Chapter 11 Noise

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List of Abbreviations

Abbreviation	Description
AM	Amplitude Modulation
ANC	Association of Noise Consultants
AOD	Above Ordnance Datum
BESS	Battery Energy Storage System
BNAL	BESS and Solar Noise Sensitive Location
BS	British Standard
CNAL	Construction Noise Sensitive Location
dB	Decibel
ECU	Energy Consents Unit
EHO	Environmental Health Officer
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
FI	Financial Involvement
FML	Fixed Minimum Limit
GPG	Good Practice Guidance

GW	Gigawatts
ha	hectare
IOA	Institute of Acoustics
LFN	Low Frequency Noise
m	metre
MW	Megawatt
NAL	Noise Assessment Location
NML	Noise Monitoring Location
NSR	Noise Sensitive Receptor
NWG	Noise Working Group
PAN	Planning Advice Note
SBC	Scottish Borders Council
SSNL	Site Specific Noise Limit
TNL	Total ETSU-R-97 Noise Limit
WHO	World Health Organisation

Glossary

Term	Definition
The Applicant	Fred. Olsen Renewables Limited
Amplitude Modulation	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.
Background Noise	The noise level rarely fallen below in any given location over any given time period, often classed according to daytime and night time periods. The L_{A90} indices (see below) is often used to represent the background noise level.
Daytime Hours	07:00 to 23:00 every day
Decibel	the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.
Directivity	The property of a sound source that causes more sound to be radiated in one direction than another.
EIA Regulations	The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of drawing together by the developer, in a systematic way, a description of the development and information relating to of the likely significant environmental effects arising from a proposed development.
Environmental Impact Assessment Report	A document describing the environmental effects of the Proposed Development and produced in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 Regulation.
Ground Effects	The modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).
L_w	Is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The L_{WA} is the A-weighted sound power level.
L_{eq}	Is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $L_{Aeq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).
L_{90}	Index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample
Natural Power	The lead consultant EIA co-ordinator is: Natural Power Consultants Limited
Night time Hours	ETSU-R-97 defines the night time hours as 23.00 to 07.00 every day
Noise emission	the noise energy emitted by a source (e.g. a wind turbine).
Noise immission	the sound pressure level received at a given location (e.g. the nearest dwelling).
Proposed Development	The proposed Lees Hill Renewable Energy Park as described in Chapter 4 of this EIAR.
Proposed Development Site	The project development area within the site boundary as shown in Figure 1.2.
Quiet Daytime Hours	ETSU-R-97 defines the quiet daytime hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.
Standardised Wind Speed	a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).
Wind Shear	the change in the relationship between wind speed at different heights

11. Noise

11.1. Introduction

11.1.1. This chapter considers the likely significant effects with respect to the noise associated with the construction and operation of Lees Hill Renewable Energy Park ("the Proposed Development"). The Proposed Development comprises up to six wind turbines with maximum tip heights of 200 m, up to 69.83 ha of solar photovoltaics (PV array), a Battery Energy Storage System (BESS) and associated infrastructure,

11.1.2. The specific objectives of the chapter are to:

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

11.1.3. This chapter is supported by the following figures (in Volume 3a of the EIAR) and Technical Appendices:

- Figure 11.1: Construction Noise Assessment Locations;
- Figure 11.2: Operational Noise Assessment and Noise Monitoring Locations;
- Figure 11.3: Cumulative Wind Turbine Locations;
- Figure 11.4: BESS and Solar Noise Assessment Locations;
- Technical Appendix 11.1: Construction Noise Report;
- Technical Appendix 11.2: Operational Noise Report; and
- Technical Appendix 11.3: Battery Energy Storage System and Solar Farm Noise Report.

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

11.2. Legislation Policy and Guidance

11.2.1. The assessment used the following combination of guidance and assessment methodologies:

- National Planning Framework 4, (Scottish Government, 2023)[1];
- Planning Advice Note (PAN) 1/2011: 'Planning and Noise' (Scottish Government, 2011)[2];
- Web Based Renewables Advice: 'Onshore Wind Turbines' (Scottish Government, 2014)[3];

[1] *Scottish Government (2023). National Planning Framework 4*

[2] *Scottish Government (2011). PAN 1/2011 Planning and Noise Scotland*

[3] *Scottish Government (2014) Web Based Renewables Advice: 'Onshore Wind Turbines' [Online] Available From https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ [Accessed 30th September 2023]*

- BS 5228-1: 2009+A1:2014 'Code of practice for noise and vibration control on construction and open developments - Noise'[4];
- ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' (NWG, 1996)[5];
- ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation' (ISO, 1996)[6];
- Institute of Acoustics (IOA) 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (IOA GPG, 2013)[7];
- British Standard BS 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'[8]; and
- British Standard BS 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'[9].

11.2.2. Further information on the documents can be found in Sections 11.3 below and they are discussed in detail within Section 2 of Technical Appendices 11.1 - 11.3, where relevant.

11.3. Method of Assessment

Study Area

Construction Noise Study Area

11.3.1. For the construction noise assessment, Noise Sensitive Receptors (NSRs) in proximity to potential construction activities were identified following a desk-based assessment. A total of six Construction Noise Assessment Locations (CNALs) have been selected for the assessment as shown on Figure 11.1, Volume 3a. The CNALs represent the closest NSRs to the proposed construction activities.

Wind Farm Noise Study Area

11.3.2. The Noise Assessment Locations (NALs 1 to 12) for the operational noise assessment are shown on Figure 11.2, Volume 3a and have been selected based on them having the loudest predicted wind farm noise levels within a group of nearby NSRs, which are scattered properties found around the Proposed Development.

11.3.3. There is an operational wind farm and a single turbine development located in the vicinity of the Proposed Development. The schemes detailed in Table 11.1 below and shown on Figure 11.3, Volume 3a have been considered as part of the cumulative operational noise assessment.

