13 NOISE

13.1 INTRODUCTION

The Proposed Development has the potential to create noise and vibration during the construction, operational and decommissioning phases.

This chapter assesses the potential noise impacts at the nearest Noise Sensitive Receptors (NSRs). The full description of the Proposed Development is detailed in **Chapter 2: Description of Proposed Development**. The Proposed Development refers to all elements of the application for the construction and operation of the wind farm, including the grid connection, Battery Energy Storage System (BESS) and the Substation (**Chapter 2: Description of the Proposed Development**).

This chapter assesses the likely significant noise and vibration effects associated with the construction, operation and decommissioning of the Proposed Development.

The specific objectives of the chapter are to:

- describe the existing noise baseline;
- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the potential effects (including cumulative effects);
- describe the mitigation measures proposed to address likely significant effects; and
- assess the residual effects remaining, following the implementation of mitigation.

This chapter is supported by the following figures and appendices:

- **Figure 13.1**: Construction Noise Assessment Locations;
- **Figure 13.2:** Operational Noise Assessment and Noise Monitoring Locations;
- **Figure 13.3:** BESS Noise Assessment Locations;
- **Technical Appendix 13.1:** Construction Noise Report;
- **Technical Appendix 13.2:** Operational Noise Report;
- **Technical Appendix 13.3:** Battery Energy Storage System Noise Report; and
- **Technical Appendix 13.4:** Ground Vibration and Air Overpressure Blast Report

The Figures and the supporting Technical Appendices are referenced in the text where relevant. The Technical Appendices contain detailed assessment information and this chapter presents a summary of the main findings of the assessments.

13.1.1 Statement of Authority

The noise assessments were carried out by TNEI Ireland Ltd (TNEI). TNEI is a specialist energy consultancy with an Acoustics team that has undertaken noise assessments for over 5 GW of onshore wind farm developments. The noise work was undertaken by the following TNEI staff, who are all affiliated with the Institute of Acoustics (IOA):

- Baseline Noise Survey – Colum Breslin (BSc, MSc, Dip, TechIOA). Colum had over two year's experience of undertaking baseline noise surveys.
- Construction Noise Modelling and Reporting – Will Conway (BSc, TechIOA) and Mark Tideswell (BSc, Dip, AMIOA). Will is a Technical Consultant with over two year's experience of undertaken construction noise assessments and Mark is a Senior Consultant with over 10 year's experience on undertaken noise assessment for wind farms.
- Operational Noise Modelling and Reporting – Alex Dell (MEng, PhD (Acoustics), AMIOA). Alex is a Senior Consultant and has three years of experience of undertaking wind farm noise assessments.
- Quality Assurance (Wind Farm Noise) – Gemma Clark (BSc, MSc, MIOA). Gemma is an experienced Project Manager, who provides technical support and assessment of proposed and operational developments. Gemma has extensive experience, over 17 years, on undertaking wind farm noise assessments to support planning applications. Gemma is a full member of the Institute of Acoustics.
- Quality Assurance (Construction, BESS and Substation) – Jim Singleton (BSc, Dip, MIOA) Jim is a Specialist Consultant who has over 17 years experience in undertaking a wide variety of noise assessments. Jim holds the Diploma in Acoustics and Noise Control and is a full member of the Institute of Acoustics.

13.1.2 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria;
- Baseline Description;
- Assessment of Potential Effects;
- Mitigation Measures and Residual Effects;
- Summary of Effects; and
- Statement of Significance.

This chapter assesses the noise impact of the Proposed Development. A full description of the Proposed Development is outlined in section 2.3 of Chapter 2 and includes one TDR (the Proposed TDR) and one GCR (the proposed GCR). Other viable GCR/TDRs have also been assessed as part of the EIAR. Although planning permission is not being sought for these viable routes (GCR option 2 and TDR option 2 and TDR option 3) they have been fully assessed. All EIA aspects of GCR option 2 and TDR option 2 and 3 are documented in Appendix 3.1. Refer to section 9 of Appendix 3.1 for the environmental impact assessment of GCR option 2 and TDR option 2 and 3 on noise.

13.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

13.2.1 Relevant Policy and Guidance

This assessment adheres to the following guidance and assessment methodologies:

- British Standard BS 5228-1: 2009+A1:2014 'Code of practice for noise and vibration control on construction and open developments - Noise'[1];
- Department of Environment Heritage and Local Government (DoEHLG) 'Wind Energy Development Guidelines,' 2006[2];
- The Working Group on Noise from Wind Turbines (NWG) (1996). ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms'[3];
- Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (2013) (IOA GPG)[4];
- ISO 9613-2: 1996 'Acoustics - Attenuation of sound during propagation outdoors Part 2: General method of calculation'[5];
- British Standard BS 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'[6];
- British Standard BS 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'[7];

[1] British Standards Institute, 2014. Code of practice for noise and vibration control on construction and open sites. Noise. UK : BSI, 2014. BS 5228-1:2009+A1:2014
[2] Department of Environment Heritage and Local Government (DoEHLG) 'Wind Energy Development Guidelines,' 2006.
[3] ETSU for the DTI (Department of Trade and Industry), 1996 . The Working Group on Noise from Wind Turbines ETSU-R-97 The Assessment and Rating of Noise from Wind Farms'.
[4] Institute of Acoustics, 2013. Good Practice Guidance on the application of ETSU-R-97 for wind turbine noise assessment.
[5] (ISO), International Organisation for Standardisation. 1996. Acoustics – Attenuation of Sound During Propagation Outdoors: Part 2 – General Method of Calculation. Geneva: ISO, 1996. ISO 9613-2:1996
[6] British Standard BS 4142:2014 + A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'
[7] British Standard BS 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'

- Association of Acoustic Consultants of Ireland (AACI) 'Environmental Noise Guidance for Local Authority Planning & Enforcement Departments'[8]; and
- Environmental Protection Agency 'Guidelines on the information to be contained in Environmental Impact Assessment Reports'[9].

The above documents are discussed in detail within Section 2 of Technical Appendix 13.1, 13.2 and 13.3, where relevant. The WEDG, WHO and AACI are also discussed below.

13.2.1.1 Wind Energy Development Guidelines

With regards to national planning policy and guidance, it is noted that the Irish Government Wind Energy Development Guidelines for Planning Authorities (2006) (WEDG 2006 Guidelines) are currently under review. A set of draft updated guidelines were issued for consultation in December 2019 (Draft WEDG 2019 Guidelines) but these guidelines have not, at the time of writing, been adopted. In keeping with best international practice the Draft WEDG 2019 Guidelines relied upon, some elements of the 'Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) and the Institute of Acoustics 'Good Practice Guidelines to the Application of ETSU-R-97 For the Assessment and Rating of Wind Turbine Noise' (IOA GPG).

Significant concerns were raised during the public consultation process on the Draft WEDG 2019 Guidelines, including by a group of wind farm acousticians[10], regarding the noise section of the draft guidelines and how the authors had misinterpreted existing guidance and incorporated a number of errors within the technical approaches proposed. In light of these concerns, and the fact that significant changes would need to be made before they could be adopted, an assessment using the Draft WEDG 2019 Guidelines is not, in our opinion, technically feasible or appropriate and has not therefore been undertaken.

At the time of writing this report, no further updates on the review process have been issued, however, on the 22 February 2023, a request for tender (RFT) was published for the review and redraft of the WEDG 2006 Guidelines by the Department of Environment. Timelines for the review are still unclear, however, the Government of Irelands' Climate Action Plan 2024

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[8] Association of Acoustic Consultants of Ireland, 2021. 'Environmental Noise Guidance for Local Authority Planning & Enforcement Departments.

[9] The Environmental Protection Agency, 2022. 'Guidelines on the information to be contained in Environmental Impact Assessment Reports'

[10] Mackay, J, Singleton, J, Reid, M, Cand, M, Mahon, J, McKenzie, A, Keaney, D, Hayes, M, Bowdler, D, Kelly, D, Jiggins, M, Irvine, G & Lester, M, 2020. Public consultation on the revised wind energy development guidelines: Joint consultation response. Available at: https://www.tneigroup.com/news_event/tnei-submit-joint-consultation-response-and-meet-with-government-regarding-proposed-updates-to-the-irish-wind-farm-noise-guidelines-wedg/

includes a 2024 Action (EL/24/5) to 'Publish the Revised Wind Energy Development Guidelines for onshore wind.'

The WEDG 2006 Guidelines, therefore, remain the relevant statutory guidelines at this time and, as a result, they have been used for this assessment, appropriately supplemented by the guidance contained in ETSU-R-97 and the IOA GPG, which are considered by TNEI to represent current best practice.

13.2.1.2 World Health Guidelines (WHO) 2018

In 2018, the World Health Organisation (WHO) issued noise guidelines 'Environmental Noise Guidelines for the European Region' (the WHO Guidelines) that provide recommendations for protecting human health from exposure to environmental noise. The WHO Guidelines consider noise originating from various sources including wind turbine noise. The WHO Guidelines make a series of 'strong' and 'conditional' recommendations. Two conditional recommendations were made in relation to wind turbine noise. No strong recommendations were made. In relation to conditional recommendations the WHO Guidelines notes that:

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

The WHO Guidelines make recommendations based on noise exposure levels characterised using the Lden parameter. Lden is a weighted annual average sound pressure level over all days, evenings and nights in a year, which is commonly used for transportation noise but rarely used for wind turbine noise.

In relation to wind turbine noise the WHO Guidelines 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.'

'Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing

exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region.'

Notwithstanding the limitations associated with the derivation of the L_{den} threshold levels, serious concerns have been raised about the practicality of using a threshold which is based on a weighed annual average, which cannot actually be measured. Given the strength of recommendation and limitations associated with the use of L_{den} it is not considered appropriate to undertake an assessment against L_{den} levels.

