H141	Predicted	27.1	29.2	34.4	37.2	39.1	39.1	39.1
H142	Predicted	27.1	29.7	34.4	37.7	39.6	39.6	39.5
H143	Predicted	25.6	27.6	32.8	35.6	37.5	37.5	37.4
H144	Predicted	25.5	28.5	32.8	36.4	38.4	38.3	38.3
H145	Predicted	21.0	24.1	28.4	32.1	34.0	34.0	33.9
H146	Predicted	20.9	23.9	28.3	31.9	33.8	33.8	33.8
H147	Predicted	21.3	24.4	28.7	32.4	34.3	34.2	34.2
H148	Predicted	23.6	26.6	30.9	34.5	36.4	36.4	36.4
H149	Predicted	20.9	23.9	28.2	31.9	33.8	33.8	33.8
H150	Predicted	21.7	24.8	29.1	32.8	34.7	34.6	34.6
H151	Predicted	20.9	23.9	28.2	31.9	33.8	33.8	33.8
H152	Predicted	19.5	22.6	26.9	30.6	32.5	32.5	32.4
H153	Predicted	18.9	22.0	26.3	30.0	31.9	31.9	31.9
H154	Predicted	19.4	22.4	26.7	30.4	32.3	32.3	32.3
H155	Predicted	19.3	22.4	26.7	30.3	32.3	32.2	32.2
H156	Predicted	19.0	22.0	26.4	30.0	31.9	31.9	31.9
H157	Predicted	18.6	21.7	26.0	29.7	31.6	31.5	31.5
H158	Predicted	18.7	21.8	26.1	29.8	31.7	31.6	31.6
H159	Predicted	19.3	22.4	26.7	30.4	32.3	32.3	32.2

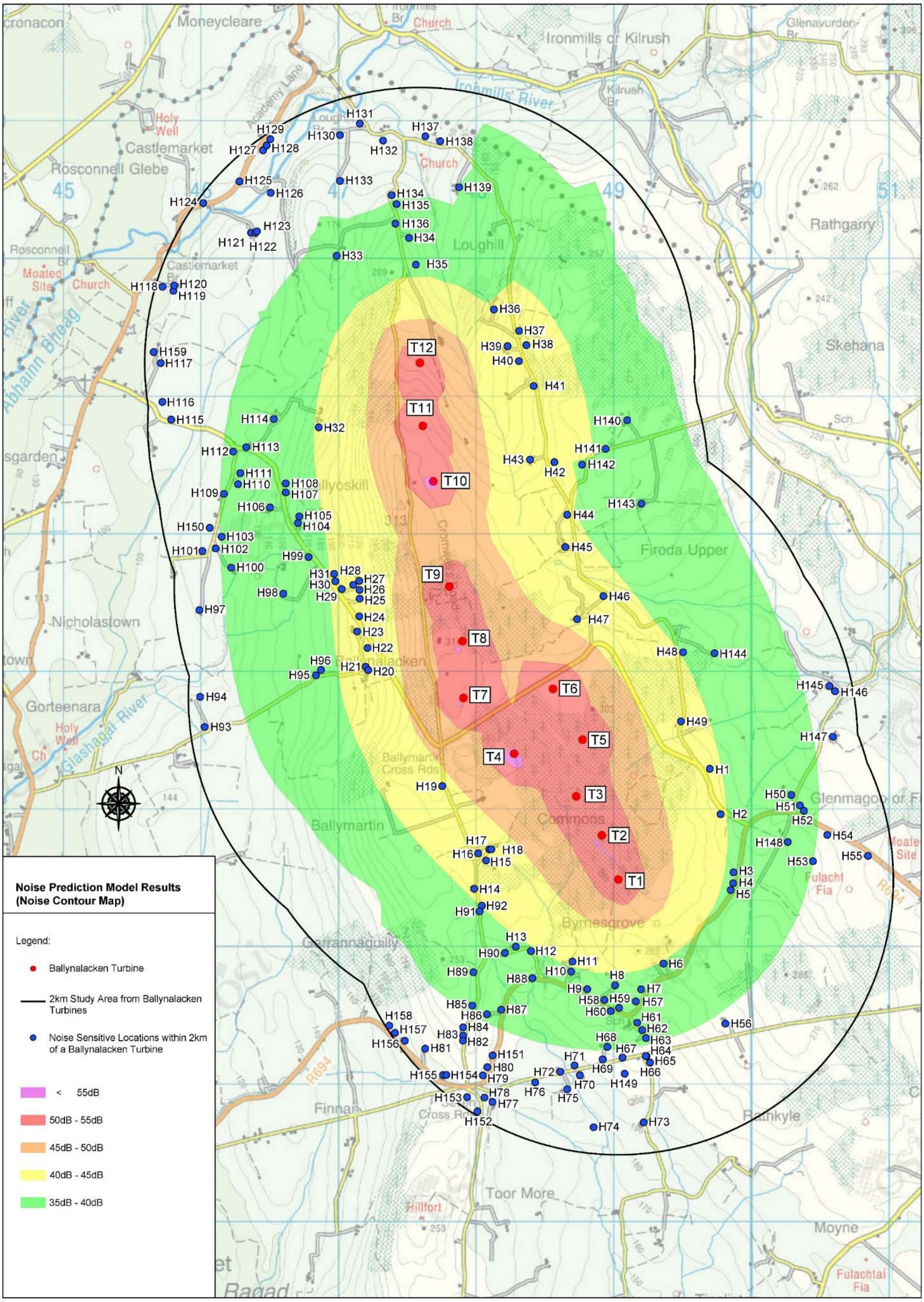


Figure 10.4 Noise Prediction Model Results (Noise Contour Map)

Assessment of Effects for omni-directional propagation analysis

With the exception of ten noise sensitive locations (NSLs) where marginal exceedance was found, noise levels from the operating turbines at the remaining NSLs were within the noise criteria curves. Therefore, with respect to the EPA's criteria for description of effects, the potential worst-case effects at these noise sensitive locations is considered **negative, not significant and long-term**.

For the set of ten locations where exceedances are noted an additional assessment was carried out, as described in the following sections.

Additional Assessment

Under worst case scenario omni-directional propagation, there are slight day-time exceedances at 10 No. NSLs of between 0.2 dB(A) and 2.0dB(A). It is predicted that there is marginal night-time exceedance of between 0.2 dB(A) and 1.0 dB(A) also at 4 No. NSLs. These exceedance values are immaterial and within the margin of error. See Table 10-13 showing predicted exceedance at H015, H016, H017, H018, H019, and H022, with the predicted daytime; night-time and the exceedance values.

Table 10-13 Cumulative Noise Prediction Model for NSLs with exceedances only

Location	Parameter	Predicted Noise Level (dB L_{A90}) for windspeed at standardised 10 m height (m/s)						
		3	4	5	6	7	8	9
H015	Predicted	29.6	32.6	36.8	40.5	42.4	42.4	42.4
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.5	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H016	Predicted	29.5	32.5	36.8	40.4	42.4	42.3	42.3
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H017	Predicted	30.3	33.3	37.6	41.2	43.1	43.1	43.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	0.1	0.1
H018	Predicted	30.4	33.4	37.7	41.3	43.2	43.2	43.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.2	0.2	0.2
H019	Predicted	31.0	34.1	38.4	42.0	43.9	43.9	43.8
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	2.0	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.9	0.9	0.8
H020	Predicted	29.2	32.2	36.5	40.2	42.1	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H022	Predicted	29.4	32.4	36.7	40.4	42.3	42.2	42.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H037	Predicted	29.5	32.3	36.8	40.2	42.1	42.1	42.1
	Daytime Criterion	40	40	40	40	45	45	45

	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H038	Predicted	29.6	32.3	36.8	40.3	42.2	42.2	42.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H047	Predicted	31.1	34.1	38.4	42.0	44.0	43.9	43.9
	Daytime Criterion	40	40	45	45	45	49.3	53.2
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	46	55.6
	Night-time Excess	--	--	--	--	1.0	--	--

Consideration of Wind Direction and Noise Propagation on 10 No. NSLs where marginal exceedance is predicted

This section discusses additional considerations in respect of the predicted noise levels at the 10 No. NSLs where marginal exceedance is predicted.

The analysis presented above for operational noise impact on all Noise Sensitive Locations (NSLs) is the worst-case scenario of omni-directional propagation. When considering noise impacts of wind turbines, the effects of propagation in different wind directions should be considered. The day to day operations of the proposed windfarm will not result in a worst-case condition of all NSLs being downwind of all turbines at the same time i.e. omni-directional predictions. Therefore, to address this and present a more realistic view, a review of expected noise levels downwind of the turbines has been prepared for various wind directions in accordance with the Institute of Acoustics Good Practice Guidance (IOA GPG).

For any given wind direction, a property can be assigned one of the following classifications in relation to turbine noise propagation:

- Downwind (i.e. 0° ±80°);
- Crosswind (i.e. 90° ±10° and 270° ±10°);
- Upwind (i.e. 180° ±70°).

Figure 10.5 (over) illustrates the directivity attenuation factor that has been applied to turbines when considering noise propagation in downwind conditions (downwind is represented by 0° with upwind being 180°).

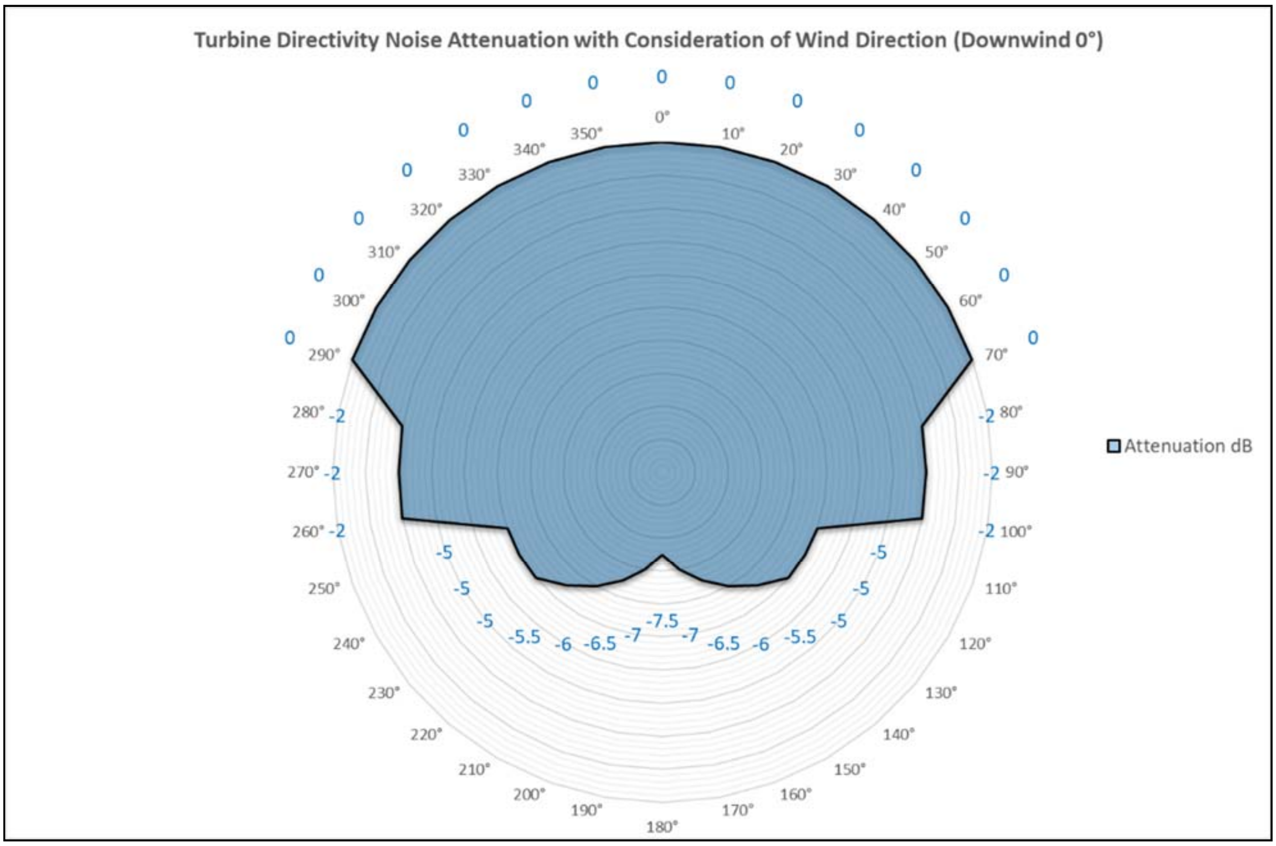


Figure 10.5 Directivity Attenuation Factor

Additional noise prediction models have been developed to account for the directional pattern shown in the above **Figure 10.5**.

The following tables - Table 10-14 – Table 10-20 present the results for the NSL where exceedances are noted in Table 10-13. For daytime periods, there are no exceedances in the south and northwest directions. For night-time periods, there are no exceedances in the southeast and northwest directions.

Table 10-14 Cumulative Predicted Directional Noise Levels – North wind direction

House	Parameter	Derived $L_{A90,10-min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H017 Stakeholder	Predicted	29.8	32.8	37.1	40.7	42.6	42.6	42.6
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.7	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H018 Stakeholder	Predicted	29.8	32.8	37.1	40.7	42.6	42.6	42.6
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.7	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H019	Predicted	30.6	33.7	38.0	41.6	43.5	43.5	43.4
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.6	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.5	0.5	0.4

Table 10-15 Cumulative Predicted Directional Noise Levels – Northeast wind direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H015	Predicted	29.6	32.6	36.8	40.5	42.4	42.4	42.4
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.5	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H016 Stakeholder	Predicted	29.5	32.5	36.8	40.4	42.4	42.3	42.3
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H017 Stakeholder	Predicted	30.3	33.3	37.6	41.2	43.1	43.1	43.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	0.1	0.1
H018 Stakeholder	Predicted	30.4	33.4	37.7	41.3	43.2	43.2	43.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.2	0.2	0.2
H019	Predicted	31.0	34.1	38.4	42.0	43.9	43.9	43.8
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	2.0	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.9	0.9	0.8
H020	Predicted	29.1	32.1	36.4	40.1	42.0	41.9	41.9
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.1	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H022	Predicted	29.1	32.1	36.4	40.1	42.0	41.9	41.9
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.1	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--

Table 10-16 Cumulative Predicted Directional Noise Levels – East wind direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H016 Stakeholder	Predicted	29.2	32.2	36.5	40.1	42.1	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.1	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H017 Stakeholder	Predicted	29.8	32.8	37.1	40.7	42.6	42.6	42.6
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.7	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H018 Stakeholder	Predicted	29.9	32.9	37.2	40.8	42.7	42.7	42.7
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.8	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
	Night-time Excess	--	--	--	--	--	--	--
H019	Predicted	30.6	33.7	38.0	41.6	43.5	43.5	43.4
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	1.6	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.5	0.5	0.4
H020	Predicted	29.2	32.2	36.5	40.2	42.1	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H022	Predicted	29.4	32.4	36.7	40.4	42.3	42.2	42.2
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.4	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--

Table 10-17 Cumulative Predicted Directional Noise Levels – Southeast direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H019	Predicted	29.7	32.8	37.1	40.7	42.6	42.6	42.5
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.7	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--

Table 10-18 Cumulative Predicted Directional Noise Levels – South direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H047 Stakeholder	Predicted	30.5	33.5	37.8	41.4	43.4	43.3	43.3
	Daytime Criterion	40	40	45	45	45	49.3	53.2
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	46	55.6
	Night-time Excess	--	--	--	--	0.4	--	--

Table 10-19 Cumulative Predicted Directional Noise Levels – Southwest direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H037 Stakeholder	Predicted	29.4	32.2	36.7	40.1	42.0	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.1	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H038	Predicted	29.6	32.3	36.8	40.3	42.2	42.2	42.1
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.3	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H047	Predicted	31.0	34.0	38.3	41.9	43.9	43.8	43.8

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
Stakeholder	Daytime Criterion	40	40	45	45	45	49.3	53.2
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	46	55.6
	Night-time Excess	--	--	--	--	0.9	--	--

Table 10-20 Cumulative Predicted Directional Noise Levels – West direction

House	Parameter	Derived $L_{A90,10\text{-}min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds						
		3	4	5	6	7	8	≥9
H037 Stakeholder	Predicted	29.4	32.2	36.7	40.1	42.0	42.0	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.1	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H038	Predicted	29.5	32.2	36.7	40.2	42.1	42.1	42.0
	Daytime Criterion	40	40	40	40	45	45	45
	Daytime Excess	--	--	--	0.2	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	--	--	--
H047 Stakeholder	Predicted	30.7	33.7	38.0	41.6	43.6	43.5	43.5
	Daytime Criterion	40	40	45	45	45	49.3	53.2
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	46	55.6
	Night-time Excess	--	--	--	--	0.6	--	--

Discussion on Results of the additional assessment on 10 No. NSLs

The results in Tables 10-14 to 10-20 show that once the effect of wind direction on noise propagation in taken into account, the only remaining potential exceedances are:

For daytime periods:

- North wind directions: H017, H018 and H019
- Northeast wind directions: H015, H016, H017, H018, H019, H020 and H022
- East wind directions: H016, H017, H018, H019, H020 and H022
- Southeast wind directions: H019
- Southwest wind directions: H037 and H038
- West wind directions: H037 and H038

For night-time periods:

- North wind directions: H019
- Northeast wind directions: H017, H018, and H019
- East wind directions: H019
- South wind directions: H047
- Southwest wind directions: H047
- West wind directions: H047

For daytime periods, there are no exceedances in the south and northwest directions. For night-time periods, there are no exceedances in the southeast and northwest directions.

EIAR 10.3.1.3.1.1 Assessment of Effects on 10 No. NSLs showing exceedances

As discussed in *Section EIAR 10.3.1.2.1.7: Good Practice for Operational Noise Predictions*, it noted again that the noise prediction calculations have been made using the ISO 9613-2 standard and relate to conditions favourable to noise propagation (typically downwind propagation from source to receiver and/or downward refraction under temperature inversions). A +2 dB uncertainty has been applied to turbine emissions in line with the IOA GPG.

