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ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED COUMNAGAPPUL WIND FARM, CO. WATERFORD

VOLUME 2 – Main EIAR

CHAPTER 8 – Noise & Vibration

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TABLE OF CONTENTS

8. NOISE AND VIBRATION 1
8.1 Introduction 1
8.2 Statement of Authority 2
8.3 Noise and Vibration Criteria 2
8.3.1 Construction Noise and Vibration 2
8.3.2 Operational Noise and Vibration 3
8.3.3 Blade Swish (Amplitude Modulation of Aerodynamic Noise 3
8.3.4 Infrasound & Low Frequency Noise 5
8.3.5 Tonal Noise 6
8.3.6 Vibration 7
8.4 Methodology 7
8.4.1 Relevant Guidance 8
8.4.2 Study Area 9
8.4.3 Evaluation Criteria 9
8.4.4 Significance of Effect 13
8.4.5 Consultation 13
8.5 Existing Environment 14
8.5.1 Analysis of the Baseline Data 15
8.5.2 Derived Wind Farm Noise Limits 16
8.6 Potential Effects 17
8.6.1 Do Nothing Scenario 17
8.6.2 Potential Effects during Construction 17
8.6.3 Potential Effects during Operation 24
8.6.4 Potential Effects during Decommissioning 39
8.6.5 Potential Cumulative Effects 39
8.7 Mitigation Measures 46
8.7.1 Mitigation Measures During Construction 46
8.7.2 Mitigation Measures During Wind Farm Operation 46
8.7.3 Mitigation Measures during Decommissioning 47
8.8 Residual Effects 47
8.9 References 47

LIST OF APPENDICES (Volume III)

Appendix 8.1a: Baseline Noise Measurements and Data Analysis

Appendix 8.1b: Equipment Calibration Certificates

Appendix 8.1c: Noise Sensitive Location Details

Appendix 8.1d: Valley Correction

Appendix 8.1e: Sound Power Level Data For Wind Turbines

Appendix 8.1f: Predicted Noise Levels From Wind farm at Nearby Noise Sensitive Locations

LIST OF FIGURES (Volume IV)

Figure 8.1: Noise Sensitive Locations within the Study Area

Figure 8.2: Noise Monitoring Locations

Figure 8.3 Cumulative Noise from Coumnagappul, Tierny and Dyrick Hill Wind Farms

LIST OF TABLES

Page

Table 8-1: Threshold of Potential Significant Effect during Construction and Decommissioning 10

Table 8-2: Details on the Noise Monitoring Locations 14

Table 8-3: Prevailing Background Noise during Daytime Periods 15

Table 8-4: Prevailing Background Noise Night-time Periods 15

Table 8-5: Derived Noise limit Daytime and Night time, based on minimum daytime and night time noise 17

Table 8-6: Preparation of Access roads, Hardstands and Drainage – Likely Plant and Predicted Levels..19

Table 8-7: Preparation of Wind Turbine Foundations – Likely Plant and Predicted Levels 20

Table 8-8: Installation of Wind Turbines – Likely Plan and Predicted Levels 20

Table 8-9: Construction of Substation – Likely Plant and Predicted Levels 21

Table 8-10: Grid Connection Works – Likely Plant and Predicted Noise Levels 23

Table 8-11: Atmospheric Octave Band Attenuation coefficients dB/m 25

Table 8-12: Wind Turbine Sound Power Levels, dB L_{WA} standardised to 10m (hub height 104m) 26

Table 8-13: Wind Turbine Octave Band Noise Levels, dB(A) for a range of Standardised 10 m Height Wind Speeds 27

Table 8-14: Assessment of Predicted L_{A90} Noise Levels for Coumnagappul Wind Farm against Noise Limits 28

Table 8-15: Assessment of Predicted L_{A90} Noise Levels for proposed Coumnagappul Windfarm with Transformer (Substation) against Noise Limits 33

Table 8-16: Octave Band Sound Power Level Data 37

Table 8-17: Predicted Rated Noise from proposed Substation....38
Table 8-18: Cumulative Wind Farms....39
Table 8-19: Assessment of Predicted L_{A90} Noise Levels for Coumnagappul, Dyrik Hill and Tierney Wind Farm against Noise Limits....41

8. NOISE AND VIBRATION

8.1 Introduction

This chapter contains an assessment of the potential noise and vibration effects associated with the proposed Coumnagappul Wind Farm. The assessment including, undertaking of background noise surveys has been carried out by Fehily Timoney and Company, based on information provided by the Applicant and in accordance with current guidance and best practice. The proposed project assessed in this EIAR comprises the following key elements, as described in Chapter 2, Volume 2 of the EIAR:

The wind farm site (referred to in this EIAR as the 'Site');

The grid connection (referred to in this EIAR as the 'GCR');

The turbine delivery route (referred to in this EIAR as the 'TDR').

Potential construction noise and vibration effects have been determined with reference to British Standard 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise.

Potential operational noise effects associated with the Proposed Development have been determined with reference to the UK Institute of Acoustics', A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013). Operational noise associated with the Proposed Development includes noise from the wind turbines and on-site substation. The operational noise is compared with noise limits derived in accordance with the Wind Energy Development Guidelines 2006 and in accordance with current industry best practice (refer to Section 8.4 for further information). Decommissioning noise and vibration impacts have been assessed in accordance with the same standards used to determine the construction noise and vibration impacts.

This assessment considers the Vestas V162 wind turbine model which has been selected for this Project as described in Chapter 1 Introduction and Chapter 2 Development Description. The plans and particulars submitted with this application for consent provide dimensions for the turbine structures. The turbine specifications will have a hub height of 104 m and a rotor diameter of 162 m, with a tip height of 185 m.

This chapter of the EIAR is supported by the Figures in Volume IV and following Technical Appendices documents provided in Volume III of this EIAR:

- Appendix 8.1a: Baseline Noise Measurements and Data Analysis
- Appendix 8.1b: Equipment Calibration Certificates
- Appendix 8.1c: Noise Sensitive Location Details
- Appendix 8.1d: Valley Correction
- Appendix 8.1e: Sound Power Level Data For Wind Turbines
- Appendix 8.1f: Predicted Noise Levels From Wind farm at Nearby Noise Sensitive Locations

8.2 Statement of Authority

Maureen Marsden is an acoustic engineer with a Master of Engineering degree in Acoustics and Vibration and over 20 years' experience, in noise and vibration, most recently within industrial and environmental noise. Maureen Marsden undertook the baseline noise survey, construction noise predictions and operational noise predictions and compiled the noise and vibration chapter.

John Mahon has a PhD in Acoustics and Vibration and a BA BAI (Hons) degree in Mechanical Engineering from Trinity College Dublin. He is a member of Engineers Ireland and the Institute of Acoustics. The preliminary noise model was undertaken by John Mahon to advise on selection of noise monitoring locations. John Mahon also undertook the noise survey data analysis.

John Cullen is an Environmental and Acoustic Engineer with a BAgrSc in Agri-Environmental Science, a post Graduate Diploma in Environmental Engineering and a Diploma in Acoustics and Noise Control. John has over five years' experience in the assessment of noise and vibration and is a member of the Institute of Engineers Ireland, the Institute of Environmental Sciences and the Institute of Acoustics. John assisted with noise predictions and compiling the noise and vibration chapter.

8.3 Noise and Vibration Criteria

8.3.1 Construction Noise and Vibration

Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks, and construction of the substations.

Noise from vehicles on local roads and access tracks is also generated from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

Vibration is generated by construction activities such as rock breaking and passing heavy goods vehicles. The threshold of human perception of vibration is in the range of 0.14mm/s to 0.3mm/s, described as "might just be perceptible".

The guideline values for damage to buildings from vibration are 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above , as summarised in BS 5228 Control of Noise and Vibration on Open and Construction Sites- Part 2: Vibration.

Vibration levels generated from the construction activities proposed at Coumnagappul Wind Farm are calculated as:

Tracked excavators and disc cutters from cable trenching (0.8 mm/s at 4m)
Pneumatic breakers for cable trenching (0.7 mm/s at 10 m)
Excavation of turbine foundations (0.06 mm/s at 100 m)
HGV traffic on normal road surfaces (0.01 to 0.5 mm/s) at footings of buildings located 20 m from roadway.

The nearest noise sensitive locations are sufficiently distant, and less than the values above such that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration. As such, construction vibration will not be considered further in this chapter.

8.3.2 Operational Noise and Vibration

Noise is generated by wind turbines as they rotate to generate power. This only occurs above the 'cut-in' wind speed and below the 'cut-out' wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring. The cut-in speed of the V162 turbine is 3 m/s and the cut-out wind speed is 25 m/s.

The principal sources of noise are from the blades rotating in the air (aerodynamic noise) and from internal machinery, normally the gearbox and, to a lesser extent, the generator (mechanical noise).

The blades are carefully designed to minimize noise whilst optimising power transfer from the wind. See Oerlemans et al. (2008) 'Location and quantification of noise sources on a wind turbine' for further details on the principal sources of noise from a wind turbine.

Noise may also be generated from ancillary equipment such as transformers at on-site substations. However, these generally have low source noise levels compared to wind turbines themselves and, provided they are not located within the immediate vicinity of a residential dwelling, are unlikely to cause disturbance in the context of the other noise sources. Noise from the substation has been considered as part of this assessment and is discussed further in Section 8.6.3.3.