13.2.1.3 Association of Acoustic Consultants of Ireland Guidance 2021

The Association of Acoustic Consultants of Ireland (AACI) published noise guidance *'Environmental Noise Guidance for Local Authority Planning & Enforcement Departments'* in May 2021. The AACI guidance document provides advice to local authority officers involved in the assessment of noise reports, the drafting of noise conditions for planning purposes and permitting, and also enforcement activities. Section 17 of the AACI Guidelines covers operational wind farm noise, Section 11 covers industrial noise (relevant here for the BESS noise assessment), and construction noise guidance is included within Section 27. These are considered further in Section 13.4 below.

13.2.2 Consultation

The scoping and consultation exercise carried out as part of the Proposed Development is described in Chapter 2 of this EIAR. No formal scoping response in relation to noise was provided.

13.2.3 Noise Sensitive Receptors and Noise Assessment Locations

Noise Sensitive Receptors (NSRs) are properties, people or fauna which are sensitive to noise and, therefore, may require protection from nearby noise sources. The NSRs identified for the noise assessment are all residential properties. The Study Area for the noise assessment has been defined through the identification of all NSRs located within 2 km of the Proposed Development. In addition, the closest NSRs to the Horizontal Directional Drilling (HDD) activities (under the M1 motorway) have also been identified and assessed.

Rather than predicting noise levels for each individual NSR, a number of Noise Assessment Locations (NALs) were chosen to represent the NSRs located closest to the Proposed Development. The modelling results for the NALs have been presented within the main body of this Chapter and supporting Technical Appendices whilst an assessment for all NSRs has been included within an Annex to the Technical Appendices.

13.2.4 Construction Noise Assessment Methodology

There is no published statutory Irish guidance that contains suggested noise limits for construction or decommissioning activities, other than for road construction works, however, the AACI Guidelines state:

"The chief guidance document applied in the assessment of construction phase noise impacts is British Standard BS 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise (2014)".

The construction noise assessment has therefore been undertaken using the BS 5228 guidance. The prediction of construction noise levels was undertaken using the calculation methodology presented in ISO 9613:1996, using noise source level data for appropriate construction plant from Annex C of the current version of BS 5228.

To undertake an assessment of the construction noise impact in accordance with the BS 5228 criteria, the following steps have been undertaken:

- identify NSRs and select representative Construction Noise Assessment Locations (CNALs);
- identify applicable thresholds of significant effects;
- predict noise levels for various construction noise activities;
- compare predicted noise levels against the applicable thresholds;
- where necessary, develop suitable mitigation measures to minimise any significant adverse effects during the construction phase; and, if required
- assess any residual adverse effects taking into account any identified mitigation measures.

Of the NSRs identified in the surroundings, a total of 15 have been chosen as CNALs when considering the construction of the wind turbines, substation, BESS and ancillary infrastructure. An additional three CNALs were also selected to consider HDD activities which are proposed under the M1 Motorway to the south west of the Site. All 18 are residential properties. The CNALs represent the closest NSRs, or clusters of NSRs, to the proposed construction activities, and are summarised in Table 13.1Table 13.1 and shown on Figure 13.1.

Table 13.1: Construction Noise Assessment Locations (CNALs)

CNAL/ Receptor ID	ITM Easting	ITM Northing
CNAL01 (H62)	706612	783934
CNAL02 (H233)	706701	784453
CNAL03 (H55)	707042	784741
CNAL04 (H235)	707506	784843
CNAL05 (H187)	707874	784854
CNAL06 (H70)	708483	784848
CNAL07 (H71)	708669	784739
CNAL08 (H179)	709215	784252
CNAL09 (H115)	709255	783893
CNAL10 (H110)	709289	783047
CNAL11 (H27)	709496	782453
CNAL12 (H374)	708781	782534
CNAL13 (H237)	708102	782128
CNAL14 (H226)	707609	782297
CNAL15 (H46)	707344	782894
CNAL16 *	705950	776991
CNAL17 *	705953	776917
CNAL18 *	705846	777037
* (HDD assessment only)		

The construction phase of the Proposed Development will include civil engineering works, electrical works, and turbine/met mast erection (please refer to Section 2.3 of Chapter 2 of this EIAR for details). During each phase the plant, equipment, and the associated traffic, will influence the noise generated. The selection of plant and equipment to be used will be determined by the main contractor when they are commissioned, therefore the assessment has been based upon a typical selection of plant for a wind farm project of this size, alongside an indicative construction programme (EIAR Chapter 2, Table 2.11). In view of this, the plant has been modelled operating at the closest points to each NSR for a given activity area in each construction phase. This presents predicted construction noise levels under a precautionary scenario, as working in these locations would generate the highest noise levels, whereas in reality, only certain plant and equipment will be working at the closest locations for short periods of time.

The core hours for the proposed works will be normal construction hours, 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 Saturday. There will be no working on Saturday afternoons, Sundays and Public Holidays, however, it should be noted that out of necessity some activity outside of the core hours could arise, from delivery and unloading of abnormal loads, health and safety requirements, or to ensure optimal use is made of fair weather windows for the erection of turbine blades and erection or dismantling of cranes.

Chapter 2 of this EIAR describes the Proposed Development in detail and outlines the tasks that will be undertaken during the construction phase, which is estimated to last approximately 16-24 months. For the purposes of this assessment, noise modelling has been undertaken for the key construction months detailed in EIAR Chapter 2, Table 2.11, which simulate the likely overlap of several activities that could occur in a given month.

More detailed information on each of the construction scenarios and modelling assumptions can be found within Technical Appendix 13.1 of this EIAR. The noise levels for all modelled months have been calculated at the CNALs and compared to the appropriate BS 5228 threshold levels (detailed in Table E.1, Annex E of BS 5228). It is worth noting that for much of the working day, the noise associated with construction activities will be less than predicted, as the assessment has assumed all equipment is constantly operating at full power, as well as being located at the closest anticipated activity locations to each receptor.

The modelling represents the following construction activities:

- **Month 1 and 2:** Removal of vegetation around entrances 1 and 2 and establishment of site entrances. The construction of temporary construction compounds to north of site begins alongside the construction or upgrade of internal access tracks leading to turbine 1 and 2. Forestry felling along internal access tracks and around turbine 1.

- **Month 3:** Forestry felling and completion of temporary construction compounds and tracks to turbine 1 and 2, preparation of foundations for turbine 1.
- **Month 4:** Concrete pour at turbine 1, completion of access track establishment to turbine 4 and preparation of foundations at turbine 2. Track from entrance 3 to substation/BESS upgraded and adjacent temporary construction compound established. Forestry felling around turbine 5.
- **Month 5:** Completion of track upgrades to turbines 3 and 5. Upgrade of track from entrance 4 to turbine 4, preparation of foundations at turbine 4 and concrete pour at turbine 2. Groundworks for construction of substation and BESS compound begins.
- **Month 6:** Concrete pour at turbine 4 and BESS and substation compounds. Preparation of foundations at turbine 3, and track upgrade from turbine 5 to substation and BESS compounds are completed.
- **Month 7:** Preparation of foundations for turbine 5, concrete pour at turbine 3. Completion of substation and BESS foundations.
- **Month 8:** Concrete pour at turbine 5, onsite cable route trenching for turbine 1.
- **Month 9:** Onsite cable route trenching for turbines 2 and 4.
- **Month 10:** Turbine delivery and erection of turbine 1 and 2, onsite cable route trenching for turbines 3 and 5.
- **Month 11:** Erection of turbines 3 and 4.
- **Months 12-16:** Erection of turbine 5 (month 12) and met mast. Other construction activity during months 13-16 is expected to be limited. It is assumed that HGVs would be delivering plant and materials to complete the construction of the substation and/or BESS during this period. As a result, modelling includes the movement of an HGV from entrance 3 to the substation area and the modelling of a small crane to lift batteries, transformers inverters etc., into place for connection by hand tools.
- **Month 17:** Restoration/backfill of land around turbines 1, 2 and 4.
- **Month 18:** Restoration/backfill of land around turbines 3 and 5, and the area around the substation and BESS compounds.
- **Night-time operations:** Generators for lighting, power, welfare facilities at the temporary construction compound and the substation/BESS area.

Construction activities along the proposed grid connection route will be of short duration and best practice during construction methods would be employed to minimise any potential impact in line with BS 5228. As such a detailed assessment of noise is not required. The exception to this is for one Horizontal Directional Drilling (HDD) location, where the cable route is required to pass under the M1 motorway. For this particular activity, construction noise will be of a longer duration and therefore full noise propagation modelling and assessment has been undertaken.

Gravity based foundations will be used onsite, as is typical for most wind farm developments, therefore noise from piling activities has not been assessed.

13.2.5 Construction and Operational Vibration

In relation to potential vibration during the construction phase of the Proposed Development, no vibration effects are anticipated due to the separation distances between construction activity areas and sensitive receptor locations, however, two sets of vibration limits could be applied in any planning conditions (if required), one regarding the potential for damage to buildings and one regarding the vibration effects on people within buildings.

Threshold values to determine the potential for damage to buildings are detailed in BS 7385-2:1993 (which is also referred to in BS 5228). The unit of measurement used for this assessment method is the Peak Particle Velocity (PPV), which is measured in mm/s or $mm.s^{-1}$. For dwellings, the standard provides the guideline threshold levels, as set out in Table 13.2 below.

Table 13.2: Transient vibration guide values for residential building damage

Peak Component Particle Velocity (mm/s)	Damage Levels for residential buildings
15 mm/s PPV for a frequency of 4 Hz, rising to 50 mm/s PPV for a frequency of 40Hz and above.	Cosmetic
30 mm/s PPV for a frequency of 4 Hz, rising to 100 mm/s PPV for a frequency of 40Hz and above.	Minor Damage
60 mm/s PPV for a frequency of 4 Hz, rising to 200 mm/s PPV for a frequency of 40Hz and above.	Major Damage

In respect of vibration effects on humans (as opposed to buildings), Table B.1 of BS 5228-2, reproduced here as Table 13.3, provides guideline PPV levels that can be used in a construction setting. It is important to note that the levels refer to internal vibration within a building, and not external levels.