The remaining exceedances are as follows:

- At H015, potential exceedances of up to 0.5 dB L_{A90} in northeast wind direction are indicated
- At H016, potential exceedances of up to 0.5 dB L_{A90} in northeast and east wind direction are indicated
- At H017, potential exceedances of up to 1.2 dB L_{A90} in north, northeast and east wind direction are indicated
- At H018, potential exceedances of up to 1.3 dB L_{A90} in north, northeast and east wind direction are indicated
- At H019, potential exceedances of up to 2.0 dB L_{A90} in north, northeast, east and southeast wind directions are indicated.
- At H020, potential exceedances of up to 0.2 dB L_{A90} in northeast and east wind directions are indicated.
- At H022, potential exceedances of up to 0.4 dB L_{A90} in northeast and east wind direction are indicated.
- At H037, potential exceedances of up to 0.1 dB L_{A90} in southwest and west wind directions are indicated.
- At H038, potential exceedances of up to 0.3 dB L_{A90} in southwest and west wind direction are indicated.
- At H047, potential exceedances of up to 0.9 dB L_{A90} in south, southwest and west wind direction are indicated.

With the exception of the NSLs listed above, it is considered that no significant effect is associates with the operation of the proposed development, as the predicted noise levels associated with the proposed development will be within the relevant best-practice noise criteria for wind farms. The noise effects at the majority of NSLs are negative, not significant and long-term.

At the NSLs listed above, where exceedances of 0.1 to 2.0 dB L_{A90} are predicted, simply as the wind farm noise levels exceed the criteria, the noise effects are considered negative, significant and long-term and mitigation measures are required.

Mitigation measures to reduce noise levels to within criteria are discussed hereunder.

EIAR 10.3.1.3.1.2 Operating Turbine Noise Mitigation Measures

The noise predictions provided above, are based on turbine operating in normal sound power mode with no restrictions. The findings of the assessment confirmed that the predicted operational noise levels from the Proposed Development at 149 of the 159 No. Noise Sensitive Locations (NSLs) will not exceed the day or night noise criteria.

At the remaining 10 No. of NSLs, marginal exceedance is predicted to occur in certain wind direction conditions. 5 No. of these locations are stakeholders in the project.

Although exceedances are predicted in these 10 NSL cases, mitigation can be put in place to address these exceedances, if they are confirmed by commissioning noise surveys. Modern wind turbines are available with a range of sound power operating modes which can be deployed if required to reduce noise output when exceedance is predicted by the wind turbine's computer SCADA software. Implementation of specified sound power modes resulting in curtailment of the operation of the wind turbine, can be implemented for specified turbines operating in specified wind conditions.

An outline noise curtailment strategy developed to eliminate the incidences of exceedance at the 10 No. NSLs is presented in Table 10-21 and Table 10-22 (over):

Table 10-21 Indicative Curtailment Matrix for Daytime Periods

Turbine	Reduction in dB (and Mode name) at 6 m/s windspeed at standardised 10m height							
	N	NE	E	SE	S	SW	W	NW
T1	--	--	--	--	--	--	--	--
T2	--	--	--	--	--	--	--	--
T3	--	SO2	SO2	--	--	--	--	--
T4	SO3	SO3	SO3	SO2	--	--	--	--
T5	--	SO1	--	--	--	--	--	--
T6	--	SO1	--	--	--	--	--	--
T7	SO3	SO3	SO3	--	--	--	--	--
T8	--	SO2	--	--	--	--	--	--
T9	--	--	--	--	--	--	--	--
T10	--	--	--	--	--	--	--	--
T11	--	--	--	--	--	--	--	--
T12	--	--	--	--	--	SO1	SO1	--

Table 10-22 Indicative Curtailment Matrix for Night-time Periods

Turbine	Reduction in dB (and Mode name) at 7, 8 and 9 m/s windspeed at standardised 10m height							
	N	NE	E	SE	S	SW	W	NW
T1	--	--	--	--	--	--	--	--
T2	--	--	--	--	--	--	--	--
T3	--	--	--	--	--	--	--	--
T4	SO3	SO2	SO2	--	--	--	--	--
T5	--	--	--	--	--	--	--	--
T6	--	--	--	--	SO1*	SO2*	SO2*	--
T7	--	SO1**	--	--	--	--	--	--
T8	--	--	--	--	--	--	--	--
T9	--	--	--	--	--	--	--	--
T10	--	--	--	--	--	--	--	--
T11	--	--	--	--	--	--	--	--
T12	--	--	--	--	--	--	--	--

*Note that modes in S, SW and W directions apply for windspeed of 7 m/s only.

** 9 m/s only.

With these mitigation measures in place, the predicted noise levels at 6m/s for daytime periods are presented in Table 10-23 (for daytime periods) and Table 10-24 (for nighttime periods) taking account of the curtailment. Similar predicted results apply to 8 and 9 m/s standardised wind speeds.

Table 10-23 Predicted Residual Noise Levels for Daytime Periods

Parameter	Predicted $L_{A90,10\text{-}min}$ Levels (dB) at 6 m/s Standardised 10m Height Wind Speeds							
	N	NE	E	SE	S	SW	W	NW
H015	39.3	39.2	39.0	38.1	35.9	34.5	35.9	38.8
H016	39.1	39.1	39.0	38.1	35.9	34.5	35.5	38.7
H017	39.8	39.9	39.7	38.9	36.8	35.3	36.6	39.4
H018	39.9	40.0	39.8	39.0	37.0	35.4	36.8	39.5
H019	39.9	40.0	39.8	39.8	37.5	36.1	37.3	39.6
H020	38.1	38.5	39.2	39.4	37.7	34.7	34.2	36.2
H022	38.2	38.8	39.6	39.4	38.3	35.3	34.4	36.7
H037	35.2	33.6	34.6	37.3	40	39.9	39.8	39.0
Daytime Criterion	40	40	40	40	40	40	40	40
Daytime Excess	--	--	--	--	--	--	--	

Table 10-24 Predicted Residual Noise Levels for Night-time Periods

Parameter	Predicted $L_{A90,10\text{-}min}$ Levels (dB) at 7 m/s Standardised 10m Height Wind Speeds							
	N	NE	E	SE	S	SW	W	NW
H017	41.9	42.5	42.1	41.0	38.7	37.1	38.4	41.4
H018	42.0	42.6	42.2	41.1	38.9	37.2	38.6	41.5
H019	42.5	43.0	42.4	42.5	39.4	37.9	39.1	41.5
H047	39.5	38.3	39.3	42.8	42.9	42.8	42.4	41.2
Night-time Criterion	43	43	43	43	43	43	43	43
Night-time Excess	--	--	--	--	--	--	--	

The outline curtailment matrix and residual noise levels presented above shows that it is possible for the proposed development to comply with the wind turbine noise criteria presented in Table 10-11.

The above mitigation, identified as OMM17 in Chapter 19 Mitigation & Monitoring Arrangements, as:

OMM17: A noise curtailment strategy will be developed and implemented to ensure that the operating windfarm complies with the prescribed operational noise criterion. In order to develop this strategy: (i) a pre-construction noise survey will be carried out to establish the background noise levels and to confirm the applicable wind turbine noise criteria at identified Noise Sensitive Locations (NSL) and (ii) following the commissioning of the Project and the commencement of operation of the wind farm, a second noise survey will be carried out at the NSLs to establish compliance with the noise limit conditions applied to the development. This survey will be carried out according to the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014).

Where exceedances are confirmed during surveys, then appropriate sound power operating modes will be activated for specified turbines operating in specified wind conditions as required to reduce noise output when exceedance at a NSL is predicted by the wind turbines computer SCADA software. A third noise survey will be carried following the activation of sound power modes to confirm the effectiveness of the curtailment strategy.

This mitigation measured will ensure that operating windfarm noise levels at noise sensitive locations (NSLs) which are prescribed either by planning condition or other required noise criterion, are achieved.

EIAR 10.3.1.3.1.3 Residual Impact (noise from operating turbines)

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

It is concluded that, while noise levels at low wind speeds will increase due to the operation of the turbines, the predicted levels of noise in the local environment will remain low, albeit new sources of noise will be introduced into the soundscape. **The predicted residual operational turbine noise effects at the closest NSLs are considered to be negative, not significant and 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 and impacts in the worst-case scenario.

EIAR 10.3.1.3.2 Special Characteristics – Low Frequency Noise and Infrasound

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200 Hz. Infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it must be at very high amplitude, and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance. However, wind turbines do not produce infrasound at amplitudes capable of causing annoyance as outlined in the following paragraphs.

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms'[1], concluded that:

infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion.

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 (Berglund & Lindvall, 1995)** has stated that:

"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects" and that "it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour"

The **Environmental Noise Guidelines (WHO, 2018)** states the following in relation to infrasound from wind turbines:

Wind turbines can generate infrasound or lower frequencies of sound than traffic sources. However, few studies relating exposure to such noise from wind turbines to health effects are available. It is also unknown whether lower frequencies of sound generated outdoors are audible indoors, particularly when windows are closed.

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

[1] W/45/00656/00/00, The Measurement of Low Frequency Noise at Three UK Windfarms, Department of Trade and Industry, 2006

JS2009). The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. The article notes the following with respect to infrasound:

> *"Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.*
> *Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low-frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view."*

The article concludes that:

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

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."*

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

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

In conclusion, there is a significant body of evidence to show that the infrasound and low-frequency noise associated with wind turbines will be below perceptibility thresholds and typically in line with existing baseline levels of infrasound and low-frequency noise within the environment and therefore need not be considered further in this assessment.

EIAR 10.3.1.3.3 Special Characteristics – Amplitude Modulation

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

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

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

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

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

'Normal' AM An observer at ground level close to a wind turbine will be aware of 'blade swish' because of the directional characteristics of the noise from the tip of the blade as it rotates towards and then away from the observer. This tends to become less noticeable with increasing distance such that it is often not normally a significant feature at sensitive locations, at least on relatively level sites.

The RenewableUK AM project (RenewableUK, 2013)[2] 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 a form of AM is observed at residential 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 OAM

Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the UK Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of OAM 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

[2] Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines - Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect, Report for Renewable UK, December 2013

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 OAM was confirmed as an issue, it was considered that conditions associated with OAM 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 OAM is a rare and unlikely occurrence at operational wind farms.**

It should be noted that OAM is associated with wind turbine operation and there is no method for predicting OAM at any particular location before turbines begin operation due to the general features of a site or the known attributes of a particular turbine. 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 (von Hunerbein *et al*. 2013) 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 D "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 (Other AM) 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."

Guidance on Amplitude Modulation (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 Reference Method)". The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation. At present there is no method for predicting AM at any particular location before turbines begin operation due to the general features of a site or the known attributes of a particular turbine.

Therefore an appropriate approach is to develop monitoring and mitigation measures in the event of AM in the following Section.

Where it occurs, AM is typically an intermittent occurrence, therefore monitoring and 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 important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation, in the unlikely event that amplitude modulation occurs.

Amplitude Modulation Mitigation Measures

OMM18: In the event of a complaint which indicates potential amplitude modulation (AM) associated with turbine operation, the windfarm operator will employ an independent acoustic consultant to assess the level of AM experienced by the complainant in accordance with the methods outlined in the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, "Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group

Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016)" or subsequent revisions.

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

The mitigation measures, if required, will consist of the implementation of operational controls on specified turbines, which will curtail or stop the relevant turbines under specific operational conditions, so that OAM at noise-sensitive locations is eliminated.

Amplitude Modulation Residual Effect

Although no Amplitude Modulation (AM) is expected to occur at sensitive locations, if a complaint arises, the matter will be investigated and mitigation measures will be put in place. **Therefore the residual impact of any AM experienced will not be significant.**

EIAR 10.3.1.3.4 Noise from the operational Tinnalintan Substation

Details of the proposed Tinnalintan Substation are described in Chapter 5 of the EIAR (Description of the Development). The noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the Tinnalintan Substation.

As part of the Proposed Development, the Tinnalintan Substation will be operational on a continuous basis. The noise emission level associated with a typical 110kV substation that would support a development of this nature is the order of 93 dB(A) L_W (sound power level). An earth berm of 2m height and a solid fence of 2m on top of the berm are proposed along the northwestern boundary of the substation area.

Noise prediction calculations for the operation of the Tinnalintan Substation have been undertaken in accordance with *ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors* (ISO, 2024). The set of NSLs near the substation are as presented in **Figure 10.6** below. Predicted noise levels are presented in Table 10-25 below.

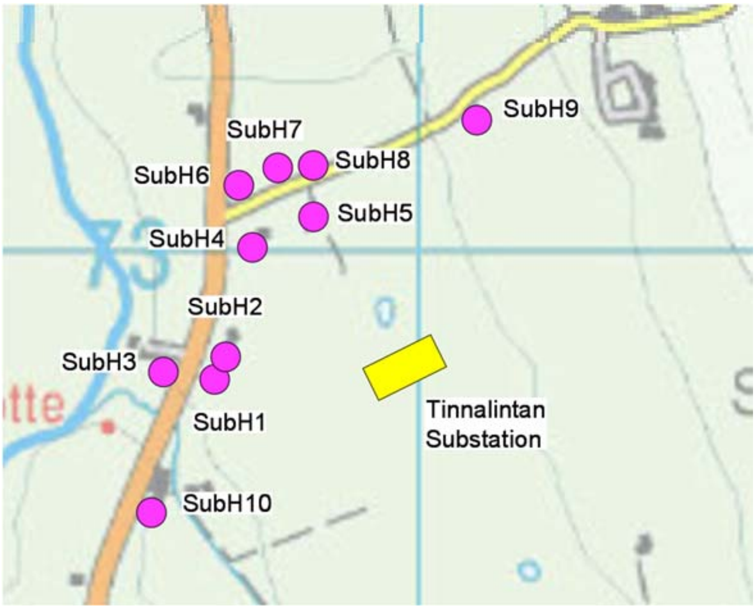


Figure 10.6 Substation and nearby NSLs

Name	Distance from Tinnalintan Substation (m)	Day dB L_{Aeq}
SubH1	253	30
SubH2	234	29
SubH3	340	27
SubH4	279	27
SubH5	270	28
SubH6	377	25
SubH7	370	26
SubH8	350	26
SubH9	375	25
SubH10	432	30

Table 10-25 Predicted noise levels due to substation

The highest predicted noise level from the operation of the substation at the nearest NSL is 30 dB L_{Aeq}. In selecting a suitable criterion for substations, reference is made to EPA Noise Guidance note NG4 where a noise criterion of 35 dB L_{Aeq} for night-time periods is stipulated.

The highest predicted noise level due to the operation of the substation is below the criteria for night-time noise.

Additionally, due to the separation distance between the turbines and the Tinnalintan Substation, there will be no cumulative impact of operational noise because there is no overlap between the noise sensitive locations (NSls) assessed for operational substation and NSLs assessed for operational turbines. See **Figure 10.2 Location of Noise Sensitive Locations (NSL) in relation to Ballynalacken Turbines and Tinnalintan Substation (Section EIAR 10.3 above).**

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the proposed substation is described as **negative, not significant and long-term**

The operating Tinnalintan Substation will be negligible at the nearest NSL and therefore mitigation measures are not required

Residual Impact: In relation to the proposed substation location the associated effect at the closest NSLs is **negative, not significant and long-term.**

EIAR 10.3.1.3.5 Noise from Construction Works

Construction noise prediction calculations have been conducted using the methodology outlined in Appendix 10.1 Methodology for the evaluation of Noise – Construction Phase. 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.

There are several stages and elements associated with the construction phase of the Proposed Development which will include the following:

- Construction of turbines and hardstand areas;
- Construction of internal roads;
- Operation of borrow pits;
- Construction of substation; and
- Construction Traffic

Detailed information is included in Chapter 5: Description of the Development.

In general, the distances between the construction activities associated with the Proposed Development and the nearest Noise Sensitive Locations (NSLs) are such that it is not expected that there will be significant noise and vibration impacts at NSLs. These NSLs can be found on Figure 10.7: Construction Phase Noise Sources at the end of this Chapter.

The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration impacts, all other stages and elements are considered not to have potential for significant noise and vibration impacts at NSLs.

It should be noted that construction activities will be carried out during normal daytime working hours (i.e., weekdays 0700 – 1900hrs and Saturdays 0800 – 1650hrs). However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (e.g., concrete pours) or to accommodate delivery of large turbine 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 Kilkenny County Council.

Noise from the construction of Turbines and Hardstands

Several 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 closest noise-sensitive receptor is location H047, situated approximately 535m from the proposed turbine T6.

Table 10-26 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations in this and the following construction noise tables have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Item (BS 5228-1 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)
			535 m (nearest NSL)
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	37
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	35

Item (BS 5228-1 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)
			535 m (nearest NSL)
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	43
Piling Operations (C.12.14)	Piling Foundations (if required).	89	47
General Construction (Various)	All general activities plus deliveries of materials and plant	84	42
Dumper Truck (C.4.4)	Moving fill	76	34
Mobile Telescopic Crane (C.4.39)	Turbine construction	77	35
Dewatering Pumps (D.7.70)	If required.	80	38
JCB (D.8.13)	For services, drainage and landscaping.	82	40
Vibrating Rollers (D.8.29)	Road surfacing.	77	35
Total			51

Table 10-26 Typical Wind Farm Turbine Construction Noise Emission Levels

At 535m from the works, the predicted noise levels at this house from construction activities are in the range of 34 to 47 dB $L_{Aeq,1hr}$ with a total worst-case cumulative construction level of the order of 51 dB $L_{Aeq,1hr}$. In all instances the predicted noise levels at the nearest NSLs are below the appropriate criteria outlined in Appendix 10.1 Table 1 (Category A - 65 dB $L_{Aeq,1hr}$ during daytime periods). This assessment is considered representative of worst-case construction noise levels at NSLs.

Pre-Mitigation Impact: 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 10-26 and this finding is valid should all items of plant operate simultaneously.

