Planning and Environmental Consultants

Environmental Impact Assessment Report (EIAR)

Lackareagh Wind Farm, Co. Clare

Chapter 12 –Noise and Vibration

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12. NOISE & VIBRATION

12.1 Introduction

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

As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Project', 'Proposed Wind Farm', 'Proposed Grid Connection Route' and the 'site'.

This chapter assesses the potential noise and vibration impacts at the nearest Noise Sensitive Receptors (NSRs), which are residential properties located within c. 3 km of the proposed turbine locations. The full description of the Proposed Project is detailed in Chapter 4.

This chapter considers the likely significant noise and vibration effects associated with the construction, operation and decommissioning of the Proposed Project. 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); and
- Describe the mitigation measures proposed to address any likely significant effects; and assess the residual noise effects remaining, following the implementation of mitigation.

This EIAR Report is supported by the following figures and appendices:

- Figures
  - Figure 12-1: Construction Noise Assessment Locations;
  - Figure 12-2: Wind Turbines Operational Noise Assessment Locations;
  - Figure 12-3: Cumulative Wind Farm Locations; and
  - Figure 12-4: BESS Operational Noise Assessment Locations.
- Appendices
  - Appendix 12-1: Construction Noise Report;
  - Appendix 12-2: Wind Turbine Operational Noise Report; and,
  - Appendix 12-3: BESS Operational Noise Report.

Figures and technical appendices are referenced in the text where relevant.

12.1.1.1 Statement of Authority

The noise and vibration assessments were carried out by TNEI Ireland Ltd. 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 led by Alex Dell, Technical Consultant at TNEI, and approved by Gemma Clark, Principal Consultant at TNEI. Alex is an Associate Member of the Institute of Acoustics and holds a PhD in Mechanical Engineering with three years of experience undertaking wind farm and industrial noise assessments. Gemma is an experienced Project Manager, who provides technical support and assessment of proposed and operational developments. Gemma has extensive experience, over seventeen years, on undertaking wind farm noise assessments as well as other noise assessments (construction and industrial) to support planning applications. Gemma is a full member of the Institute of Acoustics.

12.2 Legislation, Policy and Guidelines

As well as the guidance listed in Section 1.6 of Chapter 1 of this EIAR, this assessment adhered to the following combination of guidance and assessment methodologies:

- British Standard BS 5228: 2009+A1:2014 'Code of practice for noise and vibration control on construction and open developments'[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' (2019) (BS 4142)[6];
- British Standard BS 8233: 2014 'Guidance on sound insulation and noise reduction for buildings' (2014)(BS 8233)[7]; and,
- Association of Acoustic Consultants of Ireland 'Environmental Noise Guidance for Local Authority Planning & Enforcement Departments'(2021) (AACI Guidelines) [8].

The above documents are discussed in detail within Section 2 of Appendices 12-1, 12-2 and 12-3, where relevant.

With regards to national planning policy and guidance, it is noted that the Irish Government Wind Energy Development Guidelines for Planning Authorities (2006) (DoEHLG 2006 Guidelines) are currently under review. A set of draft updated guidelines were issued for consultation in December 2019 ('DoEHLG Draft 2019 Guidelines) but these guidelines have not, at the time of writing, been adopted. In keeping with best international practice, the Draft DoEHLG 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 DoEHLG 2019 Guidelines, including by a group of wind farm acousticians[9], regarding the noise section of these 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 DoEHLG 2019 Guidelines is not, in our opinion, technically feasible or appropriate and therefore has not been undertaken.

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[1] *British Standards Institute, 2014. Code of practice for noise and vibration control on construction and open sites. Noise. UK : BSI, 2014. BS 5228:2009+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 Standards Institute, 2019. Methods for rating and assessing industrial and commercial sound UK : BSI, 2019. BS 4142:2014+A1:2019*
[7] *British Standards Institute, 2014. Guidance on sound insulation and noise reduction for buildings UK : BSI, 2014. BS 8233:2014*
[8] *Association of Acoustic Consultants of Ireland, 2021. 'Environmental Noise Guidance for Local Authority Planning & Enforcement Departments.*
[9] *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/*

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 DoEHLG 2006 Guidelines by the Department of Environment. Timelines for the review are still unclear however, the Government of Irelands' Climate Action Plan 2024 includes a 2024 Action (EL/24/5) to 'Publish the Revised Wind Energy Development Guidelines for onshore wind.'

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

In 2018 the World Health Organisation (WHO) issued noise guidelines *'Environmental Noise Guidelines for the European Region'*[10] (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. 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 L_{den} parameter. L_{den} 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:

> *'Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.'*
>
> *'Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region.'*

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.

The Association of Acoustic Consultants of Ireland (AACI) published the AACI Guidelines in May 2021. The 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 and construction noise guidance is included within Section 27. These are considered further in Section 12.4 below.

[10] *World Health Organisation, 2018. Environmental Noise Guidelines for the European Region'*

12.3 Scoping and Consultation

The scoping exercise carried out as part of the Proposed Project is described in Chapter 2 of this EIAR. The Environmental Health Service (HSE) stated the following in relation to noise:

> *'The potential impacts for noise and vibration from the proposed development on all noise sensitive locations must be clearly identified in the EIAR. The EIAR must also consider the appropriateness and effectiveness of all proposed mitigation measures to minimise noise and vibration.*
>
> *A baseline noise monitoring survey should be undertaken to establish the existing background noise levels. Noise from any existing turbines in the area should not be included as part of the background levels.*
>
> *In addition, an assessment of the predicted noise impacts during the construction phase and the operational phase of the proposed windfarm development must be undertaken which details the change in the noise environment resulting from the proposed development.*
>
> *The Draft Revised Wind Energy Development Guidelines were published in December 2019. Whilst these have yet to be adopted, any proposed wind farm development should have consideration of the draft Guidelines.'*

Consideration of all points raised by HSE are presented within this EIAR Report, with specific mention of the Draft 2019 Revised Wind Energy Development Guidelines in Section 2.6 of Appendix 12-2.

12.4 Assessment Methodology and Significance Criteria

12.4.1.1 Construction Noise Methodology

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

> *"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 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 threshold 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 9 have been chosen as CNALs. All 9 are residential properties. The CNALs represent the closest NSRs or clusters of NSRs to the Proposed Project construction activities. The CNAL are summarised in Table 12-1 below and are shown on Figure 12-1.

Table 12.1: Summary of Construction Noise Assessment Locations

Receptor	ITM Easting	ITM Northing
CNAL01 (NSR12)	564702	673649
CNAL02 (NSR3)	564689	673091
CNAL03 (NSR22)	564759	672513
CNAL04 (NSR6)	562790	672791
CNAL05 (NSR8)	562253	672814
CNAL06 (NSR11)	561663	673086
CNAL07 (NSR46)	561078	673791
CNAL08 (NSR9)	562540	671813
CNAL09 (NSR17)	562416	671818

The construction phase of the Proposed Project will include civil engineering works, electrical works, and turbine/met mast erection (please refer to Section 4.6.9 of Chapter 4 of this EIAR for details). During each phase the plant and equipment, and the associated traffic, would 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 and the indicative construction schedule (included in Chapter 4 of this EIAR). In view of this, the plant has been modelled operating at the closest points to each NSR for a given activity in each construction phase, under a precautionary scenario as it would generate the highest noise levels, whereas in reality only certain plant and equipment will be working at the closest point 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 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.

Chapter 4: Description of the Proposed Project outlines the tasks that will be undertaken during the construction period, which is estimated to be 18-24 months. For the purposes of this assessment, noise modelling has been undertaken for a number of construction scenarios, which simulate the likely overlap of several tasks that could occur throughout the construction period (which is assumed as a maximum of 24 months). The modelled construction scenarios are detailed in Table 12.2.

Table 12.2: Summary of Modelled Construction Scenarios

Scenario	Construction Activities	Description
01	Operation of the temporary construction compound	The welfare facilities located within the temporary construction compound are in operation.
	Provision of new roads	Upgrade/ construction of the road along the existing L7080 is carried out .
	Felling	Tree felling around the locations of turbines 3, 4 and 5 and associated infrastructure is carried out.
02	Operation of the temporary construction compound	The welfare facilities located within the temporary construction compound are in operation.
	Upgrades to existing roads and provision of new roads	Construction/ upgrade to all four proposed access tracks is carried out. These access tracks are, namely; the tracks leading to T1, T3, T5, and T7, respectively.
	Operation of the borrow pit	Operation of the borrow pit for extraction of supplemental aggregate is underway.
03	Operation of the temporary construction compound	The welfare facilities located within the temporary construction compound are in operation.
	Operation of the borrow pit	Operation of the borrow pit for extraction of supplemental aggregate is underway.
	Construction of foundations for the proposed onsite 38kV substation and BESS	Construction of the foundations for the proposed BESS and onsite 38kV substation is undertaken, ready for the installation of the respective plant.
	Construction of turbine hardstands and foundations	The construction of foundations and hardstands for turbines 3, 4, and 5 is undertaken.
04	Operation of the temporary construction compound	The welfare facilities located within the temporary construction compound are in operation.
	Operation of the borrow pit	Operation of the borrow pit for extraction of supplemental aggregate is underway.
	Installation of plant for the proposed onsite 38kV substation and BESS	The installation of the respective plant for both the proposed onsite 38kVsubstation and BESS is undertaken.
	Construction of turbine hardstands and foundations	The construction of foundations and hardstands for turbines T1, T2, T6, and T7 is undertaken.
	Erection of turbines	The erection turbines T3, T4, and T5 is undertaken.
05	Operation of the temporary construction compound	The welfare facilities located within the temporary construction compound are in operation.
	Erection of turbines	The erection turbines T1, T2, T6, and T7 is undertaken.