Table 13.3: BS5228-2 Guidance on Effects of Vibration Levels

Vibration Level (A) (B) (C)	Effect
0.14 $mm.s^{-1}$	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 $mm.s^{-1}$	Vibration might be just perceptible in residential environments.
1.0 $mm.s^{-1}$	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10 $mm.s^{-1}$	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.
(A) The magnitudes of the values presented apply to a measurement position that is representative of the point of entry into the recipient. (B) A transfer function (which relates an external level to an internal level) needs to be applied if only external measurements are available. (C) Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 64721-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment.	

With due regard to the above, external vibration level limits to protect residential buildings from cosmetic damage can be set at 15 mm/s PPV for frequencies between 4 Hz and 40 Hz, and at 50 mm/s for frequencies above 40Hz.

To protect against adverse impacts on the occupants of buildings, internal PPV limits can be set at 1 $mm.s^{-1}$, however, it should be noted that the measurement of vibration levels indoors is invasive and can be problematic. It should also be noted that the limits in Table 13.3 are generally considered guideline levels that should not be exceeded regularly or for long periods of time (see note c of Table 13.3).
Vibration levels generated from the operation of the turbines are typically imperceptible even at

the base of the turbine and will have no impacts at the nearest NSRs.

13.2.6 Operational Noise Methodology

13.2.6.1 Wind Turbine Noise

The assessment has been undertaken in accordance with the WEDG 2006 Guidelines. The AACI Environmental Noise Guidance states the following in relation to the WEDG 2006:

'The document includes daytime and night-time noise criteria. As criteria included in the document are evidently derived from ETSU-R-97, it is considered more robust to base noise assessments on the ETSU and IOA documents, particularly as the DOEHLG document is somewhat vague. The document has been undergoing a protracted review process for several years.'

Given the lack of detail in parts of the WEDG 2006, information contained in ETSU-R-97 and the IOA GPG has been used to supplement the WEDG 2006.

The WEDG 2006 guidelines include limits for daytime and night-time periods. Consequently, the test applied to operational noise is whether or not the calculated wind farm noise levels at nearby NSRs will be below the noise limits derived in accordance with WEDG 2006.

Of the NSRs identified,14 Noise Assessment Locations (NALs) were selected for a detailed assessment. All are residential properties. Predictions of wind turbine noise have been made at each of the NALs detailed in Table 13.4 and as shown on Figure 13.2. All other NSRs have also been assessed, and these are presented separately in Appendix 13.2.

Table 13.4: Summary of Operational Noise Assessment Locations

Receptor	ITM Easting	ITM Northing	Elevation (m AOD)	Approximate Distance to Nearest Kellystown Turbine* (m)	Background Noise Data Used
NAL1 (H62)	706620	783942	101	724 (T4)	NML5
NAL2 (H233)	706708	784461	95	760 (T4)	NML6
NAL3 (H158)	707198	784739	101	717 (T4)	NML7
NAL4 (H187)	707878	784833	90	875 (T5)	NML7

NAL5 (H71)	708655	784720	81	596 (T5)	NML7
NAL6 (H181)	709261	784688	80	973 (T5)	NML1
NAL7 (H179)	709203	784231	98	764 (T5)	NML1
NAL8 (H115)	709235	783884	100	701 (T2)	NML1
NAL9 (H14)	709600	783414	82	915 (T2)	NML1
NAL10 (H109)	709198	783016	92	669 (T2)	NML2
NAL11 (H374)	708769	782531	110	543 (T3)	NML3
NAL12 (H265)	708257	782112	120	725 (T3)	NML4
NAL13 (H226)	707618	782312	127	874 (T3)	NML4
NAL14 (H46)	707377	782884	130	944 (T3)	NML4

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere in the EIAR. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden).*

The daytime and night-time periods are not defined within the WEDG 2006, therefore the assessment has utilised the definition of these periods as detailed within ETSU-R-97. 'Quiet daytime' criteria are based upon background noise levels measured during 'quiet periods of the day' comprising:

- All weekday evenings from 18:00 to 23:00;
- Saturday afternoons and evenings from 13:00 to 23:00; and
- All day Sunday 07:00 to 23:00.

For the avoidance of doubt, it should be noted that although daytime limits are set based upon background data collected only during the quiet daytime periods detailed above, they apply to the entire daytime period (07:00 – 23:00).

Night-time periods are defined as 23:00 to 07:00, with no differentiation made between weekdays and weekends.

The WEDG 2006 include guidance on how to derive limits for daytime and night-time periods.

Daytime Limits: The daytime limits take account of existing background noise levels and include a fixed limit of 45 dB or background + 5 dB, whichever is the greater, except in low background noise environments where a fixed minimum limit in the range 35-40 dB should be considered. TNEIs interpretation of these limits is that turbine noise should not exceed:

- 40 dB $L_{A90, 10 min}$ where background noise levels are less than 30 dB L_{A90}; and
- 45 dB $L_{A90, 10 min}$ or background noise + 5 dB, whichever is the greater, where background noise levels are greater than 30 dB.

Night-time Limits: The WEDG 2006 states that a *'fixed limit of 43dB(A) will protect sleep inside properties during the night'*, however, whilst it is not explicit within the WEDG 2006 guidance, the addition of a night-time 'background noise +5 dB' parameter is commonly applied in wind turbine noise assessments. This is detailed in numerous examples of planning conditions issued by local authorities. On that basis, the night time noise limits used in this assessment have been based on 43 dB or background noise + 5 dB, whichever is the greater.

The aim of the operational noise assessment is to establish the WEDG Noise Limits and determine whether the Proposed Development can operate within those limits.

The exact model of turbine to be installed on the site will be the result of a future tendering process and within the dimensions prescribed in this planning application should planning permission be granted. Achievement of the WEDG 2006 Noise Limits determined by this assessment will be a key determining requirement in the final choice of turbine for the Proposed Development. Whichever turbine model is ultimately selected will need to adhere to the limits set within this assessment. This can be achieved through implementation of mitigation measures, such as low-noise modes, where required.

Predictions of wind turbine noise for the Proposed Development were made for the purpose of this Noise EIAR based upon the sound power level data for a candidate wind turbine, the Nordex N163, which has a 163 m rotor diameter, a maximum rated output capacity of 7 MW, serrated trailing edge blades and a hub height of 98.5 m. In order to consider the full design envelope for the site (i.e. tip height 179.5 m – 180 m, rotor diameter 149 m – 163 m and hub height 98 m – 105 m), additional modelling was undertaken using two other candidates; the Siemens-Gamesa SG 6.6-155 with a 155 m rotor diameter, a maximum rated output capacity of 6.6 MW and a hub height of 102.5 m and the Nordex N149 with a 149 m rotor diameter with a maximum rated output capacity of 5.7 MW, serrated trailing edge blades and a hub height of 105 m. The Nordex N163 turbine has been chosen as the candidate for the main assessment, as it resulted in the highest predicted levels of the candidates at the key wind speed range. Prediction modelling results for the other two candidates are included within Appendix 13.2.

Calculations of operational noise have been undertaken in accordance with International Standard ISO 9613-2, *'Acoustics – Attenuation of sound during propagation outdoors'* (ISO 1996). The model calculates, on an octave band basis, attenuation due to geometric spreading, atmospheric absorption and ground effects. The noise model was set up to provide realistic noise predictions, including mixed ground attenuation (G=0.5) and atmospheric attenuation relating to 70 % relative humidity and 10 °C (Section 4.3 of the IOA GPG). The receiver height modelled was 4 m.

Noise propagation from a turbine across a valley (concave ground) increases the number of reflection paths, and in turn, has the potential to increase sound levels at a given receptor. Terrain screening effects (barrier corrections) act as blocking points, subsequently reductions in sound levels at a given receptor can potentially be observed. Accordingly, in line with the IOA GPG, an assessment has been undertaken to determine whether a concave ground profile correction (+3 dB) or barrier correction (-2 dB), is required due to the topography between the turbines and the NSRs. Concave ground and barrier corrections were found to not be required for the turbines at any receptors, and this is detailed in Annex 6 of Appendix 13.2.

Other topics relating to operational wind farm noise characteristics, such as tonality, Low Frequency Noise (LFN) and amplitude modulation were considered as part of this assessment. There is no evidence that LFN has adverse impacts on the health of wind farm neighbours and has therefore been scoped out - more information on LFN is provided in Appendix 10-2. Tonality associated with wind turbines is well understood and has been assessed in accordance with the guidance in ETSU-R-97 and the IOA GPG. The topic of amplitude modulation is considered in more detail below.

13.2.6.2 Amplitude Modulation

In the context of wind turbine noise, Amplitude Modulation (AM) describes a variation in noise level over time; for example, observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. The AM of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68, which states:

'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade

noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.

This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dBA (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'

The Acoustics community has sought to make a distinction between the AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at the blade passing frequency, typically once per second. In some literature it may also be referred to as 'Excess Amplitude Modulation' (EAM). It should be noted that the noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

Persistent OAM can be a source of nuisance to wind farm neighbours. Indeed, in a recent decision of the Irish High Court on the 8th March 2024, the court found that frequent and sustained periods of OAM arising from the operational Ballyduff Wind Farm was an unreasonable interference with a neighbour's use and enjoyment of their property which was located approximately 359 m from the nearest turbine. The issue of damages and/or an injunction were held over for later determination by the court but in the meantime, the court directed all parties to engage in mediation with a view to devising ***'appropriate mitigation measures and if possible, to resolve all outstanding issues between them'.*** In summary, therefore, where persistent and sustained OAM arises mitigation is possible and is the appropriate response.