Noise from the Construction of Internal Site Roads

It is proposed to construct new and to upgrade existing internal roads to access the various parts of the development. Review of the track layout has identified that the nearest NSL to any point along the proposed roads are:

- H44 at a distance of 14m;
- H17 at a distance of 14m;
- H18 at a distance of 18m;
- H16 at a distance of 30m; and
- H45 at a distance of 64m.

Note, the five NSLs identified above are all stakeholders and involved with the project.

Also a length of approximately 360 m of new road is proposed to join the proposed substation to the local road off the R423 at Coole. There is an NSL (SubH9) at 57m distance from this new road.

All other locations are at greater distances with the majority at significantly greater distances. The full description of the new and upgraded roads can be found in Chapter 5 and Chapter 5 Figures: Description of the Development.

Table 10-27 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Item (BS 5228-1 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)			
			14 m	18 m	30 m	60 m
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials	79	74	72	67	61
Tracked Excavator (C.4.64)	Excavation / filling	77	72	70	65	59
Vibrating Rollers (D.8.29)	Road surfacing	77	72	70	65	59
Total			**78**	**76**	**71**	**65**

Table 10-27 Indicative Noise Levels from Construction Plant at Various Distances from the New Internal Access Track Works

Significance of the Pre-Mitigation Impact: It should be noted that the effect is variable, and that this assessment considers the locations of the greatest potential impact. It is evaluated that the potential worst-case effects at the nearest noise sensitive locations associated with construction of turbines, hardstanding areas and internal site roads are described as **negative, not significant and short-term**.

Noise from Construction Traffic

This section of the report 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 peak construction traffic flows, which apply to more intense periods of construction activity such as concrete poring of turbine bases are commented upon here

Based on information in Appendix 16.1: Traffic and Transport Assessment, changes in traffic noise levels associated with the additional traffic for each of the construction situations listed above have been calculated. Table 10-28 presents a summary of the traffic noise calculations.

Construction Activity	Route	Existing 24Hr 2-way AADT	Existing + Construction Traffic	Increase in Noise Level
Peak	R694	1,353	1,667	+0.9
Peak	R432	1,027	1,043	+0.1
Peak	L5846	136	450	+5.2
Peak	L5840	31	219	+8.5
Peak	L5845	62	188	+4.8
Peak	L58442	74	90	+0.9

Table 10-28 Estimated Changed to Traffic Noise Levels due to Construction

In the case of routes R694, R423 and L58442, the increases in noise level are less than 1dB and therefore, according to the criteria in Appendix 10.1 Table 4, the noise effects will be **imperceptible**.

At road links L5846, L5840 and L5845, where greater increases in noise level are predicted, it is noted that the existing traffic volumes are low; in these instances it is appropriate to consider the absolute traffic noise level.

The potential noise impact of HGV movements along these roads is assessed through consideration of the cumulative noise level associated with a series of individual events.

The noise level associated with an event of short duration, such as a vehicle drive-by, may be expressed in terms of its Sound Exposure Level (SEL) (LAx). The SEL can be used to calculate the contribution of an event or series of events to the overall noise level in a given period. The appropriate formula is as follows.

$$L_{Aeq,T} = L_{Ax} + 10\log_{10}(N) - 10\log_{10}(T) - 10\log_{10}(r_2/r_1) - S \text{ dB}$$

Where:

$L_{Aeq,T}$	is the equivalent continuous sound level over the time period T (s);
L_{Ax}	is the "A-weighted" Sound Exposure Level of the event under consideration (dB);
N	is the number of events over the course of time period T.
r_2	is the distance from the edge of the entrance road to the facade of nearest property
r_1	is the distance from vehicle to the point of original measurement
S	is the attenuation due to screening

The mean value of Sound Exposure Level for a HGV at low speeds is of the order of 85 dB L_{Ax} at a distance of 5m from the edge of the road. This figure is based on a series of measurements conducted under controlled conditions. Based on the 'Existing + Construction Traffic' values above, considered over an 12-hour period, the predicted noise levels at 5m from the edge of the routes are:

- 65 dB $L_{Aeq,8hr}$ at L5846
- 62 dB $L_{Aeq,8hr}$ at L5840
- 61 dB $L_{Aeq,8hr}$ at L5845

These predicted noise levels are in the range 61 to 65 dB $L_{Aeq,8hr}$ for peak construction activity, are within the relevant construction noise criteria (65 dB $L_{Aeq,1hr}$).

Significance of the Pre-Mitigation Impact: With respect to the EPA's criteria for description of effects, the potential worst-case construction traffic noise impact at the nearest NSLs are described **negative, not significant and short-term.**

Noise from Borrow Pits Activity

To inform this aspect of the proposal a comparative noise assessment has been prepared and is outlined in the following paragraphs. Rock breaking at the 2 No. borrow pits is considered. It is not anticipated that blasting will be required. In terms of rock break activities please note the following:

- A mobile crusher will operate on site.
- Two rock breakers will be in use on site during daytime periods.

For the purposes of this assessment, we have assumed the plant indicated in Table 10-30, is working simultaneously in the vicinity of all proposed borrow pit locations. Table 10-30 outlines the assumed noise levels for the plant items as extracted from BS5228-1 (BSI 2014a).

Borrow Pit Ref	Co-ordinates (ITM)	
	Easting	Northing
1	648097	675708
2	648712	674714

Table 10-29 Proposed Borrow Pit Locations

Item	BS 5228-1 Ref.	Sound Pressure Level at 10m from Source, dB $L_{Aeq,1hr}$
Excavator	Tracked Excavator (C2.21)	71
Stockpiling bulk material	Dozer (C8.9)	74
Loading into crusher	Shovel (C.10.5)	80
Crushing	Tracked Semi-Mobile Crusher (C.9.14)	90
Stockpiling crushed material	Dozer (C8.9)	74
Loading into crusher	Shovel (C.10.5)	80
Loading Dumpers	Dump Truck (C.9.20)	90
Transport	HGV Movement (C.2.30)	79
Generator	Diesel Generator (C.6.39)	65
Rock Breaking	Excavator-mounted Rock Breaker C9.12	85

Table 10-30 Borrow Pit Plant Noise Emissions

A construction noise model has been prepared to consider the expected noise emissions from the proposed construction works for rock breaking. A percentage on-time of 66% has been assumed for the noise calculations. The results at the 10 no. NSLs with the highest predicted noise levels are presented in Table 10-31.

Location Ref.	Approx. Distance from nearest Borrow Pits	Predicted Noise Level (dB $L_{Aeq,1hr)}$
H045	494	54
H047	596	53
H044	642	51
H046	687	50
H042	911	47
H142	933	47
H019	1105	46
H143	1128	46
H043	874	45
H141	1186	45

Table 10-31 Prediction Noise Levels from Borrow Pit Activity at Nearest NSLs to Borrow Pits

Review of the results contained in Table 10-31 confirm that the predicted construction noise levels for rock breaking are well within the relevant construction noise criteria (65 dB $L_{Aeq,1hr}$). It is assumed that construction works at the borrow pit will only occur during daytime periods only (07:00 to 19:00hrs).

Significance of the Pre-Mitigation Impact: Therefore, the potential worst-case effects at the nearest NSLs associated with the operation of borrow pits is considered to be **negative, not significant and short-term**.

Noise from the construction of Tinnalintan Substation

The substation is to be located at Tinnalintan. The nearest NSLs to the proposed substation is 234 m from the substation SubH2. As a worst-case example assuming the same construction activities as outlined in *Table 10-26 Typical Wind Farm Turbine Construction Noise Emission Levels,* it is predicted that the potential noise levels from construction activities associated with the substation will be in the order of 58 dB $L_{Aeq,1hr}$ at the NSL. This level of noise is within the within the relevant construction noise criteria (65 dB $L_{Aeq,1hr}$). Therefore, it is considered that the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of the substation are **negative, not significant and temporary.**

Noise from cable construction works

Cabling works will predominately be linear and will progress quickly, and will be carried out during regular working hours. The main item of plant to be used will be an excavator, which will emit 71dB of noise at a separation distance of 10m. This is a piece of machinery with similar noise emissions to an agricultural tractor, which are commonplace in the area. It is considered that the potential worst cabling noise impact at the nearest NSLs are described **negative, not significant and temporary**.

Mitigation Measures for Construction Noise

Regarding construction activities, reference shall be made to BS5228-1 (BSI 2014a), 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:

ID	Mitigation Measure/Monitoring Arrangement
SM24	All plant and machinery which will be used during construction will be fit for purpose and in good working order prior to mobilisation to works areas.
SM25	Monitoring of noise and vibration will be carried out at a number of nearby residences during critical periods of the construction works.
MM48	Construction operations shall generally be restricted to between 0700-1800hrs Monday to Friday, and 0700-1400hrs on Saturdays. Site activities which are likely to create high levels of noise or vibration will be limited to these hours of operation. 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.
MM49	A Community Liaison Officer (CLO) will be appointed. The CLO will liaise with and keep the local community up-to-date with relevant construction work schedules, through the use of signage at selected Site Entrances, letter drops to nearest neighbours and through the Project website which will be kept up-to date. The CLO will be the point of contact for local residents for matters relating to noise and vibration. The Environmental Clerk of Works will liaise with the CLO and will be the point of contact between the contractor/developer and the Local Authority regarding any matters relating to noise or vibration from the construction works.
MM50	The Windfarm Site Roads will be maintained to an even surface in order to reduce the potential for vibration from lorries travelling over them.
MM51	Plant and machinery will not be permitted to idle. Machinery used intermittently will be shut down or throttled back to a minimum when not in use, and if any plant/machine is required to operate before 07:00hrs or after 19:00hrs, then it will be surrounded by an acoustic enclosure or portable screen. The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produces by on-site operations. All vehicles and plant will be fitted with effective exhaust silencers. Noise dampeners will be fitted where required.
MM52	The Contractor undertaking the construction of the Ballynalacken Windfarm Project will be obliged to take specific noise abatement measures when deemed necessary to comply with the recommendations of BS5228-1 (BSI 2014a)
MM53	If rock breaking is required at the borrow pits, then the following measures will be employed: the rock-breaking tool will be fitted with a suitably designed muffler or sound reduction equipment (without impairing machine efficiency); to ensure air lines are sealed- all air lines will be checked for leaks; an acoustic screen will be erected between the compressor or generator and noise sensitive area; when possible, the line of sight between the top of the machine and reception point will be obscured; and the breaker or rock drill will be enclosed in a portable or fixed acoustic enclosure with suitable ventilation

Residual Construction Noise Impact

With the application of the best practice mitigation measures to control noise at construction sites, as described above, it is considered that significant adverse impacts will not occur at noise-sensitive locations due to construction activity.

During the construction phase of the project there will be some effect on nearby Noise Sensitive Locations (NSLs) due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby NSLs and the fact that the 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 control measures, will ensure that the noise effects are kept to a minimum.

With respect to the EPA's criteria for description of effects, in terms of the construction activities, the potential worst-case associated effects at the nearest NSLs associated with the various elements of the construction phase **it is considered that, with mitigation measures taken into account, the environmental noise effects of construction phase of the proposed development will be negative, not significant and short-term**

EIAR 10.3.1.3.6 Vibration from Construction Works

Assessment of effects from vibration during the construction phase was conducted using the methodology outlined in Appendix 10.3: Methodology for the evaluation of 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.

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

BS 5228-2 recommends that, for a soundly constructed residential properties and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e., non-structural) damage should be taken as a peak particle velocity (PPV) of 15mm/s for transient vibration at frequencies below 15Hz and 20mm/s at frequencies above than 15Hz. Below these vibration magnitudes minor damage is unlikely, although the standard notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (TII, 2014) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 10-32.

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

Table 10-32 Allowable Vibration at Sensitive Properties (NRA, 2014)

Following review of the guidance documents set out above, the TII values in Table 10-32 are considered appropriate for this assessment as they provide more stringent vibration criteria.

Evaluation of vibration emissions during construction works

It is recommended that vibration from construction activities be limited to the values set out in Table 10-32 above.

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. Magnitudes of vibration slightly greater than those in the table are normally unlikely to cause cosmetic damage, but construction work creating such magnitudes should proceed with caution. Where there is existing damage these limits may need to be reduced by up to 50%.

As stated in the previous section, noise monitoring locations were selected generally on proximity to the proposed wind turbines. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps). No significant sources of vibration were noted at any of the survey locations.

Also, it is not expected that piling is required; in any case, based on the large distances between the windfarm site construction works boundary within which any piling would take place and the nearest Noise Sensitive Locations (NSLs), no significant impact will be experienced if limited piling was required. It is not anticipated that blasting will be required.

General Construction Vibration – Turbines, Hardstands and Internal Site Roads:

Due to the distance of the proposed works boundary from noise sensitive locations (NSLs), the limited extent of piling required (if any) and that no blasting is anticipated, the vibration level at the nearest NSL will be below the allowable TII values and therefore vibration effects at NSLs are not expected. **Construction vibration effects on NSLs is assessed as neutral, imperceptible and short-term.**

Vibration from Borrow Pits

Due to the distance of the nearest NSL to the Borrow Pits (450m to the nearest NSL) and the duration of any potential impact on any single dwelling, significant vibration effects are not expected. **Borrow Pit activity vibration effects on NSLs is assessed as neutral, imperceptible and short-term.**

Vibration from Tinnalintan Substation Construction

Due to the general nature of the construction works at the Tinnalintan Substation site significant vibration effects at the nearest sensitive locations are not expected. **Construction vibration effects on NSLs to Tinnalintan Substation is assessed as neutral, imperceptible and short-term.**

Mitigation measures:

There are no specific vibration mitigation measures proposed for the development. Noise mitigation measures deployed during construction/decommissioning will mitigate vibration also.

Residual Impact:

There are no expected significant sources of vibration associated with the proposed development and no mitigation measures are required. The residual effect remains as pre-mitigation, **neutral, imperceptible and short-term and therefore not significant**.

EIAR 10.3.1.3.7 Vibration Emissions during Operational Phase

Vibration from operational wind turbines is low and will not result in perceptible levels at nearby sensitive receptors nor will the levels of vibration result in any structural damage. Research undertaken by Snow[3] found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) and were lower than limits specified for residential premises by an even greater margin. Hence, the level of vibration produced by wind turbines at this distance is low and does not pose a risk to human health.

More recently, the Low Frequency Noise Report[4] published by the Federal State of Baden-Württemberg simultaneously measured vibration at several locations, ranging from directly at the wind turbine tower to up to 285m distance from an operational Nordex N117 – 2.4 MW wind turbine with a hub height of 140.6m. The report concluded that beyond 300m from the turbine, the vibration levels had reduced such that they could no longer be differentiated from the background vibration levels.

Considering that all NSL are over 300m away, the level of vibration is significantly below any thresholds of perceptibility. Vibration from the turbines is too low to be perceived at neighbouring residential properties. Vibration levels will also be significantly below levels that would result in damage to the nearest buildings (including farm buildings and buildings on site).

Therefore, there are no expected sources of vibration associated with the operational phase of the proposed development. As reported in the Special Characteristics section below, in the UK Institute of Acoustics Bulletin (March 2009) compiled by acoustic consultants regularly employed on behalf of wind farm developers and acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments (IAO, 2009), the article concludes that "**there is no robust evidence that ground - borne vibration from wind farms, generally has adverse effects on wind farm neighbours".**

In that context, it is assessed that operational vibration effects on NSLs will be neutral, imperceptible and short-term and therefore not significant.

Mitigation measures: There are no specific vibration mitigation measures proposed for the development. Noise mitigation measures deployed during construction/decommissioning will mitigate vibration also.

Residual Impact: There are no expected significant sources of vibration associated with the proposed development and no mitigation measures are required. The residual effect remains as pre-mitigation, **neutral, imperceptible and short-term and therefore not significant**.

[3] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow

[4] Low-frequency noise incl. infrasound from wind turbines and other sources', State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany, 2016

EIAR 10.3.1.4 Cumulative Impact on Local Residents with Other Projects

EIAR 10.3.1.4.1 Introduction to the Cumulative Evaluation for Local Residents

The proposed Ballynalacken Windfarm Project (*whose effects range from Neutral/Not Significant to Significant Adverse, as per Section EIAR 10.3.1.3*) was examined for potential to have cumulative effects on Local Residents, with other existing or permitted projects and projects advanced in the planning system. The potential for off-site and secondary consequential development is also considered. These projects are referred to as 'Other Projects' herein.

A Cumulative Study Area is set out below and Other Projects which occur or are planned within this Study Area are identified and examined for in-combination effects with the Ballynalacken Windfarm Project.

EIAR 10.3.1.4.2 Cumulative Study Areas

Cumulative Operational Noise: 5km as per Section 10.2.3.

Cumulative Construction Noise: Local residences along the R432 in the vicinity of the Eirgrid Ballyragget Substation at Moatpark.

EIAR 10.3.1.4.3 Evaluation of Cumulative Impacts

The Other Projects which occur within the Cumulative Study Area are identified in the table below and in Figure 10.8: Other Projects within Noise & Vibration Cumulative Study Areas *(included at end of this chapter)*.

The Ballynalacken Windfarm Project is examined below for cumulative effects with each of the Other Projects within the Cumulative Study Area. An evaluation of the collective cumulative impact of the Ballynalacken Windfarm Project in-combination with all the Other Projects then follows.

Table 10-33: Evaluation of Ballynalacken Windfarm Project cumulatively with Other Projects

Other Project	Status	Evaluation of Cumulative impact
Farranrory Wind Farm Grid Connection Ballyragget and Parksgrove Solar Farms Grid Connection Battery Energy Storage Developments at Moatpark	Consented	See Section EIAR 10.3.1.4.4
Pinewood Windfarm	Consented	See Section EIAR 10.3.1.4.5.
Laois-Kilkenny Grid Reinforcement Project Moatpark – Loan 38kV Overhead Line Telecom Masts, Ballyouskill Other Existing OHLs	Existing	No Cumulative Impact: No potential for cumulative construction impacts as construction phase for the 110kV OHL will be completed prior to the construction of the proposed Ballynalacken Project, and the 38kV OHL and Telecom Masts already exist. In relation to the recently approved extension to the Ballyragget Substation, effects will be negligible due to the small footprint of works. No potential for operational impacts due to the separation of the Ballyragget Substation to either the Tinnalintan Substation or the Ballynalacken Wind Turbines.
Offsite Project – Forestry Replant Lands (outside the	Future activity	No Cumulative Impact: The replanting area distant from the proposed windfarm site – no potential for cumulative impacts.