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[4] *British Standard BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites' – Part 1: Noise*

[5] *The Working Group on Noise from Wind Turbines (1996). ETSU-R-97 The Assessment and Rating of Noise From Wind Farms. UK: Energy Technology Support Unit*

[6] *ISO (1996). ISO 9613-2:1996 Acoustics – Attenuation of Sound during Propagation Outdoors: Part 2 – General Method of Calculation. Geneva: International Organization for Standardisation.*

[7] *IOA (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'. UK: Institute of Acoustics.*

[8] *British Standard BS 4142:2014 + A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'*

[9] *British Standard BS 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings'*

Table 11.1 Wind Farm/ Turbine considered in the cumulative assessment

Wind Farm	Number of Turbines	Status	Make and Model of turbine considered in Modelling	Hub Height modelled (m)
Black Hill	22	Operational	Siemens SWT-1.3-62, 1.3 MW, Standard Blades	47
Langton Field Turbine	1	Operational	C&F, 11 kW	18.3

11.3.4. Should the Proposed Development be consented, the three micro turbines located to the north east of Langtonlees Farmhouse will be decommissioned, prior to commencement of development and have therefore not been considered as part of the cumulative noise assessment. The turbines are included on Figure 11.3, Volume 3a for completeness.

11.3.5. The wind farm / turbine development included within the cumulative assessment were selected on the basis that the individual predictions from the developments were found to be within 10 dB of the predictions from the Proposed Development. Section 5.1.4 of the IOA GPG States:

'During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.'

11.3.6. Where predictions from the Proposed Development were found to be 10 dB greater than the individual predictions from other wind farm/ turbines then those developments were excluded from the assessment as per Section 5.1.5 of the IOA GPG which states:

'Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary.'

BESS and Solar Operational Noise Study Area

11.3.7. The BESS and Solar Noise Assessment Locations (BNALs) are shown on Figure 11.4, Volume 3a and have been selected based on the proximity of the BESS and solar farm to the nearest noise sensitive receptors.

Methodology

Lees Hill Renewable Energy Park

11.3.8. Renewable energy parks including wind turbines, BESS and solar have the potential to create noise during their construction and operational phases. This chapter assesses the potential noise impacts at the nearest noise sensitive receptors (NSRs); during each of the project phases.

Construction Noise Methodology

11.3.9. The construction noise assessment was undertaken using guidance contained in BS5228: Part 1 2009+A1:2014 (BS5228). The prediction of construction noise levels was undertaken using the calculation methodology presented in ISO9613:1996 (International Standards Organisation, 1996), together with published noise data for appropriate construction plant. To

undertake an assessment of the construction noise impact, the following steps have been undertaken:

- identify noise sensitive receptors near potential construction activities and select representative Construction Noise Assessment Locations (CNALs);
- identify applicable threshold of significant effects from BS5228;
- predict noise levels for various construction noise phases;
- compare predicted noise levels against the applicable threshold;
- 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.

11.3.10. Construction of the Proposed Development would be undertaken in several successive phases. 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 would be determined by the main contractor and detailed arrangements for on site management would be decided at that time. This assessment has therefore been based upon a typical selection of plant for a wind farm project of this size. In view of this, the plant has been modelled operating at the closest point to each receptor for a given activity in each construction phase whereas in reality only certain plant would be working at the closest point.

11.3.11. The core hours for construction activity will likely be typical construction hours of 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 Saturday, however, the assessment also considered construction works outside of these hours.

11.3.12. No scheduled construction is anticipated during the night-time, although, there may be a requirement for some plant to be operational during night-time, for example, a portable generator to provide lighting. A night-time scenario was therefore also considered within the construction noise assessment.

11.3.13. EIAR Chapter 4: Development Description, Volume 2 describes the outline tasks that will be undertaken during the construction period, which is estimated to last 18 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 would occur throughout the construction period:

- Scenario 01 (Month 2): The construction of the access tracks leading up to the construction compound; installation and operation of the construction compound.
- Scenario 02 (Month 3): Operation of the construction compound; construction of the site tracks leading to Turbine 3 (T3); turbine crane pad construction at T1 and T2; operation of the quarry; and concrete batching in the batching plant.
- Scenario 03 (Month 7): Operation of the construction compound; construction of the solar farm; construction of the site tracks leading to junction for T5 and T6; turbine crane pad construction at T3 and T4; operation of the quarry; concrete batching in the batching plant; deliveries to construction compound; construction of BESS.
- Scenario 04 (Month 10): Operation of the construction compound; construction of the site tracks from the junction to T5 and T6; construction of the solar farm; turbine crane pad construction at T5 and T6; operation of the quarry; concrete batching in the batching plant; construction of the turbine foundations at T1, T2 and T3; construction of the substation; deliveries to construction compound.

- Scenario 05 (Month 11): Operation of the construction compound; construction of the solar farm;; construction of the site tracks from the junction to T5 and T6; construction of the turbine foundations at T4, T5 and T6; deliveries to construction compound; construction of the substation.
- Scenario 06 (Month 14): Operation of the construction compound; construction of the solar farm; deliveries to construction compound; installation of turbines at T1, T2 and T3.
- Scenario 07 (Month 16): Operation of the construction compound; deliveries to construction compound; installation of turbines at T4, T5 and T6.
- Scenario 08 (Night time) Operation two diesel generators for the construction compound cabin and lighting.

11.3.14. The noise-generating equipment assessed for each construction phase is detailed in the Construction Noise Report (Technical Appendix 11.1: Construction Noise Assessment Locations, Volume 4). It is noted that for much of the working day the noise associated with construction activities would 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 varies.

11.3.15. To protect the amenity of local residents, construction noise activities would be controlled under The Control of Pollution Act 1974 (COPA) (HM Government, 1974), which is specifically concerned with the control of noise pollution. In particular, Section 60 Part III of the COPA refers to the control of noise on construction sites. It provides legislation by which a Local Authority can control noise from construction sites to prevent disturbance occurring. In addition, it recommends that guidance provided by BS5228 should be implemented to ensure compliance with Section 60 (see Technical Appendix 4.1: Outline CEMP, Volume 4).

Operational Noise Methodology

11.3.16. In Scotland, Planning Advice Note PAN 1/2011 'Planning and Noise' references ETSU-R-97 and the associated 'Onshore Wind Turbines' web-based planning advice states:

'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'

11.3.17. The web-based document then refers to the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 (IOA GPG) as a source, which provides:

'significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'

11.3.18. The wind farm operational noise assessment has been undertaken in accordance with ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' and the IOA GPG. ETSU-R-97 provides a robust basis for determining acceptable noise limits for wind farm developments. Consequently, the test applied to operational noise is whether or not the calculated wind farm noise levels at nearby noise sensitive properties would be below the noise limits derived in accordance with ETSU R 97.

11.3.19. Limits differ between daytime and night-time periods. The daytime criteria are based upon background noise levels measured during the 'quiet periods of the day' comprising:

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

11.3.20. For the avoidance of doubt, the limits set based upon the background data collected during the quiet daytime period apply to the entire daytime period (07:00 – 23:00).