A significant amount of research has been undertaken in relation to OAM and a summary of the most relevant research is included in Section 3.3 of Appendix 10-2. Key outcomes of the research are that:

- It is clear that OAM, if it occurs frequently and for sustained periods, it has the potential to result in adverse impacts for wind farm neighbours.
- It is not currently possible to predict if and when OAM will occur at a proposed wind farm site. On sites where OAM has been identified it occurs intermittently and varies in terms of severity.
- There are methodologies available that can be used to measure and quantify OAM, in particular the method produced by the Amplitude Modulation Working Group (AMWG), which was formed by the Institute of Acoustics. The methodology was presented in a report *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'* which was published in April 2015.
- Whilst it is possible to measure and quantify OAM using the AMWG methodology (which provides an AM rating for each 10 minute period), further study is still required to help quantify what level of OAM, if any, is acceptable. This is complicated by the fact that it is unclear whether a small amount of OAM that occurs regularly is likely to be more (or less) annoying than a large amount of OAM that occurs very infrequently.
- Notwithstanding a lack of a defined threshold detailing what level of OAM is acceptable, there are measures available which have been shown to mitigate OAM should it occur. Measures can include:
    - Changes to the operation of the relevant wind turbine(s) by changing parameters such as blade pitch;
    - Addition of blade furniture (such has vortex generators) to alter the flow of air over the wind turbine blades; and, in extreme cases,
    - Targeted wind turbine shutdowns in specific conditions where OAM is found to occur.
    - Where mitigation is required, it needs to be designed on a site-specific basis.

13.2.6.3 BESS and Substation Operational Noise

The BESS and substation noise were considered using a qualitative assessment method, as detailed in BS 4142. The assessment compares the predicted noise levels to existing background sound levels and also considers the context of the development and its setting, to determine the likelihood for adverse impacts.

To predict the noise immission levels attributable to the BESS and substation, a noise propagation model was created using the propriety noise modelling software CadnaA[11]. Within

[11] CadnaA (Computer Aided Noise Abatement) software by Datakustik.

the software, complex models can be produced to simulate the propagation of noise according to a wide range of international calculation standards. For this assessment, noise propagation was calculated in accordance with ISO 9613-2:1996. To assess the scenario under theoretical precautionary conditions, the model did not include the use of specific mitigation measures that could be employed during the operational phase of the Proposed Development, such as the use of barriers, attenuated louvres, low noise plant or enclosures. The model also assumed that all plant was operating concurrently, continuously and at maximum noise output.

Of the NSRs identified,12 BESS Noise Assessment Locations (BNALs) were selected for a detailed assessment. The BNALs represent the closest residential properties to the BESS and substation. Predictions of BESS and substation noise have been made at each of the BNALs as detailed in Table 13.5 and shown on Figure 10-3. All other NSRs have also been assessed separately in Appendix 10-3.

Table 13.5: Summary of BESS and Substation Noise Assessment Locations

Receptor	ITM Easting	ITM Northing
BNAL1 (H110)	709228	783072
BNAL2 (H109)	709198	783016
BNAL3 (H108)	709192	782976
BNAL4 (H238)	708954	782502
BNAL5 (H374)	708769	782531

13.2.7 Potential Effects Scoped Out

13.2.7.1 Cumulative Wind Farm Noise Assessment

There are no existing, permitted or proposed wind energy projects within 10 km of the Wind Farm Site (as outlined in EIAR Chapter 2, Table 2.1), therefore, a cumulative noise assessment was not required. Any turbines located at distances beyond this would have no impact at any receptors around the Proposed Development.

13.2.7.2 Decommissioning

Activities that occur during the decommissioning of the Proposed Development are unlikely to produce higher noise levels than those produced during construction and many of the activities will be similar in nature. As such, decommissioning noise has been scoped out.

13.2.7.3 Blasting

The extent of any blasting requirement cannot be determined until intrusive site investigation tests are completed. Nevertheless, should blasting be required, a series of tests would be undertaken by the appointed contractor in accordance with guidance outlined in BS 5228-2:2009+A1:2014 *'Code of practice for noise and vibration control on construction and open sites' – Part 2: Vibration* [12]. Following on from these tests, blasts will be designed through appropriate specification of Maximum Instantaneous Charge (MIC) to ensure that vibration levels at the nearest NSR's would not exceed the guideline limits presented in Section 13.2.5 and related standards, such as BS 7385-2: 1993 *'The Evaluation and measurement for vibration in buildings, Guide to damage levels from groundborne vibration'*[13] *and BS6472: 2008 'Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration'*[14]. A condition could be attached to the consent to require compliance with these limits.

13.2.7.4 Vibration during Construction

Due to the separation distances between the construction activity areas on the Proposed Development and the nearest receptors, no significant effects are anticipated.

13.2.8 Desk Study

A total of 374 NSRs were identified within a 2 km search area, these are all residential properties surrounding the Proposed Development and have been assumed to be in a habitable condition for the purposes of this assessment. Initial desktop noise modelling was undertaken and seven potential Noise Monitoring Locations (NMLs) were identified. The NMLs were selected to represent background noise levels at all NSRs, and they were located to the north, east, south and west of the Proposed Development. The NSRs and NMLs are shown on Figure 13.2 and coordinates of the NMLs are also included below in **Error! Reference source not found.** More information can be found in Technical Appendix 13.2.

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[12] British Standard BS5228-2: 2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites' – Part 2: Vibration
[13] British Standard BS7385-2: 1993 'The Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration'
[14] British Standard BS6472: 2008 'Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration'

13.2.9 Field Work

The noise survey to determine the existing background noise environment at NSRs neighbouring the Proposed Development was undertaken in accordance with the guidance contained within ETSU-R-97 and current good practice (IOA GPG).

Background noise monitoring was undertaken over the period of 8 February 2023 to 21 April 2023 at seven Noise Monitoring Locations (NMLs), as detailed in Table 13.6 and shown on Figure 13.2. Further details of the NMLs can be found within Section 5 of Appendix 13.2. The NMLs were chosen by TNEI to be representative of all NSRs located around the Proposed Development.

Table 13.6: Noise Monitoring Locations

NML/ Receptor Name	ITM Easting	ITM Northing
NML1 (H115)	709238	783878
NML2 (H110)	709252	783061
NML3 (H374)	708771	782517
NML4 (H226)	707615	782310
NML5 (H66)	706345	783944
NML6 (H306)	706401	784583
NML7 (H71)	708661	784724

Simultaneous wind speed/direction data were recorded within the Proposed Wind Farm at various heights using a LiDAR Unit (located at Irish Transverse Mercator reference 708670, 783382). The wind speed data collected at 105 m (proposed maximum hub height), was standardised to 10m height, in accordance with good practice.

Wind speed/direction and rainfall data were collected over the same time scale and averaged over the same ten-minute periods as the noise data, to allow analysis of the measured background noise as a function of wind speed and wind direction. All data analysis was undertaken in accordance with ETSU-R-97 and the IOA GPG. There were no data limitations.

13.2.10 Criteria for the Assessment of Effects

The Environmental Protection Agency document *'Guidelines on the information to be contained in Environmental Impact Assessment Reports'*[15] has informed the criteria for the assessment of potential effects, as summarised below.

13.2.10.1 Criteria for Assessing Significance – Construction Noise

Appendix E part E.3.2 of BS5228-1:2009+A1:2014 presents a series of thresholds that can be used to determine whether a significant effect could occur. The thresholds are divided into three Categories; A, B and C, with Category A setting lower threshold levels for quieter noise environments.

The significance criteria adopted for this assessment, which are all from Category A, are detailed in Table 13.7 below.

Table 13.7: Construction Noise Significance Criteria

Significance of Effect	Significance Level - Category A[16]	
	Not Significant	Significant
Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	≤65dB $L_{Aeq, T}$	>65dB $L_{Aeq, T}$
Evenings and Weekends (19:00 – 23:00), Saturdays 13:00-23:00 and Sundays 07:00-23:00.	<55dB $L_{Aeq, T}$	>55dB $L_{Aeq, T}$
Night time (23:00 – 07:00)	<45dB $L_{Aeq, T}$	>45dB $L_{Aeq, T}$

It should be noted that exceedance of the threshold does not in itself indicate a significant effect, rather, the standard states, *'If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect'.*

[15] The Environmental Protection Agency, 2022. Guidelines on the information to be contained in Environmental Impact Assessment Reports

[16] Category A thresholds have been used in this assessment as they are the most stringent. Further information on all Category Thresholds can be found in Technical Appendix 13.1.

13.2.10.2 Criteria for Assessing Significance – Wind Turbine Operational Noise

The WEDG 2006 and ETSU-R-97 do not define significance criteria but describe a framework for the measurement of wind farm noise and give indicative noise levels considered to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development. Achievement of the WEDG 2006 derived noise limits ensures that wind turbine noise will comply with current Government guidance.

In terms of the EIA Regulations, in this Chapter of the EIAR the use of the term 'significance' in this EIAR refers to compliance or non-compliance with the WEDG 2006 derived noise limits. For situations where predicted wind turbine noise meets, or is less than, the noise limits defined in WEDG 2006, then the noise effects are deemed not significant. Any exceedance of the WEDG 2006 derived noise limits due to the Proposed Development has the potential to result in a significant effect.

It is not possible to predict if OAM will occur at any given site and if it does, how frequent and sustained it might be. In the event that OAM occurs frequently and for sustained periods, it has the potential to result in adverse impacts.

13.2.10.3 Criteria for Assessing Significance – BESS and Substation Operational Noise

BS 4142 does not define significance criteria; rather it describes a framework for the measurement of noise and provides a method to determine the likelihood of adverse impact. The assessment has been undertaken in two parts; firstly, a comparison is made between the Rating Level and the Background Sound Level. Secondly, the assessment considers the context in which the sound occurs to determine a qualitative assessment outcome. As such there is no definitive pass/fail. This is described in the standard as follows:

'Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following…

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

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

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

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.'