Other Project	Status	Evaluation of Cumulative impact
cumulative geographical boundary)		
Secondary Project – Other Energy Projects connecting to Tinnalintan Substation	Potential future project	No Cumulative Impact: It is assumed that the construction works for the proposed development would be carried out before another project works and therefore cumulative construction noise impacts are not predicted.

EIAR 10.3.1.4.4 Noise & Vibration - Cumulative Evaluation for the Moatpark area

In relation to cumulative construction noise, although it is unlikely to occur, there is potential that the other projects in the vicinity of the Eirgrid Ballyragget Substation at Moatpark could all be constructed during the same time period as the Ballynalacken Windfarm Grid Connection, and it is evaluated that the cumulative impacts could be short-term, localised, negative, not significant, and reversible with the completion of works.

Mitigation measures will be put in place during the construction of the proposed Ballynalacken Windfarm Project which will control noise emissions from the Ballynalacken Grid Connection works. Overall, it is considered that collectively noise would be predicted to be **Neutral and cumulatively not significant**.

EIAR 10.3.1.4.5 Noise & Vibration - Cumulative Evaluation for Operational Noise from turbines

In relation to cumulative operational noise, the assessment presented in Section 10.3.1.3.1 has already taken cumulative impacts into account in the modelling exercise, as required by the Institute of Acoustics Good Practice Guidelines, in that Pinewood Windfarm (permitted but not constructed) is included in the predicted noise levels. Other wind farms are at too great a distance from the NSLs included in this assessment to have any cumulative noise effects

EIAR 10.3.2 Statement on Certainty and Sufficiency of Information Provided

A clear documentary trail is provided throughout this chapter and chapter appendices to the competency of data and methods used and the rationale for selection of same. The information used to compile this chapter is collated from reports and documents generated by local authorities and statutory agencies, with remit in the regulatory field, including the Environmental Protection Agency, Institute of Acoustics, British Standards Institute and the World Health Organisation. All documentation used is referenced at the end of the chapter.

In respect of Noise & Vibration, no material limitations or difficulties were encountered during the course of the studies carried out to inform the assessment of impacts of the Ballynalacken Windfarm Project.

EIAR 10.4 Summary 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 phase and the long-term operational phase.

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

Based on detailed information on the site layout, the turbine noise emission levels and the turbine height, **worst-case operating turbine noise levels have been predicted** at 159 No. Noise Sensitive Locations within 2km of a proposed turbine for a range of operational wind speeds. Following mitigations, the predicted noise levels associated with the proposed operating turbines will be within best practice noise limits recommended in Irish guidance, therefore it is not considered that a significant operation noise effect will be associated with the development. If mitigation is required, reduced sound power modes can be deployed using the turbine control software to reduce noise impact at specified locations.

Noise from the proposed Tinnalintan Substation has also been assessed and found to be within the recommended limits.

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

Although very unlikely to occur at NSLs, **Amplitude Modulation** will be eliminated through operational controls in the event of a complaint.

In summary, **the noise and vibration impact of the Proposed Development is assessed as not significant** in the context of current national guidance

EIAR 10.5 Reference List for Noise & Vibration

Australian Medical Association (2014) *Wind Farms and Health*, available: https://www.ama.com.au/position-statement/wind-farms-and-health-2014.

Australia, National Health and Medical Research Council (2015) *Information Paper: Evidence on Wind Farms and Human Health*, Canberra: National Health and Medical Research Council.

Berglund, B. and Lindvall, T. (1995) *Community Noise*, World Health Organization.

British Standards Institute (1993) *BS 7385-2:1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration*.

British Standards Institute (2014 a) *BS 5228-1:2009+A1:2014 Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise*.

British Standards Institute (2014 b) *BS 5228-2:2009+A:2014 Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration*.

Environmental Protection Agency (2011) *Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licenced Sites (NG3)*.

Environmental Protection Agency (2016) *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)*.

Environmental Protection Agency (2022) *Guidelines on the information to be contained in Environmental Impact Assessment Reports*.

Evans, T., Cooper, J. and Lenchine, V. (2013) *Infrasound levels near windfarms and in other environments*, South Australian Environment Protection Agency.

Germany, State Institute for the Environment, Measurements and Nature Conservation (2016) *Low-frequency noise incl. infrasound from wind turbines and other sources*, Karlsruhe: LUBW Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Wüttemberg.

Health Canada (2014) *Wind Turbine Noise and Health Study: Summary of Results*, available: https://www.canada.ca/en/health-canada/services/health-risks-safety/radiation/everyday-things-emit-radiation/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html.

Highways England (2020) *Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2*, Highways England, Transport Scotland, Welsh Government and Department for Infrastructure.

Institute of Acoustics (2009) ‘Prediction and assessment of wind turbine noise’, *Acoustics Bulletin March-April 2009*, 34(2).

Institute of Acoustics (2013) *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*.

Institute of Acoustics (2016) *A Method for Rating Amplitude Modulation in Wind Turbine Noise*, IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group.

International Organization for Standardization (2024) *9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors - Part 2: Engineering method for the prediction of sound pressure levels outdoors*.

Ireland, Department of the Environment, Heritage, and Local Government (2006) *Wind Energy Development Guidelines*.

McCunney, R. J., Mundt, K. A., Colby, W. D., Dobie, R., Kaliski, K. and Blais, M. (2014) 'Wind turbines and health: a critical review of the scientific literature', *Journal of Occupational and Environmental Medicine*, 56(11), 108-30.

Moorhouse, A. T., Hayes, M., von Hunerbein, S. and Piper, B. (2007) *Research into aerodynamic modulation of wind turbine noise: final report*, Department of Environment, Food and Rural Affairs, Department of Business, Enterprise and Regulatory Reform, Department of Communities and Local Government.

National Roads Authority (2014) *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes*.

Snow, D. (1997) *Low frequency noise and vibrations measurements at a modern wind farm*.

United Kingdom, Department of Trade, and Industry (1996) *Energy Technology Support Unit ETSU-R-97 The Assessment and Rating of Noise from Wind Farms*.

United Kingdom, Department of Trade and Industry (2006) *The Measurement of Low Frequency Noise at Three UK Windfarms*.

United Kingdom, Health Protection Agency (2010) *Health Effects of Exposure to Ultrasound and Infrasound – Report of the independent Advisory Group on Non-Ionising Radiation*.

Von Hunerbein, S., King, A., Piper, B. and Cand, M. (2013) *Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause & Effect*, RenewableUK.

World Health Organization (2018) *Environmental Noise Guidelines for the European Region*.

EIAR 10.6 List of Figures for Noise & Vibration

FIGURES (overleaf)

Figure 10.2	Noise Sensitive Locations
Figure 10.4	Noise Prediction Model Results (Noise Contour Map)
Figure 10.7	Construction Phase Noise Sources
Figure 10.8	Other Projects considered for Cumulative Effects to Noise and Vibration

EIAR 10.7 List of Appendices for Noise and Vibration

APPENDICES (overleaf)

Appendix 10.1	Methodology for the evaluation of Noise – Construction Phase
Appendix 10.2	Methodology for the evaluation of Noise– Operational Phase
Appendix 10.3	Methodology for the evaluation of Vibration
Appendix 10.4	Background Noise Measurements
Appendix 10.5	Calibration Certificates

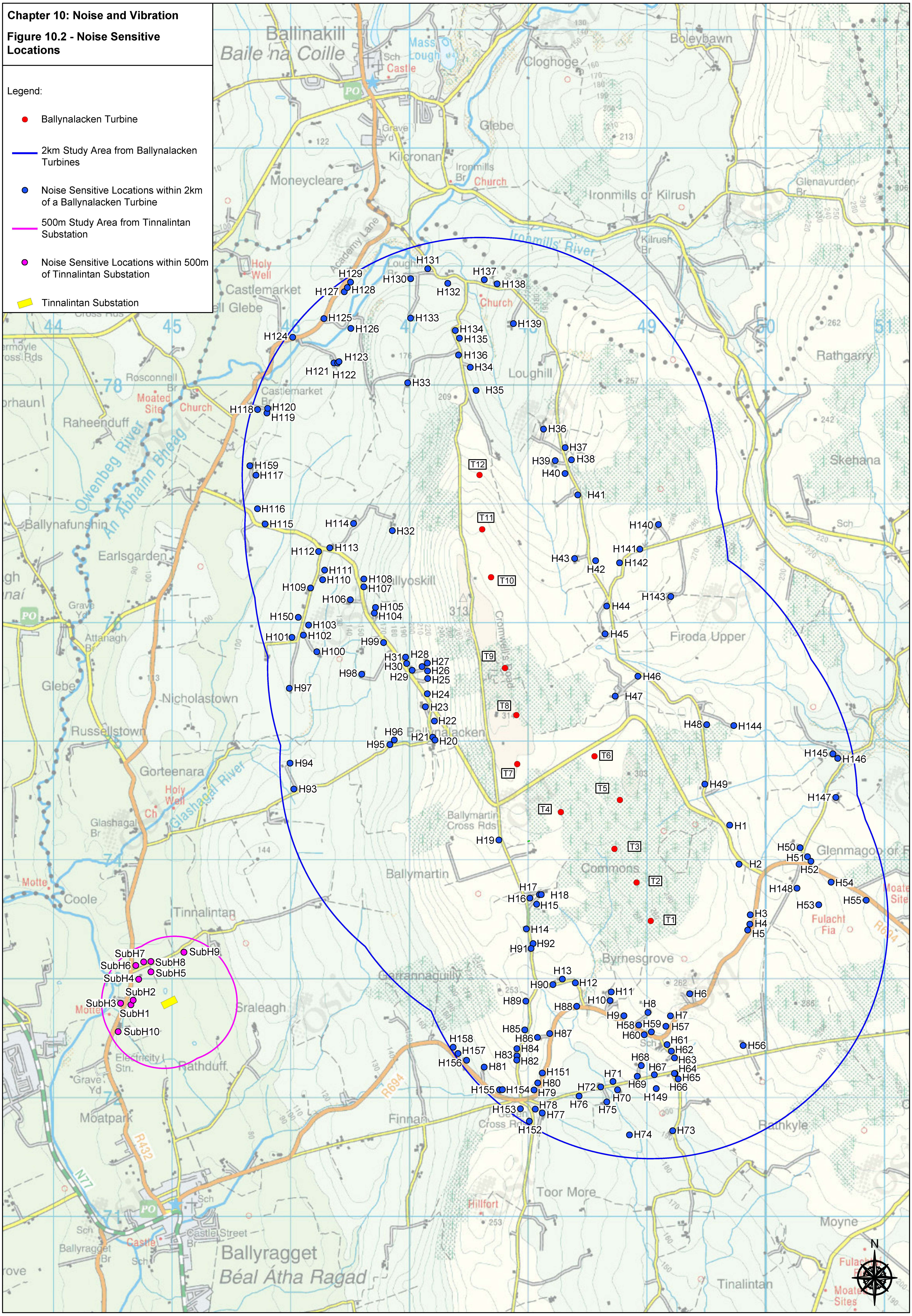
Figures for Noise and Vibration

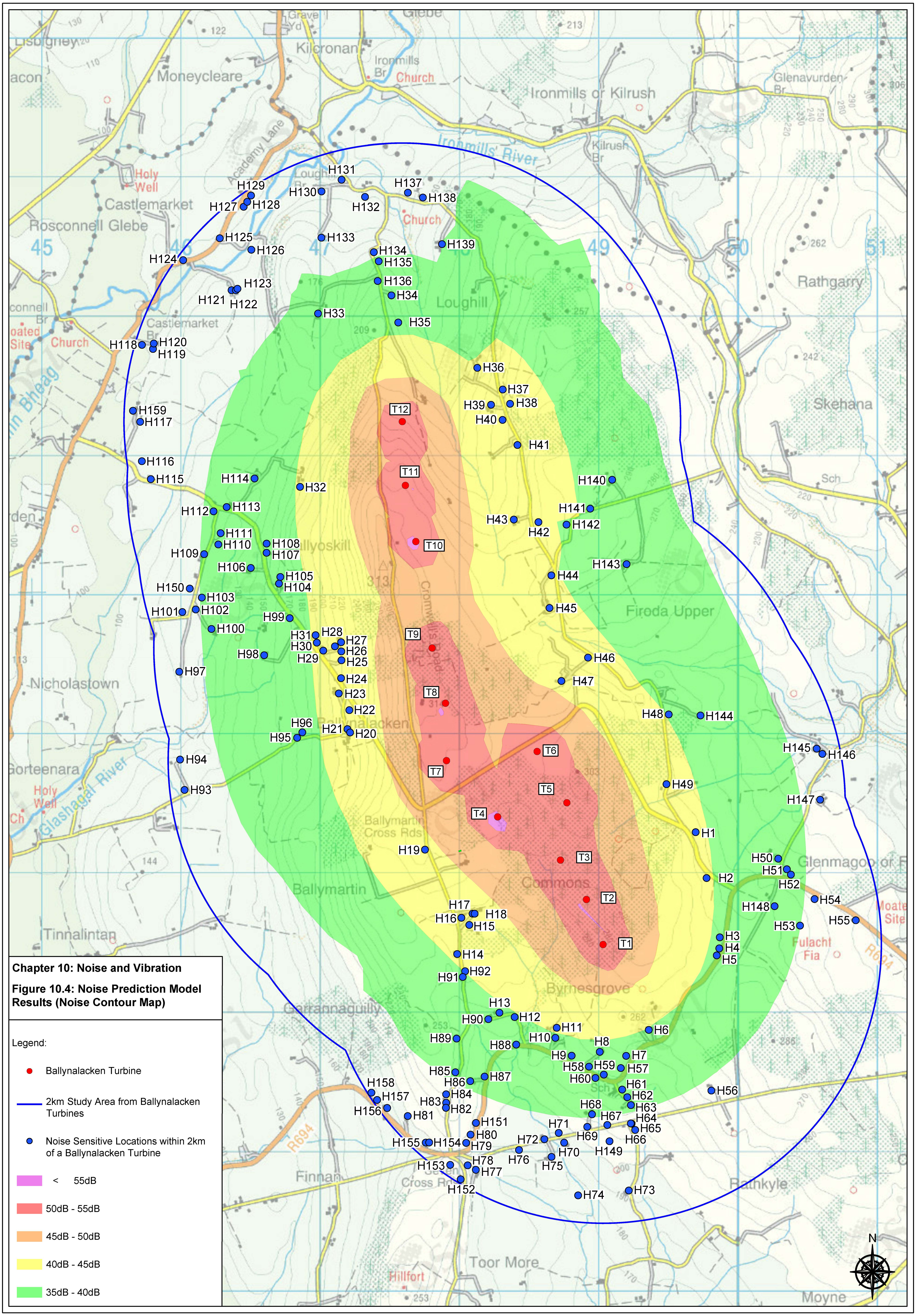
Chapter 10: Noise and Vibration

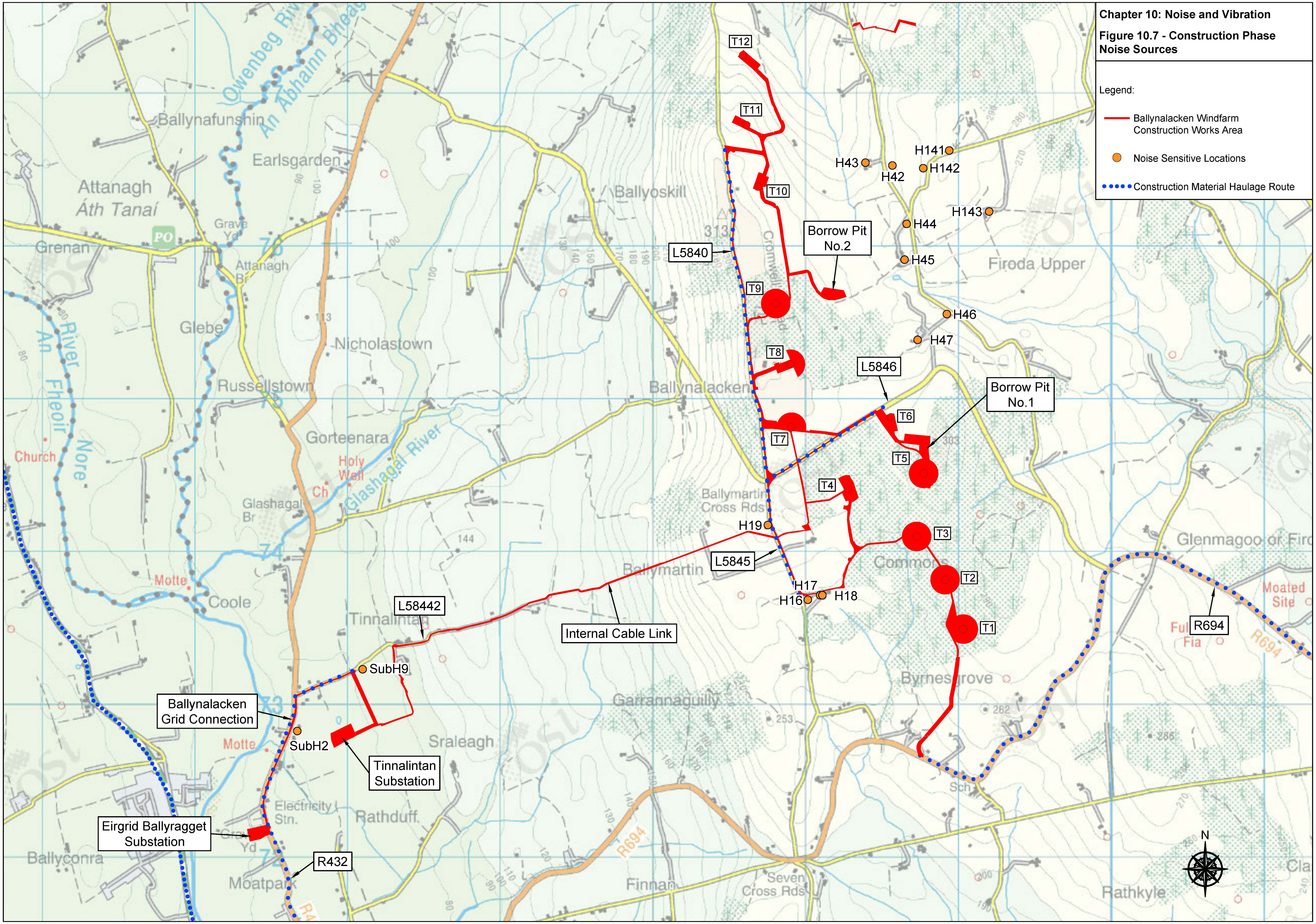
Figure 10.2 - Noise Sensitive Locations

Legend:

- Ballynalacken Turbine
- 2km Study Area from Ballynalacken Turbines
- Noise Sensitive Locations within 2km of a Ballynalacken Turbine
- 500m Study Area from Tinnalintan Substation
- Noise Sensitive Locations within 500m of Tinnalintan Substation
- Tinnalintan Substation



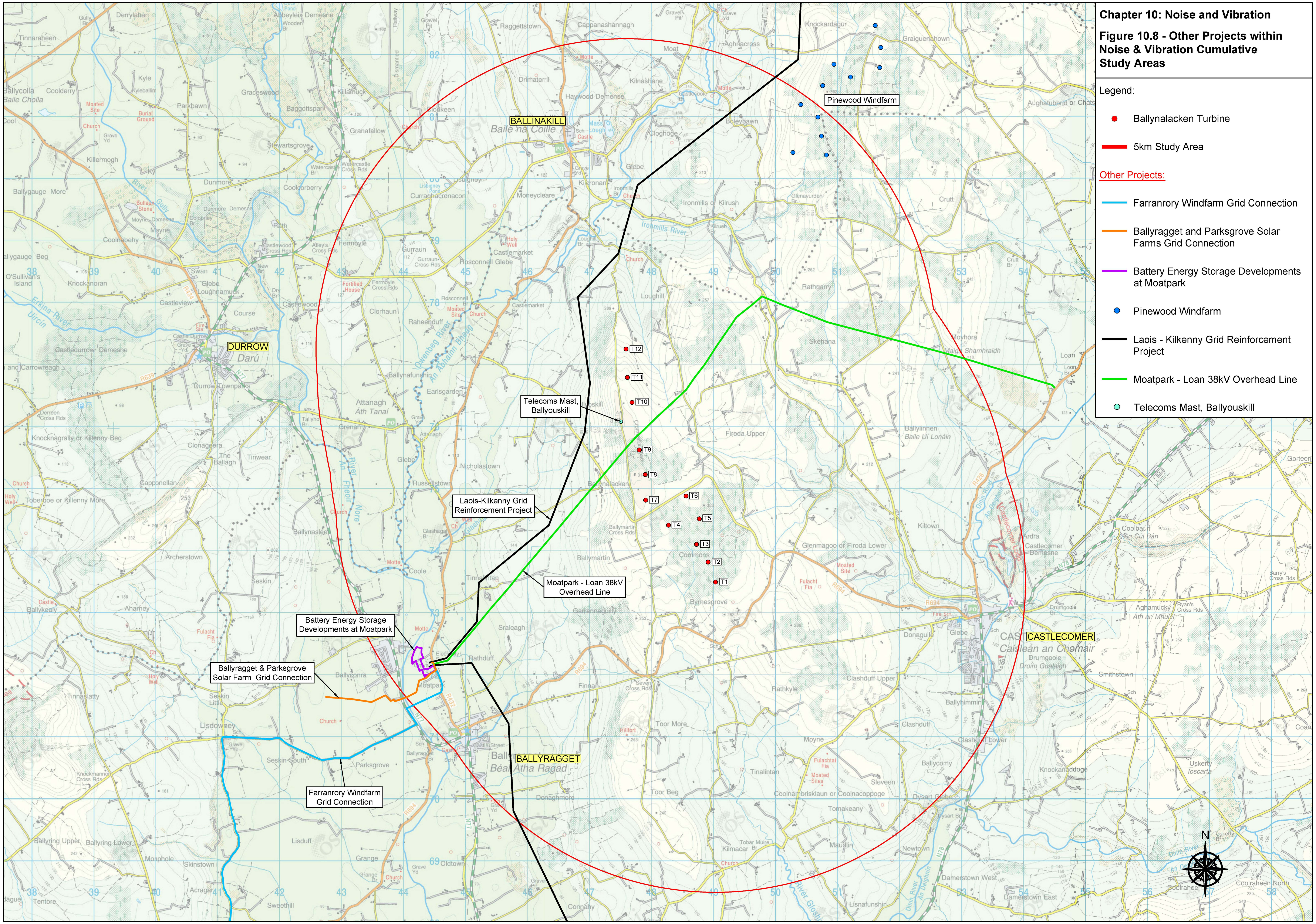

Chapter 10: Noise and Vibration
Figure 10.4: Noise Prediction Model Results (Noise Contour Map)
Legend:
Ballynalacken Turbine
2km Study Area from Ballynalacken Turbines
Noise Sensitive Locations within 2km of a Ballynalacken Turbine
< 55dB
50dB - 55dB
45dB - 50dB
40dB - 45dB
35dB - 40dB
Ironmills River
Kilcronan
Moneycleare
Castlemarket
Rosconnell Glebe
Ironmills or Kilrush
Rathgarry
Loughill
Skehana
Firoda Upper
Nicholastown
Gorteenara
Glashagal River
Ballymartin
Ballymartin Cross Rds
Commons
Byrnesgrove
Garrannaguilly
Tinnalintan
Glenmagoo or F
Rathkyle
Finnan
Toor More
Moyne
R694
N



Chapter 10: Noise and Vibration
Figure 10.7 - Construction Phase Noise Sources
Legend:
Ballynalacken Windfarm Construction Works Area
Noise Sensitive Locations
Construction Material Haulage Route
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
Borrow Pit No.2
Borrow Pit No.1
L5840
L5846
L5845
L58442
R432
R694
Internal Cable Link
Ballynalacken Grid Connection
Tinnalintan Substation
Eirgrid Ballyragget Substation
H16
H17
H18
H19
H42
H43
H44
H45
H46
H47
H141
H142
H143
SubH2
SubH9
Ballynafunshin
Earlsgarden
Attanagh
Áth Tanaí
Grenan
Glebe
Nicholastown
Russellstown
Gorteenara
Ballyoskill
Ballynalacken
Ballymartin Cross Rds
Ballymartin
Firoda Upper
Commons
Glenmagoo or Firo
Byrnesgrove
Garrannaguilly
Sraleagh
Rathduff
Tinnalintan
Coole
Ballyconra
Moatpark
Finnan
Seven Cross Rds
Rathkyle
Owenbeg River
An Abhainn Bheag
River Nore
An Fheoir
Glashagal River
Holy Well
Church
Motte
Moated Site

Chapter 10: Noise and Vibration

Figure 10.8 - Other Projects within Noise & Vibration Cumulative Study Areas



Appendix 10.1: Methodology for the evaluation of Noise – Construction Phase

Appendix to Chapter 10: Air (Noise & Vibration)

Appendix 10.1: Methodology for the evaluation of Noise – Construction Phase

A10.1 Methodology for the evaluation of Noise – Construction Phase

A10.1.1 Guidance Documents

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 summarised below:

- British Standard Institute (BSI) British Standard (BS) 5228-1:2009 +A1:2014 Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise (hereafter referred to as BS 5228–1) (BSI 2014a);
- Transport Infrastructure Ireland (TII) (previously National Roads Authority (NRA)) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (hereafter referred to as the TII Noise Guidelines 2014) (NRA 2014);
- United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020);

In addition to specific noise guidance documents outlined above, the Environmental Protection Agency (EPA) *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (EPA, 2022) was considered and consulted in the preparation of this Chapter.

A10.1.2 Overview of methodology process

The assessment methodology undertaken is summarised as follows**:**

- Review of appropriate guidance to identify appropriate noise criteria for both the construction, operational and decommissioning phases.
- Characterise the receiving environment through baseline noise surveys at various Noise Sensitive Locations (NSLs) surrounding the proposed development.
- Undertake predictive calculations to assess the potential impacts associated with the construction/decommissioning phase of the proposed development at NSLs.
- Undertake predictive calculations to assess the potential impacts associated with the operational of the proposed turbines and substation at NSLs.
- Specify mitigation measures to reduce, where necessary, the identified potential outward impacts relating to noise from the proposed development.
- Describe the significance of the residual noise effects associated with the proposed development.

A10.1.2.1 EPA Description of Effects

The significance of effects of the proposed development shall be described in accordance with the EPA guidance document *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (EIAR), (2022). Details of the methodology for describing the significance of the effects are provided in EIAR Chapter 1 – Introduction. The effects associated with the proposed development are described in the relevant sections of this chapter in accordance with the EPA guidance set out in Chapter 1 (Introduction).

A10.1.2.2 Guidance Documents and Assessment Criteria

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

A10.1.3 Guidance on 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 BS5528-1 (BSI 2014a).

The approach adopted here calls for the designation of a Noise Sensitive Location (NSL) into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. A threshold noise value is applied to each category. Exceedances (construction noise only) of the threshold value, at the facade of a noise-sensitive location (NSL) during construction, indicates a potential significant noise impact associated with the construction activities. The threshold values recommended by BS5228-1 (BSI 2014a) are depicted in Table 10.1.

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

Table 1 Example Threshold for Potential Significant Effect at Dwellings

- 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.

This assessment method is valid for residential properties.

The following methodology was followed to identify the Threshold values' for the Nighttime/Evening time/ Daytime for the Noise Sensitive Locations (NSLs) in relation to the proposed windfarm site:

For each period (i.e. daytime, evening and night time) the ambient noise level at the 6 No. NSLs where the ambient/baseline noise was monitored, was determined and rounded to the nearest 5dB. The resulting values indicate that the ambient noise levels are less than the values in Baseline Noise Level Category A as detailed in Table 10.1 above. Therefore the Construction Noise Threshold (CNT) values in Category A are the appropriate values in terms of the nearest noise sensitive locations (NSL) being considered in this report. See Table 10.2 below.

Period	Baseline Noise Category	Construction Noise Threshold Value $L_{Aeq,1hr}$ (dB)
Night time (23:00 to 07:00hrs)	A	45
Evening (19:00 to 23:00hrs)	A	55
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	A	65

Table 2 Baseline Noise Categories and associated Construction Noise Thresholds (CNTs)

Based on the above, the construction noise threshold value of 65 dB $L_{Aeq,1hr}$ is proposed for the site because the planned hours of work on site are during the Daytime on weekdays between 07:00 hrs and 19:00 hrs and on Saturdays between 08:00 hrs and 16:30 hrs.

A10.1.3.1.1 Interpretation of the Construction Noise Threshold (CNT)

In order to assist with interpretation of Construction Noise Thresholds (CNTs), Table 10.3 includes guidance as to the likely magnitude of impact associated with construction activities, relative to the CNT. This guidance is derived from Table 3.16 of the Design Manual for Roads and Bridges (DMRB): Noise and Vibration and adapted to include the relevant significance effects from the EPA Guidelines (EPA 2022).

Construction Noise Level	Magnitude of Impact (DMRB)	EPA Significance of Effect
Below or equal Baseline Noise Level	Negligible	Not Significant
Above Baseline and below or equal to CNT	Minor	Slight – Moderate
Above threshold and below or equal to CNT + 5dB	Moderate	Moderate – Significant
Above CNT + 5dB	Major	Significant – Very Significant

Table 3 Description of the magnitude of impacts. Adapted from Design Manual for Roads and Bridges (DMRB) Table 3.16

A10.1.3.1.2 Guidance on Noise from additional traffic on Public Roads during the Construction Phase

There are no specific guidelines or limits relating to traffic related sources of noise 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, 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 2020.

Table 4, taken from DMRB offers guidance as to the likely short term impact associated with any change in traffic noise level.

Change in Sound Level (dB L_{A10})	Magnitude of Impact	EPA Significance of Effect
Less than 1 dB	Negligible	Imperceptible
1 – 2.9	Minor	Not Significant
3 – 4.9	Moderate	Slight, Moderate
5+	Major	Significant

Table 4 Likely Short Term Effects Associated with Change in Traffic Noise Level (Source Design Manual for Roads and Bridges (DMRB), 2020).

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

The DMRB guidance will be used to assess the predicted increases in traffic noise levels on public roads associated with the proposed development and comment on the likely short-term impacts during the construction phase (and by extension the decommissioning phase).

A10.1.3.1.3 Guidance on Construction Noise Calculations

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

Due to the nature of construction activities, it is difficult to calculate the actual magnitude of emissions to the local environment in the absence of a detailed construction programme. The standard best practice approach is to predict typical noise levels at the Noise Sensitive Locations (NSLs) using guidance set out in BS5228-1 (BSI 2014a). Construction noise predictions have been carried out using guidance set out in BS5228-1 (BSI 2014a).

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 BS5228-1 (BSI 2014a) at various distances from these works.

A10.1.3.2 Guidance on Decommissioning Phase Noise

The guidance for construction noise assessment described above also applies to the decommissioning phase of the project because the activities and noise emissions are similar for both phases.

Appendix 10.2: Methodology for the evaluation of Noise – Operational Phase

Appendix to Chapter 10: Air (Noise & Vibration)

Appendix 10.2: Methodology for the evaluation of Noise – Operational Phase

A10.2 Methodology for the evaluation of Noise – Operational Phase

A10.2.1.1 Guidance on Operational Phase Noise from Wind Turbines

The operational noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines* for Planning Authorities 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.

- Department of the Environment, Heritage, and Local Government (DEHLG) Wind Energy Development Guidelines (hereafter referred to as WEDG (DEHLG, 2006);
- Department of Trade, and Industry (UK) Energy Technology Support Unit (ETSU) ETSU-R-97 The Assessment and Rating of Noise from Wind Farms (hereafter referred to as ETSU-R-97) (ETSU, 1996);
- Institute of Acoustics (IOA) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (hereafter referred to as IOA GPG) (IOA, 2013);
- International Organization for Standardization (ISO) 9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors - Part 2: Engineering method for the prediction of sound pressure levels outdoors (hereafter referred to as ISO 9613–2) (ISO 2024).

A10.2.1.1.1 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 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 operational wind turbine noise by the application of noise limits at the nearest noise sensitive locations (NSLs). ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind turbine developments and recommends that operational noise limits should be set relative to the existing background noise levels at NSLs. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site baseline noise surveys.

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

The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB L_{A90} and/or a higher level above the prevailing background noise level.

A10.2.1.1.2 Wind Energy Development Guidelines for Planning Authorities

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

The following extracts from this document should be considered:

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

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

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

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.

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

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

> *"However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of the $L_{A90, 10min}$ of the wind energy development be limited to an absolute level within the range of 35 – 40dB(A)."*

In relation to night time periods the following guidance is given:

> *"A fixed limit of 43dB(A) will protect sleep inside properties during the night."*

This limit is defined in terms of the $L_{A90,10min}$ parameter. This represents the commonly adopted night-time noise criterion curve in relation to wind farm developments.

In summary, the Wind Energy Development Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- An appropriate absolute limit level in the range of 35 – 40 dB $L_{A90,10min}$ for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels of not less than 30 dB $L_{A90,10min}$ and;
- 43 dB $L_{A90,10min}$ for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála.

A10.2.1.1.3 Future Potential Wind Energy Development Guidance Changes

In December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 (Draft WEDG) were published for consultation and therefore have yet to be finalised. It is important to note that as part of the public consultation several concerns in relation to the proposed approach to operational noise assessment have been expressed by various parties and it is the opinion of the authors of this assessment that the Draft WEDG 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"*

Therefore, in line with best practice, the assessment presented in this EIAR is based on the current guidance outlined in the 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 (SGNs).

If updated Wind Energy Guidelines are published during the application process for the Proposed Development it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information. It should be noted, modern wind turbines can be controlled to within permitted operational noise levels should the noise criteria change materially in the new Wind Energy Guidelines.

A10.2.1.1.4 World Health Organization (WHO) Noise Guidelines for the European Region

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'. A strong recommendation, *"can be adopted as policy in most situations" whereas a conditional recommendation, "requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply".*

The objective of the WHO Environmental Noise Guidelines for the European Region is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is risk of adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

> *"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB L_{den}, as wind turbine noise above this level is associated with adverse health effects.*
>
> *No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.*

> *To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."*

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

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

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

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

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

A10.2.1.1.5 Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics (IOA) publication of A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) including 6 Supplementary Guidance Notes. These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG, and its Supplementary Guidance Notes (SGNs) are considered to represent best practice and have been adopted for this assessment.

A10.2.1.1.6 Good Practice for Baseline Noise Measurements

The IOA GPG states, that at a minimum continuous baseline noise monitoring should be carried out at the nearest noise sensitive locations 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 collated at the site of the wind turbine development. Regression analysis is then conducted on the data sets to derive background noise levels at various wind speeds to establish the appropriate day and night time noise criterion curves.

A10.2.1.1.7 Good Practice for Operational Noise Predictions

Operational noise emissions associated with the wind turbines can be predicted in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors (2024). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

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

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

The Institute of Acoustics Good Practice Guide (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…"*

Also:

> *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."*

A10.2.2 Noise Modelling software used for the calculations

The selected software, DGMR iNoise Enterprise, calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors*, (ISO, 2024).

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

- the magnitude of the noise source in terms of A-weighted sound power levels (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 impacts at distances greater than approximately 400 m).