Scenario	Construction Activities	Description
06 (Night)	Operation of the temporary construction compound	Use of generators for lighting and providing power to the welfare facilities located within the temporary construction compound.

More detailed information on each of the construction scenarios and modelling assumptions can be found within Appendix 12-1 of this EIAR. The noise levels for all Scenarios have been calculated at the CNALs and compared to the appropriate BS 5228 thresholds (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 and is located at the closest point to each receptor, whereas in practice equipment load and precise location will vary.

Construction activities outside the wind turbine areas, along the Proposed Grid Connection Route or the turbine delivery route distant road junctions that may need reinforcement have been assessed qualitatively. These activities will be of short duration and best practice during constructions would minimise any potential impact.

12.4.1.2 Construction Vibration

In relation to potential vibration during the construction phase of the Proposed Project, two sets of vibration limits should be considered: one in regard to potential for damage to buildings and one in regard to 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 12-2 above.

Table 12.3: Transient vibration guide values for 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

Table B.1 of BS 5228-2, reproduced here as Table 12-3 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 12.4: BS 5228-2 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.

Vibration Level (A) (B) (C)	Effect
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 6472-1 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 can be set at 15 mm/s PPV for frequencies between 4 Hz and 40 Hz and 50mm/s for frequencies above 40Hz.

Internal PPV limits can be set at somewhere between 1 mm/s^{-1} and 10.0 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 12-4 are generally considered guideline levels that should not be exceeded regularly or for long periods of time (see note (C) of Table 12-4).

12.4.1.3 Operational Wind Turbines Noise Methodology

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

'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.'

In 2013, the ETSU-R-97 guidance was supplemented by a document produced by the IOA. Given the lack of detail in parts of the DoEHLG 2006 Guidelines, information contained in ETSU-R-97 and the IOA GPG has been used to supplement the DoEHLG 2006 Guidelines.

The DoEHLG 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 DoEHLG 2006 Guidelines.

Of the NSRs identified, 19 Noise Assessment Locations (NALs) were selected for a detailed assessment. All are residential properties. The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Wind Farm site and also some additional receptors were included to consider cumulative noise impacts. Predictions of wind turbine noise have been made at each of the NALs as detailed in Table 12.5 and shown on Figure 12-2 and Figure 12-3. This approach ensures that the assessment considers the worst case (loudest) noise immission level expected at the NAL. All other NSRs have also been assessed separately in Appendix 12-2.

Table 12.5: Summary of Operational Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance from Perceived Amenity Area to Nearest Lackareagh	Distance to Dwelling (m)	Background Noise Data Used
NAL1 (NSR10)	564702	673649	199	769 (T3)	812 (T3)	NML7
NAL2 (NSR2)	564689	673091	184	708 (T3)	720 (T3)	NML6
NAL3 (NSR7)	564759	672513	161	781 (T5)	775 (T5)	NML5
NAL4 (NSR65)	565439	671960	139	1507 (T5)	1532 (T5)	NML4
NAL5 (NSR87)	565486	671238	146	1878 (T5)	1881 (T5)	NML4
NAL6 (NSR100)	565226	670667	134	2107 (T5)	2149 (T5)	NML4
NAL7 (NSR126)	564748	669620	93	2632 (T7)	2661 (T7)	NML4
NAL8 (NSR133)	563181	669141	93	2749 (T7)	2776 (T7)	NML3
NAL9 (NSR105)	562940	669710	99	2221 (T7)	2264 (T7)	NML3
NAL10 (NSR75)	562417	670511	54	1688 (T7)	1702 (T7)	NML3
NAL11 (NSR55)	562467	670972	60	1305 (T7)	1369 (T7)	NML3
NAL12 (NSR39)	562401	671529	65	1062 (T7)	1080 (T7)	NML3
NAL13 (NSR16)	562540	671813	78	865 (T7)	877 (T7)	NML3
NAL14 (NSR34)	562288	672235	74	1028 (T6)	1045 (T6)	NML3
NAL15 (NSR4)	562790	672791	154	725 (T6)	749 (T6)	NML2
NAL16 (NSR8)	562253	672814	102	774 (T2)	782 (T2)	NML2
NAL17 (NSR13)	561663	673086	85	797 (T2)	823 (T2)	NML1
NAL18 (NSR46)	561078	673791	139	1146 (T1)	1173 (T1)	NML1
NAL19 (NSR78)	**560491**	**674179**	**190**	**1727 (T1)**	**1747 (T1)**	**NML1**

The daytime and night-time periods are not defined within the DoEHLG 2006 Guidelines, therefore the assessment has considered these periods as detailed within ETSU-R-97. The 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 the daytime limits are set based upon background data collected only during the quiet daytime period, 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 DoEHLG 2006 Guidelines include guidance on how to derive limits for daytime and night-time periods.

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 criteria, is that turbine noise should not exceed for daytime periods:

- 40 dB(A) where background noise levels are below 30 dB; and,
- 45 dB(A) or background noise plus 5 dB, whichever is the greater, where background noise levels are greater than 30.

The fixed minimum limit has been chosen for the daytime period with due consideration given to the limits already adopted for consented wind farm developments in the area.

The DoEHLG 2006 Guidelines states that a *"fixed limit of 43 dB(A) will protect sleep inside properties during the night"*, however, whilst it is not explicit within the DoEHLG 2006 Guidelines, 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.

Two sets of noise limits have been derived; the Total DoEHLG 2006 Guidelines Noise limits which apply to the cumulative noise level of all relevant wind turbine developments which are operating, permitted, and proposed in the area, including the Proposed Wind Farm; and the 'Site Specific Noise Limits' which apply to operational noise from the Proposed Wind Farm only. The 'Site Specific Noise Limits' are derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments.

The aim of the operational noise assessment is to establish the Total DoEHLG 2006 Guidelines Noise Limits, determine whether a cumulative assessment is required at the nearest NSRs, derive Site Specific Noise Limits (where applicable) and to establish whether the Proposed Wind Farm can operate within those limits. When considering the Total DoEHLG 2006 Guidelines Noise Limit, the aim of the assessment was to determine whether the cumulative noise predictions can operate within the Total DoEHLG 2006 Guidelines Noise Limit.

The exact model of turbine to be installed as part of the Proposed Wind Farm 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 noise limits determined by this assessment will be a key determining requirement in the final choice of turbine for the Proposed Wind Farm. 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.

This noise assessment models the Vestas V150 6.0 MW, Nordex N149 5.7 MW and Siemens Gamesa SG 6.0-155 6.6 MW which are candidate turbines that fall within the range of turbine dimensions proposed as part of the application (i.e. tip height 179.5 m – 180 m, rotor diameter 149 m – 155 m and hub height 102.5 m – 105 m). The V150 and N149 have been assumed with a proposed hub height of 105 m and the SG 6.0-155 with a proposed hub height of 102.5 m. These candidate turbine models are considered representative of the type of turbine that could be installed at the Proposed Wind Farm site,

should a grant of planning permission be received. The modelling results presented within this Chapter are based on the Vestas V150 6.0 MW turbine as that is the loudest turbine at the key wind speed range. Prediction modelling results for the other two candidate turbines are included within Appendix 12-2.

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.

Typically, wind farm noise assessments assume all properties are downwind of all turbines at all times (as this would result in the highest wind turbine noise levels). However, where properties are located in between groups of turbines they cannot be downwind of all turbines simultaneously, so it is appropriate to consider the effect of wind direction on predicted noise levels and therefore the impact of directivity has been considered in the assessment (see Section 6.3 of Appendix 12-2).

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. Propagation 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. Some concave ground and barrier corrections were required for some turbines at several receptors as detailed in Appendix 12-2.

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 12-2. Tonality associated with wind turbines is well understood and has been considered in accordance with the guidance in ETSU-R-97 and the IOA GPG. The topic of amplitude modulation is considered in more detail below.

12.4.1.4 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 l Appendix 12-2. 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.

To ensure that any future complaints relating to noise and OAM can be responded to appropriately, the Applicant proposes to appoint a community liaison officer who would be the first point of contact in the event that noise complaints were to occur and the mitigation strategy set out in section 12.7.2 below will be employed.

12.4.1.5 Cumulative Wind Turbine Operational Noise Methodology

The noise assessment considers nearby wind turbine schemes that are operational, permitted and proposed (planning application submitted). The nearby schemes found to be relevant and therefore considered in the assessment are the permitted Carrownagowan Wind Farm (19 x Nordex N133, 4.8 MW) and Fahy Beg Wind Farm (8 x Nordex N133, 4.8 MW).

A cumulative noise assessment was undertaken in accordance with the guidance contained within the IOA GPG. The noise assessment has been undertaken in three separate stages:

- Stage 1 - Establish the 'Total DoEHLG 2006 Guidelines Noise Limits' which are applicable for all wind farm schemes in the area;
- Stage 2 – undertake a cumulative assessment, comparing Total DoEHLG 2006 Guidelines Noise Limits with cumulative noise predictions. At this stage, the predicted 'likely' cumulative wind turbine noise levels are the actual levels expected at a noise assessment location; and
- Stage 3 – establish the Proposed Wind Farms Site Specific Noise Limits (at levels below the Total DoEHLG 2006 Guidelines Noise Limits, where limit apportionment is required) and compare the noise predictions from the Proposed Wind Farm on its own against the proposed Site Specific Noise Limits. In order to the derive the Site Specific Noise Limit an additional buffer of +2 dB has been added to the 'likely' predicted levels summarised in Stage 2 which results in 'cautious' Site Specific Noise Limits.