To determine a Magnitude of Impact, the following criteria has been adopted:

- Where BS 4142 indicates a significant adverse impact, this is a Major Magnitude of Impact;
- Where BS 4142 indicates adverse impact, this is a Moderate Magnitude of Impact;
- Where BS 4142 indicates no adverse impact, this is a Minor Magnitude of Impact;
- Where the BS 4142 Rating Level is less than the measured background sound levels, this is a Negligible Magnitude of Impact.

With due regard to the sensitivity of the assessed residential receptors being high, the following criteria has been adopted to determine the significance criteria:

- Where a Major Magnitude of Impact is predicted, this is a Major Significant Effect;
- Where a Moderate Magnitude of Impact is predicted, this is a Moderate Significant Effect;
- Where a Minor Magnitude of Impact is predicted, this results in No Significant Effects;
- Where a Negligible Magnitude of Impact is predicted, this results in No Significant Effect.

13.2.10.4 Limitations and Assumptions

The noise data collected during the background noise survey are representative of the typical baseline noise levels at the nearest NSRs. The guidance in the WEDG 2006 supplemented by the IOA GPG has been followed by suitably experienced Acoustic Consultants to ensure that the data collected is as representative as possible. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations deemed representative of the background noise environment was used to assess the noise impacts at those receptors.

For construction noise, predictions have been undertaken based on an indicative construction programme and proposed construction activities. The final construction programme and type of plant to be used would be decided at a later date by the contractor.

As detailed above, various types and sizes of wind turbines, within the proposed ranges, have been selected and assessed in the relevant sections of the EIAR. For the noise and vibration assessment, three candidate wind turbine models have been used for predictions of operational noise from the Proposed Development. Whilst the final model of wind turbine to be installed on the site may differ from that presented in this assessment, it will be within the parameters of the candidate wind turbine models that have been used for this assessment, and the operational noise levels of the Proposed Development will be required to comply with the conditioned noise limits in the planning permission.

Representative candidate plant were modelled for the BESS noise predictions.

No other assumptions or data gaps have been identified.

13.3 BASELINE DESCRIPTION

13.3.1.1 Current Baseline

The Proposed Project is located within a rural location which lies approximately 2.5 km east of the M1 Motorway and existing background noise levels during the daytime, particularly at NSRs along the western side of the Proposed Development, are higher than would typically be expected in a rural setting due to the influence of the motorway. During the night-time, where road traffic levels are much reduced, the background noise levels at the NSRs are generally considered to be low (<30 dB as defined in the WEDG 2006[17]) at low windspeeds. The predominant noise sources in the area are road traffic noise from the nearby motorway and local roads, wind induced noise (wind passing through vegetation and around buildings) and birdsong.

13.3.1.2 Future Baseline

It is possible that noise propagation and resulting noise immission levels could change over the life of the Proposed Development due to climate change (as noise attenuation is influenced by air temperature, relative humidity and ground conditions). However, noise limits are set based on current background noise levels in the absence of wind turbine noise and would be set for the lifetime of the project. The operator would be required to meet them for the duration of the consent.

13.3.2 Prevailing Background Noise Levels

Table 13.8 and Table 13.9 provide a summary of the background noise levels measured during the monitoring period during the quiet daytime and night-time periods. Background noise data recorded during periods of rainfall (including the preceding 10 minute period in line with IOA

[17] Section 5.6 of WEDG 2006 refers to ' low noise environments where background noise is less than 30 dB(A)'

GPG) have been excluded from the dataset, as well as data following periods of heavy rainfall. Further information of the data recorded during the noise survey can be found in Section 5 of Technical Appendix 13.2). The prevailing background noise levels are also shown on Figures A1.2a-A1.2g included in Annex 1 of Technical Appendix 13.2.

Table 13.8: Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

Noise Monitoring Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 (H115)	29.5	30.1	30.9	32.0	33.3	34.8	36.5	38.5	40.7	43.2	45.9	45.9*
NML2 (H110)	34.7	34.7	34.7	34.9	35.6	36.8	38.2	39.9	41.6	43.3	44.8	44.8*
NML3 (H374)	30.9	30.9	31.4	32.4	33.9	35.7	37.7	39.8	41.8	43.6	45.1	43.6*
NML4 (H226)	32.5	32.5	32.7	33.3	34.3	35.7	37.3	39.1	41.1	43.2	45.3	45.3*
NML5 (H66)	39.0*	39.0*	39.0*	39.0*	39.0	39.1	39.4	40.1	41.1	42.6	42.6*	42.6*
NML6 (H306)	34.4*	34.4*	34.4*	34.4*	34.4*	34.4	34.9	35.9	37.5	39.6	39.6*	39.6*
NML7 (H71)	34.5	34.5	34.8	35.6	36.6	37.9	39.4	41.0	42.6	44.3	45.9	45.9*

**flat-lined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7.7 of the Operational Noise Report (Technical Appendix 13.2).*

Table 13.9: Summary of Prevailing Background Noise Levels during Night-time Periods (dB(A))

Noise Monitoring Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 (H115)	21.1	21.8	23.0	24.7	26.9	29.4	32.3	35.4	38.7	42.1	45.6	49.1
NML2 (H110)	27.2	27.4	28.1	29.2	30.7	32.5	34.6	36.9	39.5	42.1	44.9	47.7
NML3 (H374)	20.0	20.9	22.5	24.7	27.3	30.3	33.4	36.6	39.7	42.7	45.3	47.6
NML4 (H226)	23.1	24.0	25.3	26.9	28.8	30.9	33.2	35.6	38.0	40.5	42.9	45.2
NML5 (H66)	38.6*	38.6*	38.6*	38.6*	38.6	38.8	39.2	39.9	40.4	40.7	40.7*	40.7*
NML6 (H306)	24.7*	24.7*	24.7*	24.7	25.3	27.9	31.5	34.7	36.6	36.6*	36.6*	36.6*
NML7 (H71)	31.9*	31.9*	31.9	32.1	33.0	34.4	36.3	38.5	40.9	43.3	45.6	47.7

**flat-lined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7.7 of the Operational Noise Report (Technical Appendix 13.2).*

13.4 ASSESSMENT OF POTENTIAL EFFECTS

13.4.1 Potential Construction Noise Effects

Table 13.10 presents the thresholds from BS5228 Category A (lowest thresholds in the ABC method) and the calculated noise immission levels at each CNAL for all modelled scenarios.

Table 13.10: Predicted Construction Noise Immission Levels

CNAL	Category A Threshold dB $L_{Aeq, t}$			Immission Level, dB $L_{Aeq, t}$ for modelled months													
	Daytime (07:00 – 19:00) and Saturdays (07:00 - 13:00)	Evenings (19:00-23:00 weekdays) Weekends (13:00-23:00 Saturdays and 07:00-23:00 Sundays)	Night-Time (23:00 – 07:00)	1&2	3	4	5	6	7	8	9	10	11	12-16	17	18	Night
CNAL01 (H62)	65	55	45	42	44	37	33	30	27	30	23	31	19	19	43	28	18
CNAL02 (H233)	65	55	45	52	50	33	32	28	25	33	23	27	18	17	44	27	29
CNAL03 (H55)	65	55	45	62	62	33	33	29	26	40	24	27	19	18	44	28	33
CNAL04 (H235)	65	55	45	46	45	35	34	29	26	58	26	27	19	19	37	28	24
CNAL05 (H187)	65	55	45	63	63	36	37	30	27	50	27	28	21	19	36	29	35
CNAL06 (H70)	65	55	45	54	51	38	36	29	26	46	29	29	19	20	36	29	21
CNAL07 (H71)	65	55	45	45	46	40	37	29	27	39	30	30	19	21	37	28	19
CNAL08 (H179)	65	55	45	34	37	40	40	33	29	29	33	29	23	24	36	31	8
CNAL09 (H115)	65	55	45	33	40	46	44	40	35	29	40	36	27	32	40	38	12
CNAL10 (H110)	65	55	45	29	32	48	57	41	37	28	33	32	28	44	36	40	19
CNAL11 (H27)	65	55	45	27	29	43	40	35	32	26	26	28	21	41	30	34	16

CNAL	Category A Threshold dB $L_{Aeq, t}$			Immission Level, dB $L_{Aeq, t}$ for modelled months													
	Daytime (07:00 – 19:00) and Saturdays (07:00 - 13:00)	Evenings (19:00-23:00 weekdays) Weekends (13:00-23:00 Saturdays and 07:00-23:00 Sundays)	Night-Time (23:00 – 07:00)	1&2	3	4	5	6	7	8	9	10	11	12-16	17	18	Night
CNAL12 (H374)	65	55	45	29	31	51	47	45	40	39	32	40	30	47	36	45	27
CNAL13 (H237)	65	55	45	28	30	36	38	35	35	30	25	31	21	30	30	35	11
CNAL14 (H226)	65	55	45	29	31	34	37	34	34	29	25	30	21	27	30	34	12
CNAL15 (H46)	65	55	45	34	38	35	38	35	34	29	27	32	24	26	35	34	14

The construction noise assessment results show that the predicted noise levels are below the Category A Threshold Levels for Daytime and Night-time threshold value periods. This is for all of the CNALs and for all assessment scenarios, therefore, there will be **no significant construction noise effects**. Although no evening and weekend working is proposed, predicted construction noise levels are below the Evening and Weekend threshold values at all CNALs except at CNALs 3 and 5 during months 1-3 and CNAL10 during month 5. Full details of the modelling and assessment can be found in Technical Appendix 13.1 along with the results for all other NSRs.