Appendix 10.3: Methodology for the evaluation of Vibration

Appendix to Chapter 10: Air (Noise & Vibration)

Appendix 10.3: Methodology for the evaluation of Vibration

A10.3 Methodology for the evaluation of Vibration

The assessment of impacts for the proposed development have been undertaken with reference to the most appropriate guidance documents relating to environmental vibration, which are summarised below:

- BS 5228-2:2009+A:2014 Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration (hereafter referred to as BS 5228–2) (BSI 2014b);
- BS 7385: 1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (hereafter referred to as BS 7385–2) (BSI 1993);
- United Kingdom Highways Agency (UKHA) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (hereafter referred to as DMRB Noise and Vibration) (UKHA 2020);

In addition to specific vibration guidance documents outlined above, the Environmental Protection Agency (EPA) *Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (EPA, 2022) was considered and consulted in the preparation of this Chapter.

The assessment methodology undertaken is summarised as follows**:**

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

A10.3.1.1 Guidance on 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:

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

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

BS 5228-2 recommends that, for a soundly constructed residential properties and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e., non-structural) damage should be taken as a peak particle velocity (PPV) of 15mm/s for transient vibration at frequencies below 15Hz and 20mm/s at frequencies above than 15Hz. Below these vibration magnitudes minor damage is unlikely, although the standard notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (TII, 2014) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 1.

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

Table 1 Allowable Vibration at Sensitive Properties (NRA, 2014)

Following review of the guidance documents set out above, the TII values in Table 1 are considered appropriate for this assessment as they provide more stringent vibration criteria.

A10.3.1.2 Guidance on Operational Phase Vibration

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

A report from Germany published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016, “low frequency noise incl. infrasound from wind turbines and other sources” conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

The shortest distance from any turbine in the Proposed Development to the nearest Noise Sensitive Location (NSL) is 535m. At that distance, 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.

Appendix 10.4: Background Noise Measurements

Appendix to Chapter 10: Air (Noise & Vibration)

Appendix 10.4: Background Noise Measurements

A10.4 Background Noise Measurements

This appendix documents the background noise levels measured in the vicinity of the NSLs in close proximity to the proposed development site.

A background noise survey was undertaken to determine typical background noise levels at representative Noise Sensitive Locations (NSLs) surrounding the development site. The background noise survey was conducted through installing unattended sound level meters at 6 no. representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with the Institute of Acoustics publication of A Good Practice Guide (IOA GPG) and accompanying Supplementary Guidance Note 1: Data Collection (2014).

A10.4.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Locations were selected generally on proximity to the proposed wind turbines. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps).

The selected locations for the noise monitoring are outlined in Table 1 and depicted on the map in Figure 1.

Name	Distance to nearest Ballynalacken Turbine	Easting	Northing
H35	713	647,494	677,996
H41	844	648,350	677,116
H47	535	648,666	675,421
H2	878	649,710	674,006
H18	681	648,042	673,750
H106	1203	646,429	676,228

Table 1 Noise Measurement Co-ordinates (ITM)

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

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

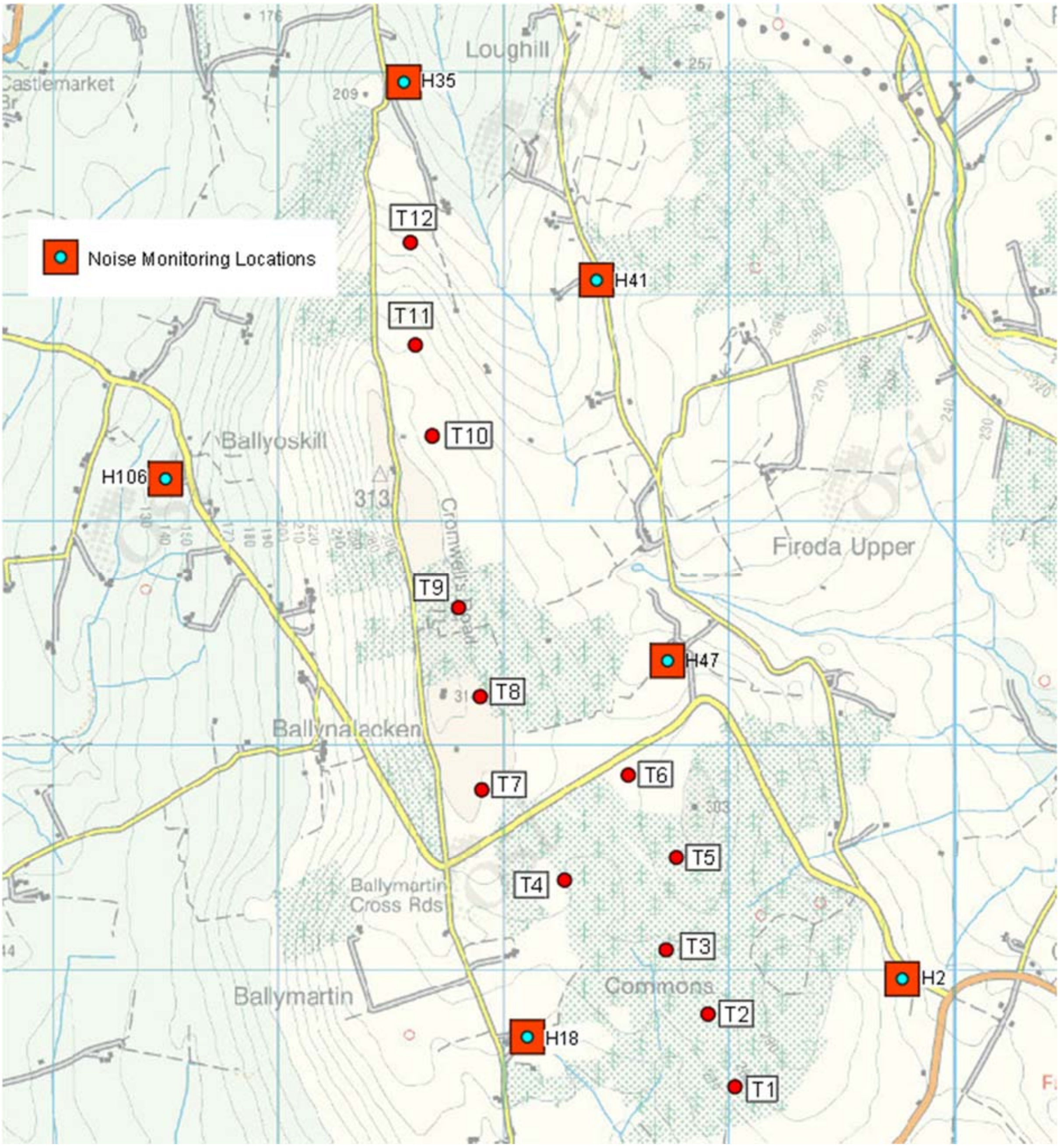


Figure 1 Noise Monitoring Locations

Figures 2 to 7 illustrate the installed noise monitoring kits at each location. Distances in the following descriptions of the locations are approximate.

Location H35

At H35, the noise monitor was positioned 70 m to the north of location H35, and 45 m from Cromwell's Road. Audible noise sources were birdsong, wind-generated noise in foliage and occasional vehicle movements along the nearby local road.

Figure 2 Noise Monitoring Installation – Location H35

Location H41

At H41, the noise monitor was positioned 10 m to the north of the house at location H41, and 30 m from the local road. Audible noise sources were birdsong, wind-generated noise in foliage.

Figure 3 Noise Monitoring Installation – Location H41

Location H47

At H47, the noise monitor was positioned 30 m to the east of farm buildings, and 290 m from the local road. The main source of noise was low-level wind generated noise in the surrounding foliage.

Figure 4 Noise Monitoring Installation – Location H47

Location H2

At H2, the noise monitor was positioned 10 m to the west of location H2, and 30 m from the local road. Audible noise sources were birdsong, wind-generated noise in foliage and distant traffic.

Figure 5 Noise Monitoring Installation – Location H2

Location H18

At H18, the noise monitor was positioned 10 m to the north of location H18, and 120 m from the local road. Audible noise sources were birdsong and a degree of wind-generated noise in foliage.

Figure 6 Noise Monitoring Installation – Location H18

Location H106

At H106, the noise monitor was positioned 15 m to the south of location H1066, and 110 m from the local road. Audible noise sources were birdsong and a degree of wind-generated noise in foliage.

Figure 7 Noise Monitoring Installation – Location H106

A10.4.2 Measurement Periods

The survey duration was typically 4 weeks, or until such time that enough data points were captured at each survey locations. Section 2.9.1 of the IOA GPG states:

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

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 periods shown in Table 2.

Name	Start Time	End Time
H35	10:50 hrs on 14 June 2022	11: 50 hrs on 18 July 2022
H41	11:40 hrs on 14 June 2022	03:30 hrs on 27 July 2022
	12:20 hrs on 18 July 2022	12:20 hrs on 9 August 2022
H47	12:10 hrs on 14 June 2022	12:20 hrs on 18 July 2022
H2	12:40 hrs on 14 June 2022	13:10 hrs on 18 July 2022
H18	13:10 hrs on 14 June 2022	07:20 hrs on 13 July 2022
H106	13:50 on 14 June 2022	14:00 on 13 July 2022

Table 2 Noise Measurement Periods

A10.4.3 Wind Speeds and Direction Recorded during Survey Period

A variety of wind speed and weather conditions were encountered over the survey periods in question. As an indication to this, Figures 8 and 9 show the distribution of wind speed and direction recorded for all periods of day and night for the survey periods. The wind speed data presented below relates to a turbine hub height of 96.5m which is the proposed turbine hub height.

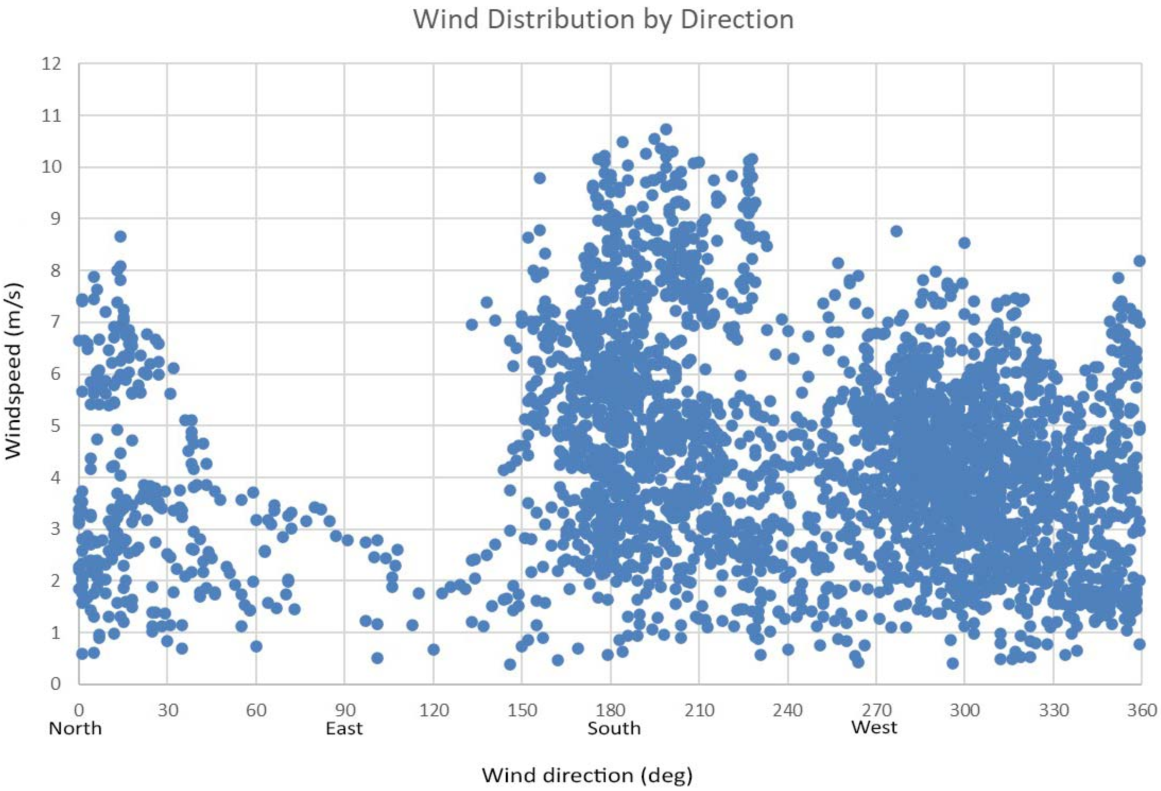


Figure 8 Distribution of Wind Speeds and Direction (14 June – 18 July 2022)

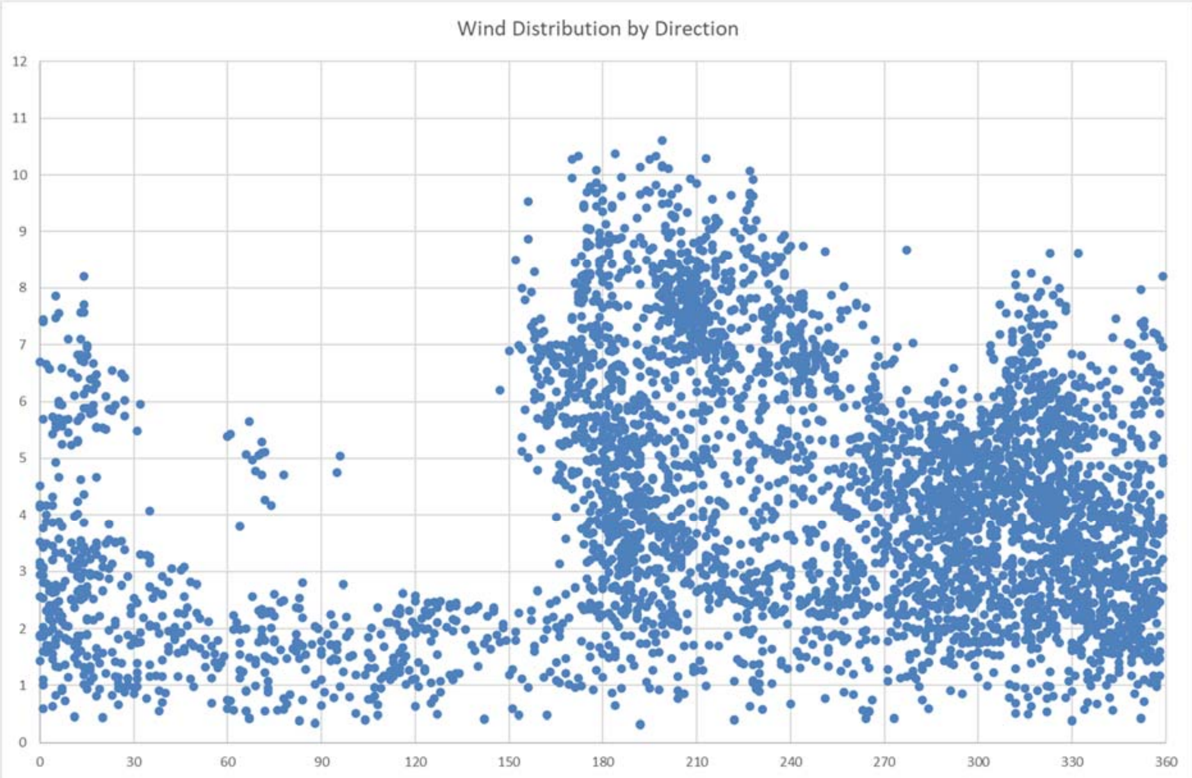


Figure 9 Distribution of Wind Speeds and Direction (18 July – 9 August 2022)

It is confirmed that survey periods were of sufficient duration to measured adequate data to determine a suitable representation of typical background at all locations in accordance with guidance contained within the Institute of Acoustics Good Practice Guide (IOA GPG).

A10.4.4 Personnel and Instrumentation

AWN Consulting installed and removed the noise monitors at all locations. Battery checks and meter calibrations were carried out part-way through the survey periods. Details of the instrumentation used at the various locations is details in Table 10.9.

Name	Equipment	Serial Number	Maximum Calibration Drift
H35	Rion NL-52	186668	0.0
H41	Rion NL-52	575782 and 1076330	-0.1
H47	Rion NL-52	1076328	-0.3
H2	Rion NL-52	186670	0.1
H18	Rion NL-52	764925	0.1
H106	Rion NL-52	186669	0.0

Table 3 Instrumentation Details

Before and after the survey the measurement apparatus was check calibrated using a sound level calibrator where appropriate. Instruments were calibrated on each interim visit and any drift noted. Relevant calibration certificates are presented in Appendix 10.4.

Rainfall was monitored and logged using a Texas Instruments TR-525 console and a data logger that was installed on-site for the duration of the surveys (at H47 and H18). This allows for the identification of periods of rain fall to allow for the removal of sample periods affected by rainfall from the noise monitoring data sets in line with best practice when calculating the prevailing background noise levels.

A10.4.5 Background Noise Measurement Results

The following sections present the results of the noise monitoring data obtained from the background noise survey in accordance with the methodology discussed above.