The location of the turbines modelled, inclusive of those considered in the cumulative noise assessment (Stage 2), are shown in Figure 12-2.

12.4.1.6 BESS Operational Noise Methodology

The BESS noise assessment considered two different assessment methods; namely a qualitative assessment, as detailed in BS 4142, and a quantitative assessment using guideline noise levels from BS 8233. The qualitative assessment method compares predicted noise levels to existing background sound levels whilst also considering the context in which the development occurs.

BS 8233 presents guideline noise levels for daytime and night-time periods for a number of different building types; for residential developments these are based on guidelines issued by the WHO. The daytime internal noise criteria of 35 dB L_{Aeq} for bedrooms and living room areas was used to set an external noise level criteria of 48 dB L_{Aeq} (i.e. assuming 13 dB attenuation offered by partially opened window). Similarly, the night internal noise criteria of 30 dB for bedroom areas was used to set a fixed external noise level criteria of 43 dB L_{Aeq}.

To predict the noise immission levels attributable to the BESS, a noise propagation model was created using the propriety noise modelling software CadnaA[11]. Within 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. In order to assess the theoretical precautionary scenario, the model did not include the use of specific mitigation measures 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.

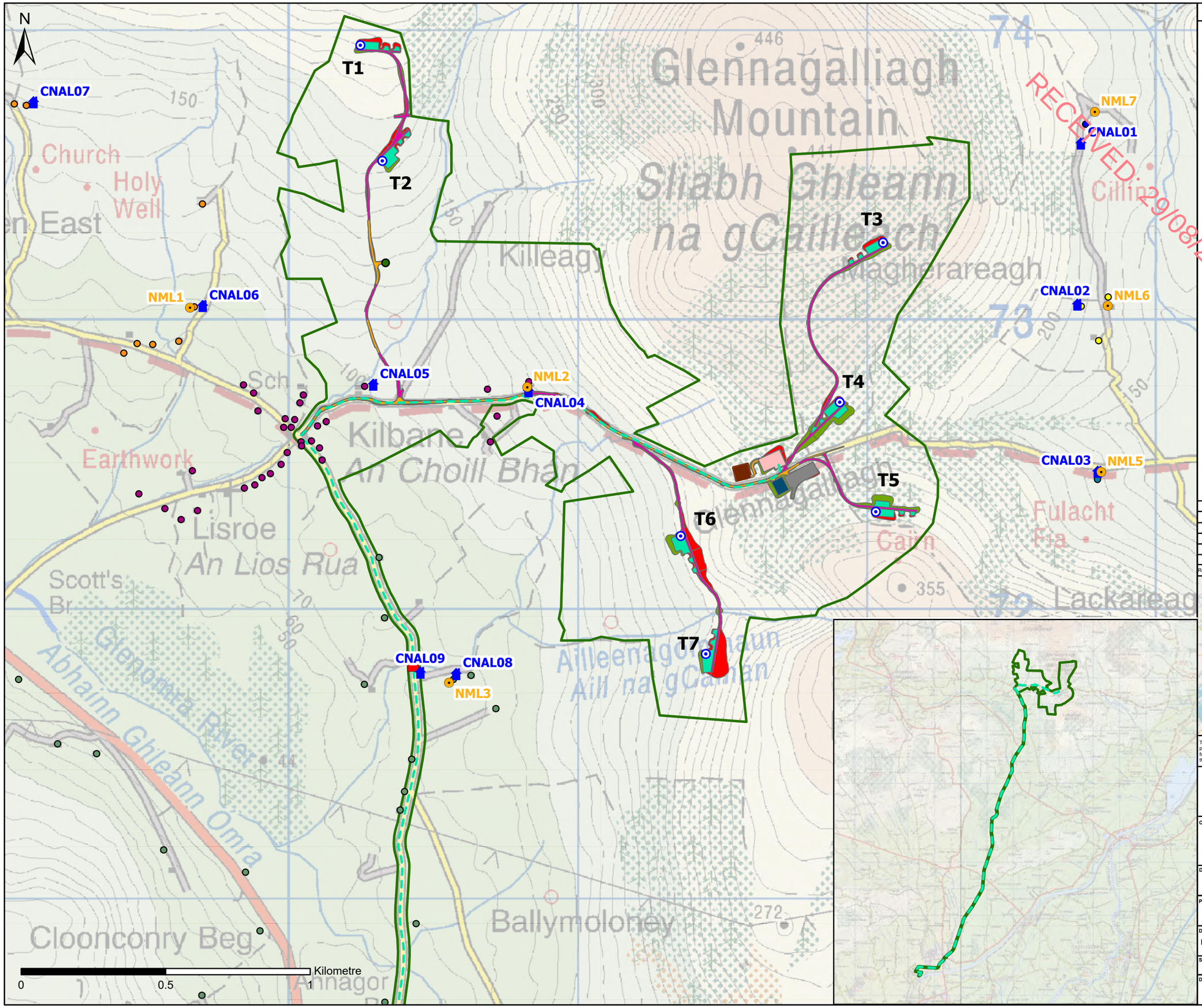
Of the NSRs identified in the surroundings, a total of 7 were chosen as BESS Noise Assessment Locations (BNALs). All 7 are residential properties. The BNALs represent the closest NSRs or clusters

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

of NSRs to the Proposed Project construction activities associated with the BESS. The BNALs are summarised in Table 12.6 below and are shown on Figure 12-4.

Table 12.6: Summary of BESS Noise Assessment Locations

Receptor	ITM Easting	ITM Northing
BNAL01 (NSR10)	564702	673649
BNAL02 (NSR2)	564689	673091
BNAL03 (NSR7)	564759	672513
BNAL04 (NSR65)	565439	671960
BNAL05 (NSR34)	562540	671813
BNAL06 (NSR8)	562288	672235
BNAL07 (NSR46)	561663	673086



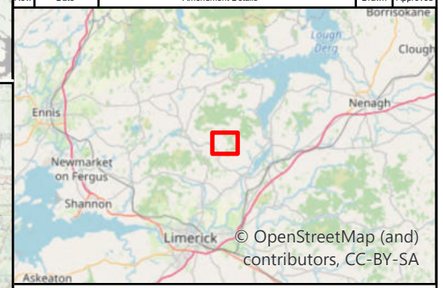
LEGEND

- Proposed EIAR Site Boundary
- Construction Noise Assessment Locations (CNALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations
- Proposed Met Mast location
- Horizontal Directional Drilling (HDD) Location
- Proposed Grid Connection Route
- Proposed Onsite 38 kV Substation and Battery Storage Compound
- Proposed Storage Area
- Proposed Passing Bays
- Proposed Hardstand Area
- Proposed Turbine Foundations
- Proposed Upgrades to Existing Roads
- Proposed New Roads
- Fill
- Cut
- Proposed Borrow pit
- Proposed Temporary Construction Compound

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

Rev.	Date	Amendment Details	Drawn	Approved
2	31/07/2024	FINAL ISSUE	MR	AD
1	02/07/2024	CLIENT COMMENTS	AD	GC
0	10/05/2024	FIRST ISSUE	JCM	AD



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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE 12-1: CONSTRUCTION NOISE ASSESSMENT LOCATIONS

Scale:	Original Size:	Spatial Reference:
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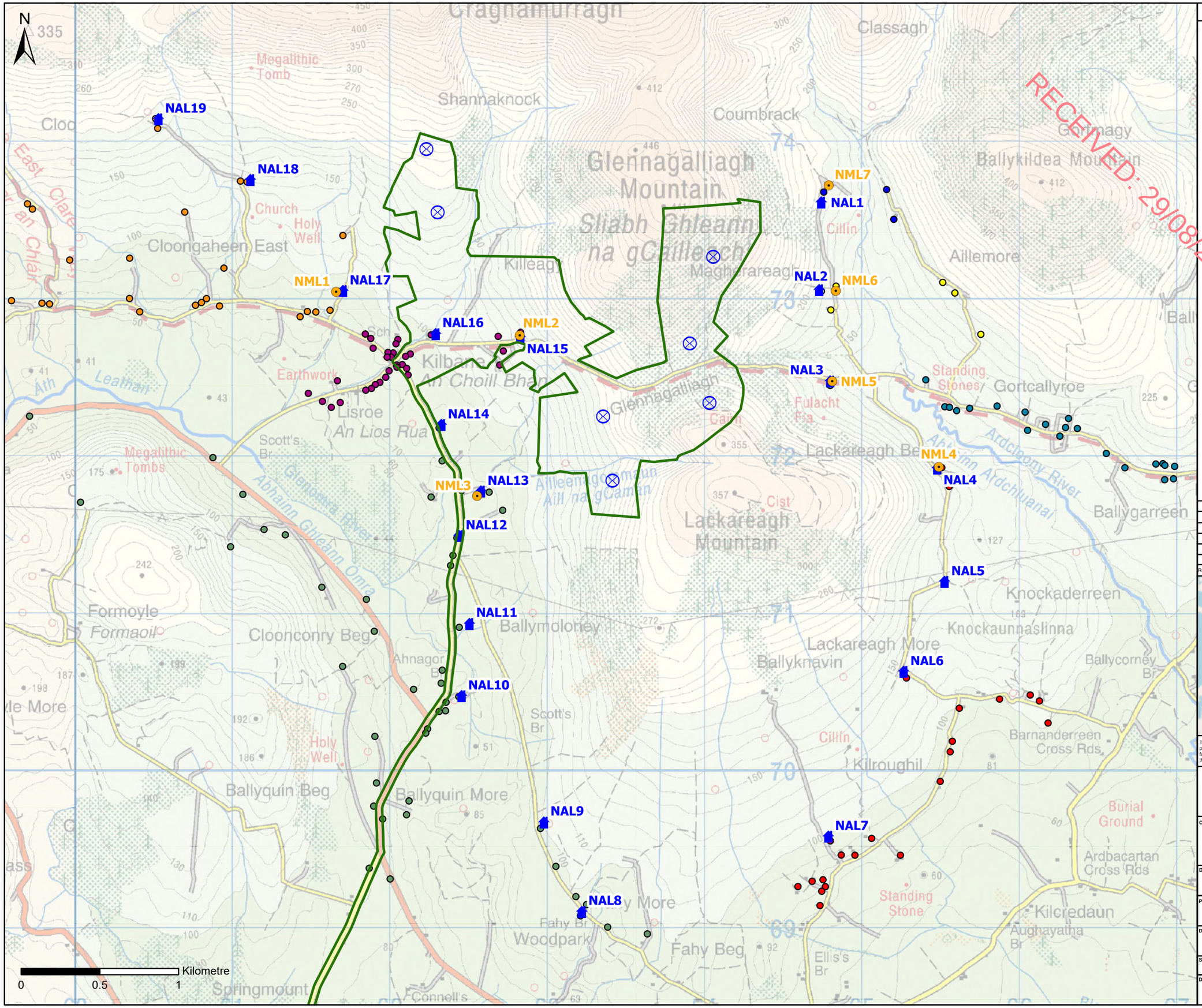
Drawing Number: IE00101-023