For the Proposed Grid Connection Route, the amount of required plant is relatively small, typically being based around an excavator for trenching and backfill activities. As such, construction activities in any one location will be limited in duration and adverse noise effects are anticipated to be negligible. Where construction activities occur directly beside a dwelling, the noise levels at that location are likely to be in the region of 75 – 80 dB(A) for a short period of time. It should be noted, however, that this would only occur where construction activities are directly outside the curtilage of a dwelling within approximately 20 m and would result in an instant noise level increase (i.e. not considering a full construction day). To put this into context, trenching and backfill activities are anticipated to move along the Proposed Grid Connection Route at approximately 150 m to 300 m a day, therefore, the length of time when construction activities will be occurring adjacent to any given receptor is only likely to be for a few hours. For the majority of the time, plant and equipment will be located at greater distances from dwellings and therefore, noise levels will be lower. It is possible that noise levels from trenching and backfill operations may occasionally exceed the BS 5228 threshold if within 20 m to a dwelling, however this would only occur for a short period of time at any one location.

HDD will be required at six locations along the Grid Connection Route. At one road crossing (under the M1 Motorway) there will be a requirement for the use of a large HDD rig which would the use of multiple items of plant including pumps, mud recyclers, and generators. Detailed noise modelling has been undertaken at three CNALs located in closest proximity to the proposed HDD activities and the modelling results are summarised in Table 13.11 below against BS5228 Daytime Category A (lowest thresholds in the ABC method).

Table 13.11: Predicted Noise Immission Levels from HDD activity

CNAL	Category A Threshold dB $L_{Aeq, t}$ Daytime (07:00 – 19:00) and Saturdays (07:00 - 13:00)	Immission Level, dB $L_{Aeq, t}$
CNAL16	65	59
CNAL17	65	59
CNAL18	65	56

The proposed plant for the five smaller crossings is a small Vermeer D36 x 50 Directional Drill. Calculations of the Vermeer DD rig, assuming a source noise level of 94 dB(A) at 1 m, indicates that noise levels would be below the 65 dB(A) threshold from a distance of approximately 30 m. For small crossings, the work would likely be completed within 1 and 2 weeks so it will be short term only. Where activities involving the small HDD drilling rig are within 30 m of a dwelling then primary mitigation measures will be implemented, which includes the erection of temporary boarding alongside the drilling rig or use of 'acoustic blanket panels' to hang from heras fencing or similar. This would be installed as close to the drilling rig as is practicable and fitted so as to interrupt any direct line of site between the drilling rig and the closest residential receptors. Examples of appropriate products include Echo Noise Defender and Soundex DeciBloc.

Construction works related to distant road junction improvements may also occur outwith the CNALs considered above, in close proximity to some residential receptors. It is possible that noise from these activities may at times exceed the guideline levels, however it should be noted that this will be a short-term, temporary impact.

Accordingly, the impact is deemed **not significant for construction activities associated with cable trenching, HDD and distant road junction upgrades.**

13.4.2 Potential Construction Vibration Effects

Where construction activities on the underground electrical cabling route are close to residential receptors, some local vibration effects may be present, however, levels are expected to be low and of limited duration. Also, similarly to construction noise, good practice during construction is recommended and will reduce vibration levels from these short-term works to minimum levels. Accordingly, the impact is deemed **not significant for construction vibration**.

13.4.3 Potential Wind Turbine Operational Noise Effects

13.4.3.1 Setting the WEDG 2006 Noise Limits

Based on the prevailing background noise levels, the WEDG 2006 Noise Limits have been established for each of the NALs detailed in Table 13.4 above. The WEDG 2006 Noise Limits for the other NSRs are detailed in Annex 5 of Appendix 13.2.

The WEDG 2006 Noise Limits are as detailed in Table 13.12 and Table 13.13 below.

Table 13.12: WEDG 2006 Noise Limit - Daytime dB(A)

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (H3)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	46.1	47.6	47.6	47.6
NAL2 (H4)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL3 (H5)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	47.6	49.3	50.9	50.9
NAL4 (H6)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	47.6	49.3	50.9	50.9
NAL5 (H7)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	47.6	49.3	50.9	50.9
NAL6 (H8)	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	48.2	50.9	50.9
NAL7 (H10)	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	48.2	50.9	50.9
NAL8 (H13)	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	48.2	50.9	50.9
NAL9 (H14)	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	48.2	50.9	50.9
NAL10 (H19)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.6	48.3	49.8	49.8
NAL11 (H25)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	48.6	50.1	50.1
NAL12 (H28)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.2	50.3	50.3
NAL13 (H35)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.2	50.3	50.3
NAL14 (H67)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.2	50.3	50.3

Table 13.13: WEDG 2006 Noise Limit – Night-time dB(A)

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (H3)	43.6	43.6	43.6	43.6	43.6	43.8	44.2	44.9	45.4	45.7	45.7	45.7
NAL2 (H4)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL3 (H5)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.7

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL4 (H6)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.7
NAL5 (H7)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.7
NAL6 (H8)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	47.1	50.6	54.1
NAL7 (H10)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	47.1	50.6	54.1
NAL8 (H13)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	47.1	50.6	54.1
NAL9 (H14)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	47.1	50.6	54.1
NAL10 (H19)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	47.1	49.9	52.7
NAL11 (H25)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.7	47.7	50.3	52.6
NAL12 (H28)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.5	47.9	50.2
NAL13 (H35)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.5	47.9	50.2
NAL14 (H67)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.5	47.9	50.2

13.4.3.2 Predictions

The WEDG 2006 Noise Limits were compared to the predictions of the Proposed Development and the results are summarised below in Table 13.14 for the daytime and Table 13.15 for the night-time. The tables also show the exceedance level, which is the difference between the predicted noise level and the WEDG Noise Limit at a given wind speed. A negative exceedance level indicates satisfaction of the noise limit. The WEDG Noise Limits and predictions are also shown on Figures A1.3a-n in Annex 1 of Appendix 13.2.

The assessment shows that the predicted wind turbine noise immission levels meet the WEDG 2006 Noise Limits under all conditions for both daytime and night-time periods at all receptors and as such there will be **no significant effects** at those receptors.

It is not possible to predict if OAM will occur at the NALs surrounding this Proposed Development and if it does, how frequent and sustained it might be. In the event that frequent and sustained OAM occurs there is the potential for this to result in an adverse impact in the absence of mitigation.

Table 13.14: Compliance Table –Comparison of predicted noise levels from the Proposed Development against the WEDG 2006 Noise Limit at each receptor – Daytime

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (H62)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	47.1	47.1	47.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.9	33.2	37.6	38.9	39.0	39.0	39.0	39.0	39.0
	Exceedance Level	-	-	-	-16.1	-11.8	-7.4	-6.1	-6.0	-6.7	-8.1	-8.1	-8.1
NAL2 (H233)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.3	32.7	37.1	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-	-16.7	-12.3	-7.9	-6.6	-6.5	-6.5	-6.5	-6.5	-6.5
NAL3 (H158)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	47.5	49.3	51.0	51.0
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.3	33.7	38.0	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-15.7	-11.3	-7.0	-5.7	-6.3	-8.1	-9.9	-11.6	-11.6
NAL4 (H187)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	47.5	49.3	51.0	51.0
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.4	33.8	38.2	39.4	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-15.6	-11.2	-6.8	-5.6	-6.1	-7.9	-9.7	-11.4	-11.4
NAL5 (H71)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	47.5	49.3	51.0	51.0
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	39.7	41.0	41.1	41.1	41.1	41.1	41.1
	Exceedance Level	-	-	-	-14.0	-9.6	-5.3	-4.0	-4.6	-6.4	-8.2	-9.9	-9.9
NAL6 (H181)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.8	48.5	51.4	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	31.7	36.0	37.3	37.5	37.5	37.5	37.5	37.5
	Exceedance Level	-	-	-	-17.7	-13.3	-9.0	-7.7	-7.5	-8.3	-11.0	-13.9	-13.9
NAL7 (H179)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.8	48.5	51.4	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.1	34.5	38.8	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-14.9	-10.5	-6.2	-4.9	-4.8	-5.6	-8.3	-11.2	-11.2
NAL8 (H115)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.8	48.5	51.4	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.1	35.5	39.8	41.1	41.2	41.2	41.2	41.2	41.2
	Exceedance Level	-	-	-	-13.9	-9.5	-5.2	-3.9	-3.8	-4.6	-7.3	-10.2	-10.2
NAL9 (H14)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.8	48.5	51.4	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.1	32.5	36.8	38.1	38.3	38.3	38.3	38.3	38.3

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedance Level	-	-	-	-16.9	-12.5	-8.2	-6.9	-6.7	-7.5	-10.2	-13.1	-13.1
NAL10 (H109)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.4	48.3	50.0	50.0
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.1	35.4	39.8	41.1	41.2	41.2	41.2	41.2	41.2
	Exceedance Level	-	-	-	-13.9	-9.6	-5.2	-3.9	-3.8	-5.2	-7.1	-8.8	-8.8
NAL11 (H374)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.7	48.7	50.3	50.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	32.1	36.5	40.8	42.1	42.2	42.2	42.2	42.2	42.2
	Exceedance Level	-	-	-	-12.9	-8.5	-4.2	-2.9	-2.8	-4.5	-6.5	-8.1	-8.1
NAL12 (H265)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	48.1	50.1	50.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.2	33.6	37.9	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-	-15.8	-11.4	-7.1	-5.8	-5.7	-6.7	-8.8	-10.8	-10.8
NAL13 (H226)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	48.1	50.1	50.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.2	32.6	37.0	38.3	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-16.8	-12.4	-8.0	-6.7	-6.6	-7.6	-9.7	-11.7	-11.7
NAL14 (H46)	WEDG Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0	48.1	50.1	50.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.7	34.1	38.4	39.7	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-15.3	-10.9	-6.6	-5.3	-5.2	-6.2	-8.3	-10.3	-10.3

Table 13.15: Compliance Table – Comparison of predicted noise levels from the Proposed Development against the WEDG 2006 Noise Limit at each receptor – Night-time

