Environmental Impact Assessment Report

Teindland Wind Farm

Volume 1

Chapter 9: Noise

Document prepared by Envams Ltd for: Teindland Wind Farm Ltd

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Contents

9 NOISE

9.1 INTRODUCTION

This chapter of the Environmental Impact Assessment (EIA) Report evaluates the effects of noise from the proposed Teindland Wind Farm (the Development) on land owned by Forestry and Land Scotland approximately 3 km north of Rothes, Moray, (the Site) on nearby noise-sensitive receptors (NSRs) during construction, operation and decommissioning. The aim of this assessment is to predict and assess the levels of noise potentially produced by the Development at the nearest NSRs and assess these against relevant standards and guidelines. The Development is described in Chapter 4.

This chapter refers to the following figures in Volume 2a of this EIAR:

- Figure 9.1: Noise Contour Plot.

This chapter is supported by the following Technical Appendices (TAs) in Volume 3 of this EIAR:

- TA A9.1: Survey Record Sheets; and
- TA A9.2: Construction Noise Parameters.

A glossary of terms is provided in EIAR chapter 17.

This assessment was undertaken by Alan Moore, one of the directors of Metrica Ltd, specialist noise, shadow flicker, vibration, air quality and glint and glare consultants. Alan has over 14 years of experience of the assessment of environmental noise, with a particular specialism in wind turbine noise. Alan is a member of the Institute of Acoustics (MIOA), the Institute of Environmental Management and Assessment (AIEMA) and has complete the Institute of Acoustics Diploma in Acoustics and Noise Control.

9.2 LEGISLATION, POLICY AND GUIDANCE

The assessment of noise is required in response to National Planning Framework 4 (NPF4)1 policy 11(e), which states that,

> *"In addition, project design and mitigation will demonstrate how the following impacts are addressed:*
>
> *i) impacts on communities and individual dwellings, including, residential amenity, visual impact, noise, and shadow flicker; …"*

In addition, the Moray Local Development Plan 20202, policy DP9: Renewable Energy and Policy EP14: Pollution, Contamination and Hazards require the assessment of noise.

9.2.1 Construction Noise

The following legislation, guidance and standards are of particular relevance to construction noise:

- The Control of Pollution Act 1974 (CoPA 1974)[3];
- The Environmental Protection Act 1990 (EPA 1990)[4]; and
- British Standard BS 5228:2009+A1:2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites'[5].

[1] Scottish Government (2024). National Planning Framework 4. Available at: https://www.gov.scot/publications/national-planning-framework-4/pages/3/ [accessed on 26/4/2025].

[2] Moray Council (2020). Moray Local Development Plan 2020. Available at: http://www.moray.gov.uk/moray_standard/page_133431.html [accessed on 26/4/2025].

[3] UK Government (1974) The control of Pollution Act 1974, available at: http://www.legislation.gov.uk/ukpga/1974/40 (last accessed 23/01/2025)

[4] UK Government (1990) The Environmental Protection Act 1990. Available at: http://www.legislation.gov.uk/ukpga/1990/43/contents (last accessed 23/01/2025)

[5] BS 5228:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites – Part 1: Noise and Part 2: Vibration

9.2.1.1 *The Control of Pollution Act 1974*

CoPA 1974 provides Local Authorities with powers to control noise and vibration from construction sites.

Section 60 of the CoPA 1974 enables a Local Authority to serve a notice to persons carrying out construction work of its requirements for the control of site noise. This may specify plant or machinery that is or is not to be used, the hours during which construction work may be carried out or the level of noise or vibration that may be emitted.

9.2.1.2 *The Environmental Protection Act 1990*

The EPA 1990 specifies mandatory powers available to Local Authorities in respect of any noise that either constitutes or is likely to cause a statutory nuisance, which is also defined in the CoPA 1974. A duty is imposed on Local Authorities to carry out inspections to identify statutory nuisances, and to serve abatement notices against these. Procedures are also specified with regards to complaints from persons affected by a statutory nuisance.

9.2.1.3 *BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites*

Guidance relevant to the effects of noise and vibration during construction and decommissioning is provided by BS 5228. This standard:

- Is published in two parts: Part 1 - Noise and Part 2 - Vibration. The discussion below relates mainly to Part 1, however, the recommendations of Part 2 in terms of vibration are broadly very similar;
- Refers to the need for the protection against noise and vibration of persons living and working in the vicinity of, and those working on construction and open sites;
- Recommends procedures for noise and vibration control in respect of construction operations;
- Stresses the importance of community relations, and states that early establishment and maintenance of these relations throughout site operations will go some way towards allaying people's concerns;
- Provides recommendations regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the operation;
- Describes methods of controlling noise at source and its spread; and
- Includes a discussion of noise control targets, and example criteria for the assessment of the significance of noise effects.

9.2.2 Operational Noise

The following guidance and information sources have been considered in the assessment of operational noise:

- The Scottish Government's web-based planning information on onshore wind turbines[6];
- Planning Advice Note 1/2011 (PAN 1/2011): 'Planning and Noise'[7];
- ETSU-R-97: 'The Assessment and Rating of Noise from Wind Farms'[8]; and
- 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'[9].

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[6] Scottish Government (2014) Onshore Wind Turbines Planning Advice [Online] Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ (last accessed 23/01/2025)

[7] The Scottish Government 2011 Planning Advice Note Pan 1/2011 Planning and Noise and accompanying Technical Advice Note (TAN)

[8] ETSU 1996, ETSU-R-97 The Assessment and Rating of Noise from Wind Turbines.

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

9.2.2.1 *The Scottish Government's web-based planning information on onshore wind turbines*

The Scottish Government's web-based information provides advice to Local Authorities on the planning issues associated with wind farm development. With respect to noise from wind farms, it recommends the use of ETSU-R-97: 'The Assessment and Rating of Noise from Wind Farms' and the Institute of Acoustics' (IOA) 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'.

It goes on to refer to PAN 1/2011 as providing advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, and states that the associated Technical Advice Note (TAN) 'Assessment of Noise' provides guidance which may assist in the technical evaluation of noise assessment.

This was further confirmed by the Scottish Government in the Onshore Wind Policy Statement 2022[10], which states:

> *"The Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments."*

9.2.2.2 *PAN 1/2011*

PAN 1/2011 promotes the principles of good acoustic design and the appropriate location of new potentially noisy development. The TAN offers advice on the assessment of noise impact and includes details of the legislation, technical standards and codes of practice appropriate to specific noise issues. Appendix 1 of the TAN 'Assessment of Noise' describes the use of ETSU R-97 in the assessment of wind turbine noise.

9.2.2.3 *ETSU-R-97*

ETSU-R-97 provides a framework for the assessment and rating of noise from wind turbine installations. It is the de facto standard for wind farm developments in the UK, and the methodology has therefore been adopted for the present assessment.

Both background noise and noise from wind turbines typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the wind turbines. Noise from existing wind turbines should not form part of the background noise level from which noise limits for new wind energy developments are derived.

ETSU-R-97 specifies the use of the $L_{A90,10min}$ descriptor for both background and wind turbine noise. Therefore, unless otherwise specified, all references to noise levels within this chapter relate to this descriptor. Similarly, all wind speeds referred to relate to a height of 10 metres (m) Above Ground Level (AGL) at the location of the Development, standardised to that height in accordance with current good practice guidance.

ETSU-R-97 recommends the application of external noise limits at the nearest NSRs, to protect outside amenity and prevent sleep disturbance inside dwellings. These limits take the form of a 5 decibel (dB) margin above the prevailing background noise level, except where background noise levels are lower than certain thresholds, in which case fixed lower limits apply. Separate limits apply for quiet daytime and night-time periods, as outlined below. The limits apply to the cumulative effects of all wind turbines that affect a particular location.

During daytime, the guidance specifies limits designed to protect the amenity of residents whilst within the external amenity areas of their properties. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ESTU-R-97 as:

- 18:00 – 23:00 every day;
- 13:00 – 18:00 on Saturday; and
- 07:00 – 18:00 on Sundays.