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

11.3.22. ETSU-R-97 recommends that wind farm noise for the daytime periods should be limited to 5 dB(A) above the prevailing background or a fixed minimum level (FML) within the range 35 - 40 dB $L_{A90,10min}$, whichever is the higher. The precise choice of criterion level within the range 35 - 40 dB(A) depends on a number of factors, including:

- the number of dwellings in the neighbourhood of the wind farm (relatively few dwellings suggest a figure towards the upper end);
- the effect of noise limits on the number of kWh generated (larger sites tend to suggest a higher figure) and;
- the duration and level of exposure to any noise.

11.3.23. Following a review of the guidance in ETSU-R-97, the three factors listed in Section 11.3.22, as well as a review of the noise limits for other wind turbine developments in the surrounding area, the 'Total ETSU-R-97 Noise Limits' for the Proposed Development operating in conjunction with other cumulative schemes has been set at 40 dB(A) or background plus 5 dB whichever is the greater. The proposed limits were set out in consultation undertaken directly with Scottish Borders Council (SBC) in October 2022 (as included in Annex 2 of Technical Appendix 11.2: Operational Noise Report, Volume 4). This 'Total' limit relates to noise from all wind farm developments (as detailed in Table 11.1 plus the Proposed Development) in the area.

11.3.24. The daytime Site Specific Noise Limits have been derived based on a lower FML of 35 dB(A), or background plus 5 dB whichever is the greater whilst taking account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other schemes (as detailed in Table 11.1). Where wind turbine immission from the other wind turbines at a given receptor were found to be at least 10 dB below the Total ETSU-R-97 Noise Limit, it is considered that they will be using a negligible proportion of the limit[10], as such it was considered appropriate to allocate the entire noise limit to the Proposed Development. For the receptors where turbine predictions were found to be within 10 dB of the Total ETSU-R-97 Noise Limit, apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with current good practice.

11.3.25. At one receptor, Henlaw Cottage, noise limits for Black Hill Wind Farm have already been established. On that basis a Cumulative Noise Limit has been proposed whereby the Proposed Development would be conditioned to ensure that the cumulative wind turbine noise (from the combined operation of Black Hill and the Proposed Development) would be below the Total ETSU-R-97 Noise Limit. The use of Cumulative Noise Limits would allow the Proposed Development to use the 'spare limit' available at the receptor. In the event that noise from Black Hill Wind Farm were to exceed the Cumulative Noise Limits, the operator of the Proposed Development would have to reduce output such that it resulted in a negligible

[10] *For example - 40 dB + 30 dB = 40.4 dB and this is considered to be a negligible change.*

contribution at the receptor. Accordingly, the noise conditions would include Backstop Noise Limits for the Proposed Development set at 10 dB below the Cumulative Noise Limit. Further information on Cumulative Noise Limits can be found in Sections 4.6 and 6.7 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

11.3.26. For night-time periods the recommended limits are 5 dB(A) above prevailing background or a fixed minimum level of 43 dB $L_{A90,10min}$, whichever is higher whilst taking account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other schemes.

11.3.27. The exception to the setting of both the daytime and night time fixed minimum on the noise limits occurs where a property occupier has a financial involvement in the wind farm development where the fixed minimum limit can be increased to 45 dB(A) or a higher permissible limit above background during the daytime and night time periods.

11.3.28. In addition to ETSU-R-97, the recommendations included in the IOA GPG have been considered in the noise assessment.

11.3.29. The exact model of turbine to be installed on the site would be the result of a future tendering process should consent be granted. Achievement of the Site Specific Noise Limits determined by this assessment will be a key determining factor in the final choice of turbine for the Proposed Development. The Vestas V162 7.2 MW with serrated blades and a hub height of 119 m has been chosen as the candidate turbine for the Proposed Development and is considered to be representative of the type of turbine that could be installed as part of the Proposed Development.

11.3.30. All the other turbines modelled in the cumulative assessment are summarised in Table 11.1 above. Further information can be found in Section 6.2 and Annex 7 of Appendix 11.2. The noise data modelled for the Vestas V162 was taken from Vestas Report 0116-1715_02 'Third octave noise emission EnVentus™ V162-7.2MW 50/60 Hz.'

11.3.31. The location of the wind turbines for the Proposed Development and the other schemes included in the cumulative assessment are shown on Figure 11.3, Volume 3a.

11.3.32. Noise predictions have been undertaken using the propagation model contained within Part 2 of International Standard ISO 9613-2, 'Acoustics – Attenuation of sound during propagation outdoors'. 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), atmospheric attenuation relating to 70% Relative Humidity and 10ºC temperature and a receiver height of 4 m.

11.3.33. 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. Further information on the methodology adopted where this condition comes into effect is provided in Section 6.3 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

11.3.34. The wind turbine noise immission levels are based on the $L_{A90,10\ minute}$ noise indicator in accordance with the recommendations in ETSU-R-97, which were obtained by subtracting 2 dB(A) from the turbine sound power level data (L_{Aeq} indicator).

11.3.35. In line with the IOA GPG (2013), 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. A concave ground and barrier correction was found to be required for a number of turbines at a number of receptors as detailed in Annex 6 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

11.3.36. More information relating to all the parameters for operational noise discussed above and on other topics such as Amplitude Modulation (AM) and Low Frequency Noise (LFN) has been provided in the Operational Noise Report (Technical Appendix 11.2: Operational Noise Report, Volume 4). There is no evidence that LFN has adverse impacts on the health of wind farm neighbours and at time of writing there is no agreed methodology which can be used to predict the occurrence of AM or an agreed methodology that can be used to determine whether the effects of AM, should it occur, are likely to be significant.

Wind Farm – Cumulative Operational Noise

11.3.37. The need for a cumulative noise assessment was considered in accordance with the guidance contained within the IOA GPG (2013). There is an operational wind farm and single turbine development within the vicinity of the Proposed Development. As such, and where required, a cumulative noise assessment was undertaken. The noise assessment has been undertaken in three separate stages:

- Stage 1 – establish the Total ETSU-R-97 Noise Limits for each Noise Assessment Location (NAL) using the measured background noise levels to derive new limits;
- Stage 2 – undertake noise modelling to determine whether noise predictions from the Proposed Development on its own are within 10 dB of the noise predictions from other wind turbines within the area. Where turbine predictions are within 10 dB then a likely cumulative noise assessment will be undertaken; and
- Stage 3 – derive the Site Specific Noise Limits for the Proposed Development (through apportioning the Total ETSU-R-97 Noise Limits) and compare the noise predictions from the Proposed Development on its own against the Site Specific Noise Limits.