8.3.3 Blade Swish (Amplitude Modulation of Aerodynamic Noise

This is the periodic variation in noise level associated with turbine operation, at the rate of the blade passing frequency (rotational speed multiplied by number of blades). It is often referred to as blade swish or amplitude / aerodynamic modulation (AM). This effect is discussed in ETSU-R-97, 'The Assessment and Rating of Noise from Wind Farms' (1996), which states that *'… modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine... '* and that at distances further from the turbine where there are *'… more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)'*. It concludes that *'the noise levels (i.e. limits) recommended in this report take into account the character of noise described ... as blade swish'.*

An observer close to a wind turbine will experience *'blade swish'* because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from them. This effect is reduced for an observer on or close to the (horizontal) turbine axis, and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

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

It was proposed in the RenewableUK 2013 study that the fundamental cause of OAM 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[1] of the rotor blade.

[1] The stall source mechanism radiates equally upwind and downwind, but propagation effects reduce noise levels upwind.

The University of Salford carried out a study on behalf the Department for Business, Enterprise and Regulatory Reform (BERR) to investigate the prevalence of amplitude modulation of aerodynamic noise on UK wind farm sites. The study concluded that AM has occurred at 4 out of 133 wind farms in the UK. A further investigation of the four sites by the Local Authority showed that the conditions associated with AM might occur between 7% and 15% of the time.

The most recent research into AM was conducted by RenewableUK, 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' (December 2013).

This research focused on the less understood *'Other AM or OAM'* where reported incidents are relatively limited and infrequent but is a recognised phenomenon. However, the occurrence and intensity of Other AM is specific to a location and its likelihood of occurrence cannot be reliably predicted.

Section 6 of the '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' states that *'At present there is no way of 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.'*

However, the Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) states…

'features which are thought to enhance this effect are:

- *close spacing of turbines in linear rows;*
- *tower height to rotor diameter ratio less than approximately 0.75;*
- *stable atmospheric conditions;*
- *topography leading to different wind directions being seen by the blades at different points in their rotation'.*

The Renewable study *'has found that by minimising the onset of blade stall, the occurrence of OAM is also likely to be minimised.'* It goes on to discuss *'the future involvement of turbine manufacturers in developing methods of avoiding or minimising the partial stall mechanism identified as a primary cause of OAM; and suggests that in future changes to blade design and the way in which the blade pitch (the angle of attack of the blade to the incoming air flow) is controlled are likely to have a role to play in achieving better management of the phenomenon.'* Ultimately, further work is required to identify the exact on-blade conditions required for OAM to occur. The further work will aid in the development of a measure to fully mitigate the OAM. If OAM occurs from the proposed project, the wind turbine(s) will be operated in a manner to address this by way of implementation of blade pitch regulation, vortex generators or shut downs.

In 2016, the IOA published 'A Method for Rating Amplitude Modulation in Wind Turbine Noise'. It sets out a procedure for obtaining input noise data.

The procedure proposed in the IOA guidance document is recommended by the Department of Business, Energy & Industrial Strategy (BEIS) who have published a study on amplitude modulation.

At present there is no method for predicting OAM at any particular location before turbines begin operation based on the general features of a site or the known attributes of a particular turbine. Therefore, it is not possible to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule. The RenewableUK study states that "even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent.", and "There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."

Assessment of AM Research and Guidance is ongoing, with recent publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) :"A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016)". The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of AM. The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work. There has been no adoption of endorsement of an AM 'penalty' scheme by any government.

The IOA GPG states "The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM."

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

8.3.4 Infrasound & Low Frequency Noise

The definition of low frequency noise can vary, but it is generally accepted that low frequency noise is noise that occurs within the frequency range of 10 Hz to 160 Hz as defined in NANR45: Procedure for assessment of low frequency noise, Salford University Report.

Infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, owning 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', 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.*

It goes on to state that, based on information from the World Health Organisation, 'there is no reliable evidence that infrasound 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 study reports that low frequency noise is measurable but below the DEFRA low frequency noise criterion. The study also assessed low frequency measurements against the Danish criterion of LpA,LF = 20 dB. It was found that internal levels do not exceed 20dB when measurements are undertaken within rooms with the windows closed. However, the study acknowledges that wind turbine noise (low frequency) may result in an internal noise level that is just above the threshold of audibility as defined in ISO 226. The study goes on to say… *'However, at all the measurement sites, low frequency noise associated with traffic movement along local roads has been found to be greater than that from the neighbouring wind farm.'*

Bowdler et al. (2009) concludes 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 January 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms. Measurements were undertaken at seven locations in urban areas and four locations in rural areas including two residences approximately 1.5 km from the wind turbines. The study concluded *'that the level of infrasound at houses near the wind turbines … is no greater than that experienced in other urban and rural environments and is also significantly below the human perception threshold.'*

In 2016, the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany published a report entitled *'Low-frequency noise incl. infrasound from wind turbines and other sources.'* It assessed infrasound and low frequency sound from wind turbines and other sources. It found that 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).'*

We conclude that infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Infrasound is not a source which may be injurious to the health of a wind farm neighbour.

Wind turbines may produce low frequency noise at levels above the threshold of audibility. However, there is no evidence of health effects arising from low frequency noise generated by wind turbines. Given the evidence described above, an assessment of infrasound and low frequency noise from the wind farm has been scoped out.

8.3.5 Tonal Noise

ETSU-R-97 describes tonal noise as *'noise containing a discrete frequency component most often of mechanical origin'.* Wind turbine sound can be tonal in some cases, for example if there is a defect in a turbine blade or a fault in the mechanical equipment such as the gearbox. Tonality from wind turbines is generally caused by structural resonances in the mechanical parts of the turbine and thus is highly specific not only to the turbine model but the specific components used, including tower height. However, a correctly operating wind turbine is not considered to have tonal sound emission. In the event of tonal noise being present and following establishment of the likely cause, this can be addressed by turbine manufacturers and/or operator as and when it occurs. The assessment of the wind turbine noise assumed that a tonal penalty is 0 dB.

8.3.6 Vibration

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 Snow2 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 Report3 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 at less than 300m from the turbine, the vibration levels had reduced such that they could no longer be differentiated from the background vibration levels.

Considering that the curtilage of the nearest sensitive receptor is over 711m from the nearest turbine, the level of vibration is significantly below any thresholds of perceptibility. Vibration from the turbines is too low to be perceived at neighbouring residential dwellings.

Vibration levels will also be significantly below levels that would result in damage to the nearest buildings (including farm buildings). Therefore, operational vibration has been scoped out.

8.4 Methodology

The methodology employed for this noise and vibration assessment is as follows:

- Review of appropriate guidance and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise environment;
- Prediction of the noise impact associated with the proposed development, and;
- Evaluation of noise impacts;
- Propose mitigation, and;
- Assess residual impacts.

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

[3] 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.

8.4.1 Relevant Guidance

A list of relevant guidance documents is provided below. These have been referred to where referenced or applied in the sections hereafter.

EIA Guidance:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022.

Noise Modelling Standards and Technical Advice:

- International Standard ISO 9613-2: 1996 Attenuation of sound during propagation outdoors, Part 2: General method of calculation;
- UK Institute of Acoustics', A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise (2013) and supplementary notes;
- British Standard BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise;
- Irish Wind Energy Association, Best Practice Guidelines for the Irish Wind Energy Industry (2012);
- UK Department of Trade and Industry (DTI), ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996);
- British Standard 4142:2014+A1:2019, Methods for rating and assessing industrial and commercial sound.

Guideline Noise Levels:

- Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government (2006);
- Waterford City and County Development Plan 2022 – 2028.

Note on the Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government, 2019 (DRWEDG 2019):

The DRWEDG 2019 guidelines are currently in draft format and are currently under review by the Department of Housing Local Government and Heritage and the Department of the Environment, Climate and Communications. This process has yet to be completed. As such, this assessment is based on the current guidance: Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government (2006), issued under section 28 of the Planning and Development Act 2000, as amended. This is discussed further in the following section.

8.4.2 Study Area

Construction and decommissioning noise have been assessed by comparing wind energy development construction activities[4] against best practice construction noise criteria at the nearest residential dwellings to the construction activities. As such, if the construction noise meets the relevant noise limits at the nearest locations, it will also be below the relevant noise limits at more distant residential locations (having regard also to any potential for cumulative noise effects). This is discussed in Section 8.6.2.

The operational noise study area includes all residential dwellings with a predicted noise level greater than 35 dB L_{A90} (which is the lowest limit prescribed in the 2006 Department of the Environment, Heritage, and Local Government, *Wind Energy Development Guidelines*). The study area is also in accordance with the UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) whereby the guidance document defines the study area as "*the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35dB L_{A90} at up to 10 m/s wind speed*."

The IOA guidance documents also states… *"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."* As the proposed windfarm is sufficiently distant from adjacent windfarms, no cumulative noise from adjacent windfarms has been considered as part of this assessment. Potential Cumulative Effects are discussed in more detail in Section 8.6.5. The operational study area is presented in Figure 8.1, Volume IV. The study area includes 4 no. noise sensitive locations.

As operational and construction vibration have been scoped out there is no requirement to set study areas for this.