[10] Scottish Government (2022): Onshore wind: policy statement 2022.

ETSU-R-97 recommends that the fixed lower noise limit for daytime should be set within the range 35 to 40 dB, $L_{A90,10min}$. Different standards apply at night, where potential sleep disturbance is the primary concern rather than the requirement to protect outdoor amenity. 'Night-time' is considered to be all periods between 23:00 and 07:00. A limit of 43 dB(A) is recommended at night at wind speeds or locations where the prevailing wind speed related night-time background noise level is lower than 38dB(A). At other times, the limit of 5 dB above the prevailing wind speed related background noise level applies. The value of the night-time fixed lower limit was selected in order to ensure that internal noise levels remained below those considered to have the potential to cause sleep disturbance, taking account of the attenuation of noise when passing from outdoors to indoors, and making allowance for the presence of open windows.

Where the occupier of the property has a financial involvement in a development, ETSU-R-97 states that the fixed lower noise limit for both daytime and night-time can be increased to 45 dB(A) and that *"…consideration should be given to increasing the permissible margin above background"*.

A 'simplified assessment' criterion is also described which is applicable where there are large separation distances between the turbines and nearest NSRs. In such cases, a fixed limit of 35 dB, $L_{A90,10min}$ applies at wind speeds of up to 10 metres per second (m/s), without reference to background noise levels.

9.2.2.4 The IOA Good Practice Guide

The Good Practice Guide (GPG) was published by Institute of Acoustics (IOA) in May 2013 and has been endorsed by the Scottish Government as current industry good practice. The GPG is supported by a suite of six Supplementary Guidance Notes (SGNs), published in 2014. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind turbine developments at the various stages of the assessment process. The recommendations provided in the GPG and associated SGNs have been followed throughout this assessment.

The GPG provides advice on the assessment of cumulative noise impact, detailing a number of possible cumulative scenarios and recommended approaches. Advice is also provided with regard to the geographical scope of a cumulative noise assessment, to determine the area within which a cumulative noise assessment is necessary.

Where a new noise source is introduced to a given scenario with a noise level which is predicted to be 10 dB or more below the existing level, the increase in the total noise level is considered to be negligible. On this basis, the extents of a cumulative noise assessment can be determined. Section 5.1.4 of the GPG states:

> *"If the wind farm produces noise levels within 10dB of any existing wind farm(s) at the same receptor location, then a cumulative noise impact assessment is necessary".*

As noted in ETSU-R-97, noise from existing wind turbines should not form part of the background noise level from which noise limits for new wind energy developments are derived.

9.2.2.5 Low-Frequency Noise and Infrasound

A study[11], published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the Department for Trade and Industry (DTI), investigated low-frequency noise from wind farms. This study concluded that there is no evidence of health effects arising from infrasound or low-frequency noise generated by wind turbines, but that complaints attributed to low-frequency noise were in fact, possibly due to a phenomenon known as Amplitude Modulation (AM) (see Section 9.2.2.6 for further details).

Further, in February 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms[12]. This study

[11] The measurement of low frequency noise at three UK wind farms, Hayes McKenzie, The Department for Trade and Industry, URN 06/1412, 2006.

[12] Environment Protection authority (2013) Infrasound levels near wind farms and in other environments [online] Available at: http://www.epa.sa.gov.au/xstd_files/Noise/Report/infrasound.pdf (last accessed 31/01/2025).

measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shutdowns of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.

Bowdler et al. (2009)[13] concludes that:

"...there is no robust evidence that low-frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours".

9.2.2.6 *Amplitude Modulation*

In 2007, a study[14] was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with AM. This report defined AM as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency. Its aims were to ascertain the prevalence of AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

The study concluded that AM has occurred at only a small number (4 of 133) of wind farms in the UK, and only for between 7% and 15% of the time when they were operational. It also states that the causes of AM were not well understood, and that prediction of the effect is not currently possible. The Government decided against conducting further research into the phenomenon, and as such no revision to the current guidelines (ETSU-R-97) on wind farm noise assessment has been recommended.

The 2007 study was updated in 2013 by an in-depth study undertaken by Renewable UK[15], which has identified that many of the previously suggested causes of AM have little or no association with the occurrence of AM in practice. The generation of AM is based upon the interaction of a number of factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM, and the incidence of AM occurring at any particular site remains low, as identified in the University of Salford study.

In 2016, the IOA a measurement technique[16] to quantify the level of AM present in any particular sample of wind farm noise. This technique is supported by the Department of Business, Energy & Industrial Strategy (BEIS), (now the Department for Energy Security and Net Zero) who published guidance[17] which follows on from the conclusions of the IOA study in order to define an appropriate assessment method for AM, including a penalty scheme and an outline planning condition. Notwithstanding this, the suggested outline planning condition remains in a draft form and would require site-specific legal advice on its appropriateness to a specific development.

Section 7.2.1 of the GPG therefore remains valid, stating:

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

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[13] Bowdler et al. (2009). Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects. Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics.

[14] Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.

[15] Renewable UK (2013). 'Wind Turbine Amplitude Modulation: Research to improve understanding as to its Cause and effects', Renewable UK, 2013.

[16] Institute of Acoustics, (2016) A Method for Rating Amplitude Modulation in Wind Turbine Noise

[17] BEIS, (2016), Review of the evidence on the response to amplitude modulation from wind turbines.

9.2.2.7 *Vibration*

Research undertaken by Snow[18] found that levels of ground-borne vibration 100 m from the nearest wind turbine were substantially below criteria for 'critical working areas' given by British Standard BS 6472:1992 'Evaluation of human exposure to vibration in buildings (1 Hertz (Hz) to 80 Hz)' and were lower than limits specified for residential premises by an even greater margin.

Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres from a wind farm site as reported by Keele University19. This report clearly shows that, although detectable using highly sensitive instruments, the magnitude of the vibration is orders of magnitude below the human level of perception and does not pose any risk to human health.

Given the above, it is therefore not considered necessary to carry out specific assessments of low-frequency noise, infrasound, AM or ground-borne vibration.

9.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

9.3.1 Construction Noise Assessment Methodology

Beyond a distance of 500 m, there is no reasonable prospect of a significant effect due to construction noise. Other than construction of the substation compound all other construction activities would be located more than 500 m from any NSR; the assessment has therefore been limited to noise generated by the construction of the substation compound. All other construction activities have been scoped out of this assessment on the basis of there being no reasonable prospect of a significant effect.

Noise from construction traffic on public roads has been assessed on the basis of the change in traffic noise levels due to the addition of traffic associated with construction of the Development. Baseline traffic flows for each location have been sourced from **Chapter 11: Traffic and Transport**. The percentage increases in traffic have then been used together with the number of vehicles, proportion of HGVs and likely speed (based on the type of road) to calculate the likely change in traffic noise level due to construction traffic for each month of the construction programme, using the method described in Calculation of Road Traffic Noise (CRTN[20]).

9.3.2 Operational Noise Assessment Methodology

9.3.2.1 *Noise Predictions*

Noise predictions have been made using 3D noise modelling software[21] which implements the ISO 9613-2[22] methodology as recommended by the GPG and takes account of the GPG specific parameters as summarised below:

- The turbine sound power levels should be stated and these should include an appropriate allowance for measurement uncertainty. If the data provided contain no allowance for measurement uncertainty, or uncertainties are not stated, an additional 2 dB should be included;
- Atmospheric absorption should be calculated based on conditions of 10°C and 70% relative humidity;
- The ground factor assumed should be G=0.5 (mixed ground) except in urban areas or where noise propagates across large bodies of water, where G=0 (hard ground) should be assumed;

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

[19] Recommendations on the siting of wind farms in the vicinity of Eskdalemuir, Scotland". Keele University, 2005.

[20] Calculation of Road Traffic Noise, Department of the Environment, 1988

[21] SoundPLAN v9.

[22] ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors Part 2: General method of calculation.