11.3.38. The aim of the operational noise assessment therefore is to establish the Total ETSU-R-97 Noise Limits, determine the likely impacts of the Proposed Development and other schemes at the nearest NSRs, derive Site Specific Noise Limits and, where applicable, Cumulative Noise Limits and to demonstrate that the Proposed Development could meet those limits.

BESS and Solar

11.3.39. The BESS and Solar 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.

11.3.40. The qualitative assessment method compares predicted noise levels to existing background sound levels, however, with due regard to guidance presented within the Association of Noise Consultants (ANC) *BS 4142 Technical Note 2020*[11], it was deemed that this assessment methodology was not appropriate, due to the background noise levels being low (<30 dB L_{A90}). Accordingly, the assessment was made against the fixed guideline levels detailed in BS 8233.

11.3.41. 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 World Health Organisation (WHO). Specifically, the Standard states; *'In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values in Table 4.'* Table 4 is reproduced here as Table 11.2.

[11] *Acoustics & Noise Consultants, March 2020. BS 4142:2014+A1:2019 Technical Note, Version 1.0*

Table 11.2 Indoor Ambient Noise Levels for Dwellings (*BS 8233:2014 Table 4*)

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq(16hour)}$	-
Dining	Dining room/area	40 dB $L_{Aeq(16hour)}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq(16hour)}$	30 dB $L_{Aeq(8hour)}$

11.3.42. BS 8223 suggests that an allowance of between 10 and 15 dB for the attenuation of a partially open window is reasonable in order to convert between internal and external sound levels and limits. Therefore, an assessment of external noise levels can assume an external noise level limit of between 10 and 15 dB above those values detailed within Table 11.2 (i.e. to achieve an internal night-time level of 30 dB $L_{Aeq(8hour)}$ with windows open, the external sound level must not exceed 40 - 45 dB $L_{Aeq(8hour)}$.

11.3.43. To predict the noise immission levels attributable to the BESS and solar farm a noise propagation model was created using the propriety noise modelling software CadnaA[12]. 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.

11.3.44. In order to assess a worst-case scenario, the model did not include the use of specific mitigation measures that might be employed on the final site, 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.

Significance Criteria

Wind Farm - Construction Noise

11.3.45. 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 11.3 below:

Table 11.3 Construction Noise Category A Criteria

Significance of Effect	Criteria Thresholds	
	Criteria Met	Criteria Exceeded
Category A Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	≤65 dB $L_{Aeq,\ 12\ hr}$	>65 dB $L_{Aeq,\ 12\ hr}$
Category A Evenings and Weekends	≤50 dB $L_{Aeq,\ 12\ hr}$	>50 dB $L_{Aeq,\ 12\ hr}$
Category A Night time (23:00 – 07:00)	≤45 dB $L_{Aeq,\ 12\ hr}$	>45 dB $L_{Aeq,\ 12\ hr}$

11.3.46. 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-*

[12] *DataKustik Gmbh. CadnaA Version 2023 MR2*

specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect.'

Wind Farm - Operational Noise

11.3.47. PAN 1/2011 'Planning and Noise' provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. PAN 1/2011 refers to the Web-based planning advice on renewable technologies for Onshore Wind Turbines which states that ETSU-R-97 should be used to assess and rate noise from wind energy developments. ETSU-R-97 does not define significance criteria, but describes a framework for the measurement of wind farm noise and gives 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 ETSU-R-97 derived noise limits ensures that wind turbine noise will comply with current Government guidance.

11.3.48. The use of the term 'significance' in this Chapter in relation to operational wind turbine noise refers to compliance / non-compliance with the ETSU-R-97 derived noise limits. For situations where predicted wind turbine noise meets or is less than the noise limits defined in ETSU-R-97, then the noise effects are deemed not significant in EIA regulation terms. Any breach of the ETSU-R-97 derived noise limits due to the Proposed Development is deemed to result in a significant effect in EIA regulation terms.

11.3.49. For the purposes of this assessment, residential dwellings are considered to be NSRs.

BESS and Solar Operational Noise

11.3.50. The derived external noise limits to meet the BS 8233 internal guideline levels are 45 dB $L_{Aeq(16hours)}$ during the daytime and 40 dB $L_{Aeq(8hours)}$ at night, however, these are considerably higher than the measured background sound levels at the nearest receptors and as such the noise impact assessment (Technical Appendix 11.3: Battery Energy Storage System and Solar Farm Noise Report, Volume 4) suggest a lower fixed noise limit of 35 dB $L_{Aeq(1\ hour)}$.

11.3.51. The use of the term 'significance' for the assessment of operational noise from the BESS and Solar Farm, refers to compliance / non-compliance with the proposed 35 dB $L_{Aeq(1\ hour)}$ noise limit. Any breach of the 35dB noise limit due from the operation of the BESS and Solar Farm is deemed to result in a significant effect in EIA Regulations terms.

Limitations and Assumptions

11.3.52. A candidate wind turbine has been used for predictions of operational noise from the Proposed Development. The final model of wind turbine to be used may differ from that presented here, however the operational noise levels from the Proposed Development would have to comply with the noise limits imposed within the noise condition attached to any consent. Similarly, candidate plant has been used for the prediction of BESS and Solar Farm operational noise and final plant specifications may differ. No other assumptions or data gaps have been identified.

Data Sources

11.3.53. Wind turbine noise data is provided by turbine manufacturers as sound power level and octave data. Due to the differences in the way in which noise levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG (2013).

11.3.54. The noise data for the BESS and Solar has been sourced from TNEI's internal database and experience. The assumptions are detailed within the respective assessments.