LEGEND

- Proposed EIAR Site Boundary
- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

Rev.	Date	Amendment Details	Drawn	Approved
1	31/07/2024	FINAL ISSUE	MR	AD

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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE 12-2: WIND FARM NOISE MONITORING AND ASSESSMENT LOCATIONS

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1:22,500	A3	IRENET95 Irish Transverse Mercator

Drawing Number: IE00101-020

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NAL19 NAL18 NAL17 NAL16 NAL15 NAL14 NAL13 NAL12 NAL11 NAL10 NAL9 NAL8

NAL1 NAL2 NAL3 NAL4 NAL5 NAL6 NAL7

T1 T2 T3 T4 T5 T6 T7

NML1 NML2 NML3 NML4 NML5 NML6 NML7

Kilometre
0 0.5 1

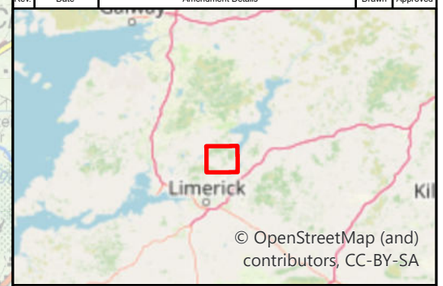
LEGEND

- Proposed EIAR Site Boundary
- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Location
- Fahy Beg Wind Farm
- Carrownagowan Wind Farm

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

Rev.	Date	Amendment Details	Drawn	Approved
1	31/07/2024	FINAL ISSUE	MR	AD



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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE 12-3: CUMULATIVE WIND FARM LOCATIONS

Scale:	Original Size:	Spatial Reference:
1:35,000	A3	IRENET95 Irish Transverse Mercator

Drawing Number: IE00101-021

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NML7
BNAL01
NML1
BNAL07
NML2
BNAL06
BNAL02
NML6
BNAL03
NML5
NML4
BNAL04
NML3
BNAL05

25
30
35
40
45
50

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LEGEND

- Proposed EIAR Site Boundary
- Battery Noise Assessment Locations (BNALs)
- Noise Monitoring Locations (NMLs)
- Modelled Noise Sources
- Modelled Buildings

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

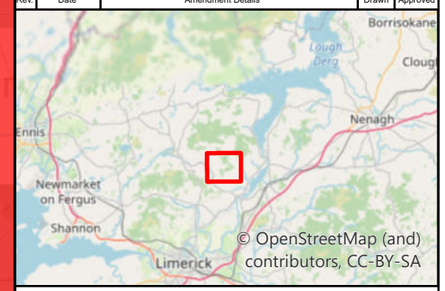
Predicted Noise Levels (dBA)

25 - 30	55 - 60
30 - 35	60 - 65
35 - 40	65 - 70
40 - 45	70 - 75
45 - 50	75 - 80
50 - 55	80 - 85

Noise contours modelled in accordance with ISO9613 Part 2:1996 at a height of 4 m and displayed on a 10 m by 10 m grid. All noise sources assumed to be operating concurrently.

All levels shown as dB LAeq(t)

Rev.	Date	Amendment Details	Drawn	Approved
1	31/07/2024	FINAL ISSUE	MR	AD



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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE 12-4: BESS NOISE CONTOUR PLOT

Scale:	Original Size:	Spatial Reference:
1:15,625	A3	IRENET95 Irish Transverse Mercator

Drawing Number: IE00101-022

12.4.5 Potential Effects Scoped Out

12.4.5.1 Decommissioning

Activities that occur during the decommissioning of the Proposed Project are unlikely to produce higher noise levels than those produced during construction and many of the activities will be similar in nature. As such it is considered that if construction noise levels are predicted to be below the threshold levels, then decommissioning noise will also be within the threshold levels. Decommissioning of the Proposed Project is detailed in Section 4.9 of Chapter 4 of this EIAR and in the Decommissioning Plan (Appendix 4-7).

12.4.6 Method of Baseline Characterisation

12.4.6.1 Extent of the Study Area

Prior to the commencement of the operational noise assessment, initial desktop noise modelling was undertaken in order to identify all NSRs and to select potential Noise Monitoring Locations (NMLs). A total of 160 NSRs were identified within a 3 km search area, these are nearly all residential properties surrounding the Proposed Wind Farm, only a few were derelict and some reflect locations where a planning application has been submitted. Seven NMLs were selected to represent background noise levels at all NSRs, and they are located to the east, west, southeast and southwest of the Proposed Wind Farm. The NSRs and NMLs are all shown on Figure 12-2 and coordinates of the NMLs are also included below in Table 12.7. More information can be found in Appendix 12-2.

Construction works related to Proposed Grid Connection Route and road improvements will occur outwith the Proposed Wind Farm site so this has been assessed qualitatively.

12.4.6.2 Field Survey

The noise survey to determine the existing background noise environment at NSRs neighbouring the Proposed Wind Farm 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 4th April 2023 to 21st June 2023 at seven NMLs (shown on Figure 12-2). The NMLs were installed, where possible within or in proximity to the amenity area at the residential dwellings. The noise monitoring equipment was sited with due consideration of local noise sources such as boiler flues, watercourses, and vegetation. Further details on the NMLs can be found within Appendix 12-2.

Table 12.7: Summary of Noise Monitoring Locations

Receptor	ITM Easting	ITM Northing
NML1	561618	673080
NML2	562785	672805
NML3	562514	671783
NML4	565447	671967
NML5	564770	672512

Receptor	ITM Easting	ITM Northing
NML6	564793	673086
NML7	564748	673758

Simultaneous wind speed/direction data were recorded within the Proposed Wind Farm at various heights using a LiDAR Unit located at Irish Grid Reference 52.80473, -8.53435. The wind speed data collected at 100 m and 110 m was used to calculate wind speed at 105 m (proposed maximum hub height) which was then standardised to 10 m 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.

12.4.7 Criteria for the Assessment of Effects

The Environmental Protection Agency document *'Guidelines on the information to be contained in Environmental Impact Assessment Reports'* [12] has been adhered to for the assessment of potential effects as summarised below.

12.4.7.1 Criteria for Assessing Significance – Construction Noise

The significance criteria adopted for this assessment are based on Appendix E part E.3.2 of BS 5228-1:2009+A1:2014 and detailed in Table 12.8 below.

Table 12.8: Construction Noise Significance Criteria

Significance of Effect	Significance Level	
	Not Significant	Potentially Significant
Category A Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	≤65dB $L_{Aeq, T}$	>65dB $L_{Aeq, T}$
Category A Evenings and Weekends (19:00 – 23:00)	<55dB $L_{Aeq, T}$	>55dB $L_{Aeq, T}$
Category A Night-time (23:00 – 07:00)	<45dB $L_{Aeq, T}$	>45dB $L_{Aeq, T}$
Note: The L_{Aeq} is the A-weighted, equivalent continuous sound level in decibels measured over a stated period of time, ($L_{Aeq,T}$) where T is the length of the assessment period (Time).		

It should be noted that exceedance of the limit 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*

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

of receptors affected and the duration and character of the impact, to determine if there is a significant effect.'

12.4.7.2 Criteria for Assessing Significance – Wind Turbine Operational Noise

The DoEHLG 2006 Guidelines 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 DoEHLG 2006 Guidelines derived noise limits ensures that noise from the Proposed Wind Farm will comply with current Government guidance.

In terms of the EIA Regulations, in this noise and vibration assessment the use of the term "significance" refers to compliance or non-compliance with the DoEHLG 2006 Guidelines derived noise limits. For situations where predicted wind turbine noise meets or is less than the noise limits defined in DoEHLG 2006 Guidelines, then the noise effects are deemed not significant. Any breach of the derived Total DoEHLG 2006 Guidelines or Site Specific Noise Limits due to the Proposed Wind Farm 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.

12.4.7.3 Criteria for Assessing Significance – BESS 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 is 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 is a Minor Significant Effect;
- Where a Negligible Magnitude of Impact is predicted, this is a Negligible Significant Effect.

12.4.7.4 Limitations and Assumptions

The noise data collected during the background noise survey are representative of the typical background noise levels at the nearest NSRs. The guidance in the DoEHLG 2006 Guidelines supplemented by ETSU-R-97 and 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 typical activities expected.