8.4.3 Evaluation Criteria

8.4.3.1 Construction Noise Criteria

There is no statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. In the absence of specific noise limits, appropriate emission criteria relating to permissible construction noise levels for a project of this scale may be found in the British Standard *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Noise.*

BS 5228-1:2009+A1:2014 contains several methods for the assessment of the potential significance of noise effects. The ABC Method was used to derive appropriate noise limits for the proposed project. The threshold limit to be applied (as defined in Table 8.1) is dependent on the existing ambient noise levels (rounded to the nearest 5dB).

[4] Please refer to Chapter 2 - Project Description for Construction methodology. Note that blasting will not be required for construction (see Chapter 11 - Soils, Geology and Hydrogeology for details on ground conditions).

Table 8-1: Threshold of Potential Significant Effect during Construction and Decommissioning

Threshold value period (L_{Aeq})	Threshold Value, in decibels (dB)		
	Category A	Category B	Category C
Night-time (23:00 - 07:00hrs)	45	50	55
Evenings (19:00 – 23:00 hrs.) and weekends (13:00 – 22:00 Saturdays) and (07:00 – 19:00 hrs. Sundays)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (08:00 – 16:30)	65	70	75
Note Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values. Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values. Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.			

The approach adopted here calls for the designation of a noise sensitive location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. For the appropriate period (e.g. daytime), the ambient noise level is determined and rounded to the nearest 5dB.

The baseline noise survey results ambient (free field) noise levels were analysed. A correction of +3dB was added to the noise levels to convert free-field noise levels to façade noise levels. The ambient façade noise level when rounded to the nearest 5dB varies, but for the most part it is less than 60 dB L_{Aeq}. The nearest residential dwellings to the proposed development are afforded Category A designation (65 dB $L_{Aeq,1hr}$ during daytime periods) as detailed in section 8.6.2.

If the modelled construction noise level exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,1hr}$ during daytime periods) then a potential significant effect is predicted and mitigation measures may be required to reduce the noise levels below the $L_{Aeq,1hr}$ daytime noise limit.

8.4.3.2 Wind Farm Operational Noise Criteria

The operational noise assessment summarised in the following sections has been based on guidance in relation to acceptable levels of noise from wind farms as contained in the document Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006).

ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996) published by the Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) and Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013) has been used to supplement the guidance contained within the 'Wind Energy Development Guidelines' publication where necessary.

Waterford City and County Development Plan, Utilities Infrastructure, Energy & Communication has the following objectives with respect to noise:

UTL14 Energy Developments & Human Health

"Proposals for energy development should demonstrate that human health has been considered, including those relating to the topics of:

- *Noise (including consistency with the World Health Organisation's 2018 Environmental Noise Guidelines for the European Region developments must comply with the Wind Energy Development Guidelines (2006), or any subsequent update / review of these)."*

UTL21 Construction and Environmental Management Plan

"Construction Environment Management Plans shall be prepared in advance of the construction of relevant projects and implemented throughout. Such plans shall incorporate relevant mitigation measures which have been integrated into the Plan and any lower tier Environmental Impact Statement or Appropriate Assessment. CEMPs typically provide details of intended construction practice for the proposed development, including…..

i. details of appropriate mitigation measures for noise, dust and vibration, and monitoring of such levels….."

The noise criteria used to assess operational noise from the proposed development is based on a Best Practice Approach, currently used by the acoustics industry. This best practice approach is based on:

- Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006);
- ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996);
- Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013).

The DoEHLG guidelines (2006) contain recommended noise limits to control operational noise from wind farms and state...

"In general, a lower fixed limit of 45 dB(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. 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 30 dB(A), it is recommended that the daytime level of the LA90,10min of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).

Separate noise limits should apply for day-time and for night-time. During the night, the protection of external amenity becomes less important, and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night."

In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, best practice has typically been to consider the guidance contained in ETSU-R-97 and more recently the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes.

Where background noise is less than 30 dB(A), an absolute level within the range of 35-40 dB(A) is applicable. However, there is no appropriate approach in relation to the identification of low noise environments *"where background noise is less than 30dB(A)"* nor is there details on the application of *"an absolute level within the range of 35-40 dB(A)."* In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, on what range of *35-40 dB* to use, we have referred to guidance from ETSU-R-97[5] which states...

"The actual value chosen for the day-time lower limit, within the range of 35-40dB(A), should depend upon a number of factors:

- Number of dwellings in the neighbourhood of the wind farm.
- The effect of noise limits on the number of kWh generated.
- Duration and level of exposure."

The 2006 DoEHLG Wind Energy Development Guidelines do not provide the specific periods which are represented by daytime and night-time hours, therefore the definitions from ETSU-R-97 are taken as 07:00 to 23:00 hrs for daytime and 23:00 to 07:00 hrs for night-time.

The operational noise criteria include noise from wind turbines and any other ancillary noise sources such as the on-site substation transformer.

The Supreme Court decision in Balz and Heubach v An Bord Pleanála and others [2018] IEHC 309 does not change the legal position of the Wind Energy Development Guidelines, 2006 (WEDGs). It has however clarified the extent of the duty on planning authorities to consider submissions in relation to the continued relevance of the WEDGs. The EIAR considered the application of other noise guidelines. However, the Draft Revised Wind Energy Development Guidelines, published in December 2019 which is the most recent publication from the Department of Housing, Planning and Local Government have a number of technical errors, ambiguities and inconsistencies and requires further detailed review and amendment. This is a fact supported by several acoustic consultants from Ireland and the UK. In assessing the draft Guidelines, the WHO 45 dB L_{den} noise criterion was considered. The WHO document is based on a very limited data set, which only estimated the L_{den} for the sites studied, rather than assessing it directly from wind statistics. Furthermore, the WHO recommendation is "conditional".

The guidelines also state… *"it may be concluded that the acoustical description of wind turbine noise by means of Lden or Lnight may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes."* A conditional recommendation, before it becomes folded into any legislative context, would require substantial debate of stakeholders (such as, but not limited to the Public, government bodies, wind farm developers and operators as well as turbine manufacturers). A conditional recommendation is based on low quality evidence that this chosen noise level is effective. Therefore, it would be premature to adopt the WHO recommendations without further careful and detailed consideration and therefore this has not been adopted. The best practice guidance contained in ETSU-R-97 together with the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes haves been considered and applied to ensure a robust and best practice approach to the assessment.

[5] See Page 65 of *The Assessment and rating of noise from wind farms (ETSU-R-97)*: ETSU (Energy Technology Support Unit) for more details.

8.4.4 Significance of Effect

The criteria for determining the significance of effects are set out in the EPAs 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports' (2022). The EPA guidelines do not quantify the effects in decibel terms. In absence of such information, reference is made to relevant standards and guidance documents noise limits as detailed in 8.4.3. If the predicted effect from the construction or operational phase are below the respective noise limits, it is considered that no significant effect occurs.

For this assessment, it has been assumed that dwellings have a medium to high sensitivity.

8.4.5 Consultation

The details of consultation are discussed further in Chapter 5. The consultation issues relating to noise and vibration are summarised below:

Transport Infrastructure Ireland (TII)

The developer/scheme promoter should have regard, inter alia, to the following:

- The EIAR/EIS should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the relevant competent authority. The developer may need to consider the incorporation of noise barriers to reduce noise impacts (see Guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev., National Roads Authority, 2004)).

Community Consultation raised the following in relation to noise:

1. What potential noise effect from the proposed project would there be.

8.5 Existing Environment

Baseline noise monitoring was undertaken at four receptor locations surrounding the proposed Coumnagappul Wind Farm to establish the existing background noise levels in the vicinity of the Proposed Development. These represent the closest locations to the Proposed Development as well as representing different noise environments in the vicinity of the Proposed Development. The rationale for the selection of these monitoring locations is described in Appendix 8.1 which presents details on the baseline measurements and data analysis.

The 35 dB L_{A90} study area as described in Section 8.4.2 and Figure 8.1 was reviewed to determine receivers to be considered for noise monitoring. Permission to access the noise measurement locations was arranged by the Applicant, with Fehily Timoney & Company setting up the noise monitoring equipment. Baseline noise data was collected at the four locations, shown in Figure 8.2 and details of the noise monitoring locations are presented in Table 8.2

Table 8-2: Details on the Noise Monitoring Locations

Location ID	Easting	Northing	Description	Photograph
R6	623019	611473	Noise meter in front garden, approximately 10m from front façade of property.	Plate 7.1-1
R25	623943	607284	Noise meter in north west corner of property approximately 9m from the property.	Plate 7.1-2
R51	622155	608843	Noise meter in field south of property, approximately 12m from the property.	Plate 7.1-3
R71	626025	612230	Noise meter in a field just south of the property to the rear of the property, approximately 13m from the property.	Plate 7.1-4

8.5.1 Analysis of the Baseline Data

The raw background L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level owing to equipment malfunction. Any inconsistent data points were removed from the raw noise level data. The raw noise level data was then correlated with the time synchronised 10 m standardised wind speed, based on a hub height of 104m, and rainfall data, . Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. Once the remaining data sets were found to be representative of the noise environment, they were analysed to ensure that sufficient data sets remained to provide sufficient data coverage over the necessary wind speeds. A "best-fitting polynomial" (not higher than a fourth order) was determined to present the prevailing background noise level at each monitoring location. Appendix 8.1 presents the results of the data analysis.