- A receiver height of 4.0 m should be assumed;
- Barrier attenuation should not be included, unless there is no line of sight from the receptor, in which case a 2 dB barrier effect may be included;
- An additional 3 dB should be added to noise immission levels at properties located across a valley or with heavily concave ground between the receptor location and the wind turbine(s); and
- The predicted noise levels ($L_{Aeq,t}$) should be converted to the required $L_{A90,10min}$ by subtracting 2 dB.

ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e., downwind or under a moderate, ground based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the GPG have been shown to provide good correlation with levels of wind turbine noise measured at operational wind farms[23],[24].

9.3.2.2 *Selection of Fixed Lower Limits*

As discussed in Section 9.2.2 the noise limits described in ETSU-R-97 are a combination of a 5 dB margin above the prevailing wind speed dependent background noise level and fixed lower limits, applicable where background noise levels are low. These limits apply to the total level of wind turbine noise affecting a receptor (i.e., cumulative effects).

Consideration of the appropriate fixed lower noise limit for daytime in the range 35 to 40 dB, LA90,10min is considered in line with the three factors specified in ETSU-R-97:

- The number of affected properties;
- The effect on the number of kilowatt-hours produced; and
- The duration and level of exposure.

For the purposes of this assessment, fixed lower limits of 35 dB,L_{A90} during daytime periods and 43 dB,L_{A90} during night-time periods have been applied, being the most stringent limits stated in ETSU-R-97.

None of the assessed NSRs have a financial involvement in the Development and as such, the increased fixed lower limit for financial involvement is not applicable to this assessment.

9.3.2.3 *Design Parameters*

The GPG notes that most sites at planning stage will not have selected a preferred turbine, therefore a candidate turbine representative of a range of turbines should be selected to provide appropriate noise levels. Once noise levels have been predicted at the potentially affected properties, compliance with noise limits can be assessed and design advice provided if compliance with the limits is considered unlikely.

For the purposes of this assessment, the Vestas V162 5.6 Megawatt (MW) turbine with hub heights of 119 m and 149 m have been selected as the candidate turbine type. This assessment assumes all turbines are operating at full power (Mode 0) as a worst-case approach. The manufacturer's noise emission data does not contain any margin for uncertainty, and as such an additional 2 dB has been included in the sound power levels in this assessment, as detailed in Table 9.1.

[23] Bullmore et al. (2009). Wind Farm Noise Predictions and Comparison with Measurements, Third International Meeting on Wind Turbine Noise, Aalborg, Denmark 17 – 19 June 2009.

[24] Cooper & Evans (2013). Effects of different meteorological conditions on wind turbine noise.

Table 9.1 – Manufacturer's Noise Emission Data – Vestas V162 5.6 MW, 119 m and 149 m hub height

	Standardised 10 m Wind Speed, m/s									
	3	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)									
119 m Hub Height										
Sound Power Level, dB, L_{WA}, incl. 2 dB for uncertainty	95.9	98.9	103.1	105.8	106.0	106.0	106.0	106.0	106.0	106.0
149 m Hub Height										
Sound Power Level, dB, L_{WA}, incl. 2 dB for uncertainty	96.0	99.4	103.7	106.0	106.0	106.0	106.0	106.0	106.0	106.0

The octave-band frequency spectrum for the candidate turbine has been scaled to meet the maximum sound power level of 106.0 dB(A) for as detailed in Table 9.2.

Table 9.2 – Octave Band Spectrum, Vestas V162 5.6 MW

	Octave band frequency, Hz								
	32	63	125	250	500	1000	2000	4000	8000
	Sound Power Level, dB(A)								
119 m and 149 m Hub Heights									
Sound Power Level, scaled to 106.0 dB, L_{WA}	75.9	86.8	94.5	99.3	101.2	100.0	95.9	88.8	78.7

9.3.2.4 *Cumulative Assessment*

ETSU-R-97 states that the assessment should take account of the effect of noise from all wind turbines that may affect a particular receptor. A screening exercise was conducted to identify any wind turbines either operational, consented, or the subject of a valid planning application[25] with the potential to result in cumulative noise impacts when assessed in conjunction with the Development. For the purposes of the noise assessment, any cumulative developments with any wind turbines within 5 km of the Development's turbines have been assessed (the distance within which other developments are considered to have the potential to result in cumulative noise impacts).

No such developments were identified during the screening exercise. As such, the assessment of cumulative noise effects has not been considered further.

[25] Status of wind turbines / farms as of January 2025.

9.3.3 Significance of Effects

9.3.3.1 Construction Noise

BS 5228-1 provides several example criteria for the assessment of the significance of noise effects from construction activities. Of those available, 'Example Method 2 – 5 dB(A) Change' has been selected for the current assessment as it is more in keeping with conventional EIA methodologies for noise than alternative methods provided and offers a slightly less complex procedure than Example Method 1, which relates to eligibility for noise insulation. Using this method, noise levels generated by construction activities are potentially significant if the L_{Aeq} level of construction noise exceeds lower threshold values of:

- 65 dB(A) during daytime (includes 0700 to 1300 Saturday);
- 55 dB(A) during evenings and weekends; or
- 45 dB(A) at night; and
- The total noise level (pre-construction ambient noise plus construction noise) exceeds the pre-construction ambient noise level by 5dB(A) or more for a period of one month or more.

In low background noise environments, it is likely that the pre-existing ambient noise level would be substantially less than the lower thresholds detailed above. As such, construction noise levels in excess of the lower thresholds would inherently result in total noise levels of more than 5 dB(A) above the pre-existing ambient noise level. Where this is likely to occur for a period of one month or more, the effect is considered to be significant in terms of the EIA Regulations.

It is likely that a planning condition will be applied restricting the times of construction activities to daytime periods as defined in BS 5228-1:2009. Therefore, the assessment of construction noise has been carried out primarily by comparing the predicted noise levels to the BS 5228 daytime lower threshold of 65 dB, $L_{Aeq,12hr}$ with consideration as to whether the predicted effects are likely to occur for a period of one month or more.

9.3.3.2 Construction Traffic Noise

The magnitude of effects, in terms of the predicted change in traffic noise levels on public roads, expressed as $LA_{10,18hour}$ in accordance with Construction Road Traffic Noise CRTN and based on criteria defined in the Design Manual for Roads and Bridges (DMRB)[26] are defined as follows:

- Negligible: change of less than 1 dB;
- Minor: change of 1 to 3 dB;
- Moderate: change of 3 to 5 dB; and
- Major: change of 5 dB or more.

Effects of Moderate or Major magnitude are considered to be significant in terms of the EIA Regulations. Effects of Negligible or Minor magnitude are considered to be not significant in terms of the EIA Regulations.

It should be noted than CRTN methodology requires a minimum baseline traffic flow volume of 1,000 vehicles per day to determine reliable predictions. For public roads with baseline flows below this threshold, the methodology detailed in BS 5228-1 has therefore been applied, as described in Section 9.3.3.1.

9.3.3.3 Operational Noise

The acceptable limits for wind turbine operational noise are clearly defined in ETSU-R-97, the methodology for assessment of wind turbine noise recommended by Government guidance. Therefore, this assessment determines whether the calculated immission levels at nearby NSRs are below the noise limits derived in accordance with ETSU-R-97. Where

[26] Highways Agency / Transport Scotland (2011) Design Manual for Roads and Bridges, Volume II Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 7 HD 213/11 , Noise and Vibration – Revision 1, November 2011, Table 3.1 – Classification of Magnitude of Noise Impacts in the Short Term.

the noise immission levels at NSRs are shown to be below derived noise limits, the impact is considered to be not significant in terms of the EIA Regulations.

9.3.4 Elements Scoped out of Assessment

9.3.4.1 Construction and Decommissioning Noise / Vibration (Other than Substation Compound Construction)

The minimum distance between any element of Development infrastructure and the closest NSR (excluding the substation compound) is 520 m. As such, there is no realistic prospect of a significant noise effect arising from any construction activities, other than the construction of the substation compound. An assessment of noise relating to the construction of the substation compound is provided in Section 9.5.1. For all other construction activities, mitigation measures outlined in Section 9.6.1 are to be adopted, which are considered to be best practice, as advocated in BS 5228.