11.4. Consultation

11.4.1. An EIA Scoping Opinion for the Proposed Development was issued in October 2022 by the Energy Consents Unit (ECU) on behalf of the Scottish Government. A summary of consultation responses received as part of the scoping exercise and response / actions taken, is given in Table 11.4 below. Consultation was undertaken directly with the Environmental Health Department at Scottish Borders Council (SBC) and a summary of the response provided is given in Table 11.5 below. A full copy of the consultation letter and subsequent responses is included in Annex 2 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

Table 11.4 Scoping Consultation Response - Noise

Consultee	Summary of Response	Response/ Action Taken
ECU – Scoping	The noise assessment should be carried out in line with the legislation and standards as detailed in Section 16 of the scoping report.	The standards detailed within Section 16 of the Scoping Report are reproduced in Section 11.2 and have been considered within the noise assessments.
	The noise report should be formatted as per Table 6.1 of the IOA GPG.	Technical Appendix 11.2: Operational Noise Report, Volume 4 provides all the relevant information detailed within Table 6.1 of the IOA GPG.
SBC - Scoping	SBC agreed with the proposed assessment methodologies. SBC agreed that in principle the assessment of vibration, construction noise for the battery storage and solar PV, low frequency noise (LFN) and amplitude modulation (AM) could be scoped out of the EIA, however they recommended that the EIAR considers the latest supporting information on them.	The construction noise assessment has been undertaken in accordance with BS5228. The operational noise assessment has been undertaken in accordance with ETSU-R-97 and the IOA GPG. Further information on the scoped out topics can be found in Scoped Out Section below. Further information on AM and LFN can be found in Section 3 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

Table 11.5 Post-scoping Consultation Response - Noise

Consultee	Summary of Response	Response/ Action Taken
SBC	Agreed to the scoping out of decommissioning noise.	Decommissioning noise has not be assessed.
	Confirmed agreement that the building Kippet Law and two others identified do not need to considered as Noise Sensitive Receptors (NSRs).	The buildings have not been included as NSRs within the assessment.
	Confirmed that they are not aware of any other cumulative schemes which require consideration.	
Carmichael Acoustics (on behalf of SBC)	Carmichael Acoustics (on behalf of SBC) also commented on the consultation letter.	
	Recommended that the use of 40 dB as the lower fixed limit is not agreed. Stated that SBC rarely use a fixed lower limit based on 40 dB. Instead most have a lower limit in the range 35-38 dB. The use of 40 dB would need to be considered and agreed by SBC and that TNEI should provide justification for the choice of fixed limit chosen.	The justification for the use of a limit based on the upper daytime fixed minimum noise limit of 40 dB is included within Table 6.11 of Technical Appendix 11.2: Operational Noise Report, Volume 4. In summary, the limit was chosen to reflect the predicted noise levels from the existing Black Hill Wind Farm. The Site Specific Noise Limits for the Proposed Development are based on the lower daytime fixed minimum noise limit of 35 dB.
	Agreed with the use of 2 dB uplift margin to predicted levels.	
	Agreed with the proposed noise monitoring locations.	
	Agreed with the proposed assessment methodologies and that decommissioning can be scoped out.	An Environmental Health Officer from SBC also attended the installation of the noise monitoring equipment in order to agree the exact siting of the equipment.

Impacts Scoped Out

Decommissioning

11.4.2. Activities that occur during the decommissioning of the Proposed Development are unlikely to produce higher noise levels than those produced during the construction phase and many of the activities will be similar in nature. As such it is assumed that if construction noise levels are predicted to be below the threshold levels then decommissioning noise will also be within the threshold levels.

Vibration

11.4.3. Vibration from wind turbines is low therefore on that basis it was not considered necessary to carry out a specific assessment of perceptible vibration and it has been scoped out of the EIA. However, further information on vibration can be found in Section 3.2 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

Impacts Scoped In

Wind Farm, Solar and BESS

11.4.4. Construction

- Potential impact of construction noise from the Proposed Development.

Wind Farm, Solar and BESS

11.4.5. Operation

- Potential impact of operational noise from the wind turbines at NSRs located in proximity to the Proposed Development;
- Potential impact of operational wind turbine noise from the Proposed Development operating concurrently with other operational developments in the area; and
- Potential impact of operational noise from the BESS and Solar at NSRs located in proximity to the Proposed Development.

11.5. Baseline

Noise Survey

11.5.1. The Proposed Development is located within a rural location where existing background noise levels at the NSRs are generally considered to be low. The predominant noise sources in the area include wind induced noise (wind passing through vegetation and around buildings), local watercourses, agricultural noise and birdsong.

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

11.5.3. Prior to the commencement of the operational noise survey, initial desktop noise modelling was undertaken in order to identify suitable locations at which to monitor background noise. The proposed noise monitoring locations were included in a consultation letter issued to SBC as part of the consultation process (see Annex 2 of Technical Appendix 11.1: Construction Noise Report, Volume 4).

11.5.4. Background noise monitoring was undertaken at five Noise Monitoring Locations (NMLs). An EHO from SBC also attended the installation of the noise equipment in order to agree the

exact siting of the equipment. The selection of the noise monitoring locations considered local noise sources such as boiler flues, watercourses and vegetation.

11.5.5. The background Noise Monitoring Locations (NMLs) are detailed in Table 11.6 below and are shown on Figure 11.2, Volume 3a. More information on the NMLs can be found in Section 5 of Technical Appendix 11.2 and within the detailed Field Data Sheets included within Annex 3 of Technical Appendix 11.2: Operational Noise Report, Volume 4.

11.5.6. The sound level meters were set to log the L_{A90} (as required by ETSU-R-97) and L_{Aeq} noise levels over the required ten-minute intervals continuously over the deployment period.

Table 11.6 Summary of Noise Monitoring Locations

Noise Monitoring Location	Easting	Northing
NML1 - Old Langtonlees	373451	652464
NML2 - 1 Langtonlees Cottages	373380	653654
NML3 - Shepherds Cottage	370911	656114
NML4 - Raecleughhead Farmhouse	374722	652936
NML5 - Hardens Hill House	374408	653797

11.5.7. Simultaneous wind speed/direction data was recorded at various heights using a Lidar, which was located within the site (grid coordinate: 372216, 654291). The wind speed data collected at 110 m and 120 m on the Lidar was used to derive hub height wind speeds (119 m) which were standardised to 10 m height in accordance with good practice.

11.5.8. 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, and to remove periods of rainfall. All data analysis was undertaken in accordance with ETSU-R-97 and the IOA GPG.

Current Baseline

11.5.9. Table 11.7 and Table 11.8 provide a summary of the background noise levels measured during the monitoring period for the ETSU-R-97 quiet daytime and night time periods.