The prevailing daytime amenity noise levels at the four noise monitoring locations are presented in Table 8.3. The derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point. Table 8-4 presents the Night time prevailing noise level.

Table 8-3: Prevailing Background Noise during Daytime Periods

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)												
	2	3	4	5	6	7	8	9	10	11	12	13	14
R6	30.2	30.2	31.0	32.4	34.2	36.1	37.8	39.1	39.8	39.6	38.3	35.6	35.6§
R25	29.3	29.7	30.8	32.5	34.7	37.0	39.5	42.0	44.3	46.3	47.8	48.7	§ 48.7§
R51	32.7	33.2	34.0	35.3	36.9	38.9	41.3	44.0	47.1	50.4	54.1	54.1 §	§ 54.1§
R71	35.2	35.2	35.5	36.2	37.3	38.8	40.7	43.1	45.8	49.0	52.6	56.6	§ 56.6§
§ - noise level restricted to the highest derived point * - noise level restricted to lowest derived point													

Table 8-4: Prevailing Background Noise Night-time Periods

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)												
	2	3	4	5	6	7	8	9	10	11	12	13	14
R6	22.5	22.0	22.2	22.9	23.9	24.8	25.3	25.3	25.3	25.3	25.3	25.3	25.3§
R25	30.1	30.1	30.4	31.2	32.4	33.9	35.7	37.7	39.9	42.2	44.7	47.2	49.8
R51	32.6	32.4	32.4	32.7	33.3	34.3	35.8	37.7	40.2	43.4	47.2	47.2§	47.2§
R71	35.5	35.6	35.4	35.1	35.1	35.3	36.1	37.7	40.2	43.8	48.7	48.7§	48.7§
§ - noise level restricted to the highest derived point * - noise level restricted to lowest derived point													

8.5.2 Derived Wind Farm Noise Limits

The standard approach (outlined in the IOA GPG) to derivation of noise limits is to carry out background measurements at several locations representative of different noise environments around the proposed site. As it is not usually possible to carry out measurements at every noise sensitive location (NSL), NSLs near to the measurement location are then assigned the same limits as the measurement location. The operational impact at each of the measurement locations was assessed in accordance with the IOA GPG.

As detailed in previous sections the noise criteria used to assess operational noise from the proposed development is based on a Best Practice Approach, currently used by the acoustics fraternity. This best practice approach is based on:

- Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006);
- ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996);
- Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013).

The 2006 guidelines state that a fixed limit of 43 dB L_{A90} applies during night-time periods. In this case a limit of 43 dB L_{A90} has been assumed or +5dB above background, whichever is the greater. However, the derivation of the daytime noise limit uses the prevailing daytime amenity background noise data. Where low background noise levels are found, the 2006 guidelines recommend a limit of 35 to 40 dB L_{A90}. There is no advice within the guidelines on how to choose the noise limit from within this range. For this Proposed Development for low noise areas (<30 dB L_{A90}) a limit of 40 dB L_{A90} has been adopted. There is no further detail provided on which to determine how the appropriate noise limit be derived as stated previously above. However, the guidelines state… "An appropriate balance must be achieved between power generation and noise impact." Finally, reference is also made to ETSU-R-97 which recommends that the following three factors be considered when determining the fixed limit:

1. Number of dwellings in neighbourhood of the wind farm.
2. The effect of noise limits on the kWh.
3. Duration and level of exposure.

The IOA GPG states the following with respect to the ETSU-R-97 criteria… "It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration."

The first factor to be considered is the "Number of dwellings in neighbourhood of the wind farm". ETSU-R-97 describes this factor as balancing the benefits from a wind energy project with the local environment impact, "The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate." The number of noise sensitive locations (includes planning permissions) within the 35dB L_{A90} study area is 4. Based on the methodology in IOA GPG with respect to the ETSU-R-97, it is considered that a noise limit of 40 dB L_{A90} is appropriate. Note that the properties above the 35 dB study area are south of the Proposed Development and therefore upwind of the prevailing wind. The calculation is based on a downwind case, which is when the wind is from a northerly direction, which would occur relatively irregularly.

The second factor is the effect of noise limits on the power output of the wind farm. Similarly, to the first factor, this balances the planning merit of the Proposed Development against the local impact. The Proposed Development has 10 turbines. If the limit is lowered, then, based on the noise modelling results in Section 8.6.3.1, curtailment would be required. Since this Proposed Development is considered to have merit in assisting Ireland in meeting its renewable energy targets, the upper end of the limit range is appropriate.

The final ETSU factor relates to the duration and level of exposure. The prevailing background noise levels are described in detail in Section 8.5.1 and Appendix 8.1 In terms of the location of the properties within the Study Area, these are mainly located south of the Site, which are upwind of the prevailing wind direction.

Table 8-5: Derived Noise limit Daytime and Night time, based on minimum daytime and night time noise

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Daytime	40	40	45	45	45	45	45	45	45	45
Night time	43	43	43	43	43	43	43	43	43	43
§ - noise level restricted to the highest derived point										

8.6 Potential Effects

8.6.1 Do Nothing Scenario

Under the Do-Nothing scenario, the Project is not constructed or operated. The noise environment will remain largely unchanged.

8.6.2 Potential Effects during Construction

The Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks, and construction of the substations.

Noise from vehicles on local roads and access tracks is also generated from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

Vibration is generated by construction activities such as rock breaking and passing heavy goods vehicles. The threshold of human perception of vibration is in the range of 0.14mm/s to 0.3mm/s, described as “might just be perceptible”. Airborne noise and ground borne vibration will be generated from the proposed rock breaking at the Site.

The guideline values for damage to buildings from vibration are 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above, as summarised in BS 5228 Control of Noise and Vibration on Open and Construction Sites- Part 2: Vibration.

Vibration levels generated from the construction activities proposed at Coumnagappul Wind Farm are calculated as:

- Tracked excavators and disc cutters from cable trenching (0.8 mm/s at 4m);
- Pneumatic breakers for cable trenching (0.7 mm/s at 10 m);

- Excavation of turbine foundations (0.06 mm/s at 100 m);
- HGV traffic on normal road surfaces (0.01 to 0.5 mm/s) at footings of buildings located 20 m from roadway.

The nearest noise sensitive locations are sufficiently distant (the nearest location to the access tracks is over 60m, the nearest turbines works are over 700m from the nearest noise sensitive locations), and less than the values above such that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration.

Noise predictions were undertaken to determine the likely impact during the construction works. BS 5228-1:2009+A1:2014 sets out sound power levels and L_{Aeq} noise levels of plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations. Construction noise modelling is based on the details presented in Chapter 13 of this EIAR and the Construction and Environmental Management Plan as well as a review of other chapters in the EIAR. Noise modelling was carried out using guidance and plant noise data from BS 5228:2009+A1:2014. The ground cover is predominately acoustically soft (G=1)[6]. The noise model assumes that the ground cover is a mix between acoustically hard and soft ground with a ground cover of G=0.75 to allow for pockets of acoustically hard ground. Percentage on time[7] for plant is outlined for each of the plant items used during construction.

The construction noise model assessed several tasks with the potential to generate noise. These tasks included: deliveries and/or removal of material to and from site, felling, preparation of access roads, excavation of material from a borrow pit, preparation of hardstands and drainage, excavation of foundations, pouring of foundations and installation of wind turbines. The off-site works assessed included: works associated with grid connection, directional drilling at 4 no. locations along the proposed grid route. **

Site Traffic

Detailed information on construction traffic is presented in Chapter 14. To summarise, additional light goods vehicles travelling to and from the Site during the construction phase would be expected to peak during the morning (arrival of contractors at the Site) and evening (departure of contractors from the site) and are envisaged not to be a continuous source of noise emissions from the site during a typical working day. The noise impact from construction personnel movements to and from the site is expected to be low.

All deliveries of turbine components to the site will only be by way of the proposed transport route outlined in Chapter 14. The most intensive period of the works programme will be Month 6 when multiple construction activities take place concurrently. The noise impact for construction works traffic will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection and foundation pours, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions.

If turbine deliveries are required at night, it will be subject to agreement with the relevant planning authority and it would be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

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[6] G denotes the ground cover from an acoustic perspective. G=0 refers to acoustically hard or reflective surface and G=1 refers to acoustic soft or absorptive surface.

[7] Percentage on-time refers to the percentage of the assessment period for which the activity takes place.

Preparation of Access Roads, Hardstands and Drainage

Table 867 presents the predicted noise levels from this activity at the closest properties to the site entrance to the north west of the site, and at the road to the south of the site. R41 is located approximately 120m from access road near the Site entrance, and R25 is approximately 70m from the nearest access road. Assuming all construction activities required for the preparation of the hardstanding occur simultaneously, the predicted noise level from the construction activities is 64.2 dB $L_{Aeq,1hr}$ and 58.1 dB $L_{Aeq,1hr}$ at R25 and R41, respectively, which is below the 65dB $L_{Aeq,1hr}$ noise limit. The preparation of access roads, hardstands and drainage are expected to have a slight impact and temporary in duration.