Given the large separation distances between construction activities and the closest NSRs, no significant vibration effects are anticipated, and therefore vibration has not been considered further in this assessment.

9.3.4.2 Operational Noise Sources Other than Wind Turbines

Other sources of potentially significant operational noise are limited to the Battery Energy Storage System (BESS) plant. The BESS plant will be located a substantial distance (approximately 520 m) from the nearest NSR, and with intervening forestry along the large majority of the noise propagation path. Based upon Metrica’s substantial experience of BESS facilities, there is no reasonable prospect of a significant noise impact occurring, and noise from the BESS has therefore not been considered further.

9.3.4.3 *Consultation*

Consultation for in relation to noise from the Development was undertaken as summarised in Table 9.3.

Table 9.3 – Consultation Summary

Consultee	Date of correspondence	Subject raised and response to Consultee	Section within the EIAR where comment has been addressed
The Scottish Government Energy Consents Unit (ECU)	Scoping Report July 2022.	The Scottish Government recommends that the list of receptors in respect of the noise assessment should be agreed with Moray Council.	Consultation was undertaken with the Environmental Health Officer (EHO), as detailed in Section 9.4.2.
	Scoping response, September 2022	Requested that the noise assessment and subsequent report should accord with the GPG and ETSU-R-97.	The requirements of ETSU-R-97 and the GPG, as set out in Section 9.3.2 have been followed throughout this assessment.
		Requested that an assessment of operational noise be carried out for any BESS.	By virtue of the substantial distance to the closest NSR, a detailed assessment of the BESS has been scoped out of this assessment, as described in Section 9.3.4.1.
Moray Council Environmental Health Officer (EHO)	Email from Metrica (the authors of this noise assessment) to EHO: 15/09/2024	Seeking agreement on assessment methodology (i.e. ETSU-R-97 and the GPG) and background noise monitoring locations. Seeking agreement on approach to assessment of construction noise.	The agreed methodologies have been followed throughout this assessment. Background noise monitoring locations were agreed and confirmed by the EHO who attended the equipment installation. Details are provided in Section 9.4.5.
	Email from EHO to Metrica: 16/08/2024	EHO agrees with suggested methodology and monitoring locations and requested to be attend the deployment of baseline survey monitoring equipment. Agrees with the construction noise assessment methodology. Notes that any blasting relating to the use of borrow pits be considered in terms of PAN 50 Annex C. Should no blasting be required then this can be confirmed in EIA.	An assessment of construction effects has been undertaken as described in Section 9.3.1. No borrow pits, and therefore no blasting is proposed. Best practice measures to control construction noise are presented in Section 9.6.1.

9.4 BASELINE CONDITIONS

9.4.1 Identification of Receptors

Potential NSRs (habitable residential dwellings) in the area around the Development were identified from Ordnance Survey (OS) 1:25,000 scale digital mapping and online aerial imagery. NSRs were also identified using OS AddressBase data; a database which combines Royal Mail address data with buildings identified on large-scale OS mapping and provides addresses, descriptions and grid references. These are shown in Figure 9.1.

9.4.2 Survey Details

Baseline noise measurements were carried out between the 2nd October and 21st October 2024. The EHO from Moray Council was present during the deployment of the survey equipment, with the precise position of each monitoring location agreed on site. The survey was carried out in accordance with the method specified in ETSU-R-97 and following GPG advice. The following specific measures ensured this compliance:

- Type 1 measuring equipment was used, which was calibrated at the start of the survey and at each site visit. No significant calibration drift occurred;
- Noise monitoring equipment was equipped with specially-designed, dual-layer windshields, which have been confirmed by the supplier as being suitable for use in elevated wind speeds;
- Measurements were performed at a height of 1.4 m AGL, in free field conditions, i.e., a minimum of 3.5 m from any reflective surface other than the ground;
- Background noise levels were recorded at continuous 10-minute intervals, as $L_{A90,10min}$;
- During the survey, wind speeds were measured at various heights using a LiDAR system, and standardised to a height of 10 m AGL;
- Logging rain gauges were deployed at Teindland Wells and Hillhouse. Data from periods potentially affected by rainfall were excluded from further analysis at all locations;
- Periods of elevated background noise levels which were not considered representative of the location were identified and excluded from analysis; and
- The GPG recommends at least 200 valid data points in each quiet daytime and night time period for each monitoring location, after exclusions are taken into account. In practice, this minimum was comfortably exceeded.

Survey record sheets and calibration certificates for the monitoring equipment used during the survey are included in Technical Appendix A9.1. Details of the monitoring locations are presented in Table 9.4, and shown on Figure 9.1.

Table 9.4 – Background Noise Survey Details

NSR	Easting	Northing
Teindland Wells	328110	856341
Hillhouse	330257	854535
Sauchenbush	327322	851790

9.4.2.1 Teindland Wells

During the deployment of the noise monitoring equipment, it was not possible to obtain permission nor access to the originally-agreed monitoring location (Burnside House) nor the back-up location (Teindland Mains) which was found to be non-residential in nature. It was therefore agreed with the EHO at the time that Teindland Wells was a suitable proxy location for NSRs in the surrounding area.

9.4.2.2 Hillhouse

During the deployment of the noise monitoring equipment, it was found that the side of the NSR facing the Development was subject to noise from a water pump and boiler flue. Monitoring was therefore undertaken at the rear of the property as a conservative approach, and as agreed with both the EHO and the residents of Hillhouse.

9.4.2.3 Sauchenbush

Deployment of the monitoring equipment at this NSR was pre-agreed with the resident and EHO, who confirmed that that this location was suitably representative of the other NSRs in the local area.

9.4.3 Data Analysis

The background noise data were analysed according to the following process:

- Synchronisation of measured noise level ($L_{A90,10min}$), 10 m standardised wind speed, wind direction and rainfall data, corrected for differences in the timestamp averaging period (i.e. start or end of the 10-minute period) and daylight savings time (GMT/BST) for each;
- Exclusion of any 10-minute periods where rainfall was recorded (including the preceding 10-minute period), and any other atypical periods judged to have been affected by rainfall, (e.g. extended periods of elevated watercourse noise following rainfall);
- Elimination of any periods where the sound level meters recorded 'over-range' measurements as these are likely to be associated with short-duration, high intensity noise events or sources, such as machinery which may not be typical of the background noise environment;
- Exclusion of any other data points located above the resulting trendline which were considered atypical relative to the overall dataset;
- Sorting of data into 'quiet daytime' and night-time periods, as defined in ETSU-R-97;
- Preparation of an X-Y scatter plot of measured noise levels against standardised 10 m wind speed for quiet daytime and night-time periods;
- Application of a polynomial trendline to the plot. In all cases, the use of second and third-order polynomial trendlines were considered most appropriate; and
- Determination of the prevailing background noise levels from the trendline curves.

Following filtering, resulting charts were found to show a good correlation between noise level and wind speed.

9.4.4 Background Noise Levels

Charts 9.1 to 9.6 detail the results of the background noise data analysis for each location, for quiet daytime and night periods, as defined in ETSU-R-97.

In accordance with GPG advice, where the prevailing background noise curve was found to increase at lower wind speeds, the prevailing background noise level has been fixed at the minimum level. Conversely, where insufficient data were available to determine the background noise level at higher wind speeds (i.e., fewer than 5 data points within each wind speed bin), the prevailing background noise level has been capped at the level for which sufficient data were available, as a conservative approach.