As detailed in Section 1.7.3 in Chapter 1 of this EIAR, various types and sizes of wind turbines, within the proposed ranges, have been selected and considered 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 Wind Farm, whilst the final model of wind turbine to be used may differ from that presented in this assessment, operational noise levels would have to comply with the noise limits imposed by the Local Authority, derived in this noise assessment.

Representative candidate plant were modelled for the BESS noise predictions.

No other assumptions or data gaps have been identified.

12.5 Baseline Conditions

12.5.1 Current Baseline

The Proposed Wind Farm is located within a rural location where existing background noise levels at the NSRs are generally considered to be low (<30 dB at low wind speeds as defined in the DoEHLG 2006 Guidelines[13]). The predominant sound sources in the area are wind induced noise (wind passing through vegetation and around buildings) and birdsong, with cars on local roads also audible on occasions.

Table 12.9 and Table 12.10 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 GPG) have been excluded from the dataset, as well as data following periods of heavy rainfall in accordance with best

[13] *Section 5.4 of the DoEHLG 2006 Guidelines refers to ' low noise environments where background noise is less than 30 dB(A)'*

practice. Further information of the data recorded during the noise survey can be found in Appendix 12-2.

Table 12.9: 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	34.5*	34.5	34.5	34.7	35.2	36.1	37.3	38.7	40.2	42.0	43.9	45.8
NML2	29.4	30.5	31.4	32.2	33.0	33.6	34.1	34.5	34.6	34.6	34.6*	34.6*
NML3	33.0*	33.0	33.0	33.3	34.0	34.8	35.9	37.0	38.3	39.5	40.7	41.7
NML4	31.7*	31.7*	31.7	31.8	31.9	32.3	33.0	34.1	35.6	37.6	40.1	43.2
NML5	31.1*	31.1	31.2	31.4	31.8	32.5	33.4	34.6	36.2	38.2	40.6	43.3
NML6	32.4*	32.4	32.5	33.2	34.2	35.4	36.7	38.1	39.3	40.3	40.9	41.1
NML7	29.8*	29.8	30.1	30.7	31.7	32.8	34.1	35.4	36.8	38.0	39.0	39.8

** Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.8 of Appendix 12.2: Operational Noise Report.*

Table 12.10: 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	31.8*	31.8	31.9	32.4	33.3	34.3	35.6	37.2	38.9	40.7	40.7*	40.7*
NML2	24.1	25.6	26.6	27.3	28.1	29.2	30.8	33.1	36.5	41.1	41.1*	41.1*
NML3	28.6*	28.6	28.7	29.5	30.8	32.3	33.8	35.0	35.8	35.7	35.7*	35.7*
NML4	25.5*	25.5*	25.5	25.9	26.8	28.1	29.6	31.3	32.9	34.4	34.4*	34.4*
NML5	25.5*	25.5*	25.5	25.7	26.5	27.9	29.8	32.2	35.2	38.7	38.7*	38.7*
NML6	26.2*	26.2*	26.2	27.4	29.4	31.9	34.5	36.9	38.8	39.7	39.7*	39.7*
NML7	25.0*	25.0*	25.0	26.0	27.6	29.6	31.6	33.3	34.4	34.6	34.6*	34.6*

** Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.8 of Appendix 12.2: Operational Noise Report.*

12.5.2 Future Baseline

It is possible that noise propagation and resulting noise immission levels could change over the life of the project 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 Proposed Project. The operator would be required to meet them for the duration of the consent.

12.5.3 Summary of Sensitive Receptors

12.5.3.1 Scoped Out Receptors

All of the buildings within a c. 3 km of the Proposed Wind Farm turbines have been identified. Of the 153 buildings identified, a number have subsequently identified as derelict. These locations are not considered to be NSRs for the purposes of this assessment and have not been considered further. The locations of the NSRs are presented in Figure 12-2.

12.5.3.2 Scoped In Receptors

Of all the NSRs identified within the 3 km search area (see Figure 12-2) around the Proposed Wind Farm, a sample of the nearest and likely to be most sensitive to noise were selected as Construction Noise Assessment Locations (CNALs), Noise Assessment Locations (NALs) or Battery Noise Assessment Locations (BNALs). These were chosen to represent the noise sensitive receptors located closest to the Proposed Project during either the construction or operational phase. Some of the assessment locations were included to consider locations which may be close to both the Proposed Wind Farm and nearby permitted wind farms.

The assessment results for the CNALs, NALs and BNALs have been presented within the main body of this report, whilst results for all other NSRs have been included for completeness within Annex 3 of Appendix 12-1, Annex 5 of Appendix 12-2 and Annex 6 of Appendix 12-3.

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.

12.6 Assessment of Likely Effects

12.6.1 Potential Construction Noise Effects

Table 12.11 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. Full details of the modelling and assessment can be found in Appendix 12-1.

Table 12.11: Predicted Precautionary Scenario Construction Noise Immission Levels

Construction Noise Assessment Location	Category A Threshold dB $L_{Aeq, t}$			Immission Level, dB $L_{Aeq, t}$ for each Scenario					
	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)	01	02	03	04	05	06 (Night)
CNAL01	65	55	45	26	23	29	30	13	2
CNAL02	65	55	45	34	32	39	41	17	12
CNAL03	65	55	45	34	31	39	41	19	7
CNAL04	65	55	45	65	48	47	48	45	24
CNAL05	65	55	45	56	53	40	44	43	19
CNAL06	65	55	45	34	38	35	40	41	15
CNAL07	65	55	45	29	32	30	36	37	10
CNAL08	65	55	45	36	42	41	44	43	20
CNAL09	65	55	45	35	41	40	43	42	19

The Proposed Wind Farm construction noise assessment results show that the predicted construction noise levels in core hours for Scenarios 01 - 05 do not exceed the daytime 65 dB(A) threshold Levels at all CNALs.

At CNAL04, during the construction/ upgrade of the L7080 (Scenario 01), predicted construction noise immission levels are equal the daytime 65 dB(A) threshold. It should be noted that this calculation assumes that the noise energy of mobile plant working along the road is averaged out along a linear movement path, however, for some periods it is unavoidable that construction activities and plant will be located directly outside a property. On these occasions, noise immission levels will be higher than predicted for a short time. Likewise, construction activities will also be less than predicted as plant and activities are operating elsewhere on the road.

At CNAL04 and 05 noise levels will be above the evening and weekend 55 dBA threshold levels. Whilst this is unlikely to result in a significant impact, as duration of exposure will be limited, it is recommended that construction activities are not undertaken in proximity to these properties outwith normal daytime working hours (Mon-Fri 07:00 – 19:00 and Saturday 07:00 – 13:00).

No construction activities are proposed during the night-time, however, a night-time scenario (Scenario 6) is included in the assessment in case of generator usage at night, for infrastructure such as welfare facilities and lighting only. The predicted noise levels for this scenario are comfortably below the night-time 45 dBA threshold level.

Accordingly, the impact is deemed **not significant for construction noise effects**.

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. Chapter 4 of the EIAR describes the construction of the Proposed Grid Connection Route underground electrical cable trench in more detail.

Where construction activities occur besides 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 opposite a dwelling within approximately 20 m and this 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 and 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 of a dwelling, however this would only occur for a short period of time at any one location. Accordingly, the impact is not deemed significant.

At some watercourses, culverts and drain crossings there may be a requirement for Horizontal Directional Drilling (HDD). In particular it is noted that HDD is required for one small water crossing located at ITM reference (562395, 671840), which is approximately 30 m from the centre point of the dwelling denoted by CNAL09 (NSR17), and adjacent to the amenity area.

HDD for large crossings would require the use of multiple items of plant including pumps, mud recyclers, drilling rigs and generators, however, the proposed plant for these small crossings is a small Vermeer D36 x 50 Directional Drilll, which is much smaller than many DD rigs and requires less associated plant. As such, DD operations are expected to be lower in noise output than is normal. Additionally, for small crossings, the work would likely be completed within 1 to 2 weeks, therefore is considered a short-term activity.

Calculations of the Vermeer DD rig, assuming a source noise level of 94 dBA at 1 m, indicates that noise levels would be below the 65 dBA threshold at a distance of approximately 30 m. Where activities involving the drilling rig are within 30 m of a dwelling, such as for CNAL09, then noise mitigation measures should be considered in line with the guidance presented in BS 5228. This could include the erection of temporary boarding alongside the drilling rig or use of 'acoustic blanket panels' to hang from Heras fencing or similar. This should 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.

It is also recommended that construction activities are not undertaken in proximity to CNAL09 outwith normal daytime working hours (Mon-Fri 07:00 – 19:00 and Saturday 07:00 – 13:00). Accordingly, the impact is deemed **not significant for construction activities associated with cable trenching, bridge crossings and distant road junction upgrades.**

12.6.2 Potential Construction Vibration Effects

Due to the separation distances between the construction activity areas on the Proposed Wind Farm site and the nearest receptors, no significant effects are anticipated. Where construction activities on the Proposed Grid Connection 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 will be implemented and will reduce vibration levels from

these short-term works to minimum levels. Accordingly, the impact is deemed **not significant for construction vibration.**

12.6.3 Potential Operational Noise Effects

12.6.3.1 Setting the Total DoEHLG 2006 Guidelines Noise Limits (Stage 1)

Based on the prevailing background noise levels, the Total DoEHLG 2006 Guidelines Noise Limits have been established for each of the NALs as detailed in Table 12.12 and Table 12.13 below.