Table 8-6: Preparation of Access roads, Hardstands and Drainage – Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R25, south of site	Predicted Noise Level at R41, south of site
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	60	54
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	50.5	44.5
Dozer (14t)	C5.12	Spreading chipping/fill	80	59.2	53.2
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	49.1	43.1
Excavator (21t)	C4.65	Trench for drainage	80	53.8	47.8
Articulated Dump Truck *	C2.33	Delivery of Material	82 two-way trips per day	55.4	48.5
Cumulative				64.2	58.1
* - Drive-by maximum sound level					

Preparation of Wind Turbine Foundations

Table 8.7 presents the likely plant required for the preparation of wind turbine foundations. Location R40 is located over 800m from the nearest turbine hardstanding. In addition the noise predicted at R50 is presented as this is the location where the highest noise level is predicted from this activity. R50 is close to the site main entrance and access track. Assuming all construction activities required for the preparation of the turbine foundations occur simultaneously, the predicted noise level from the construction activities is 46.0 dB $L_{Aeq,1hr}$ and 48.9 dB $L_{Aeq,1hr}$ at locations R40 and R50, respectively. The predicted noise level is below the 65dB $L_{Aeq,1hr}$ noise limit. The construction works associated with the preparation of the turbine foundations are expected to have a slight impact and temporary in duration.

Table 8-7: Preparation of Wind Turbine Foundations – Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R40	Predicted Noise Level at R50
Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	31.2	23.5
Excavator (23t)	C10.8	Loading sand / soil	80	33.9	26.2
Diesel Pump	C4.88	Pump water	100	23.5	15.7
Excavator mounted rock breaker (23t)	C9.12	Breaking Rock	50	25.8	17.8
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	32.5	24.8
Concrete mixer truck & concrete pump	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	100	36.6	28.9
Lorry*	C11.9	Delivery and removal of material	184 two-way trips per day	39.7	48.8
Cumulative				46.0	48.9
* - Drive-by maximum sound level					

Installation of Wind Turbines

Turbine components will be delivered to site and mobile telescopic cranes will lift the turbine components into place. A worst case of the two cranes lifting turbine components 100% of the time is assumed along with delivery of turbine components. The predicted noise levels are presented in Table 8.8. The predicted cumulative noise level at receptor R40 which the highest predicted noise level is 29.7 dB $L_{Aeq,1hr}$. The predicted noise levels are below the 65 dB $L_{Aeq,1hr}$ noise limit. The construction works associated with the installation of the wind turbines are expected to have been not significant and temporary in duration.

Table 8-8: Installation of Wind Turbines – Likely Plan and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R40
Mobile telescopic crane (x2)	C4.41	Lifting turbine components	100	28.7
Lorry *	C11.9	Delivery of Turbine Components	2 two-way trips per day	23.0
Cumulative				29.7
* - Drive-by maximum sound level				

Construction of Substation

The location of the on-site substation in presented in Chapter 2 - Development Description. The construction works will be progressed in several phases:

- Site clearance and preparation;
- Preparation and pouring of foundations and floor areas;
- Preparation of hardstanding areas;
- Erection of blockwork/ installation concrete slabs;
- General Construction including installation of electrical and mechanical plant.

Table 8.9 presents the likely plant required for the different construction phases of the proposed buildings to be constructed on site. The nearest dwelling (R50) from the on-site substation location will be over 1900m away from the substation area. The cumulative predicted noise levels for the worst combination of plant (Preparation of hardstanding areas) are predicted to be 42.1 dB $L_{Aeq,1hr}$ at the nearest occupied dwelling which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$. The works associated with the construction of the substation are expected to have a slight impact and temporary in duration.

Table 8-9: Construction of Substation – Likely Plant and Predicted Levels

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R50
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Clearing Site	80	26.2
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	28.9
	Loading Lorry	C10.8	Loading Sand to Lorry	80	28.4
	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	25.7
	Cumulative				33.5
Preparation and pouring of Foundations	Concrete mixer truck + truck mounted concrete pump + boom arm	C4.32	Concrete pumping	100	26.1
	Lorry*	C11.9	Delivery of material	24 two-way trips per day	39.8
	Cumulative				40.0
Preparation of hardstanding areas	Articulated Dump Truck (23t)	C2.33	Delivery/Removal of Material	24 two-way trips per day	37.8
	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	25.7
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	16.2
	Dozer (14t)	C5.12	Spreading chipping/fill	80	24.9

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R50
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	14.6
	Lorry*	C11.9	Delivery of material	24 two-way trips per day	39.8
	Cumulative				42.1
Erection of blockwork/ installation concrete slabs	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	24.9
	Lorry* (32t)	C11.9	Delivery of material	24 two-way trips per day	39.8
	Cumulative				39.9
General Construction including installation of electrical and mechanical plant	Generator	C4.84	Power for site cabins	100	22.9
	Lifting Platform (x2)	C.57	Lifting Personnel	80	18.4
	Telescopic handler	C4.54	Lifting Plant	80	27.7
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	28.9
	Cumulative				32.1
* Drive-by maximum sound level					

The most intensive period of the works programme will be in the month six of the project when multiple construction activities take place concurrently. These activities include access roads construction, turbine hard standing and foundation construction, turbine installation and substation construction. The predicted cumulative noise at all noise sensitive locations in the vicinity of the proposed project will be less than 65 dB $L_{Aeq,1hr}$. r at the nearest occupied dwelling which is below the construction noise limit.

Grid Connection Works

It is proposed to construct 1 no. on-site electricity substation within the proposed wind farm site. Each turbine will be connected to the on-site electricity substation via underground electricity cables. The cable route will follow the proposed access tracks between each turbine. The on-site substation will be connected via a grid connection cable to the existing Dungarvan Substation. The cable will be installed predominantly along 22.4km of public road.

The grid connection works will be carried out over a 12-month period and 'rolling road closures' will be implemented, whereby the site will progress each day along a road, which will have the effect of reducing the impact for residents. The likely plant required during the construction works are presented in Table 8.10:

Table 8-10: Grid Connection Works – Likely Plant and Predicted Noise Levels

Plant	Activity	Percentage on-time (%)	A-Weighted Sound Pressure Level, L_{Aeq}, dB			
			10m	25m	50m	100m
Road sweeper (C4.90)	Sweeping and dust suppression	10	49.5	41.6	35.6	29.6
Mini excavator with hydraulic breaker (C5.2)	Breaking Road Surface	25	78.9	71.4	65.5	59.5
Vibratory roller (C5.27)	Rolling and Compaction	50	66.3	58.6	52.6	46.6
Wheeled excavator (C5.34)	Trenching	50	69.9	62	56	50
Hand-held circular saw (petrol) (C5.36)	Cutting Concrete Slabs	10	79	71.6	65.6	59.6
Dump truck (tipping fill) (C2.30)	Tipping Fill	10	71.8	64.1	58.1	52.1
Vibratory plate (petrol) (C2.41)	Compaction	10	72.7	65.1	59.1	53.1
Directional drilling (2.44)	Drilling	100	-	-	58.2*	49.3
* - Directional drilling distance 40 m						

Table 8.10 also presents predicted noise level for a range of construction activities at distances of 10 m, 25 m, 50 m and 100 m from the works. The noise levels presented are predicted maximum expected levels and are expected to occur for only short periods of time at a very limited number of dwellings.

There are two dwellings within 10 m of the grid connection works, 27 dwellings between 10 – 25m, 34 dwellings between 25 – 50 m and 24 dwellings between 50 - 100 m.

In some instances, the maximum predicted noise levels from grid connection works may be above the noise limit of 65 dB $L_{Aeq,1hr}$. However, these elevated noise levels will only occur for short durations at a limited number of dwellings. Given the nature of the grid connection works, construction activities will not occur over an extended period at any one location.

As part of the grid connection works a single bridge crossing is proposed along a section of the N72 national carriageway. This would require horizontal directional drilling under the bridge structure. This location is over 300m from the nearest single property and screened by farm buildings.

Mitigation measures will be employed to reduce any potential significant effects. Mitigation measures are discussed in Section 8.7.1. With mitigation measures, there is potential for temporary elevated noise levels due to the grid connection works. However, these works will be for a short duration at a particular property (i.e. typically less than 3 days) and where the works are to occur over an extended period, a temporary barrier or screen will be used to reduce noise level below the noise limit. The works are expected to have a significant temporary impact.

8.6.3 Potential Effects during Operation

8.6.3.1 Potential Operational Effects – Predicted Noise Levels

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst case) conditions or long-term overall averages.

Only the worst-case downwind condition has been considered in this assessment, that is – for wind blowing from the proposed turbines towards the nearby houses. When the wind is blowing in the opposite direction noise levels may be significantly lower, especially where there is any shielding between the turbines and the houses.

The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level = $L_W + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

These factors are discussed in detail below.

The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

LW - Source Sound Power Level

The sound power level of a noise source is normally expressed in dB re:1pW. Sound power level data for the proposed Vestas 162 turbine to be installed as part of the proposed development has been modelled.. Further details on the wind turbine are provided later in this section. Sound Power Level data is presented in Appendix 8.1.

D – Directivity Factor

The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a downwind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment.