Chart 9.1 – Quiet Daytime – Teindland Wells

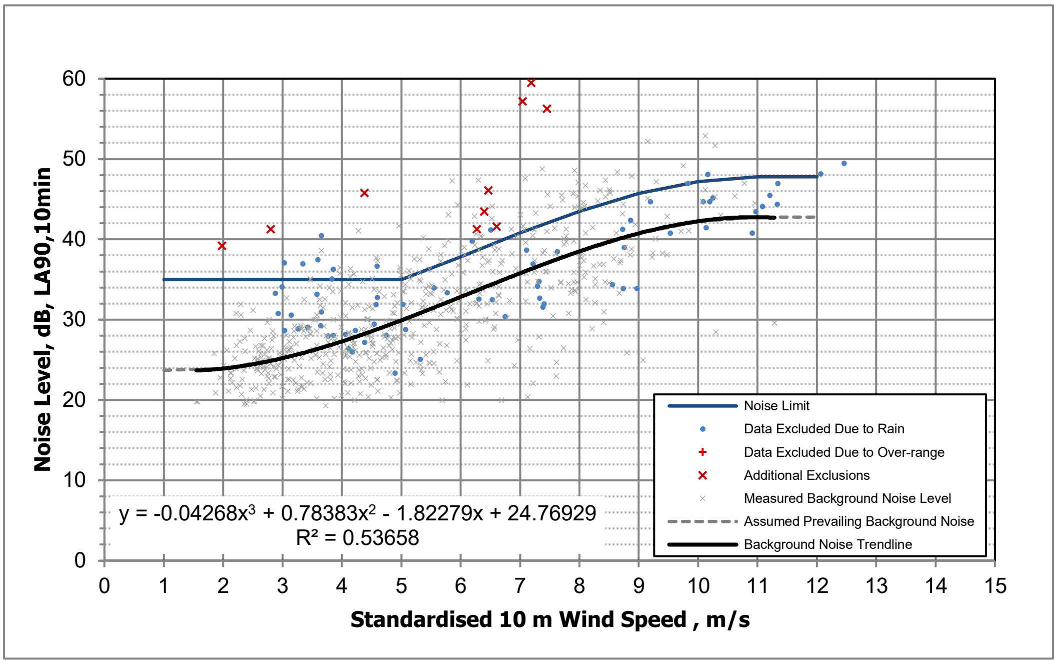

Chart 9.2 – Night-time – Teindland Wells

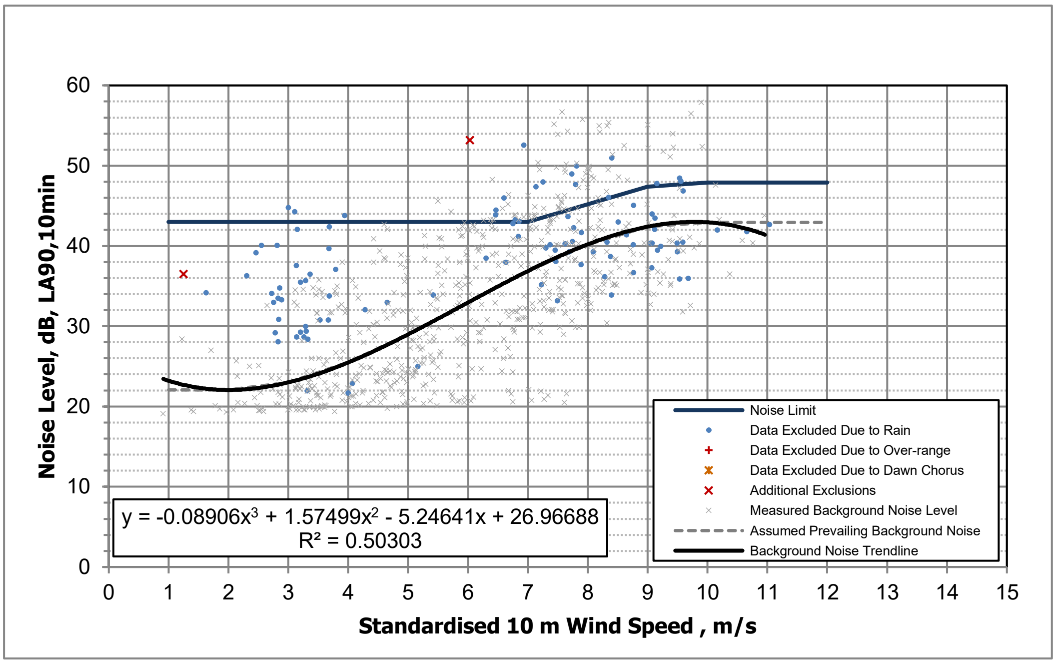

Chart 9.3 – Quiet Daytime - Hillhouse

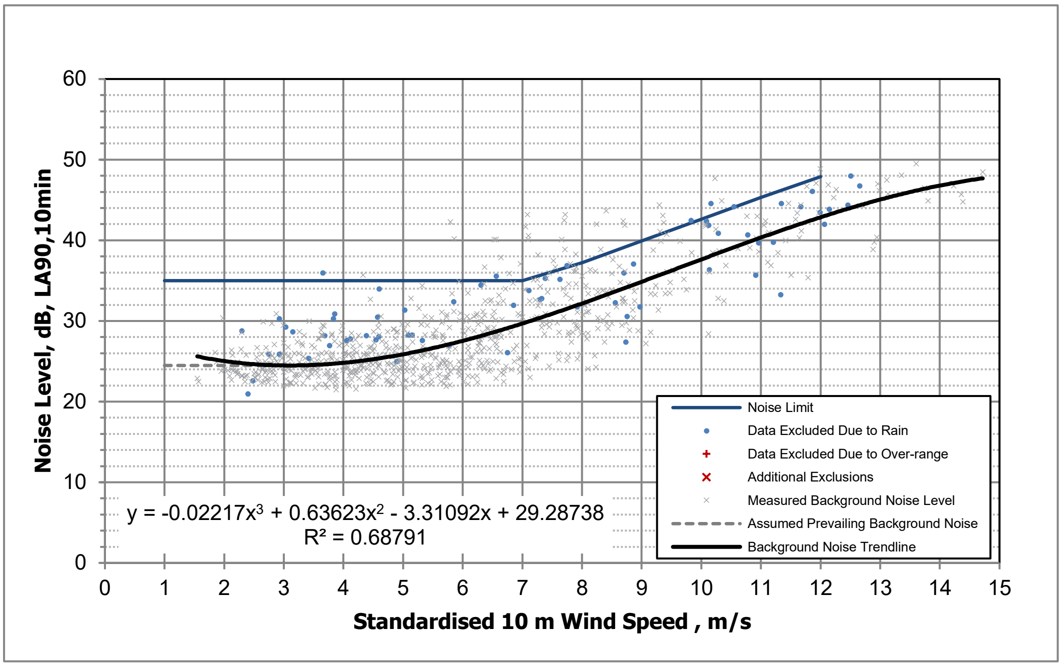

Chart 9.4 – Night-time - Hillhouse

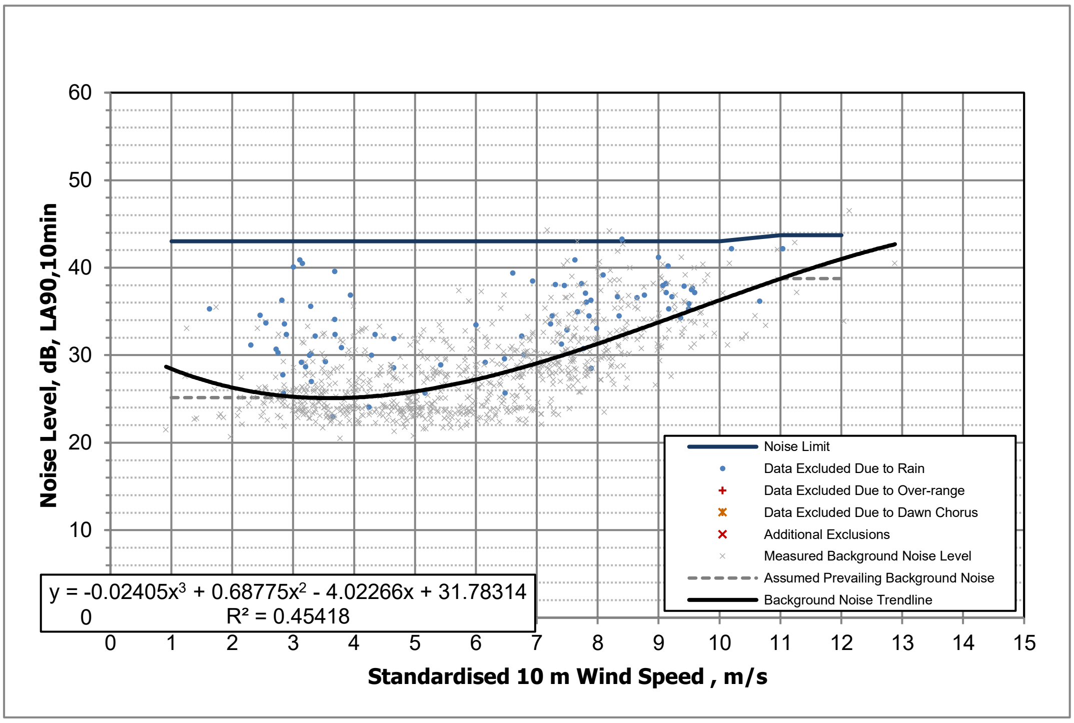

Chart 9.5 – Quiet Daytime - Sauchenbush

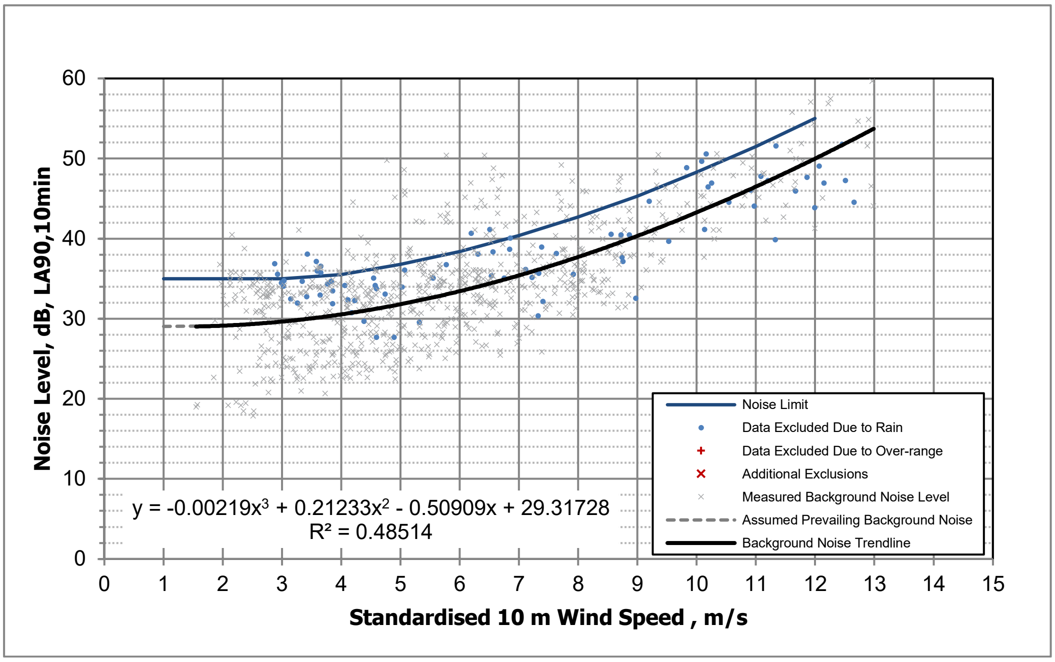

Chart 9.6 – Night-time - Sauchenbush

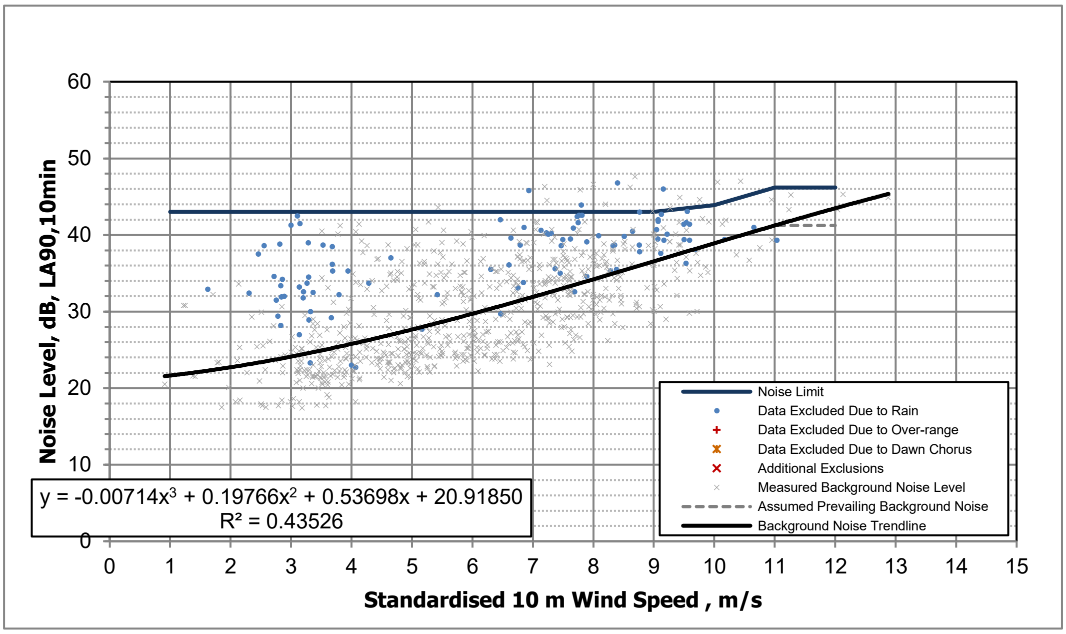

Table 9.5 summarises the resulting background noise levels applicable to each monitoring location.

Table 9.5 – Prevailing Background Noise Levels

	Standardised 10 m Wind Speed, m/s									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Background Noise Level, dB, $L_{A90,10min}$									
Daytime										
Teindland Wells	25.2	27.3	29.9	32.8	35.8	38.5	40.7	42.2	42.8	42.8
Hillhouse	24.5	24.8	25.9	27.5	29.7	32.2	34.9	37.6	40.3	42.9
Sauchenbush	29.6	30.5	31.8	33.4	35.4	37.7	40.3	43.3	46.5	50.0
Night-time										
Teindland Wells	23.0	25.5	29.0	33.0	36.9	40.2	42.4	42.9	42.9	42.9
Hillhouse	25.2	25.2	25.9	27.2	29.1	31.3	33.8	36.3	38.7	38.7
Sauchenbush	24.1	25.8	27.7	29.7	31.9	34.2	36.6	38.9	41.2	41.2

9.4.5 Assessed Receptors

9.4.6 Construction Phase

As discussed in Section 9.3.1, there is no reasonable prospect of a significant effect due to construction noise beyond a distance of 500 m. Only one NSR has been identified within 500 m of any development infrastructure (Rose Cottage, located approximately 440 m southeast of the substation compound). This NSR is shown in Figure 9.1 for reference.

9.4.7 Operational Phase

NSRs requiring consideration in the operational noise assessment are those located within the 35 dB, L_{A90} noise contour for the Development as shown in Figure 9.1 and as described in Section 9.4.1. It should be noted that following the background noise survey, the Development design has changed such that Teindland Wells is no longer within the 35 dB, L_{A90} noise contour; noise at this NSR is therefore compliant with ETSU-R-97 without the requirement for a detailed assessment. However, as background noise monitoring was undertaken at this location, it has been included in the detailed assessment in the interest of transparency.

For each assessed NSR, Table 9.6 details the source of the respective background noise levels, from which the noise limits are derived. For NSRs where a background survey was not carried out, the representative background has been taken from the closest location where monitoring took place, as agreed with the EHO.