Table 11.7 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

Wind Farm	Wind Speeds (ms^{-1}) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 - Old Langtonlees	29.0*	29.0	29.0	29.0	29.2	29.9	31.5	34.2	38.2	43.7	43.7*	43.7*
NML2 - 1 Langtonlees Cottages	26.3*	26.3	26.3	26.3	26.5	27.2	28.7	31.4	35.4	41.1	41.1*	41.1*
NML3 - Shepherds Cottage	28.1*	28.1	28.4	28.9	29.7	30.8	32.2	33.9	35.9	38.3	38.3*	38.3*
NML4 - Raecleughhead Farmhouse	29.2*	29.2	29.5	29.9	30.5	31.8	33.9	37.1	41.7	48.0	48.0*	48.0*
NML5 - Hardens Hill House	27.7*	27.7	28.2	29.0	30.4	32.6	35.8	40.3	46.4	54.2	54.2*	54.2*

** Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7 of Technical Appendix 11.2: Operational Noise Report, Volume 4.*

Table 11.8 Summary of Prevailing Background Noise Levels during Night Time Periods (dB(A))

Wind Farm	Wind Speeds (ms^{-1}) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 - Old Langtonlees	17.6*	17.6	17.7	18.8	20.7	23.5	27.0	31.1	35.8	41.1	46.7	46.7*
NML2 - 1 Langtonlees Cottages	17.4*	17.4	17.9	19.2	21.2	23.7	26.5	29.5	32.6	35.5	38.1	38.1*
NML3 - Shepherds Cottage	23.5*	23.5	23.6	24.2	25.3	27.1	29.7	33.0	37.2	42.4	48.6	48.6*
NML4 - Raecleughhead Farmhouse	19.0*	19.0	19.3	21.0	23.6	27.0	30.8	34.7	38.4	41.6	44.0	44.0*
NML5 - Hardens Hill House	16.6*	16.6	17.5	20.1	23.9	28.6	33.9	39.5	45.1	50.2	54.6	54.6*

** Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7 of Technical Appendix 11.2: Operational Noise Report, Volume 4.*

11.5.10. In line with the recommendations included in Section 3.1.19 of the IOA GPG, a polynomial line of best fit has been derived through each dataset for the daytime and night-time periods as shown on Figures A1.2a-e included within Annex 1 of Technical Appendix 11.2: Operational Noise Report, Volume 4. Any data that has been excluded due to rain, directional filtering or manual exclusions (where data was considered to be atypical) are shown on the Figures. A polynomial line of best fit has been determined for the remaining valid data and as per Section 3.1.21 of the IOA GPG, the polynomial background curve has been flatlined (where applicable) at the higher and lower wind speeds where the derived maximum/minimum occurs.

Future Baseline

11.5.11. 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 farm noise and would be set for the lifetime of the project. The operator would be required to meet them for the duration of the consent. There are no other known current or predicted future processes (other than the Proposed Development) that are likely to change the baseline conditions.

11.6. Assessment of Potential Effects

Construction Noise Assessment Locations

11.6.1. A total of six CNALs were chosen as representative of the nearest NSRs. The CNALs chosen were the closest receptors to the Proposed Development and access tracks and these are presented in Figure 11.1, Volume 3a. The CNALs refer to the position on the curtilage of a property where the predictions of construction noise levels have been made, as detailed in Table 11.9 below:

Table 11.9 Construction Noise Assessment Locations

Construction Noise Assessment Location (CNAL)	Easting	Northing
CNAL01 – Langtonlees Cottages	373347	653622
CNAL02 – Langtonlees	373322	653484
CNAL03 – Old Langtonlees	373437	652514
CNAL04 – Polwarth Mill	373995	650891
CNAL05 – Kettleshiel North	370566	651955
CNAL06 – Henlaw Cottage	371658	654795

Wind Farm Operational Noise Assessment Locations

11.6.2. A total of twelve Noise Assessment Locations (NALs) were chosen as representative of the nearest NSRs to the wind turbines and they are shown on Figure 11.2, Volume 3a and detailed in Table 11.10 below. They have been selected based on them having the loudest predicted noise levels within a group of nearby properties both around the Proposed Development and the other wind farm/ turbine development included in the cumulative assessment.

11.6.3. The NALs refer to the position on the curtilage of a property closest to the Proposed Development. Predictions of wind turbine noise have been made at each of the NALs. This approach ensures that the assessment considers the worst case (highest) noise immission level expected at the NSR. Table 11.10 also details which NML has been used to set noise limits for each NAL.

Table 11.10 Operational Noise Assessment Locations

Noise Assessment Location (NAL)	Easting	Northing	Elevation (m AOD)	Approximate Distance to Nearest Lees Hill Turbine (m)	Background Noise NML Used
NAL1 - Langtonlees Cottages	373347	653622	267	876 (T5)	NML2
NAL2 - Langtonlees	373322	653484	254	864 (T6)	NML2
NAL3 - Old Langtonlees	373437	652514	237	1,079 (T1)	NML1
NAL4 - Choicelee South	374670	651233	180	2,236 (T1)	NML2
NAL5 - Polwarth Mill	373995	650891	190	1,779 (T1)	NML2
NAL6 - Kettelshiel North	370566	651955	220	1,524 (T3)	NML2
NAL7 - Henlaw Cottage	371650	654810	228	1,270 (T5)	NML1
NAL8 - Dronshiel	370716	655584	210	2,478 (T5)	NML3
NAL9 - Stobswood	371057	656237	220	2,774 (T5)	NML3
NAL10 - Raecleugh Head	374661	652935	213	2,215 (T6)	NML4

Noise Assessment Location (NAL)	Easting	Northing	Elevation (m AOD)	Approximate Distance to Nearest Lees Hill Turbine (m)	Background Noise NML Used
NAL11 - Hardens Hill	374361	653801	298	1,854 (T5)	NML5
NAL12 – North East of Langton Edge	375709	653891	173	3,201 (T5)	NML5

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden). In addition the grid references vary due to the exact assessment location at a given property.*

Solar and BESS Operational Noise Assessment Locations

11.6.4. A total of six BESS and Solar Noise Assessment Locations (BNALs) were chosen as representative of the nearest NSRs. The BNALs chosen were the closest receptors to the proposed BESS and Solar Farm and these are presented in Figure 11.4, Volume 3a and detailed in Table 11.11 below.

Table 11.11 BESS and Solar Noise Assessment Locations

BESS and Solar Noise Assessment Location (BNAL)	Easting	Northing
BNAL01 – Langtonlees Cottages	373348	653631
BNAL02 – Langtonlees	373368	653463
BNAL03 – Old Langtonlees	373424	652492
BNAL04 – Polwarth Mill	373995	650891
BNAL05 – Kettleshiel North	370576	651952
BNAL06 – Henlaw Cottage	371658	654795

Construction Noise Assessment

11.6.5. The construction noise impact results summarised in Table 11.12 below show that the predicted construction noise levels are below the Category A Threshold Levels at all CNALs for all assessment scenarios therefore there would be **no significant effects**. Further details of the modelling and assessment can be found in Technical Appendix 11.1: Construction Noise Report, Volume 4.