Ageo – Geometrical Divergence

The geometrical divergence accounts for spherical spreading in the free field from a point sound source resulting in attenuation depending on distance according to the following:

$$A_{geo} = 20 \times \log(d) + 11$$

where, d = distance from the turbine

A wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

Aatm - Atmospheric Absorption

The atmospheric absorption accounts for the frequency dependant linear attenuation with distance of sound power over the frequency spectrum according to:

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

where, α = the atmospheric absorption coefficient of the relevant frequency band

Published values of 'α' from ISO9613 Part 1[8] have been used, corresponding to a temperature of 10^0C and a relative humidity of 70%, the values specified in the IOA GPG, which give relatively low levels of atmospheric attenuation, and subsequently conservative noise predictions as given in Table 8.11.

Table 8-11: Atmospheric Octave Band Attenuation coefficients dB/m

Octave Band Centre Frequency (Hz)							
63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
0.00012	0.00041	0.00104	0.00193	0.00366	0.00966	0.03280	0.11700

Agr - Ground Effect

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

The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The IOA GPG states that use of G = 0.5 and a receptor height of 4 m should be used to predict the resultant turbine noise level at dwellings neighbouring a proposed development provided that an appropriate allowance for measurement uncertainty is accounted for within the stated source noise levels. Therefore, predictions in this report are based on G = 0.5 with a receptor height of 4 m and, due to the inclusion of the assumed uncertainty (see 'Overview of Input Datasets' for more details) within the source noise levels, these predictions are considered to be worst case.

Abar - Barrier Attenuation

The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions.

The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of site between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of site.

The IOA GPG states that *'Topographic screening effects of the terrain (ISO 9613-2, Equation 2) should be limited to a reduction of no more than 2 dB, and then only if there is no direct line of sight between the highest point on the turbine rotor and the receiver location'*. As a conservative approach, this has not been accounted for in the noise model predictions.

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[8] ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Method of calculation of the attenuation of sound by atmospheric absorption, International Organization for Standardization, 1992

Amisc – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage and industrial plants as additional attenuation effects. The attenuation due to forestry has not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

The site topography was also analysed to determine if there is a valley correction (+3 dB) for concave ground profile, or where the ground falls away significantly, between the turbine and the receiver location. The IOA guidelines provide a criterion of application, and it was determined that a valley correction is applicable for some turbine – noise sensitive location combinations for this site and +3 dB correction has been added when the IOA criterion is met.

The valley correction for each wind turbine / noise sensitive location combination is presented in Appendix 8.1.

Predicted Noise Levels

The predicted turbine noise L_{Aeq} has been adjusted by subtracting 2 dB to give the equivalent L_{A90} as suggested in the IOA GPG.

Overview of Input Datasets

In order to calculate the noise levels at noise sensitive locations, an accurate representation of the source and receiver positions was necessary for the prediction modelling. The turbine locations are presented in Chapter 2 - Development Description of this EIAR, and noise sensitive locations are presented in Appendix 8.1, Volume III. The closest dwelling is 820 m from the nearest turbine.

Turbine model Vestas 162 with potential power ratings of 6.0 MW, 6.2 MW, 6.8 MW and 7.2 MW. For the purpose of this assessment, the 6.2MW turbine has been assessed. The 7.2MW turbine does generate a higher overall noise (up to 0.7 dB higher) level at hub height windspeeds of 13m/s and above. However no mitigation is required and at higher windspeeds the addition of 0.7dB would not lead to additional mitigation being required.

The sound power level and octave band values for the turbine are based on the noise levels provided by the manufacturers. The sound power levels at standardised 10 m height wind speeds are presented in Table 8.12 and octave band data in dB(A) is presented in Table 8.13. The manufacturer's data is presented in Appendix 8.1.

Table 8-12: Wind Turbine Sound Power Levels, dB L_{WA} standardised to 10m (hub height 104m)

Turbine	Standardised 10 m Height Wind Speed (m/s)												
	3	4	5	6	7	8	9	10	11	12	13	14	15
Vestas V162 6.2MW	93.9	94.1	94.3	96.2	99.2	102.0	104.3	104.8	104.8	104.8	104.8	104.8	104.8
Vestas V162 6.8MW	94.0	94.0	94.0	95.0	98.3	101.5	103.3	103.3	103.4	103.8	104.1	104.3	104.5
Vestas V162 7.2MW	94.0	94.0	94.0	95.0	98.3	101.5	104.1	104.6	104.6	104.8	105.0	105.3	105.5

Table 8-13: Wind Turbine Octave Band Noise Levels, dB(A) for a range of Standardised 10 m Height Wind Speeds

10 m Standardised wind speed (m/s)	Octave Band Level Centre Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
2	63.6	74.2	81.9	86.8	88.9	88.2	84.6	78.3	69.1
3	64.9	75.4	82.8	87.5	89.3	88.2	84.2	77.4	67.7
4	66.4	76.9	84.5	89.2	90.9	89.7	85.6	78.5	68.5
5	70.4	81.0	88.6	93.2	94.9	93.8	89.6	82.6	72.6
6	74.2	84.6	92.1	96.8	98.5	97.3	93.2	86.3	76.4
7	75.2	85.6	93.1	97.7	99.4	98.3	94.2	87.3	77.5
8	75.2	85.5	93.0	97.5	99.4	98.4	94.5	87.8	78.3

The IOA GPG states that it should be ensured that a margin of uncertainty is included within source wind turbine noise data used in noise predictions. A 2 dB correction is added to the sound power level to account for a margin of uncertainty.

8.6.3.2 Potential Operational Effects – Predicted Noise Levels

Noise predictions were performed for the 10-wind turbine layout using the highest noise levels at each wind speed, for the proposed turbine models have been selected for a range of standardised 10m height wind speeds from 2 m/s up to 14 m/s (to cut-out[9]). Receptors within the 35 dB L_{A90} noise contour of the turbines were modelled. A number of the receptors were identified as farm buildings or unoccupied derelict buildings, and these have not been considered as part of the impact assessment and were not assessed against the derived daytime and night-time noise levels. Predicted noise levels from other on-site noise sources were also modelled and cumulative noise from all on-site noise sources from the proposed project are assessed against the derived noise limits.

Table 8.14 presents predicted noise levels adjacent to 11 receptor locations closest to the wind farm. The predicted noise levels at all receptor locations are presented in Appendix 8.1. Note: the predicted noise levels are for a worst-case scenario with noise sensitive receptors downwind of the Proposed Development.

In practice, receptor locations will not be downwind of all noise sources and the actual noise levels will be lower than those presented in Table 8.14 and Appendix 8.1.

Table 8.14 also presents derived daytime and night-time noise limits at each of these locations. The predicted noise levels from the proposed project are below the daytime and night-time noise levels. However, at some receptor locations, a new source of noise will be introduced into the soundscape, and it is expected that there will be a long-term moderate significance of effect on the closest dwellings to the proposed wind farm.

The cumulative effect from other nearby operational and consented wind farm developments must also be considered and this is assessed herein.

[9] Noise emissions from the wind turbines plateau at wind speeds above 8 m/s

Table 8-14: Assessment of Predicted L_{A90} Noise Levels for Coumnagappul Wind Farm against Noise Limits

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
R40	Predicted Level	29.1	29.5	31.1	35.1	38.7	39.6	39.6	39.5	39.4	39.3	39.2	39.1	39.0
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R41	Predicted Level	28.2	28.6	30.2	34.3	37.8	38.8	38.7	38.6	38.5	38.4	38.3	38.2	38.1
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R25	Predicted Level	27.3	27.8	29.4	33.4	37.0	37.9	37.9	37.8	37.6	37.6	37.4	37.2	37.1

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R42	Predicted Level	26.7	27.2	28.8	32.8	36.4	37.4	37.3	37.2	37.0	36.9	36.8	36.7	36.5
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R64	Predicted Level	24.0	24.5	26.1	30.2	33.7	34.7	34.6	34.5	34.3	34.2	34.1	33.9	33.7
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R10	Predicted Level	23.0	23.6	25.2	29.2	32.8	33.7	33.7	33.5	33.3	33.2	33.0	32.9	32.7
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R69	Predicted Level	22.5	23.0	24.6	28.6	32.2	33.2	33.1	32.9	32.7	32.6	32.5	32.3	32.1
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R67	Predicted Level	22.4	22.9	24.6	28.6	32.1	33.1	33.0	32.8	32.7	32.6	32.4	32.2	32.0
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R51	Predicted Level	22.8	23.3	24.9	28.9	32.5	33.4	33.4	33.2	33.0	32.9	32.7	32.5	32.3
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R43	Predicted Level	22.1	22.6	24.2	28.2	31.8	32.8	32.7	32.5	32.3	32.2	32.0	31.8	31.6
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R50	Predicted Level	23.4	23.9	25.5	29.5	33.1	34.0	34.0	33.8	33.6	33.5	33.3	33.1	32.9
	Daytime limit	37.5	37.5	45	45	45	45	45	45	45	45	45	45	45
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43	43	43	43	43	43	43	43	43	43	43	43	43
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		

Table 8-15: Assessment of Predicted L_{A90} Noise Levels for proposed Coumnagappul Windfarm with Transformer (Substation) against Noise Limits