Location H35

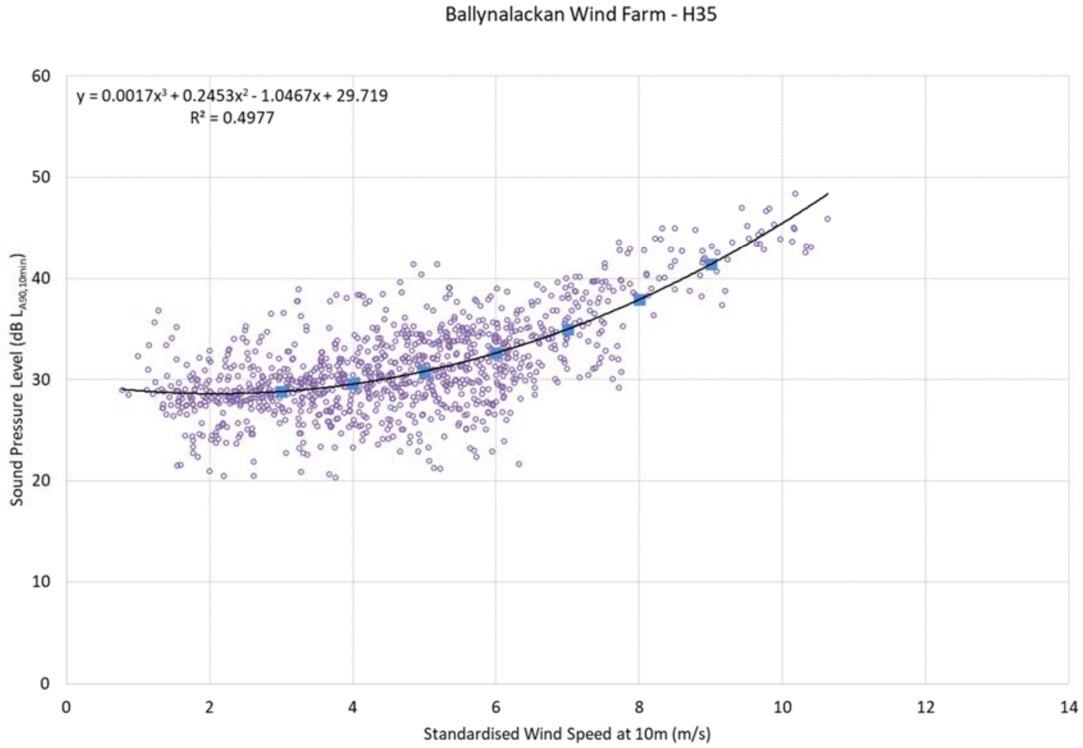


Figure 10 Background Noise Levels at H35 - Daytime

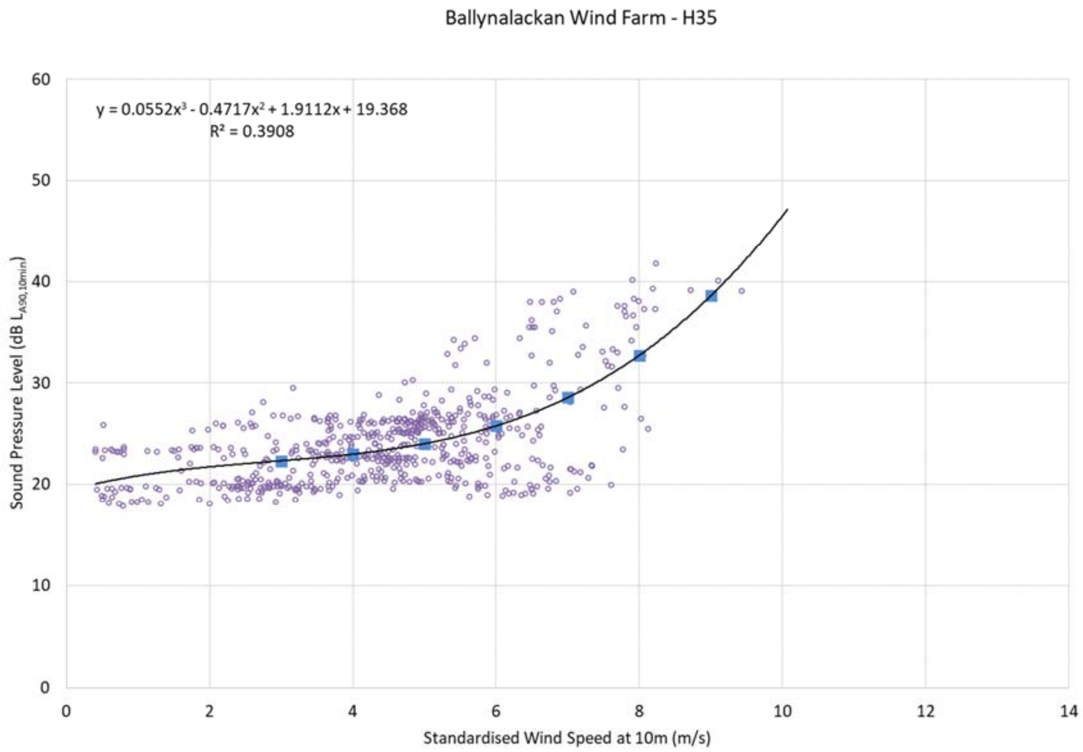


Figure 11 Background Noise Levels at H35 – Night-time

Location H41

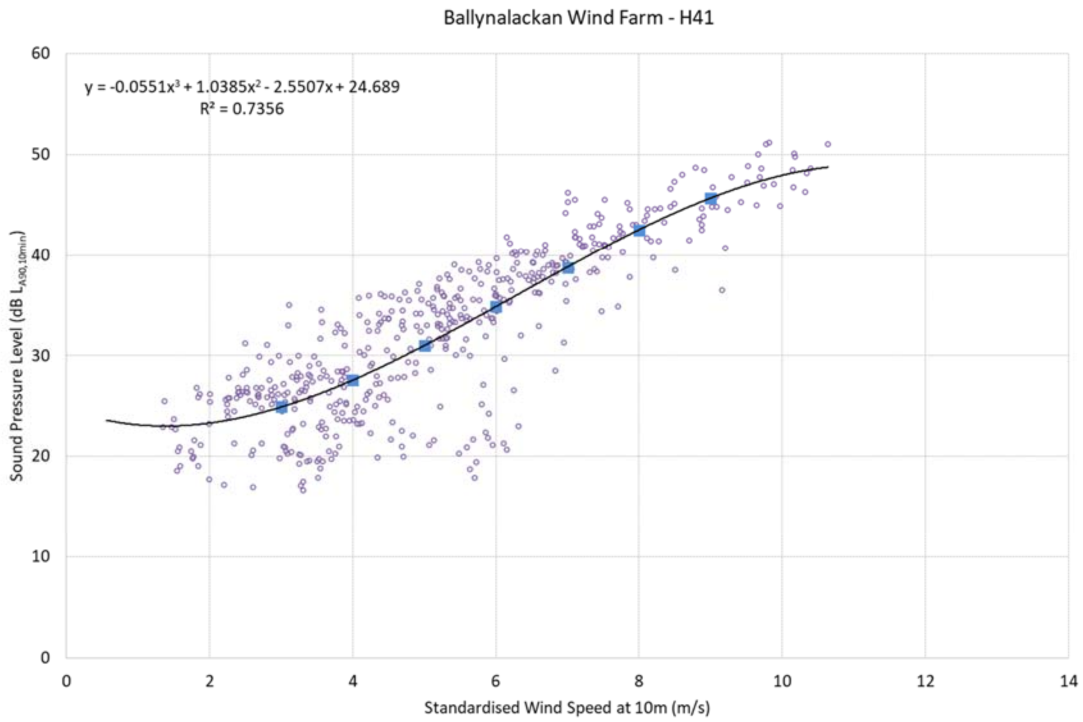


Figure 12 Background Noise Levels at H41 - Daytime

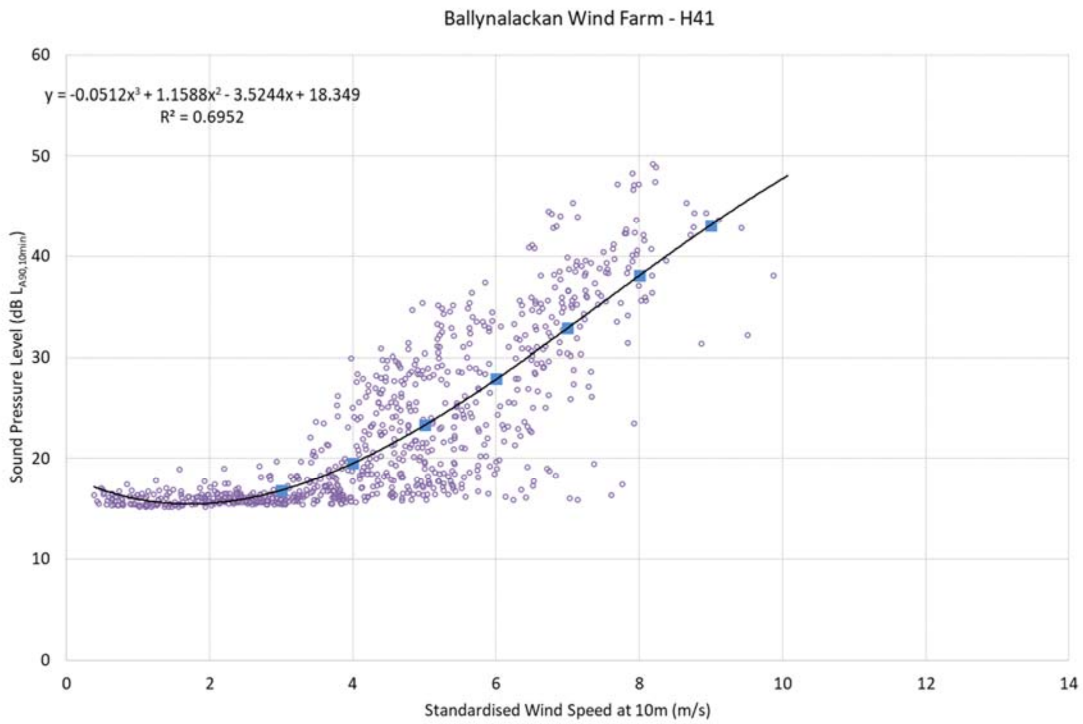


Figure 13 Background Noise Levels at H41 – Night-time

Location H47

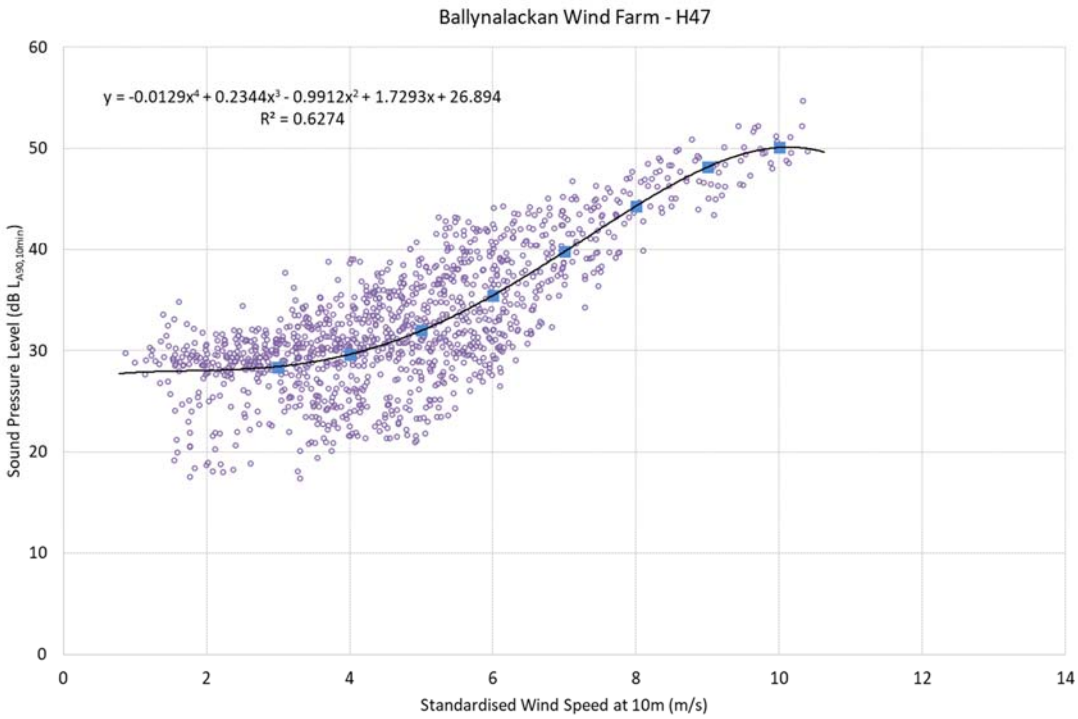


Figure 14 Background Noise Levels at H47 - Daytime

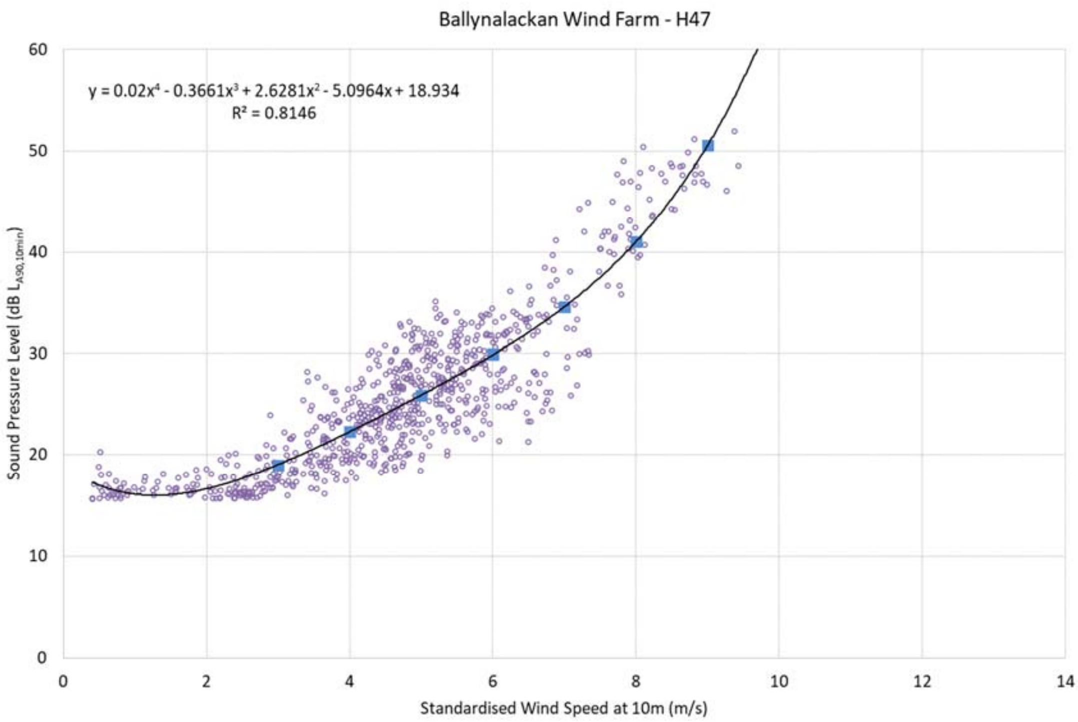


Figure 15 Background Noise Levels at H47 – Night-time

Location H2

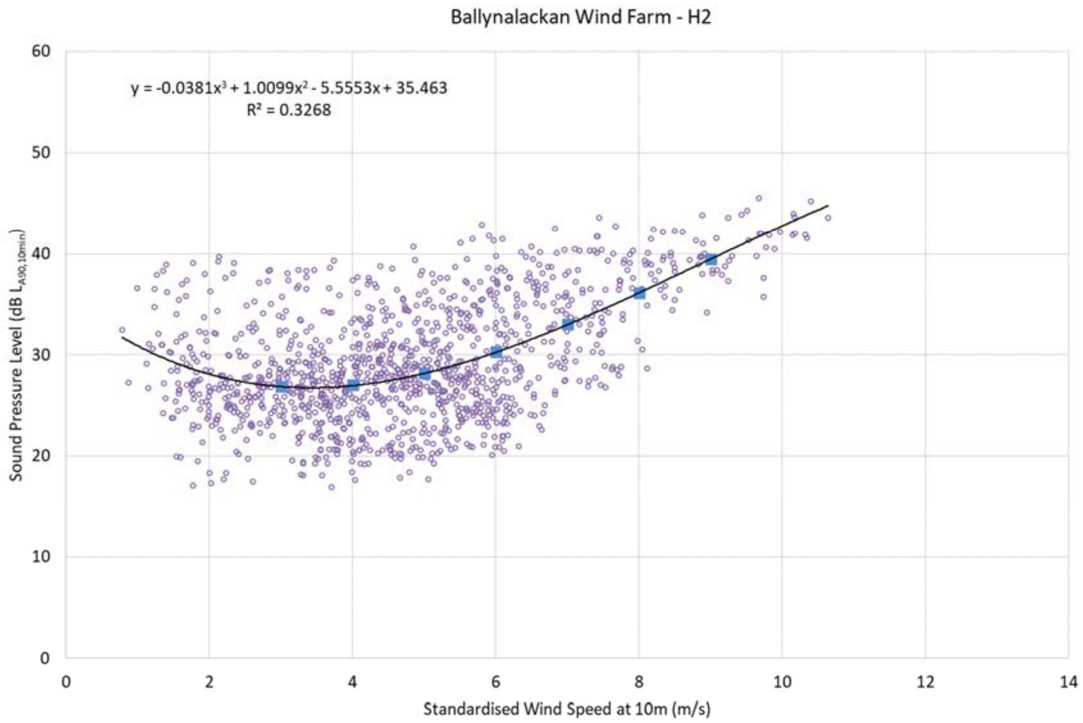


Figure 16 Background Noise Levels at H2 - Daytime

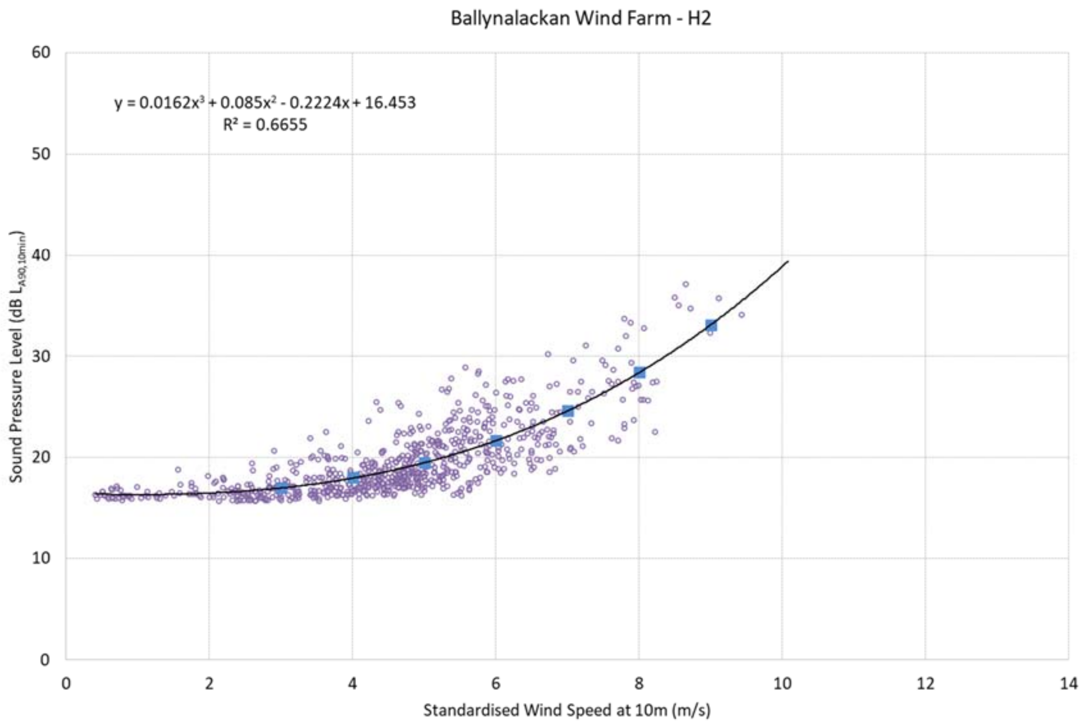


Figure 17 Background Noise Levels at H2 – Night-time

Location H18

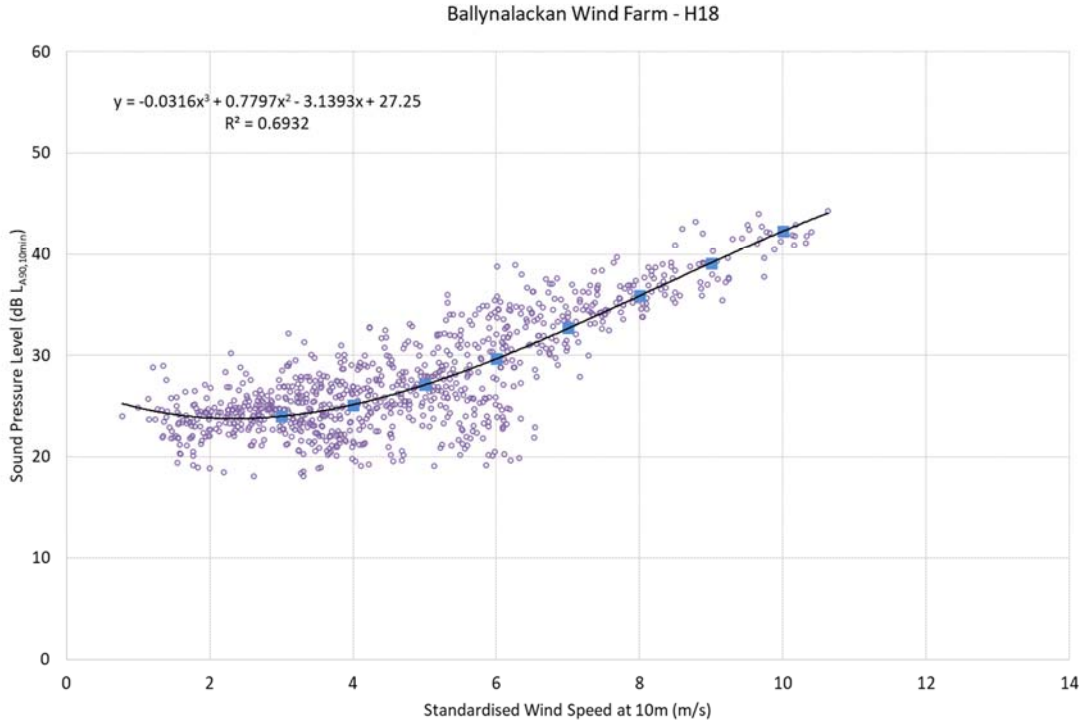


Figure 18 ***Background Noise Levels at H18 - Daytime***

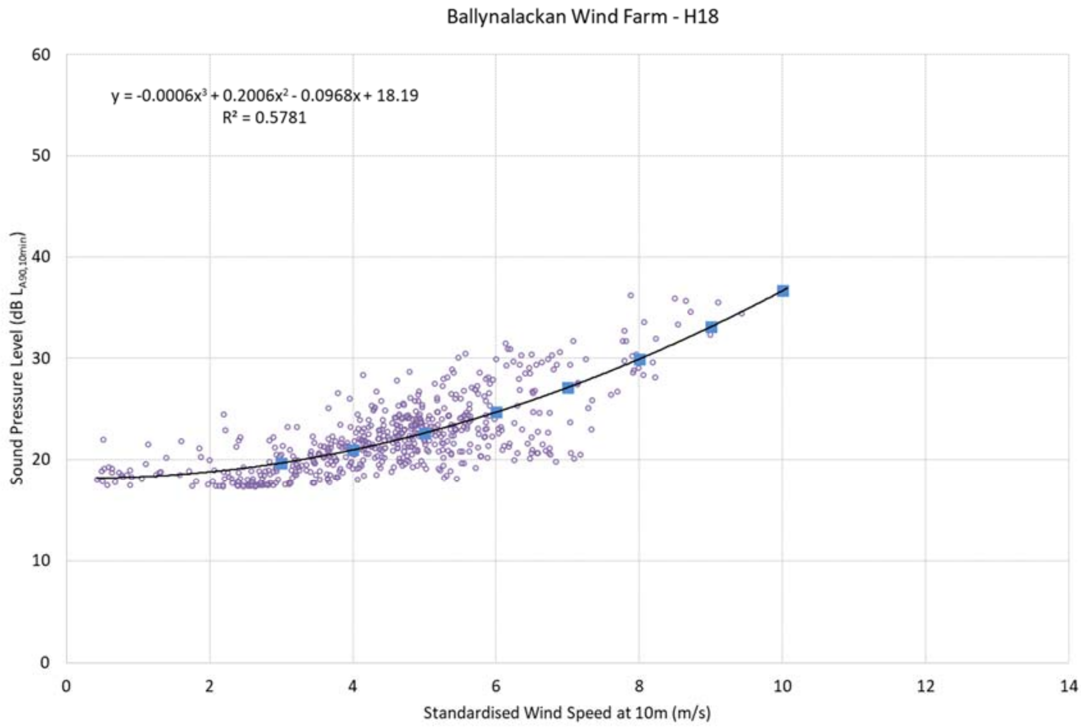


Figure 19 ***Background Noise Levels at H18 – Night-time***

Location H106

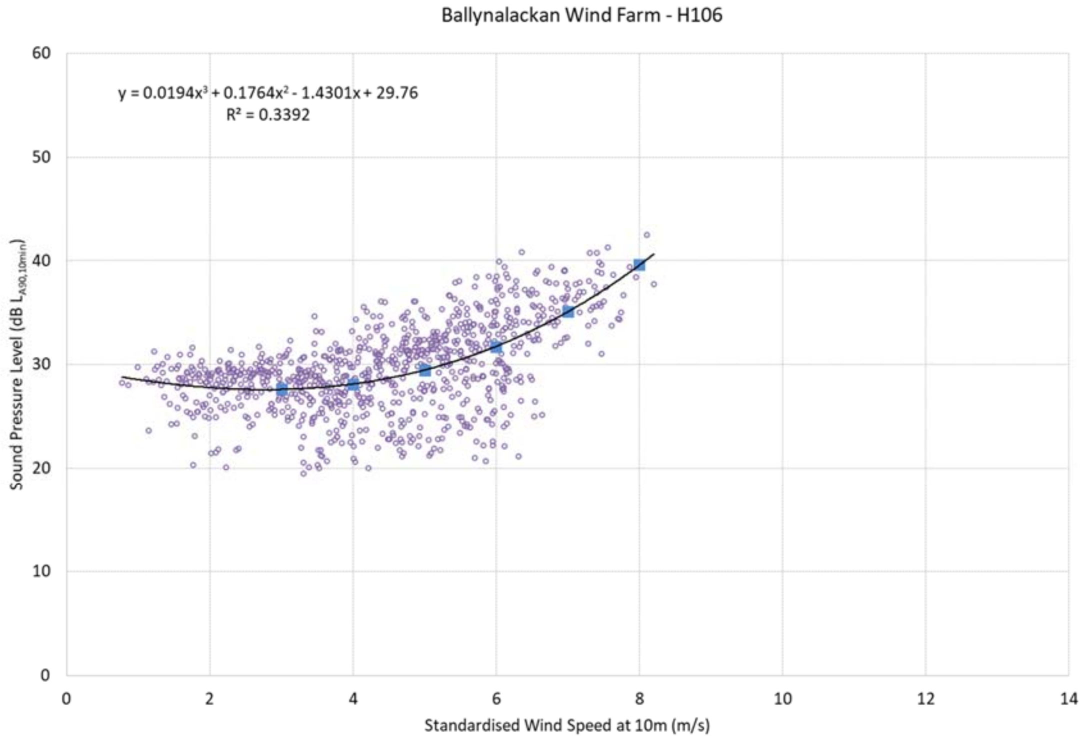


Figure 20 ***Background Noise Levels at H106 - Daytime***

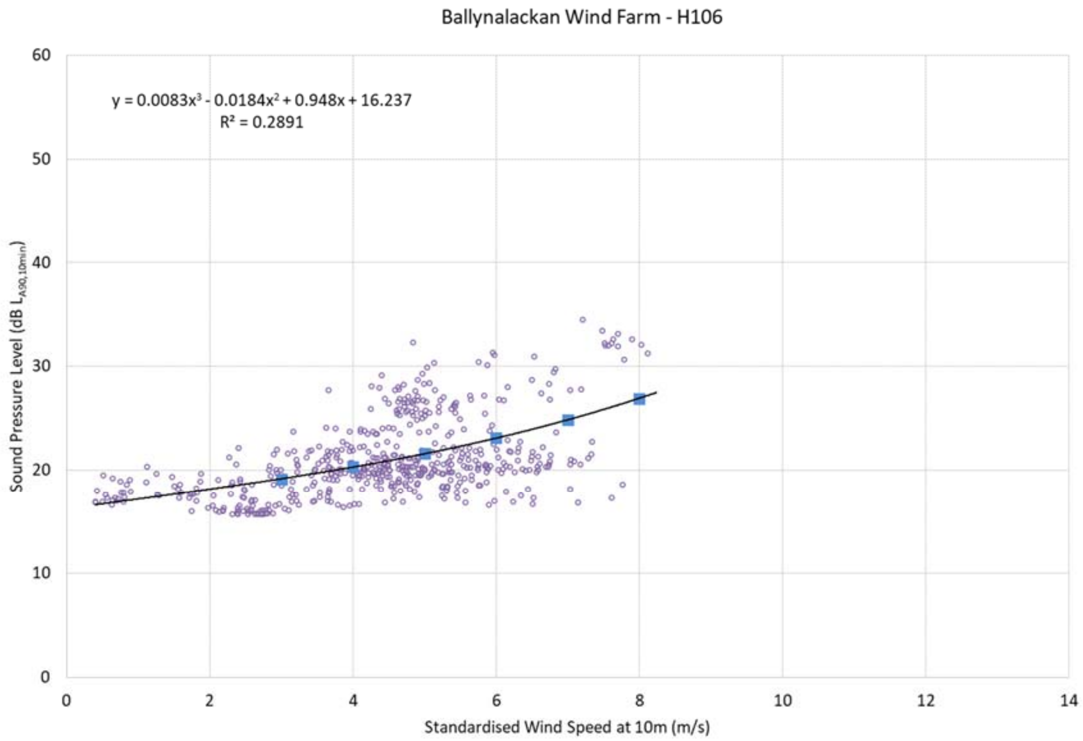


Figure 21 ***Background Noise Levels at H106 – Night-time***

A10.4.6 Summary of Background Noise Monitoring Findings

Table 4 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime 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 in the Institute of Acoustics Good Practice Guide Supplementary Guidance No. 2: Data Processing & Derivation of ETSU-R-97 Background Curves.

The 'envelope' values in Table 4 are, for each wind speed, obtained by using the lowest value measured across the noise survey locations for the same wind speed. The resulting values are used to derive wind turbine noise criteria at locations where no noise survey was carried out

House	**Period**	**Derived L_{A90}, 10-min Levels (dB) at Various Standardised 10m Height Wind Speeds**						
		3	**4**	**5**	**6**	**7**	**8**	**9**
H35	Day	28.8	29.6	30.8	32.6	35.0	37.9	41.4
	Night	22.3	23.0	24.0	25.8	28.6	32.7	38.6
H41	Day	24.9	27.6	31.0	34.9	38.8	42.5	45.7
	Night	16.8	19.5	23.3	27.9	32.9	38.1	43.1
H47	Day	28.4	29.6	32.0	35.4	39.8	44.3	48.2
	Night	19.0	22.3	25.9	29.9	34.6	41.0	50.6
H2	Day	26.9	27.0	28.2	30.3	33.0	36.1	39.5
	Night	17.0	18.0	19.5	21.7	24.6	28.4	33.1
H18	Day	24.0	25.1	27.1	29.7	32.7	35.9	39.1
	Night	19.7	21.0	22.6	24.7	27.1	29.9	33.1
H106	Day	27.6	28.1	29.4	31.7	35.1	39.6	--
	Night	19.1	20.3	21.6	23.1	24.8	26.9	--
Envelope	Day	24.0	25.1	27.1	29.7	32.7	35.9	39.1
	Night	16.8	18.0	19.5	21.7	24.6	26.9	33.1

Table 10.4 Derived Levels of $L_{A90,10\text{-}min}$ for Various Wind Speeds

Appendix 10.5: Calibration Certificates

Appendix to Chapter 10: Noise and Vibration Assessment

Appendix 10.5: Calibration Certificates

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA | UKAS CALIBRATION 0653

Date of Issue: 03 May 2022

Certificate Number: UCRT22/1600

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
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Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages

Approved Signatory

K. Mistry

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin D17 XD90 Ireland			
Order No.	DOD/22/Cal040			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00186668
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76701
	Rion	Microphone	UC-59	12813
	Brüel & Kjær	Calibrator	4231	2460007
		Calibrator adaptor type if applicable		UC 0210
Performance Class	1			
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*			
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*			
Date Received	29 April 2022		ANV Job No.	UKAS22/04300
Date Calibrated	03 May 2022			

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	07 May 2020	UCRT20/1405	0653

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 12 July 2021

Certificate Number: UCRT21/1841

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Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

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Approved Signatory
B. Giles

Customer	AWN Consulting Ltd The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin D17			
Order No.	DOD/21/Cal034			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00575782
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	65810
	Rion	Microphone	UC-59	19108
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002
Performance Class	1			