Table 11.12 Predicted Construction Noise Immission Levels

CNAL	Category A Threshold dB $L_{Aeq,\,t}$			Immission Level, dB $L_{Aeq,\,t}$ for each Scenario (S)							
	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)	S1	S2	S3	S4	S5	S6	S7	Night
CNAL1	65	55	45	26.8	39.2	42.9	44.5	44.2	40.6	39.7	15.5
CNAL2	65	55	45	27.7	39.1	42.8	44.2	43.9	40.6	38.8	16.4

CNAL	Category A Threshold dB $L_{Aeq, t}$			Immission Level, dB $L_{Aeq, t}$ for each Scenario (S)							
	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)	S1	S2	S3	S4	S5	S6	S7	Night
CNAL3	65	55	45	34.5	37.3	38.5	40.6	39.4	36.5	34.8	22.8
CNAL4	65	55	45	30.0	30.2	31.5	33.7	32.0	30.1	26.5	18
CNAL5	65	55	45	25.6	34.5	34.8	35.2	34.2	34.5	28.8	14.3
CNAL6	65	55	45	19.9	45.1	45.2	45.2	45.1	28.0	28.9	9.2

Wind Farm Operational Noise Assessment

Setting the Total ETSU-R-97 Noise Limits (Stage 1)

11.6.6. Based on the prevailing background noise levels, the Total ETSU-R-97 Noise Limits have been established for each of the NALs detailed in Table 11.10 above. The Total ETSU-R-97 Noise Limits are as detailed in Table 11.13 and Table 11.14 below and have been based on an upper fixed minimum of 40 dB (daytime) or background plus 5 dB, whichever is the greater and 43 dB (night-time) or background plus 5 dB, whichever is the greater.

Table 11.13 Total ETSU-R-97 Noise Limit – applicable to the daytime period

NAL	Wind Speed (ms^{-1}) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Langtonlees Cottages*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
NAL2 – Langtonlees*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
NAL3 - Old Langtonlees	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	43.2	48.7	48.7	48.7
NAL4 - Choicelee South	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	46.1	46.1	46.1
NAL5 - Polwarth Mill	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	46.1	46.1	46.1
NAL6 - Kettelshiel North	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	46.1	46.1	46.1
NAL7 - Henlaw Cottage	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	43.2	48.7	48.7	48.7
NAL8 - Dronshiel	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	43.3	43.3
NAL9 - Stobswood	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	43.3	43.3

NAL	Wind Speed (ms^{-1}) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL10 - Raecleugh Head	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.7	53.0	53.0	53.0
NAL11 - Hardens Hill	40.0	40.0	40.0	40.0	40.0	40.0	40.8	45.3	51.4	59.2	59.2	59.2
NAL12 – North East of Langton Edge	40.0	40.0	40.0	40.0	40.0	40.0	40.8	45.3	51.4	59.2	59.2	59.2

**FI with the Proposed Development*

Table 11.14: Total ETSU-R-97 Noise Limit – applicable to the night time period

NAL	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Langtonlees Cottages*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL2 – Langtonlees*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL3 - Old Langtonlees	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	51.7	51.7
NAL4 - Choicelee South	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
NAL5 - Polwarth Mill	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
NAL6 - Kettelshiel North	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
NAL7 - Henlaw Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	51.7	51.7
NAL8 - Dronshiel	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4	53.6	53.6
NAL9 - Stobswood	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4	53.6	53.6
NAL10 - Raecleugh Head	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.6	49.0	49.0
NAL11 - Hardens Hill	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	50.1	55.2	59.6	59.6
NAL12 – North East of	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	50.1	55.2	59.6	59.6

NAL	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
Langton Edge												

**FI with the Proposed Development*

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

11.6.7. Predicted cumulative noise levels were compared to the Total ETSU-R-97 Noise Limits. For some turbine models considered in the cumulative assessment noise data was not available for wind speeds less than 6 ms^{-1} therefore no cumulative predictions are included for wind speeds less than 6 ms^{-1}.

11.6.8. As shown in Table 11.15 and Table 11.6 the predicted wind turbine noise immission levels from the schemes summarised in Table 11.1 plus the proposed wind farm development) are below the Total ETSU-R-97 Noise Limits under all conditions and at all NALs during both quiet daytime and night time periods. As such, there would be **no significant effects**.