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
R40	Predicted Level	29.9	30.2	31.6	35.3	38.8	39.7	39.7	39.6	39.4	39.4	39.3	39.2	39.1
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R41	Predicted Level	29.1	29.4	30.8	34.5	37.9	38.8	38.8	38.7	38.6	38.5	38.4	38.3	38.1
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R25	Predicted Level	28.2	28.6	30.0	33.7	37.1	38.0	38.0	37.8	37.7	37.6	37.5	37.3	37.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R42	Predicted Level	27.6	28.0	29.4	33.0	36.5	37.4	37.4	37.2	37.0	37.0	36.8	36.7	36.6
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R64	Predicted Level	25.4	25.7	27.0	30.5	33.9	34.8	34.7	34.6	34.4	34.4	34.2	34.0	33.9
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R10	Predicted Level	24.5	24.9	26.1	29.6	32.9	33.8	33.8	33.6	33.4	33.3	33.2	33.0	32.9
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R69	Predicted Level	24.0	24.4	25.6	29.0	32.3	33.3	33.2	33.1	32.9	32.8	32.6	32.4	32.3
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R67	Predicted Level													
	Daytime limit	24.0	24.3	25.5	29.0	32.3	33.2	33.1	33.0	32.8	32.7	32.5	32.4	32.2
	Daytime Excess	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night-time limit		-	-	-	-	-	-	-	-	-	-	-	-

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R51	Predicted Level		-	-	-	-	-	-	-	-	-	-	-	-
	Daytime limit													
	Daytime Excess	24.7	25.0	26.2	29.4	32.6	33.5	33.4	33.3	33.1	33.0	32.8	32.7	32.5
	Night-time limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R43	Predicted Level	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Daytime limit		-	-	-	-	-	-	-	-	-	-		
	Daytime Excess													
	Night-time limit	23.5	23.9	25.1	28.5	31.9	32.8	32.7	32.5	32.3	32.2	32.0	31.9	31.7
	Night-time Excess	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
R50	Predicted Level		-	-	-	-	-	-	-	-	-	-		
	Daytime limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit													
	Night-time Excess	25.1	25.4	26.6	29.9	33.2	34.1	34.1	33.9	33.7	33.6	33.4	33.3	33.1

8.6.3.3 Potential Operational Effects - Substation

8.6.3.3.1 Note on BS4142:2014+A1:2019

The proposed substation has been assessed using the methodology in BS4142:2014+A1:2019 'Methods for Rating and Assessing Industrial can Commercial Sound'. This standard has a number of descriptors of the sound summarised below:

- Background sound level, $L_{A90,T}$ This is the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured with a Fast time weighting.
- Residual sound This is the ambient sound ($L_{Aeq,T}$) remaining at the assessment location when the specific sound (i.e. the source being assessed), is suppressed to such a degree that it does not contribute to the ambient sound.
- Specific Sound Level, ($LS=L_{Aeq,Tr}$) This is the equivalent continuous A-weighted sound pressure level of the specific sound source (i.e. the source being assessed) at the assessment location over a given reference time interval Tr. The reference time interval is 1 hour during the day (07:00 to 23:00) or 15minutes at night (23:00 to 07:00).
- Rating Level ($L_{Ar,Tr}$) This is the specific sound plus any adjustment for the characteristic features of the sound.

The significance of a sound of an industrial or commercial source depends on the difference between the rating level of the specific source and the background noise level and the context under which the sound occurs.

Generally, the greater the difference the greater the magnitude of the effect.

- A difference of +10dB or more is likely to be an indication of a significant adverse effect, depending on the context.
- A difference of +5dB is likely to be an indication of an adverse impact, depending on the context.

BS4142 notes that where the initial estimate of the effect needs to be modified due to the context the following needs to be considered:

- The absolute level of the sound. Where the absolute noise levels are low, absolute noise levels may be more relevant, particularly at night.
- Character and level of residual sound compared to character and level of specific sound.
- Sensitivity of receptor to sound and whether design measures that improve the acoustic environment can be considered (e.g. façade insulation, ventilation or acoustic screening).

However, it is acknowledged and stressed within the standard that the source of noise should be described and assessed both in terms of the margin above background sound and in the context of the existing sound environment, especially in instances where the existing environment may already have ambient (or residual) sound levels that are high in relation to background sound level and when existing sound is similar in character to the assessed source.

Whilst BS 4142 provides a general approach to the assessment of sound impact on residential amenity, there are no guidelines for the specific approach to be taken in particular circumstances and for acceptable criteria in terms of defining potential noise limits. In these respects, the standard is left entirely open to interpretation. However, the standard states that 'Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night'.

The previous version of BS 4142, issued in 1997 and in which a similar statement was given, contained a clarifying note stating that '…for the purposes of this standard, background noise levels below 30 dB and rating levels below about 35 dB are considered to be very low'.

It is therefore considered that, in general and for urban or industrialised sound environments in particular, if the rated noise level is below 35 dB L_{Aeq} then this will offer sufficient protection against noise for neighbouring residents.

8.6.3.3.2 Substation Noise

The substation is to be located in a particularly rural area. The background noise levels will vary with wind speed. However, the rated noise level of the substation is below 35 dB L_{Aeq} and this is considered very low as per BS 4142 and therefore as the rated noise level is below 35 dB L_{Aeq} this will offer sufficient protection against noise for neighbouring residents.

Predictions have been carried out based on an example transformer; the Siemens TLPN7747 40000 / 50000 kVA. The sound power level for the transformer is 93 dB(A). The octave band profile for the transformer has been sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' published by CED Engineering. The A-weighted octave band data is presented in Table 8.16.

Table 8-16: Octave Band Sound Power Level Data

Equipment	A-weighted Octave Band Centre Frequency (Hz)									Overall L_{WA}
	31.5	63	125	250	500	1k	2k	4k	8k	
Transformer Ω	81.0	87.0	89.0	84.0	84.0	78.0	73.0	68.0	61.0	93.0

Ω - Manufacturer's datasheet provided information on overall sound power levels. Octave band data was sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' CED Engineering

Noise predictions have been carried out using International Standard ISO 9613, Acoustics – Attenuation of Sound during Propagation Outdoors. A worst case with plant producing their highest noise emissions has been assumed. The on-site substation transformer noise has been predicted in terms of the L_{Aeq}.

Table 8-17 summarises the basis of the BS4142 assessment of the transformer noise:

Table 8-17: Predicted Rated Noise from proposed Substation

Results		
	Daytime	Night time
Measured ambient plus predicted noise from transformer	(Residual 44 dB + specific 22 dB=) 44 $L_{Aeq, 60mins}$	(Residual 43 dB + specific 22 dB=) 43 $L_{Aeq, 15mins}$
Residual sound level	44 dB $L_{Aeq, 60min}$	43 dB $L_{Aeq, 15min}$
Background sound level (when source not in operation)	34 dB $L_{A90 (60mins)}$	34 dB $L_{A90 (15 mins)}$
Reference period	1 hour	15 minutes
Specific sound level	22 dB $L_{Aeq, 60mins}$	22 dB $L_{Aeq, 15mins}$
Acoustic character correction (none applied)	-	-
Rating level (no correction applied)	22 dB $L_{A90, 60mins}$	22 dB $L_{A90, 15mins}$
Background sound level	35 dB $L_{A90, 10mins}$	34 dB $L_{A90, 10mins}$
Excess of rating over background	-13 dB	-12 dB
Results	The difference is --13dB. A difference of around +5 dB is likely to be an indication of an adverse effect, depending on the context.	The difference is -12 dB. A difference of around +5 dB is likely to be an indication of an adverse effect, depending on the context.
Uncertainty of assessment	As the difference is 18 dB less than the criteria where there would be an indication of an adverse effect, so the uncertainty of the measurement is unlikely to influence the outcome of the assessment.	As the difference is 17 dB below the level where there would be an indication of an adverse effect, depending on the context, the uncertainty is unlikely to influence the outcome of this assessment.

Daytime Assessment

From the table above, the noise level from transformers is below the level where there is a possibility of an adverse effect. There is some uncertainty or variability in the noise level assumed for the transformer compared with that which will ultimately be installed. The precise transformer to be used is currently unknown, and therefore the noise from a typical transformer has been used. As measurements were conducted over 10 minute intervals, as opposed to the reference interval of 1 hour the background may also change slightly. The measurement period was for a long time and measurements which could be influenced by wind or rain have been removed which would minimise the uncertainty. These uncertainties are unlikely to influence the outcome of the assessment, provided a transform of no greater sound power level than that in Table 8.16 is assumed..

Night-time Assessment

During the night time the noise level from the transformers is below the level there is a possibility of an adverse effect. There is some uncertainty, in that night time background measurements should be measured over 15 minute intervals rather than the actual 10 minute intervals. Also there is some uncertainty that the transformer has assumed noise levels which may differ from that which will ultimately be installed. Even with these uncertainties, these are unlikely to influence the outcome of the assessment.

In summary the proposed substation is not anticipated to result in the possibility of an adverse effect at the closest noise sensitive location.

8.6.4 Potential Effects during Decommissioning

On decommissioning, cranes will disassemble the above ground turbine components which would be removed off site for recycling. All the major component parts are bolted together, so this is a relatively straightforward process. The foundations will be covered over and allowed to re-vegetate naturally. It is proposed that the internal site access tracks will be left in place.

Grid connection infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in situ.

These activities will be undertaken during daytime hours, and noise, which will be of a lesser effect than for construction, will be controlled through the relevant guidance and standards in place at the time of decommissioning.

A detailed decommissioning plan will be agreed in advance of construction with Waterford County Council.

The effects associated with decommissioning of the project are comparable to those described for the construction phase.