Table 9.6 – Assessed Receptors

NSR name	Easting	Northing	Source of Background Noise Data
Teindland Wells	328149	856329	Teindland Wells
Carraburn	329966	854763	Hillhouse
Hillhouse	330234	854515	Hillhouse
Sauchenbush	327335	851772	Sauchenbush
Barluack Farmhouse	326864.0	852579.0	Sauchenbush
Hillfolds Cottage	326904	852594	Sauchenbush

9.4.8 ETSU-R-97 Noise Limits

The method for establishing the operational noise limits is described in Section 9.3.2.2. Table 9.7 details the ETSU-R-97 noise limits derived from the respective background noise levels for each assessed NSR.

Table 9.7 – ETSU-R-97 Noise Limits

	Standardised 10 m Wind Speed, m/s									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Background Noise Level, dB, $L_{A90,10min}$									
Daytime										
Teindland Wells	35.0	35.0	35.0	37.8	40.8	43.5	45.7	47.2	47.8	47.8
Carraburn	35.0	35.0	35.0	35.0	35.0	37.2	39.9	42.6	45.3	47.9
Hillhouse	35.0	35.0	35.0	35.0	35.0	37.2	39.9	42.6	45.3	47.9
Sauchenbush	35.0	35.5	36.8	38.4	40.4	42.7	45.3	48.3	51.5	55.0
Barluack Farm	35.0	35.5	36.8	38.4	40.4	42.7	45.3	48.3	51.5	55.0
Hillfolds Cottage	35.0	35.5	36.8	38.4	40.4	42.7	45.3	48.3	51.5	55.0
Night-time										
Teindland Wells	43.0	43.0	43.0	43.0	43.0	45.2	47.4	47.9	47.9	47.9
Carraburn	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7
Hillhouse	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7
Sauchenbush	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	46.2	46.2
Barluack Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	46.2	46.2
Hillfolds Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	46.2	46.2

9.4.9 Assumptions and Limitations

Baseline noise monitoring locations were selected to be representative of the background noise levels in the local area, following advice contained within the GPG and agreed with the EHO from Moray Council.

Valid background noise measurements were obtained during the baseline noise survey for the full range of wind speeds required by the GPG for both daytime and night-time periods, after exclusions and corrections for existing levels of wind turbine noise were accounted for.

Wind speeds were measured at hub height using a LiDAR remote sensing system and standardised to a height of 10 m in accordance with the GPG.

It is therefore concluded that no significant assessment limitations exist.

9.5 ASSESSMENT OF POTENTIAL EFFECTS

9.5.1 Construction Phase

As discussed in Section 9.3.1, potential impacts arising from construction noise are limited to noise from the construction of the substation compound at one NSR: Rose Cottage, the location of which is shown in Figure 9.1. Details of the numbers and types of plant and their noise emission levels based upon experience of similar developments are provided in Technical Appendix A9.2 together with details of the calculations carried out to predict construction noise levels.

The predicted noise levels are based on the following worst-case assumptions:

- Modelling assumes all plant is located at the closest point to the receptor;
- Noise due to HGV traffic on haulage routes is included, and assumes worst case traffic movements as described in Section 9.3.1;

- HGV traffic numbers assume that 100% of stone required for construction will be imported, and reflect the worst case month during the entire construction period (month 5); and
- No reduction from noise as a result of topographical screening.

The results of these calculations are shown in Table 9.8.

Table 9.8 – Construction Nosie Assessment

NSR name	Distance to Construction Activity, m	Predicted Noise Level, dB, $L_{Aeq,12h}$r (day)
Rose Cottage	440	54.0

As can be seen from Table 9.8, the predicted levels of construction noise are below the daytime lower threshold of 65 dB(A) at the closest, and therefore all NSRs.

In addition to the above, the good practice measures specified in Section 9.6.1 will also be employed, and site-specific measures will be included in the Development's Construction Environmental Management Plan (CEMP), to which all contractors will be contractually obliged to adhere. Given this, along with the conservative assumptions detailed earlier in this section, construction noise levels are likely to be lower than presented above.

9.5.1.1 Construction Traffic Noise

Details of the calculation of the change in road traffic noise levels are contained in Appendix A9.2. Table 9.9 provides a summary of the results for the estimated worst case increase in traffic flows for each route detailed in **Chapter 11: Traffic and Transport**, along with the resulting magnitude of effect as described in Section 9.3.3.2.

As discussed in Section 9.3.3.2, CRTN methodology requires a minimum baseline traffic flow volume of 1,000 vehicles per day to determine reliable predictions. As the B9103(N) was found to have a traffic flow below this threshold, this particular route has been assessed separately in terms of BS 5228, assuming a worst case distance from the carriageway of 4 m.

Table 9.9 –Construction Traffic Noise Assessment

Location	Change in Traffic Noise Level, dB	Magnitude of Effect
B9103(S)	1.6	Minor
B9015	2.6	Minor
A95(T)	1.2	Minor
A96(T) Fochabers	0.4	Negligible
A96(T) Elgin	0.3	Negligible
Location	**Distance from Carriageway, m**	**Predicted Noise Level, dB, $L_{Aeq,12h}$r (day)**
B9103(N)	4	61.4

It can be seen from Table 9.9 that the predicted change in the level of road traffic noise during construction of the Development is less than 3 dB for all applicable routes, with effects of negligible or minor significance. With regard to the B9103(N), predicted levels of construction traffic noise are below the daytime lower threshold of 65 dB(A), based upon a worst-case NSR location.

Given the above findings, construction traffic noise effects are not significant in terms of the EIA Regulations.

9.5.2 Operational Phase

Table 9.10 and Figure 9.1 detail the predicted noise immission levels due to the operation of the Development, based upon the noise emission data in Tables 9.1 and 9.2.

Table 9.10 – Predicted Operational Noise Levels due to the Development

	Standardised 10 m Wind Speed, m/s									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Operational Noise Level, dB, $L_{A90,10min}$									
Teindland Wells	23.1	26.5	30.7	33.1	33.0	33.0	33.0	33.0	33.0	33.0
Carraburn	25.9	29.3	33.5	35.9	35.8	35.8	35.8	35.8	35.8	35.8
Hillhouse	25.1	28.5	32.7	35.1	35.0	35.0	35.0	35.0	35.0	35.0
Sauchenbush	25.9	29.3	33.5	35.9	35.8	35.8	35.8	35.8	35.8	35.8
Barluack Farm	26.2	29.6	33.8	36.2	36.1	36.1	36.1	36.1	36.1	36.1
Hillfolds Cottage	26.5	29.9	34.1	36.5	36.4	36.4	36.4	36.4	36.4	36.4

Table 9.11 details the difference (margin) between the Development's predicted noise immission levels (Table 9.10) and the noise limits for the assessed NSRs (Table 9.7). A positive margin indicates that the predicted noise level is above the derived noise limit (highlighted in bold).