Table 12.12: Total DoEHLG 2006 Guidelines Noise Limit - Daytime

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	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL2	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
NAL3	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
NAL4	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL6	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL7	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL8	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL9	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL10	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL11	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL12	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL13	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL14	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL15	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL16	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL17	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
NAL18	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
NAL19	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8

Table 12.13: Total DoEHLG 2006 Guidelines Noise Limit – Night-time

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	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
NAL3	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7

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	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL5	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL6	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL7	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL8	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL9	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL10	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL11	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL12	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL13	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL14	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL15	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
NAL16	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
NAL17	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
NAL18	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
NAL19	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7

12.6.3.2 Predicting the Likely Effects and the Requirement for a Cumulative Noise Assessment (Stage 2)

A likely cumulative noise assessment was undertaken at the NALs and the results of the cumulative assessment are shown in Table 12.14 and Table 12-15 below. The Tables detail the Total DoEHLG 2006 Guidelines Noise Limits and predicted likely cumulative Proposed Wind Farm noise levels for daytime hours and night-time hours, when using the Vestas V150 6.0 MW with Serrated Blades on a 105 m hub, as the precautionary scenario candidate wind turbine for the Proposed Wind Farm.

The result of the likely cumulative noise assessment show that the Proposed Wind Farm can operate concurrently with the other operational and permitted wind farms in the area, whilst still meeting the Total DoEHLG 2006 Guidelines Noise limits at all NALs and as such there would be **no significant effects** at those receptors.

It is not possible to predict if OAM will occur at the NALs surrounding this Proposed Project 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 12.14: Compliance Table – Comparison of predicted likely cumulative noise levels (all schemes) against the Total DoEHLG 2006 Guidelines 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	Total DoEHLG 2006 Guidelines Noise Limit	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.2	36.7	37.5	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-16.2	-11.8	-8.3	-7.5	-7.4	-7.4	-7.4	-7.4	-7.4
NAL2	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	35.2	38.7	39.4	39.5	39.5	39.5	39.5	39.5
	Exceedance Level	-	-	-	-14.2	-9.8	-6.3	-5.6	-5.5	-5.5	-5.8	-6.4	-6.6
NAL3	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	38.9	39.7	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-14.0	-9.6	-6.1	-5.3	-5.2	-5.2	-5.2	-5.8	-8.5
NAL4	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.9	30.6	34.1	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-19.1	-14.4	-10.9	-10.2	-10.1	-10.1	-10.1	-10.2	-13.3
NAL5	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.7	35.2	35.7	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-18.4	-13.3	-9.8	-9.3	-9.2	-9.2	-9.2	-9.3	-12.4
NAL6	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.5	39.1	39.5	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-14.7	-9.5	-5.9	-5.5	-5.4	-5.4	-5.4	-5.5	-8.6
NAL7	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.9	36.2	39.7	40.2	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-14.1	-8.8	-5.3	-4.8	-4.8	-4.8	-4.8	-4.9	-8.0

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	34.3	37.9	38.4	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-15.9	-10.7	-7.1	-6.6	-6.6	-6.6	-6.6	-7.3	-8.3
NAL9	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.6	40.2	40.6	40.7	40.7	40.7	40.7	40.7
	Exceedance Level	-	-	-	-13.6	-8.4	-4.8	-4.4	-4.3	-4.3	-4.3	-5.0	-6.0
NAL10	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-14.4	-9.2	-5.7	-5.2	-5.2	-5.2	-5.2	-5.9	-6.9
NAL11	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	35.5	39.1	39.6	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-14.5	-9.5	-5.9	-5.4	-5.4	-5.4	-5.4	-6.1	-7.1
NAL12	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	33.9	37.5	38.1	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-15.7	-11.1	-7.5	-6.9	-6.8	-6.8	-6.8	-7.5	-8.5
NAL13	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.0	38.6	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-14.4	-10.0	-6.4	-5.7	-5.6	-5.6	-5.6	-6.3	-7.3
NAL14	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	34.3	37.8	38.6	38.7	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-15.1	-10.7	-7.2	-6.4	-6.3	-6.3	-6.3	-7.0	-8.0
NAL15	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.7	36.1	39.6	40.3	40.4	40.4	40.4	40.4	40.4
	Exceedance Level	-	-	-	-13.3	-8.9	-5.4	-4.7	-4.6	-4.6	-4.6	-4.6	-4.6
NAL16	Total DoEHLG 2006 Guidelines Noise Limit	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 Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-14.3	-10.0	-6.5	-5.7	-5.6	-5.6	-5.6	-5.6	-5.6
NAL17	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.5	33.9	37.4	38.2	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-15.5	-11.1	-7.6	-6.8	-6.8	-7.0	-8.8	-10.7	-12.6
NAL18	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	31.9	35.5	36.2	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-17.6	-13.1	-9.5	-8.8	-8.7	-8.9	-10.7	-12.6	-14.5
NAL19	Total DoEHLG 2006 Guidelines Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.8	30.6	34.2	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-19.2	-14.4	-10.8	-10.2	-10.1	-10.3	-12.1	-14.0	-15.9

Table 12.15: Compliance Table – Comparison of predicted likely cumulative noise levels (all schemes) against the Total DoEHLG 2006 Guidelines 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	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.2	36.7	37.5	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-14.2	-9.8	-6.3	-5.5	-5.4	-5.4	-5.4	-5.4	-5.4
NAL2	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	35.2	38.7	39.4	39.5	39.5	39.5	39.5	39.5
	Exceedance Level	-	-	-	-12.2	-7.8	-4.3	-3.6	-3.5	-4.3	-5.2	-5.2	-5.2
NAL3	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	38.9	39.7	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-12.0	-7.6	-4.1	-3.3	-3.2	-3.2	-3.9	-3.9	-3.9
NAL4	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.9	30.6	34.1	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-17.1	-12.4	-8.9	-8.2	-8.1	-8.1	-8.1	-8.1	-8.1
NAL5	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.7	35.2	35.7	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-16.4	-11.3	-7.8	-7.3	-7.2	-7.2	-7.2	-7.2	-7.2
NAL6	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.5	39.1	39.5	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-12.7	-7.5	-3.9	-3.5	-3.4	-3.4	-3.4	-3.4	-3.4
NAL7	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.9	36.2	39.7	40.2	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-12.1	-6.8	-3.3	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	34.3	37.9	38.4	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-13.9	-8.7	-5.1	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6
NAL9	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.6	40.2	40.6	40.7	40.7	40.7	40.7	40.7
	Exceedance Level	-	-	-	-11.6	-6.4	-2.8	-2.4	-2.3	-2.3	-2.3	-2.3	-2.3
NAL10	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-12.4	-7.2	-3.7	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2
NAL11	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	35.5	39.1	39.6	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-12.5	-7.5	-3.9	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4
NAL12	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	33.9	37.5	38.1	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-13.7	-9.1	-5.5	-4.9	-4.8	-4.8	-4.8	-4.8	-4.8
NAL13	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.0	38.6	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.4	-8.0	-4.4	-3.7	-3.6	-3.6	-3.6	-3.6	-3.6
NAL14	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	34.3	37.8	38.6	38.7	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-13.1	-8.7	-5.2	-4.4	-4.3	-4.3	-4.3	-4.3	-4.3
NAL15	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.7	36.1	39.6	40.3	40.4	40.4	40.4	40.4	40.4
	Exceedance Level	-	-	-	-11.3	-6.9	-3.4	-2.7	-2.6	-2.6	-5.7	-5.7	-5.7
NAL16	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.3	-8.0	-4.5	-3.7	-3.6	-3.6	-6.7	-6.7	-6.7
NAL17	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.5	33.9	37.4	38.2	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-13.5	-9.1	-5.6	-4.8	-4.8	-5.7	-7.5	-7.5	-7.5
NAL18	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	31.9	35.5	36.2	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-15.6	-11.1	-7.5	-6.8	-6.7	-7.6	-9.4	-9.4	-9.4
NAL19	Total DoEHLG 2006 Guidelines Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.8	30.6	34.2	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-17.2	-12.4	-8.8	-8.2	-8.1	-9.0	-10.8	-10.8	-10.8

12.6.3.3 Operational Phase - Derivation of Site-Specific Noise Limits for the Proposed Wind Farm (Stage 3)

In order to protect residential amenity, the initial recommendations are that cumulatively, all wind farms (including the Proposed Wind Farm) operate within the Total DoEHLG 2006 Guidelines Noise Limits, as demonstrated in the Stage 2 above.

Another recommendation is that each wind farm should operate within their own limit, whilst the cumulative situation of Stage 2 is still met. To allow this to occur, a set of Site Specific Noise limits for the Proposed Wind Farm are required.

The Site Specific Noise Limits have been derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments in proximity to the Proposed Wind Farm.

The Site Specific Noise Limits were compared to the predictions of the Proposed Wind Farm operating on its own, and the results, based on the precautionary scenario candidate turbine for the Proposed Wind Farm (Vestas V150), are summarised below in Table 12.16 for the daytime and Table 12.17 for the night-time. More details on the calculation of the Site Specific Noise Limits and predictions for the other two candidate wind turbines are provided in Appendix 12-2 and show very similar predictions and outcomes when compared to the V150.

The Stage 3 assessment shows that the predicted wind turbine noise levels from the Proposed Wind Farm on its own meet the Site Specific Noise Limits at all NALs, except NAL11, for both daytime and night time periods and as such there would be **no significant effects** at those receptors. At NAL11 a small exceedance of the Site Specific Noise Limit was predicted during the Night time from 7 ms^{-1} onwards (1.2 dB). There would therefore be a potential significant effect at NAL11. Mitigation in the form of low noise mode operation is proposed for specific wind speed and direction, for the candidate turbine.