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (H62)	WEDG Noise Limit, L_{A90}	43.6	43.6	43.6	43.6	43.6	43.8	44.2	44.9	45.4	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.9	33.2	37.6	38.9	39.0	39.0	39.0	39.0	39.0
	Exceedance Level	-	-	-	-14.7	-10.4	-6.2	-5.3	-5.9	-6.4	-6.7	-6.7	-6.7
NAL2 (H233)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.8	45.8	45.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.3	32.7	37.1	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-	-14.7	-10.3	-5.9	-4.6	-4.5	-4.5	-7.3	-7.3	-7.3
NAL3 (H158)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.3	33.7	38.0	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-13.7	-9.3	-5.0	-3.7	-4.1	-6.5	-8.9	-11.2	-13.2
NAL4 (H187)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.4	33.8	38.2	39.4	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-13.6	-9.2	-4.8	-3.6	-3.9	-6.3	-8.7	-11.0	-13.0
NAL5 (H71)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.5	45.9	48.3	50.6	52.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	39.7	41.0	41.1	41.1	41.1	41.1	41.1
	Exceedance Level	-	-	-	-12.0	-7.6	-3.3	-2.0	-2.4	-4.8	-7.2	-9.5	-11.5
NAL6 (H181)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	47.4	50.9	54.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	31.7	36.0	37.3	37.5	37.5	37.5	37.5	37.5
	Exceedance Level	-	-	-	-15.7	-11.3	-7.0	-5.7	-5.5	-6.5	-9.9	-13.4	-16.8
NAL7 (H179)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	47.4	50.9	54.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.1	34.5	38.8	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-12.9	-8.5	-4.2	-2.9	-2.8	-3.8	-7.2	-10.7	-14.1
NAL8 (H115)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	47.4	50.9	54.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.1	35.5	39.8	41.1	41.2	41.2	41.2	41.2	41.2
	Exceedance Level	-	-	-	-11.9	-7.5	-3.2	-1.9	-1.8	-2.8	-6.2	-9.7	-13.1
NAL9 (H14)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	47.4	50.9	54.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.1	32.5	36.8	38.1	38.3	38.3	38.3	38.3	38.3
	Exceedance Level	-	-	-	-14.9	-10.5	-6.2	-4.9	-4.7	-5.7	-9.1	-12.6	-16.0

NAL		Wind Speed (ms-1) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL10 (H109)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	47.1	49.9	52.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	31.1	35.4	39.8	41.1	41.2	41.2	41.2	41.2	41.2
	Exceedance Level	-	-	-	-11.9	-7.6	-3.2	-1.9	-1.8	-3.3	-5.9	-8.7	-11.5
NAL11 (H374)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.7	47.7	50.3	52.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	32.1	36.5	40.8	42.1	42.2	42.2	42.2	42.2	42.2
	Exceedance Level	-	-	-	-10.9	-6.5	-2.2	-0.9	-0.8	-2.5	-5.5	-8.1	-10.4
NAL12 (H265)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.5	47.9	50.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.2	33.6	37.9	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-	-13.8	-9.4	-5.1	-3.8	-3.7	-3.7	-6.2	-8.6	-10.9
NAL13 (H226)	WEDG Noise Limit, L_{A90}	43.6	43.6	43.6	43.6	43.6	43.8	44.2	44.9	45.4	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.9	33.2	37.6	38.9	39.0	39.0	39.0	39.0	39.0
	Exceedance Level	-	-	-	-14.7	-10.4	-6.2	-5.3	-5.9	-6.4	-6.7	-6.7	-6.7
NAL14 (H46)	WEDG Noise Limit, L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.8	45.8	45.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.3	32.7	37.1	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-	-14.7	-10.3	-5.9	-4.6	-4.5	-4.5	-7.3	-7.3	-7.3

13.4.4 Operational Noise Effects from BESS and Substation

During the daytime, the Rating Level is lower than the background sound level at all NALs, therefore, the Magnitude of Impact is Negligible and this results in **No Significant Effects**.

During the night-time, the BS 4142 assessment indicates no adverse impact all NALs. This is a Minor Magnitude of Impact, which also results in **No Significant Effects**.

Full details of the modelling and assessment can be found in Technical Appendix 13.3.

13.4.5 Potential Cumulative Effects

13.4.5.1 Construction Noise

The construction noise assessment has shown that predictions for the Proposed Development on its own are at least 10 dB below the BS5228 threshold during proposed core hours of work therefore there are sufficient margin at nearby receptors for other construction work to occur simultaneously in the area. The only exception would be CNAL3 and CNAL5 during early site establishment works on site entrance tracks (months 1 and 2) where only 2-3 dB margin in core hours is predicted. However, work for the Proposed Development will be in temporary phases and very unlikely to occur at the same time and same location as any other nearby projects near the same receptors. As such, no cumulative noise effects are anticipated in relation to the construction of the Proposed Development, and other permitted or proposed projects and plans in the area, as set out in Section 2.4.4 in Chapter 2 of this EIAR.

No cumulative noise effects are anticipated in relation to construction of the Proposed Grid Connection Route and other permitted or proposed projects and plans in the area, as set out in Section 2.4.4 in Chapter 2 of this EIAR, as construction activities will be transient in nature along the route and will not be in any one location long enough for a significant impact to occur.

Therefore no significant cumulative construction noise effects are anticipated.

13.4.5.2 Operational Phase

As detailed above, there are no existing, permitted and proposed wind energy projects within 10 km of the Wind Farm Site, therefore, there is no potential for operational cumulative noise effects with other wind energy projects. Noise generated from wind turbine projects beyond 10 km would be inaudible. With the exception of Kilsaran Quarry, which is considered below, no other noise generating developments have been identified that would need to be considered within the cumulative noise assessment.

No cumulative noise effects are anticipated in relation to construction of the underground electrical cabling route and other permitted or proposed projects and plans in the area, as set out in Section 12.4.4 in Chapter 2 of this EIAR, as construction activities will be transient in nature along the route and will not be in any one location long enough for a significant impact to occur.

13.4.6 Cumulative Noise and Vibration Impacts with Kilsaran Quarry

Louth County Council (LCC) have asked that the potential for cumulative noise and vibration impacts from the operation of the neighbouring Kilsaran Quarry be considered fully within the EIAR and Table 13.16 sets out all of the potential interactions. With regards to cumulative noise level interactions, it should be noted that due to the logarithmic nature that noise levels add together, where two noise levels are summed that are more than 10 dB apart, there is no overall increase in level, for example, 50dB + 39 dB = 50 dB.

Table 13.16: Potential for Cumulative Interactions with Kilsaran Quarry

Source	Interaction	Receptors	Possible Effects	Significance
Quarry: operational noise	Turbines: operational noise	Staff on wind farm site	Within the wind farm, noise levels from the turbines will be at least 10 dB above operational noise levels from the quarry. As such there is no possibility of a cumulative increase in overall noise level.	No Significant Effects
Turbines: operational noise	Quarry: operational noise	Staff on quarry site	As above, noise levels within the quarry would be more than 10 dB higher than noise levels from the wind turbines. Therefore, no cumulative effects could occur.	No Significant Effects
Turbines: operational noise	Quarry: operational noise	Residential Properties	Considered in more detail below.	See below
Quarry blasting: noise/air overpressure	Turbines: operational noise	Staff on either site	Blast noise is extremely short in duration, whereas turbine operational noise is assessed in 10 minute periods. It is not possible to combine these two noise types to undertake a simple quantitative assessment, however, no cumulative impacts would occur as the difference between the two noise levels at	No Significant Effects

Source	Interaction	Receptors	Possible Effects	Significance
			the receptor location would be >10 dB.	
Quarry Operational Noise	Turbine construction noise	Residential Properties	Considered in more detail below.	See below
Quarry blasting: noise/air overpressure	Turbines: operational noise	Residential Properties	As above – no cumulative interactions can occur	No Significant Effects
Quarry: activities generating vibration	Turbines: operational vibration	Residential Properties	There will be no discernible vibration from the wind turbines at residential receptors. Accordingly, there can be no cumulative vibration impacts at these receptors.	No Significant Effects
Quarry: vibration from blasting	Turbines: operational vibration	Residential Properties	As above, there will be no discernible vibration from the wind turbines at residential receptors. Accordingly, there can be no cumulative vibration impacts at these receptors.	No Significant Effects
Quarry: Vibration and air overpressure from blasting	Effects on wind turbines	Wind turbines	Considered in more detail below.	See below

Table 13.16 indicates that for most instances, cumulative noise or vibration impacts cannot occur. There are two elements, however, which require further discussion, and these are cumulative operational noise impacts on residential receptors, and quarry blast impacts on the wind turbines.

13.4.6.1 Cumulative Operational noise (Quarry and Wind Turbine noise on Residential Receptors

There is the potential for cumulative effects to occur due to the concurrent operation of Proposed Development and the quarry. It is not appropriate to consider the cumulative impacts in relation to the limits set in accordance with WEDG 2006 as they are specific to wind turbine noise. Conversely it is not appropriate to consider wind turbine noise in the context of any noise conditions set for the quarry.

The Proposed Development turbine noise will have a different characteristic than existing nearby sources such as the quarry, and will vary significantly with wind speed, just as quarry activities vary day by day. As such it is possible that under certain conditions the noise from both developments may be audible at the same time at some of the NALs.

The operational noise levels from the quarry at nearby receptors are limited through noise conditions to 55 dB for the main hours of operation. On that basis it is possible to undertake a basic comparison of the maximum predicted noise levels from the Proposed Development and the operational noise limits for the quarry. The maximum predicted wind turbine noise level at the closest receptors to the quarry (NAL3 and NAL 4) is 41.4 and 41.6 (this value is 2 dB higher than the L_{A90} values presented above due to the conversion to L_{Aeq}). The addition of this maximum predicted wind turbine noise level and the maximum noise level permitted by quarrying activities is 55.2 dB at both NALs, an overall increase of 0.2 dB. As such, the inclusion of the maximum predicted level of wind turbine noise that could occur results in a negligible increase in overall noise levels and therefore the cumulative noise effects are deemed **not significant**.