8.6.5 Potential Cumulative Effects

As detailed in Chapter 2 of this EIAR, windfarms within 20km of the proposed Coumnagappul Windfarm are as set out in Table 8-18.

Table 8-18: Cumulative Wind Farms

Wind Farm Name	Number of turbines	Distance and Direction from proposed Site	Status
Tierney Single Turbine	1	5.1km west of Site	Operational
Kilnagrance Single Turbine	1	14km east of Site	Operational
Woodhouse Wind Farm	8	17.2km west of Site	Operational
Knocknamona Wind Farm	8	17.6 km west of Site	Permitted
Dyrick Hill Wind Farm	12	7.9 km southwest of Site	Proposed (at planning)

7.1.1.1 Construction Phase

Given that these are located very distant from the proposed windfarm, these are not predicted to increase the predicted construction noise from the proposed works.

7.1.1.2 Operational Phase

According to the IOA GPG if a windfarm produces a noise level within 10 dB of an existing windfarm, then cumulative noise needs to be considered. Conversely the IOA GPG states that if the proposed windfarm generates a noise level greater than 10 dB less than an existing windfarm then cumulative noise does not need to be assessed. As stated in the IOA GPG it is usual to consider existing and consented windfarms.

The only constructed windfarm that has the potential to be within 10dB of the proposed Coumnagppul windfarm is the single turbine at just over 5km from the proposed windfarm. As this is greater than 10dB of the Coumnagappul Windfarm, this does not need to be considered.

Although it is technically not required to consider Dyrick Hill windfarm as it is not currently consented, the potential cumulative impact from Dyrick Hill has been considered. Noise from the Tierney single turbine has also been considered as part of this assessment. The 35 dB contour from cumulative noise from Coumnagappul, Tierny and Dyrick Hill windfarm is shown in Figure 8.3.

The noise predictions assume that the noise sensitive locations are downwind of the wind farm. Therefore the predictions represent a worst case scenario. For noise sensitive locations located between Dyrick Hill Wind Farm and Coumnagappul Wind Farm, in reality these will not be downwind of both windfarms at the same time. Furthermore the Dyrick Hill windfarm and Coumnagappul windfarm are being constructed by the same developer and would therefore have the ability to work within the noise criteria for both sites.

The cumulative noise meets the Wind Energy Noise Criteria at all locations, except for a property 130m north of the Tierney single turbine (R158). Daytime criteria is exceeded by 4.4dB at lower windspeeds and 1.1 dB at higher windspeeds and the night time criteria is exceeded by up to 3.7 dB. The exceedance is due to the single turbine.

Table 8-19: Assessment of Predicted L_{A90} Noise Levels for Coumnagappul, Dyrik Hill and Tierney Wind Farm against Noise Limits

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
R40	Predicted Level	29.9	30.2	31.6	35.3	38.8	39.7	39.7	39.6	39.4	39.4	39.3	39.2	39.1
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R41	Predicted Level	29.1	29.4	30.8	34.5	38.0	38.9	38.8	38.7	38.6	38.5	38.4	38.3	38.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R25	Predicted Level	28.2	28.6	30.0	33.7	37.1	38.0	38.0	37.8	37.7	37.7	37.5	37.3	37.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R42	Predicted Level	27.6	28.0	29.4	33.1	36.5	37.4	37.4	37.3	37.1	37.0	36.9	36.8	36.6
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R64	Predicted Level	25.4	25.8	27.0	30.6	33.9	34.8	34.8	34.6	34.5	34.4	34.2	34.1	33.9
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R10	Predicted Level	24.5	24.9	26.1	29.6	33.0	33.8	33.8	33.6	33.5	33.4	33.2	33.0	32.9
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R69	Predicted Level	24.1	24.4	25.6	29.1	32.4	33.3	33.2	33.1	32.9	32.8	32.6	32.5	32.3
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R67	Predicted Level	24.0	24.4	25.6	29.0	32.3	33.2	33.2	33.0	32.9	32.8	32.6	32.4	32.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess		-	-	-	-	-	-	-	-	-	-	-	-
R51	Predicted Level	24.8	25.2	26.3	29.5	32.8	33.6	33.6	33.4	33.2	33.1	33.0	32.8	32.6
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R43	Predicted Level	23.6	24.0	25.2	28.7	32.0	32.9	32.8	32.7	32.5	32.4	32.2	32.0	31.8
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R50	Predicted Level	25.2	25.5	26.7	30.0	33.3	34.2	34.2	34.0	33.8	33.7	33.5	33.4	33.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R158	Predicted Level	39.4	39.4	39.4	40.5	34.4	42.9	44.1	45.2	45.7	46.1	46.1	46.1	46.0
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	4.4	4.4	-	-	-	-	-	0.2	0.7	1.1	1.1	1.1	1.0
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess	-	-	-	-	-	-	1.1	0.2	0.7	3.1	3.1	3.1	3.0
R166	Predicted Level	29.4	29.8	31.4	35.5	39.0	40.0	39.9	39.8	39.7	39.6	39.5	39.4	39.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R235	Predicted Level	31.1	31.6	33.2	37.2	40.8	41.7	41.7	41.5	41.4	41.4	41.3	41.2	41.0
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R236	Predicted Level	31.2	31.6	33.2	37.2	40.8	41.7	41.7	41.6	41.5	41.4	41.3	41.2	41.1
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess		-	-	-	-	-	-	-	-	-	-		
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess		-	-	-	-	-	-	-	-	-	-		
R249	Predicted Level	36.1	36.5	38.1	42.2	45.7	46.7	46.6	46.6	46.5	46.5	46.4	46.3	46.2
	Daytime limit	35	35.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	1.1	1.5	-	-	-	-	1.6	1.6	1.5	1.5	1.4	1.3	1.2
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB												
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s
	Night-time Excess		-	-	-	2.7	3.7	3.6	3.6	3.5	3.5	3.4	3.3	3.2

8.7 Mitigation Measures

8.7.1 Mitigation Measures During Construction

The predicted noise levels from on-site activity from the Project is below the noise limits in BS 5228-1:2009+A1:2014. Nonetheless, several mitigation measures will be employed as standard construction practice.

Construction works traffic will generally be restricted to movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise with the Local Planning Authority. For example, during turbine erection, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions. If turbine deliveries are required at night, it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Consultation with the local community is important in minimising the effects and therefore construction will be undertaken in consultation with the Local Planning Authority as well as the residents being informed of construction activities.

The construction works on site will be carried out in accordance with the guidance set out in BS 5228:2009+A1:2014, and the noise control measures set out within the Construction Environmental Management Plan (CEMP) for this project. Proper maintenance of plant will be employed to minimise the noise produced by any site operations.

All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the Project. Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 07:00 - 19:00 hours Monday to Friday and 07:00 - 13:00 hours on Saturdays. However, to ensure that optimal use is made of fair-weather windows, or at critical periods within the programme, it could occasionally be necessary to work outside these hours. Any such out of hours working would be agreed in advance with the Local Planning Authority.

The on-site construction and decommissioning noise levels will be below the relevant noise limit of 65 dB $L_{Aeq,1hr}$ for operations exceeding one month, and therefore construction noise effects are not considered to be significant. However, there is potential for temporary elevated noise levels due to the grid connection works. However, the effect of these works at any particular receptor will be for a short duration (i.e. less than 3 days). Where the works at elevated noise levels are required over an extended period at a given location, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required. The noise effect will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable.

8.7.2 Mitigation Measures During Wind Farm Operation

The predicted noise from the proposed wind farm meets the daytime and night-time noise limits at the closest locations to the Proposed Development, and therefore no mitigation is required.

Based on the predicted noise levels, a new source of noise will be introduced into the soundscape, and it is expected that there will be a long-term slight to moderate significance of effect for dwellings within the 35 dB L_{A90} study area with a moderate significance of effect on the closest dwellings to the proposed wind farm.

8.7.3 Mitigation Measures during Decommissioning

The noise effect for decommissioning works will be similar to that generated during the construction works. In general noise generated during construction works will be within the current noise limits. The grid connection works will be left in situ post decommissioning.

The decommissioning works, which will be of a lower effect than construction works, will be carried out in accordance with the policies and guidance required at the time of the works, and restricted to normal working hours, 07:00 - 19:00 hours Monday to Friday and 07:00 - 13:00 on Saturdays in accordance with best practice.

8.8 Residual Effects

Construction and decommissioning on-site activities with a duration longer than one month will be below the construction noise limit of 65 dB $L_{Aeq,1hr}$ at residential dwellings. Therefore the effect from decommissioning construction works will be temporary and range between not significant to slight effect.

There is potential for elevated noise levels due to the grid connection works resulting in a temporary significant effect. However, these works will be for a short duration at a particular property (i.e. typically less than 3 days at any particular receptor). Where the works are to occur over an extended period at a given location, a temporary barrier or screen will be used to reduce noise level below the noise limit and reduce any potential effect resulting in a moderate short-term residual effect.

The operational wind farm noise levels meet the daytime and night-time noise limits derived using the Wind Energy Development Guidelines 2006. As detailed in the criteria section this is considered to be a current best practice approach. For some receptors a new source of noise will be introduced into the soundscape, and it is expected that there will be a slight to moderate significance of effect, with dwellings closest to the project with a long-term moderate significance of effect.

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