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*			
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*			
Date Received	08 July 2021	ANV Job No.	UKAS21/07450	
Date Calibrated	12 July 2021			

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	26 November 2020	UCRT20/2149	0653

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA

UKAS CALIBRATION
0653

Date of Issue: 20 October 2020

Certificate Number: UCRT20/2020

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Approved Signatory
K. Mistry

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin 17 Ireland			
Order No.	PO-2083			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	01076330
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	87063
	Rion	Microphone	UC-59	13407
	Brüel & Kjær	Calibrator	4231	3010369
		Calibrator adaptor type if applicable		UC 0210
Performance Class	1			
Test Procedure	TP 2.SLM 61672-3 TPS-49 *Procedures from IEC 61672-3:2006 were used to perform the periodic tests.*			

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received	19 October 2020	ANV Job No.	UKAS20/10584
Date Calibrated	20 October 2020		

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 April 2019	UCRT19/1402	0653

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 21 August 2020

Certificate Number: UCRT20/1795

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Approved Signatory

K. Mistry

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin 17 Ireland			
Order No.	PO 2062			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	01076328
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76545
	Rion	Microphone	UC-59	17212
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002
Performance Class	1			
Test Procedure	TP 2.SLM 61672-3 TPS-49 *Procedures from IEC 61672-3:2006 were used to perform the periodic tests.*			

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received	19 August 2020	ANV Job No.	UKAS20/08452
Date Calibrated	21 August 2020		

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	15 August 2018	UCRT18/1836	0653

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION
0653

Date of Issue: 03 May 2022

Certificate Number: UCRT22/1596

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Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

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Approved Signatory K. Mistry

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin, D17 XD90 Ireland			
Order No.	DOD/22/Cal040			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00186670
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76820
	Rion	Microphone	UC-59	12816
	Brüel & Kjær	Calibrator	4231	2394086
		Calibrator adaptor type if applicable		UC 0210
Performance Class	1			
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*			
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*			
Date Received	29 April 2022		ANV Job No.	UKAS22/04300
Date Calibrated	03 May 2022			

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	05 May 2020	UCRT20/1392	0653

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K. Mistry

Customer	AWN Consulting Limited The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin 17 Ireland

Order No.	PO 2062			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00764925
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	65051
	Rion	Microphone	UC-59	09853
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 19 August 2020 ANV Job No. UKAS20/08452

Date Calibrated 19 August 2020

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	22 August 2018	UCRT18/1863	0653

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 12 May 2022 **Certificate Number: UCRT22/1643**

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Beaufort Court
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Customer	AWN Consulting Ltd The Tecpro Building IDA Business and Technology Park Clonshaugh Dublin D17 XD90
Order No.	DOD/22/Cal041
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00186669
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76819
	Rion	Microphone	UC-59	12814
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 10. SLM 61672-3:2013

Procedures from IEC 61672-3:2013 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2013 Yes

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013

Date Received 10 May 2022 ANV Job No. UKAS22/05320

Date Calibrated 12 May 2022

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	04 May 2020	UCRT20/1389	0653