Table 9.11 – Margin between Development Noise and Noise Limits

	Standardised 10 m Wind Speed, m/s									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Background Noise Level, dB, $L_{A90,10min}$									
Daytime										
Teindland Wells	-11.9	-8.5	-4.3	-4.7	-7.8	-10.5	-12.7	-14.2	-14.8	-14.8
Carraburn	-9.1	-5.7	-1.5	**0.9**	**0.8**	-1.4	-4.1	-6.8	-9.5	-12.1
Hillhouse	-9.9	-6.5	-2.3	**0.1**	**0.0**	-2.2	-4.9	-7.6	-10.3	-12.9
Sauchenbush	-9.1	-6.2	-3.3	-2.5	-4.6	-6.9	-9.5	-12.5	-15.7	-19.2
Barluack Farm	-8.8	-5.9	-3.0	-2.2	-4.3	-6.6	-9.2	-12.2	-15.4	-18.9
Hillfolds Cottage	-8.5	-5.6	-2.7	-1.9	-4.0	-6.3	-8.9	-11.9	-15.1	-18.6
Night-time										
Teindland Wells	-19.9	-16.5	-12.3	-9.9	-10.0	-12.2	-14.4	-14.9	-14.9	-14.9
Carraburn	-17.1	-13.7	-9.5	-7.1	-7.2	-7.2	-7.2	-7.2	-7.9	-7.9
Hillhouse	-17.9	-14.5	-10.3	-7.9	-8.0	-8.0	-8.0	-8.0	-8.7	-8.7
Sauchenbush	-17.1	-13.7	-9.5	-7.1	-7.2	-7.2	-7.2	-8.1	-10.4	-10.4
Barluack Farm	-16.8	-13.4	-9.2	-6.8	-6.9	-6.9	-6.9	-7.8	-10.1	-10.1
Hillfolds Cottage	-16.5	-13.1	-8.9	-6.5	-6.6	-6.6	-6.6	-7.5	-9.8	-9.8

As Table 9.11 shows, worst-case noise levels due to the operation of the Development results in minor (< 1 dB) exceedances of respective noise limits at wind speeds of 6 and 7 m/s during daytime periods at two NSRs. An example mitigation strategy is presented in Section 9.6.2 which will ensure that the Development is able to operate in compliance with the requirements of ETSU-R 97.

9.5.3 Decommissioning Phase

Noise produced during decommissioning of the Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with.

9.6 MITIGATION

9.6.1 Construction Phase

The good practice measures detailed below will be implemented to manage the effects of noise and vibration during construction operations, and will be required of all contractors:

- Construction operations will be limited to times agreed with Moray Council;
- Deliveries of turbine components, plant and materials by HGV to site shall only take place within times agreed with Moray Council;
- The site contractors shall be required to employ the best practicable means of reducing noise emissions from plant, machinery and construction activities, as advocated in BS 5228-1:2009+A1:2014;
- Where practicable, the work programme will be phased, which would help to reduce the combined effects arising from several noisy operations;
- Where necessary and practicable, noise from fixed plant and equipment will be contained within suitable acoustic enclosures or behind acoustic screens;
- All sub-contractors appointed by the main contractor will be formally and legally obliged, and required through contract, to comply with all environmental noise conditions;
- Night-time construction working will not be carried out, unless otherwise agreed in advance in writing with Moray Council. Local residents shall be notified in advance of any night- time construction activities with the potential to generate significant noise levels, e.g., abnormal load movement; and
- Any plant and equipment normally required for operation at night (23:00 - 07:00), e.g. generators or dewatering pumps, shall be silenced or suitably shielded to ensure that the night-time lower threshold of 45 dB, $L_{Aeq,night}$ shall not be exceeded at the nearest NSRs.

Application of the above measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction process is operated in compliance with the relevant legislation.

9.6.2 Operational Phase

The candidate turbine model for the Development is capable of operating in a variety of reduced-noise operational modes. The associated control system is able to switch between these modes according to factors such as wind speed, direction, and time of day. The noise emission levels for the reduced noise modes utilised in this assessment, (including an appropriate allowance for uncertainty in line with GPG) are reproduced in Table 9.12.

Table 9.12 – Reduced Noise Modes for Candidate Turbine

Turbine Modes	Standardised 10 m Wind Speed, m/s									
	3	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)									
119 m Hub Height										
Mode 0	95.9	98.9	103.1	105.8	106.0	106.0	106.0	106.0	106.0	106.0
S02	95.9	98.9	102.8	104.0	104.0	104.0	104.0	104.0	104.0	104.0
149 m Hub Height										
Mode 0	96.0	99.4	103.7	106.1	106.0	106.0	106.0	106.0	106.0	106.0
S02	96.0	99.4	103.2	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Using the reduced-noise modes detailed in Table 9.12, an example mitigation strategy has been developed, which would result in noise levels no greater than the noise limits for the Development, presented in Table 9.7. Where Table 9.13 shows "-", the turbine can be operated in Mode 0 (i.e., standard mode / full power).

Mitigation would be required only during daytime periods, and only under the wind speed and direction sectors specified in Table 9.13.

Table 9.13 – Example Operational Noise Mitigation Strategy

Turbine Number	**Standardised 10 m Wind Speed, m/s**									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Applicable Reduced-Noise Operational Mode (Daytime Only)									
T1	-	-	-	-	-	-	-	-	-	-
T2	-	-	-	SO2	SO2	-	-	-	-	-
T3	-	-	-	-	-	-	-	-	-	-
T4	-	-	-	-	-	-	-	-	-	-
T5	-	-	-	SO2	SO2	-	-	-	-	-
T7	-	-	-	-	-	-	-	-	-	-
T8	-	-	-	SO2	SO2	-	-	-	-	-
T9	-	-	-	-	-	-	-	-	-	-
T10	-	-	-	-	-	-	-	-	-	-
T11	-	-	-	-	-	-	-	-	-	-
T12	-	-	-	-	-	-	-	-	-	-
T13	-	-	-	-	-	-	-	-	-	-
Mitigated Wind Sector, Deg.				180 - 330						

Table 9.14 shows the predicted noise levels following mitigation, for the worst-case wind direction at both NSRs where exceedances of the noise limit were identified.

Table 9.14 – Mitigated Operational Noise Levels due to the Development

	Standardised 10 m Wind Speed, m/s									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Background Noise Level, dB, $L_{A90,10min}$									
Carraburn	26.1	29.4	33.4	35.0	34.8	34.8	34.8	34.8	34.8	34.8
Hillhouse	25.3	28.6	32.6	34.3	34.1	34.1	34.1	34.1	34.1	34.1

Table 9.15 details the difference (margin) between predicted noise immission levels following mitigation (Table 9.13) and the noise limits (Table 9.7) for the NSRs predicted to exceed the limits without mitigation. A negative margin indicates that the mitigated noise level is below the derived noise limit. As no mitigation is required during night-time periods, Table 9.15 shows the margins for daytime only.

Table 9.15 – Margin between Mitigated Turbine Noise and Noise Limits

	Standardised 10 m Wind Speed, m/s									
	3	4	5	6	7	8	9	10	11	12
	Prevailing Background Noise Level, dB, $L_{A90,10min}$									
Carraburn	-8.9	-5.6	-1.6	0.0	-0.2	-2.4	-5.1	-7.8	-10.6	-13.1
Hillhouse	-9.7	-6.4	-2.4	-0.7	-0.9	-3.0	-5.7	-8.5	-11.2	-13.7

As can be seen, subject to appropriate mitigation during daytime periods, the Development is compliant with the requirements of ETSU-R-97. Once the make and model of turbine to be constructed is selected, the mitigation scheme would be updated in consultation with the respective turbine manufacturer.

9.7 RESIDUAL EFFECTS

9.7.1 Construction Phase

Application of the above measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction process is operated in compliance with the relevant legislation. Following completion of the construction phase, no residual construction noise or vibration effects will remain.

9.7.2 Operational Phase

Residual effects with appropriate mitigation applied would be not significant in terms of the EIA Regulations.

9.7.3 Decommissioning Phase

Noise during decommissioning will be managed to ensure compliance with best practice, legislation and guidelines current at the time. Following completion of the decommissioning phase, no residual effects will remain.

9.8 SUMMARY OF EFFECTS & STATEMENT OF SIGNIFICANCE

An assessment of potential noise effects associated with the Development has been carried out.

Predicted noise levels due to construction noise and increased traffic movements on public roads have been assessed and found to be **not significant** in either case. In addition, the application of best practice measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction process is operated in compliance with the relevant legislation.

Operational noise has been assessed in accordance with current best practice (i.e., ETSU-R-97 and the GPG). It has been shown that with appropriate mitigation under certain wind conditions during daytime periods, noise due operation of the Development would comply with the requirements of ETSU-R-97, and is therefore **not significant**.

Noise during decommissioning will be managed to ensure compliance with best practice, legislation and guidelines current at the time in order to ensure that effects are **not significant**.