Table 12.16: Compliance Table – Comparison of predicted noise levels from the Proposed Wind Farm against the SSNL 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	Site Specific Noise Limit, L_{A90}	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	25.1	28.5	32.8	36.3	37.1	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-19.9	-16.5	-12.2	-8.7	-7.9	-7.8	-7.8	-7.8	-7.8	-7.8
NAL2	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	27.2	30.6	34.9	38.4	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-17.8	-14.4	-10.1	-6.6	-5.8	-5.7	-5.7	-6.0	-6.6	-6.8
NAL3	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	27.3	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-17.7	-14.3	-10.0	-6.5	-5.7	-5.6	-5.6	-5.6	-6.2	-8.9
NAL4	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	21.0	24.4	28.7	32.2	33.0	33.1	33.1	33.1	33.1	33.1
	Exceedance Level	-	-	-24.0	-20.6	-16.3	-12.8	-12.0	-11.9	-11.9	-11.9	-12.0	-15.1
NAL5	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-28.3	-24.9	-20.6	-17.1	-16.3	-16.2	-16.2	-16.2	-16.3	-19.4
NAL6	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	44.2	42.9	42.6	42.6	42.6	42.6	42.8	47.2
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	15.8	19.2	23.5	27.0	27.8	27.9	27.9	27.9	27.9	27.9
	Exceedance Level	-	-	-29.2	-25.8	-20.7	-15.9	-14.8	-14.7	-14.7	-14.7	-14.9	-19.3
NAL7	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	44.0	42.3	42.0	42.0	42.0	42.0	42.2	47.0
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	14.0	17.4	21.7	25.2	26.0	26.1	26.1	26.1	26.1	26.1
	Exceedance Level	-	-	-31.0	-27.6	-22.3	-17.1	-16.0	-15.9	-15.9	-15.9	-16.1	-20.9
NAL8	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	43.5	43.3	43.3	43.3	43.3	44.3	45.6
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	14.6	18.0	22.3	25.8	26.6	26.7	26.7	26.7	26.7	26.7
	Exceedance Level	-	-	-30.4	-27.0	-22.7	-17.7	-16.7	-16.6	-16.6	-16.6	-17.6	-18.9
NAL9	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	43.9	42.1	35.0	35.0	35.0	35.0	43.0	44.7
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-28.3	-24.9	-19.5	-14.2	-6.3	-6.2	-6.2	-6.2	-14.2	-15.9
NAL10	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	44.2	43.0	42.7	42.7	42.7	42.7	43.9	45.3
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	19.7	23.1	27.4	30.9	31.7	31.8	31.8	31.8	31.8	31.8

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedance Level	-	-	-25.3	-21.9	-16.8	-12.1	-11.0	-10.9	-10.9	-10.9	-12.1	-13.5
NAL11	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	43.5	43.3	43.3	43.3	43.3	44.3	45.6
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	22.1	25.5	29.8	33.3	34.1	34.2	34.2	34.2	34.2	34.2
	Exceedance Level	-	-	-22.9	-19.5	-15.2	-10.2	-9.2	-9.1	-9.1	-9.1	-10.1	-11.4
NAL12	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	24.3	27.7	32.0	35.5	36.3	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-20.7	-17.3	-13.0	-9.5	-8.7	-8.6	-8.6	-8.6	-9.3	-10.3
NAL13	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	26.4	29.8	34.1	37.6	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-18.6	-15.2	-10.9	-7.4	-6.6	-6.5	-6.5	-6.5	-7.2	-8.2
NAL14	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	26.0	29.4	33.7	37.2	38.0	38.1	38.1	38.1	38.1	38.1
	Exceedance Level	-	-	-19.0	-15.6	-11.3	-7.8	-7.0	-6.9	-6.9	-6.9	-7.6	-8.6
NAL15	Site Specific 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
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	28.1	31.5	35.8	39.3	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-16.9	-13.5	-9.2	-5.7	-4.9	-4.8	-4.8	-4.8	-4.8	-4.8
NAL16	Site Specific 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
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	27.0	30.4	34.7	38.2	39.0	39.1	39.1	39.1	39.1	39.1
	Exceedance Level	-	-	-18.0	-14.6	-10.3	-6.8	-6.0	-5.9	-5.9	-5.9	-5.9	-5.9
NAL17	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	25.6	29.0	33.3	36.8	37.6	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-19.4	-16.0	-11.7	-8.2	-7.4	-7.3	-7.5	-9.3	-11.2	-13.1
NAL18	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	23.0	26.4	30.7	34.2	35.0	35.1	35.1	35.1	35.1	35.1
	Exceedance Level	-	-	-22.0	-18.6	-14.3	-10.8	-10.0	-9.9	-10.1	-11.9	-13.8	-15.7
NAL19	Site Specific Noise Limit, L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Proposed Wind Farm Turbine Noise L_{A90}	-	-	20.2	23.6	27.9	31.4	32.2	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-24.8	-21.4	-17.1	-13.6	-12.8	-12.7	-12.9	-14.7	-16.6	-18.5

Table 12.17: Compliance Table – Comparison of predicted noise levels from the Proposed Wind Farm against the SSNL 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	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	25.1	28.5	32.8	36.3	37.1	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-17.9	-14.5	-10.2	-6.7	-5.9	-5.8	-5.8	-5.8	-5.8	-5.8
NAL2	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
	Predicted Wind Turbine Noise L_{A90}	-	-	27.2	30.6	34.9	38.4	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-15.8	-12.4	-8.1	-4.6	-3.8	-3.7	-4.5	-5.4	-5.4	-5.4
NAL3	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7
	Predicted Wind Turbine Noise L_{A90}	-	-	27.3	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-15.7	-12.3	-8.0	-4.5	-3.7	-3.6	-3.6	-4.3	-4.3	-4.3
NAL4	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	21.0	24.4	28.7	32.2	33.0	33.1	33.1	33.1	33.1	33.1
	Exceedance Level	-	-	-22.0	-18.6	-14.3	-10.8	-10.0	-9.9	-9.9	-9.9	-9.9	-9.9
NAL5	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.0	41.8	41.8	41.8	41.8	41.8	41.8
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-26.3	-22.9	-18.6	-14.1	-13.1	-13.0	-13.0	-13.0	-13.0	-13.0
NAL6	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.6	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	15.8	19.2	23.5	27.0	27.8	27.9	27.9	27.9	27.9	27.9
	Exceedance Level	-	-	-27.2	-23.8	-18.1	-6.0	-5.2	-5.1	-5.1	-5.1	-5.1	-5.1
NAL7	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.3	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.0	17.4	21.7	25.2	26.0	26.1	26.1	26.1	26.1	26.1
	Exceedance Level	-	-	-29.0	-25.6	-19.6	-7.8	-7.0	-6.9	-6.9	-6.9	-6.9	-6.9
NAL8	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.0	40.3	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.6	18.0	22.3	25.8	26.6	26.7	26.7	26.7	26.7	26.7
	Exceedance Level	-	-	-28.4	-25.0	-19.7	-14.5	-6.4	-6.3	-6.3	-6.3	-6.3	-6.3
NAL9	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.2	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-26.3	-22.9	-16.8	-5.1	-4.3	-4.2	-4.2	-4.2	-4.2	-4.2
NAL10	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.7	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	19.7	23.1	27.4	30.9	31.7	31.8	31.8	31.8	31.8	31.8

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedance Level	-	-	-23.3	-19.9	-14.3	-2.1	-1.3	-1.2	-1.2	-1.2	-1.2	-1.2
NAL11	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.0	40.3	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	22.1	25.5	29.8	33.3	**33.0***	**33.0***	**33.0***	**33.0***	**33.0***	**33.0***
	Exceedance Level	-	-	-20.9	-17.5	-12.2	-7.0	0.0	0.0	0.0	0.0	0.0	0.0
NAL12	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.1	42.0	42.0	42.0	42.0	42.0	42.0
	Predicted Wind Turbine Noise L_{A90}	-	-	24.3	27.7	32.0	35.5	36.3	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-18.7	-15.3	-11.0	-6.6	-5.7	-5.6	-5.6	-5.6	-5.6	-5.6
NAL13	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.2	42.2	42.2	42.2	42.2	42.2
	Predicted Wind Turbine Noise L_{A90}	-	-	26.4	29.8	34.1	37.6	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-16.6	-13.2	-8.9	-5.4	-3.8	-3.7	-3.7	-3.7	-3.7	-3.7
NAL14	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	26.0	29.4	33.7	37.2	38.0	38.1	38.1	38.1	38.1	38.1
	Exceedance Level	-	-	-17.0	-13.6	-9.3	-5.8	-5.0	-4.9	-4.9	-4.9	-4.9	-4.9
NAL15	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	28.1	31.5	35.8	39.3	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-14.9	-11.5	-7.2	-3.7	-2.9	-2.8	-2.8	-5.9	-5.9	-5.9
NAL16	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	27.0	30.4	34.7	38.2	39.0	39.1	39.1	39.1	39.1	39.1
	Exceedance Level	-	-	-16.0	-12.6	-8.3	-4.8	-4.0	-3.9	-3.9	-7.0	-7.0	-7.0
NAL17	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	25.6	29.0	33.3	36.8	37.6	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-17.4	-14.0	-9.7	-6.2	-5.4	-5.3	-6.2	-8.0	-8.0	-8.0
NAL18	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	23.0	26.4	30.7	34.2	35.0	35.1	35.1	35.1	35.1	35.1
	Exceedance Level	-	-	-20.0	-16.6	-12.3	-8.8	-8.0	-7.9	-8.8	-10.6	-10.6	-10.6
NAL19	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	20.2	23.6	27.9	31.4	32.2	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-22.8	-19.4	-15.1	-11.6	-10.8	-10.7	-11.6	-13.4	-13.4	-13.4

**a 1.2 dB exceedance was predicted in full mode for the V150. The values shown in the table include the application of a reduced noise mode for a limited range of wind speeds and wind direction*

12.6.3.1 Operational Noise from BESS

For all NALs, except BNAL06, the Rating level remains below the background sound level during the night-time. This is an indication of the specific sound source having a low impact, depending on the context.