13.4.6.2 Cumulative Construction noise (Quarry operations and wind turbine construction noise on residential receptors

The operational noise levels from the quarry at nearby receptors are limited through noise conditions (between 08:00 and 18:00) to 55 dB. This falls within the daytime construction noise assessment period (07:00 to 19:00). The maximum allowable noise level from the quarry at any receptor is 10 dB below the daytime construction noise level threshold of 65 dB. Accordingly, the contribution of noise from the quarry cannot increase the cumulative noise level to above the construction noise level threshold. Similarly, noise levels from the quarry are limited outside of the daytime assessment period to 45 dB which is 10 dB below the evening and weekend construction noise threshold of 55 dB. Therefore the cumulative noise effects from the operation of the quarry during the wind farm construction period are deemed **not significant**.

13.4.6.3 Quarry Blast Impacts on the Wind Turbines

The effects of blasting within the quarry on the Proposed Development is considered separately within the report; *'Kellystown Wind Farm Ground Vibration and Air Overpressure Blast Monitoring for the proposed Kellystown Wind Farm, County Louth'* by WSP (Ref: 70123789.P04), which is included in Technical Appendix 13.4: Ground Vibration and Air Overpressure Blast Report. The report sets out a Peak Particle Velocity (PPV) vibration limit of 100 mm/s at the base of the turbines and then compares measured blasting from the quarry, as well as predicted levels from future blasts, to points at the base of the turbines.

The measured vibration levels were well below the PPV limits, with the highest recorded PPV being 31.31 mm/s at the proposed location for Turbine 1 during blast event 3.

Models were constructed to predict vibration levels from future blast locations at the proposed turbine locations for both free face and confined blasting. The predicted levels from the models were verified through comparison to measured blast levels.

The closest turbines to the quarry are T01, T02, T03 and T04. The maximum PPV predicted by the model at each turbine, is as follows:

- 7.1 mm/s (confined blasting) and 36.9 mm/s (free face blasting) at T01;
- 3.6 mm/s (confined blasting) and 67..9 mm/s (free face blasting) at T02;
- 2.0 mm/s (confined blasting) and 48.9 mm/s (free face blasting at T03; and,
- 0.72 mm/s (confined blasting) and 10.2 mm/s (free face blasting) at T04.
- 0.44 mm/s (Confined) and 2.28 mm/s (Free Face) at T05

Accordingly, the WSP report concluded *'the proposed locations of the WTGs are projected to remain within the anticipated PPV and PSPL limits, confirming that they are situated at a safe distance. This zone is established with the understanding that the turbines will not experience any structural or cosmetic damage due to blasting activities.'*

13.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

13.5.1 Construction Noise Mitigation

No significant effects resulting from construction noise and vibration are predicted. Nevertheless, standard good practice construction methods are presented in a Construction Environmental Management Plan (CEMP) (Appendix 2.1) to minimise any potential impacts. The core hours for the proposed works will be normal construction hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 Saturday. There will be no working on Saturday afternoons, Sundays and Public Holidays, however, it should be noted that out of necessity some activity outside of the core hours could arise, from delivery and unloading of abnormal loads or health and safety requirements, or to ensure optimal use is made of fair weather windows for concrete deliveries, the erection of turbine blades and the erection and dismantling of cranes. If occasional work is undertaken outside of core hours, especially during construction of access tracks at the site entrance, this will be agreed in advance.

Good site practices, both for construction of the Proposed Wind Farm and the Proposed Grid Connection Route will be implemented to minimise the likely effects. Particular care will be taken at the M1 crossing along the Proposed Grid Connection Route. Section 8 of BS5228-1:2009+A1:2014 recommends a number of simple control measures as summarised below that will be employed onsite:

- Keep local residents informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern;
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and be subject to programmed maintenance;
- Select inherently quiet plant where appropriate - all major compressors will be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which will be kept closed whenever the machines are in use;
- All ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Machines will be shut down between work periods (or when not in use) or throttled down to a minimum;
- Regularly maintain all equipment used on site, including maintenance related to noise emissions;
- Vehicles will be loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and
- All ancillary plant such as generators and pumps will be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures will be provided.

13.5.2 Noise mitigation during operation

The exact model of wind turbine to be used for the Proposed Development will be the result of a future tendering process. The final choice of turbine will, however, have to meet the derived noise limits and/or noise limits determined and contained within any planning permission condition imposed.

As detailed above, the predicted noise levels from the Proposed Development are within the noise limits, and therefore no mitigation measures are required in respect of noise. Notwithstanding the above, this section outlines noise curtailment measures which will be implemented in the event that adverse noise impacts arise during the operation of the proposed development, including through the complaints procedure outlined below.

Wind turbines can be programmed to run in reduced modes of operation (or low noise modes) in order to achieve noise criteria during certain periods (i.e. day or night) and under specific wind conditions (i.e. wind speed and direction). The turbine technology that has been proposed for this assessment offers various noise modes of operation which typically will have an associated energy output reduction. Operating the turbines in reduced modes is generally referred to as curtailment and is a proven effective mitigation to ensure noise limits are complied with. Low noise modes are available for all modern turbines likely to be considered for this Site.

Whilst it is not possible to predict if OAM will occur, in the event that complaints are received regarding OAM, mitigation measures are available. The design of such mitigation measures can only be determined once the wind farm is operational if OAM is found to occur frequently and at sustained levels. For this Proposed Project, the developer is committed to investigating all noise complaints, inclusive of any complaint which may relate to OAM (i.e. beyond overall noise levels found in planning conditions). To deal with any potential complaints the following approach will be adopted:

- A community liaison officer will be appointed prior to first generation of electricity and contact details made publicly available;
- Any complaint relating to noise can be reported to the community liaison officer, who will undertake an initial screening of the complaint (review of logs submitted, review of wind conditions and turbine data etc..) and speak to the complainant in person, with an eventual visit to the complainant location if possible;
- Following initial screening, the community liaison officer will be responsible for commissioning a detailed noise complaint investigation. This will include appointing a qualified acoustic consultant to undertake noise measurements at the complaint location and quantify the occurrence and depth (in dB) of OAM for every 10 minute of the measurement campaign. The measured 10 minute noise levels and OAM depth would also be correlated with 10 minute wind conditions and operational data to find patterns; and,

- If frequent and sustained OAM is found, then appropriate mitigation would be designed and implemented and the complainant informed by the community liaison officer. Mitigation measures considered would include: changes to the operation of the relevant wind turbine(s) by changing software parameters such as blade pitch for specific wind conditions and time periods, addition of blade furniture (such as vortex generators) to alter the flow of air over the wind turbine blades; and, in extreme cases, targeted wind turbine shutdowns in specific conditions;
- In the event that other noise impacts are identified (but not OAM) then the curtailment measures described above can be implemented.

No specific mitigation measures are proposed for the BESS or substation.

13.5.3 Residual Construction Effects

Predicted construction noise levels are below the assessment criteria at all receptors, for all phases of construction of the wind farm. Good practice mitigation measures are outlined above, however, with or without the good practice construction mitigation measures there will be **no significant residual effects**.

13.5.4 Residual Operational Effects

Predicted Proposed Development turbine operational noise levels at all the NALs and NSRs lie below the WEDG daytime and night-time Noise Limits, there will be **no significant residual effects**.

13.5.5 Residual Cumulative Effects

It was found that without mitigation there would be no significant cumulative construction noise and vibration effects. As such there would be no residual cumulative effects during the construction phase.

13.6 SUMMARY OF EFFECTS

A noise assessment was undertaken to determine the likely significant noise effects from the construction, operation and decommissioning phases of the Proposed Development.

Predicted construction noise levels at the nearest noise sensitive receptors during all months of construction and during the HDD activities under the M1 Motorway are below the Daytime and Night-time threshold values within BS 5228 and are therefore deemed to be **not significant**.

Construction vibration is likely be at low levels and would be short term in nature. Vibration levels generated from operational wind turbines are typically imperceptible even at the base of the turbine. As a result, **no significant** effects are anticipated.

A background noise survey was undertaken at seven noise monitoring locations. The data was analysed in conjunction with on-site measured wind speed data and operational noise limits have been derived in accordance with the WEDG 2006.

Predictions of wind turbine noise from the Proposed Development have been made in accordance with good practice using the Nordex N163 with serrated trailing edge blades as the candidate wind turbine, which has a rated power output of 7 MW, a 163 m rotor diameter and a hub height of 98.5 m. This turbine represents the worst-case noise levels for the assessed turbine design envelope. In order to consider the full design envelope for the site (i.e. tip height 179.5 m – 180 m, rotor diameter 149 m – 163 m and hub height 98 m – 105 m), additional modelling was undertaken using two other candidates; the Siemens-Gamesa SG 6.6-155 with a 155 m rotor diameter, a maximum rated output capacity of 6.6 MW and a hub height of 102.5 m and the Nordex N149 with a 149 m rotor diameter with a maximum rated output capacity of 5.7 MW, serrated trailing edge blades and a hub height of 105 m. Predicted operational noise levels from the Proposed Development indicate that for noise sensitive receptors neighbouring the Proposed Development, wind turbine noise from the Proposed Development will meet the WEDG 2006 Noise Limits at all assessed Noise Sensitive Receptors and are therefore deemed to be **not significant**.

The wind turbine models were chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Development receive consent, the final choice of wind turbine will be subject to a competitive tendering process. The final choice of wind turbine will, however, have to meet the WEDG 2006 Noise Limits presented in the noise assessment.

Predicted BESS and substation noise levels have been assessed in accordance with BS4142 which indicates no adverse impacts. As a result, **no significant effects** are anticipated.

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