At BNAL06, the Rating Level exceeds the background sound level by a maximum of +3 dB during the night-time, which is below the level that BS4142 states is an "indication of an adverse impact, depending on the context.".

The context in which the assessment is made is as follows;

- The primary noise generation mechanism for all plant associated with this development is related to cooling. The noise model assumes all cooling plant for batteries, inverters and transformers is operating at maximum noise level output, however, this will only occur when ambient temperatures are high or the equipment is under full load. For much of the time cooling equipment will be operating at lower capacities and overall sound output will be reduced.
- Similarly, the noise model assumes all plant is operating concurrently, however not all cooling (or heating) units will necessarily be required to operate at the same time and as such, overall noise levels are likely to be lower than predicted.
- The Rating Levels at all NALs have been classed as 'low' i.e. below 35 dB LAeq(t) and the background sound levels at night are classed as 'very low' (below 30 dB LA90(10mins)). In this situation BS 4142 states that the "absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night". The absolute levels will remain well below the fixed guideline values as detailed in BS 8233 for all receptors and for all time periods.

Additionally, BS 4142 defines Residual Sound as the "ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound". The Residual Sound Level, Lr, is the 'equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T' measured using the $L_{Aeq,t}$ index. In this situation, the specific sound source (i.e. the BESS compound) is proposed and as is not currently operational, therefore, baseline $L_{Aeq,t}$ sound level measurements represent the Residual Sound Level.

An analysis of the measured $L_{Aeq,t}$ values at NML2 (where the highest levels are predicted – BNAL06) shows the average daytime and night-time levels to be 45 dBA and 32 dBA, respectively. The overall sound level increase during the night-time (32 dB+ 28 dB) is less than 1.5 dB. For context, a change of 3 dB(A) is generally considered to be the smallest change in environmental noise that is perceptible to the human ear and is considered 'just perceptible'. As such, an increase of 1.5 dB is not anticipated to result in an adverse impact. Accordingly, there would be **no significant effects** at all BNALs, except BNAL06 where a **minor significant effect** is predicted during the nighttime. Full details of the modelling and assessment can be found in Appendix 12-3.

12.6.4 Potential Cumulative Effects

Potential cumulative effects on noise and vibration between the Proposed Project and other permitted or proposed projects and plans in the area, (wind energy or otherwise), as set out in Section 2.7 in Chapter 2 of this EIAR, were also considered as part of this assessment. The developments considered as part of the cumulative effect assessment are described in Section 2.7 of this EIAR.

12.6.4.1 Construction Phase

The construction noise assessment has shown that predictions for the Proposed Project on its own meet 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 CNAL04 during the construction/ upgrade of the L7080, where no margin during core hours is predicted. However, work for the Proposed Project 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 Project, and other permitted or proposed projects and plans in the area, as set out in Section 2.7 in Chapter 2 of this EIAR.

12.6.4.2 Operational Phase

The Proposed Wind Farm turbine operational noise assessment has taken cumulative impacts with other permitted nearby wind farms into consideration, as described in the above assessment. The likely cumulative operational noise assessment show that the Proposed Wind Farm can operate concurrently with the operational and permitted wind farms and there would therefore be **no significant cumulative wind turbines operational noise effects** at all NALs.

No cumulative noise effects are anticipated in relation to the BESS. As such **no significant cumulative BESS operational noise is anticipated**.

12.7 Mitigation

12.7.1 Mitigation during Construction

No significant effects resulting from construction noise and vibration are predicted. Nevertheless, good practice during construction is recommended and will be presented in a Construction Environmental Management Plan (CEMP) (Appendix 4-3) 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 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 should be agreed in advance.

Good onsite 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 watercourse, culvert and drain crossings along the Proposed Grid Connection Route. Section 8 of BS 5228-1:2009+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 onsite, 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.

12.7.2 Mitigation during Operation

The exact make and model of wind turbine to be used at the Proposed Wind Farm would be the result of a future tendering process. Achievement of the noise limits determined by this assessment would be a key determining factor in the final choice of the Proposed Wind Farm turbines. The noise modelling results presented within this EIAR Chapter are based on the Vestas V150 6.0 MW turbine, which results in the highest predicted noise levels at the key wind speed range and is the precautionary scenario Proposed Wind Farm turbine. Predicted operational noise levels for two other candidate turbines are also included within Appendix 12-2.

The assessment for the Vestas V150 6.0 MW turbine shows an exceedance of the derived Site Specific Noise Limits for a limited range of wind speeds and wind directions at NAL11 during the nighttime period (7 ms-1 onwards) and as a result, the assessment presented here assumes the targeted use of mode management[14] for a limited range of wind speeds and directions for the nighttime period to demonstrate that the noise limits can be met.

The assessment presented for the other two candidate turbines also demonstrate that the noise limits can be adhered to, with the implementation of low noise modes required for the Nordex N149 5.7 MW, but not the Siemens-Gamesa SG 6.0-155. Depending on the final turbine selected, it's blade type and the confirmation of final warranted levels from the manufacturer, mode management may or may not be required.

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 noise complaints, inclusive of any complaint which may relate to OAM (i.e. beyond overall noise levels found in planning conditions). To deal with the eventuality of a complaint, the developer proposes the following:

- 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 minutes of the measurement campaign. The measured 10 minute noise levels and OAM

[14] *This involves operating turbines in low noise mode. This usually involves restricting the rotor speed with a corresponding reduction in noise emissions and electrical power generation.*

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.

No specific mitigation measures are proposed for the BESS.

12.8 Assessment of Residual Effects

12.8.1 Residual Construction Effects

Predicted construction noise and vibration levels are below the assessment criteria at all receptors, for all phases of construction. Due to the low background noise levels at some locations, elements of construction noise could be audible at the closest residential receptor for certain periods during the construction phases. However, with or without the good practice construction mitigation measures outlined above there would be **no significant residual effects**.

12.8.2 Residual Operational Effects

Following the implementation of mode management for NAL11, predicted Proposed Wind Farm operational noise levels at all the NALs lie below the daytime and nighttime Site-Specific Noise Limits. In addition, the cumulative noise predictions from the Proposed Wind Farm and other operational and consented wind farms lie below the Total DoEHLG 2006 Guidelines Noise Limits. Whilst it is not possible to predict if OAM will occur, potential mitigation measures to reduce OAM have been identified in Section 12.7.2 above. The detail of the appropriate mitigation to be adopted will be determined once the wind farm is operational if and when OAM were to occur, following on-site noise measurements and assessments triggered by a complaint investigation. Having applied appropriate mitigation measures there would be **no significant residual effects.**

At some locations, under some wind conditions, and for a certain proportion of the time, operational noise from the Proposed Wind Farm would be audible; however, it would be at an acceptable level in relation to the DoEHLG 2006 Guidelines and as such, regardless of which turbine dimensions are selected within the proposed range, there would be **no significant residual effects from operational wind turbine noise**.

No mitigation was identified to be required for operational noise regarding the proposed BESS, so there would be **no significant residual effects from operational BESS noise.**

12.8.3 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**.

Predicted operational noise levels owing to the Proposed Wind Farm at all the NALs lie below the Total DoEHLG 2006 Guidelines Noise Limits during the daytime and night-time periods. There would be **no residual cumulative effects during the operational phase**.

12.9 Summary

Predicted construction noise levels compared with the Category A criteria outlined in Section E.3 of BS 5228: Part 1 2009+A1:2014 indicate that construction noise levels are below the guidelines considered acceptable at all receptors and that predicted levels would be short term. Construction vibration would also likely be at low levels and would be short term. Activities related to decommissioning would use similar plant to that used for construction activities and would occur at the same locations, as such noise level output during the decommissioning phase is expected to be no higher than the construction phase. Therefore, **no significant noise and vibration effects are anticipated for the construction and decommissioning phases.** Good practice during construction and decommissioning is recommended to minimise any potential noise impacts.

The guidance contained within the DoEHLG 2006 Guidelines was used to assess the likely operational noise impact of the Proposed Wind Farm. Predicted levels and measured background noise levels indicate that for dwellings neighbouring the Proposed Wind Farm, wind turbine noise would meet the noise criteria established in accordance with the DoEHLG 2006 Guidelines, therefore **no significant effects are anticipated for the wind turbine operational noise.** In order to meet the Site-Specific Noise Limits at NAL11, mode management would be required during the nighttime for certain wind speeds and wind directions (7 ms^{-1} onwards) based on the two loudest turbines out of the three candidate turbines considered in this assessment.

There are a range of wind turbine models that would be appropriate for the Proposed Wind Farm site. The candidate wind turbines used for this assessment were chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Project receive consent, the final choice of wind turbine would be subject to a competitive tendering process, but will fall within the range of parameters assessed within this EIAR. The final choice of wind turbine will, however, have to meet the noise limits determined and contained within any condition imposed.

Whilst it is not possible to predict if OAM will occur, potential mitigation measures to reduce OAM have been identified and the developer is proposing to appoint a community liaison officer with a commitment to investigate complaints which may relate to OAM. However, the detail of appropriate mitigation to be adopted can only be determined once the wind farm is operational, following on-site noise measurements and assessments triggered by a complaint investigation. In the event that frequent and sustained OAM is identified, suitable mitigation will be implemented and therefore no significant effects are likely as a result of OAM.

Predicted noise levels from the BESS indicate there would be **no significant effects** at all BNALs, except BNAL06 where a **minor significant effect** is predicted during the nighttime.