Table 11.15 Total ETSU-R-97 Noise Limit – Day time

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Vlangtonlees Cottages	Total Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
	Predictions L_{A90}	-	-	-	-	-	37.9	38.9	39.1	39.4	40.1	40.2	40.2
	Exceedance Level	-	-	-	-	-	-7.1	-6.1	-5.9	-5.6	-6.0	-5.9	-5.9
NAL2 - Langtonlees	Total Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
	Predictions L_{A90}	-	-	-	-	-	38.1	39.0	39.2	39.6	40.2	40.3	40.3
	Exceedance Level	-	-	-	-	-	-6.9	-6.0	-5.8	-5.4	-5.9	-5.8	-5.8
NAL3 - Old Langtonlees	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	43.2	48.7	48.7	48.7
	Predictions L_{A90}	-	-	-	-	-	35.5 *	36.9 *	37.7	38.0	38.6	38.7	38.7
	Exceedance Level	-	-	-	-	-	-4.5	-3.1	-2.3	-5.2	-10.1	-10.0	-10.0
NAL4 - Choicelee South	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	46.1	46.1	46.1
	Predictions L_{A90}	-	-	-	-	-	28.8	29.7	30.0	30.5	31.3	31.6	31.8
	Exceedance Level	-	-	-	-	-	-11.2	-10.3	-10.0	-9.9	-14.8	-14.5	-14.3
NAL 5 - Pol	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	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
	Predictions L_{A90}	-	-	-	-	-	30.1	31.0	31.3	31.7	32.4	32.5	32.6
	Exceedance Level	-	-	-	-	-	-9.9	-9.0	-8.7	-8.7	-13.7	-13.6	-13.5
NAL6 - Kettelshiel North	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.4	46.1	46.1	46.1
	Predictions L_{A90}	-	-	-	-	-	33.5	34.4	34.6	35.0	35.7	35.8	35.8
	Exceedance Level	-	-	-	-	-	-6.5	-5.6	-5.4	-5.4	-10.4	-10.3	-10.3
NAL7 - Henlaw Cottage	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	43.2	48.7	48.7	48.7
	Predictions L_{A90}	-	-	-	-	-	39.0	39.6	40.0	40.6	42.1	42.1	42.1
	Exceedance Level	-	-	-	-	-	-1.0	-0.4	0.0	-2.6	-6.6	-6.6	-6.6
NAL8 - Dronshiel	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	43.3	43.3
	Predictions L_{A90}	-	-	-	-	-	36.2	36.7	37.2	37.8	39.4	39.5	39.5
	Exceedance Level	-	-	-	-	-	-3.8	-3.3	-2.8	-3.1	-3.9	-3.8	-3.8
NAL9 - Stobswood	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	43.3	43.3
	Predictions L_{A90}	-	-	-	-	-	38.1	38.7	39.1	39.8	41.5	41.5	41.5
	Exceedance Level	-	-	-	-	-	-1.9	-1.3	-0.9	-1.1	-1.8	-1.8	-1.8
NAL10 - Raecleugh Head	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	42.1	46.7	53.0	53.0	53.0
	Predictions L_{A90}	-	-	-	-	-	31.2	32.1	32.5	33.0	34.1	34.5	34.8
	Exceedance Level	-	-	-	-	-	-8.8	-7.9	-9.6	-13.7	-18.9	-18.5	-18.2
NAL11 - Hardens Hill	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.8	45.3	51.4	59.2	59.2	59.2
	Predictions L_{A90}	-	-	-	-	-	33.2	34.0	34.3	34.8	36.0	36.0	36.1
	Exceedance Level	-	-	-	-	-	-6.8	-6.8	-11.0	-16.6	-23.2	-23.2	-23.1
NAL12 – North East of Langton Edge	Total Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.8	45.3	51.4	59.2	59.2	59.2
	Predictions L_{A90}	-	-	-	-	-	32.4	34.5	36.8	39.2	41.7	44.2	45.5

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedance Level	-	-	-	-	-	-7.6	-6.3	-8.5	-12.2	-17.5	-15.0	-13.7

**Mode management applied to Lees Hill (see Section 11.6.17 below for further information)*

Table 11.16 Total ETSU-R-97 Noise Limit Compliance Table – 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 - \langtonlees Cottages	Total 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
	Predictions L_{A90}	-	-	-	-	-	37.9	38.9	39.1	39.4	40.1	40.2	40.2
	Exceedance Level	-	-	-	-	-	-7.1	-6.1	-5.9	-5.6	-4.9	-4.8	-4.8
NAL2 - Langtonlees	Total 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
	Predictions L_{A90}	-	-	-	-	-	38.1	39.0	39.2	39.6	40.2	40.3	40.3
	Exceedance Level	-	-	-	-	-	-6.9	-6.0	-5.8	-5.4	-4.8	-4.7	-4.7
NAL3 - Old Langtonlees	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	51.7	51.7
	Predictions L_{A90}	-	-	-	-	-	36.5	37.5	37.7	38.0	38.6	38.7	38.7
	Exceedance Level	-	-	-	-	-	-6.5	-5.5	-5.3	-5.0	-7.5	-13.0	-13.0
NAL4 - Choicelee South	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
	Predictions L_{A90}	-	-	-	-	-	28.8	29.7	30.0	30.5	31.3	31.6	31.8
	Exceedance Level	-	-	-	-	-	-14.2	-13.3	-13.0	-12.5	-11.7	-11.5	-11.3
NAL5 - Polwarth Mill	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
	Predictions L_{A90}	-	-	-	-	-	30.1	31.0	31.3	31.7	32.4	32.5	32.6
	Exceedance Level	-	-	-	-	-	-12.9	-12.0	-11.7	-11.3	-10.6	-10.6	-10.5
NAL6 - Kettelshiel North	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.1	43.1
	Predictions L_{A90}	-	-	-	-	-	33.5	34.4	34.6	35.0	35.7	35.8	35.8
	Exceedance Level	-	-	-	-	-	-9.5	-8.6	-8.4	-8.0	-7.3	-7.3	-7.3

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 - Henlaw Cottage	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	51.7	51.7
	Predictions L_{A90}	-	-	-	-	-	39.0	39.6	40.0	40.6	42.1	42.1	42.1
	Exceedance Level	-	-	-	-	-	-4.0	-3.4	-3.0	-2.4	-4.0	-9.6	-9.6
NAL8 - Dronshiel	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4	53.6	53.6
	Predictions L_{A90}	-	-	-	-	-	36.2	36.7	37.2	37.8	39.4	39.5	39.5
	Exceedance Level	-	-	-	-	-	-6.8	-6.3	-5.8	-5.2	-8	-14.1	-14.1
NAL9 - Stobswood	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4	53.6	53.6
	Predictions L_{A90}	-	-	-	-	-	38.1	38.7	39.1	39.8	41.5	41.5	41.5
	Exceedance Level	-	-	-	-	-	-4.9	-4.3	-3.9	-3.2	-5.9	-12.1	-12.1
NAL10 - Raecleugh Head	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.6	49.0	49.0
	Predictions L_{A90}	-	-	-	-	-	31.2	32.1	32.5	33.0	34.1	34.5	34.8
	Exceedance Level	-	-	-	-	-	-11.8	-10.9	-10.5	-10.4	-12.5	-14.5	-14.2
NAL11 - Hardens Hill	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	50.1	55.2	59.6	59.6
	Predictions L_{A90}	-	-	-	-	-	33.2	34.0	34.3	34.8	36.0	36.0	36.1
	Exceedance Level	-	-	-	-	-	-9.8	-9.0	-10.2	-15.3	-19.2	-23.6	-23.5
NAL12 – North East of Langton Edge	Total Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	50.1	55.2	59.6	59.6
	Predictions L_{A90}	-	-	-	-	-	32.4	34.5	36.8	39.2	41.7	44.2	45.5
	Exceedance Level	-	-	-	-	-	-10.6	-8.5	-7.7	-10.9	-13.5	-15.4	-14.1

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

11.6.9. In order to protect residential amenity, in accordance with ETSU-R-97 cumulatively, all wind farms (including the Proposed Development) should operate within the Total ETSU-R-97 Noise Limits, as demonstrated in the Stage 2 above.

11.6.10. 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 Development are required and these have been derived for

each NAL, except NAL7 where a Cumulative Noise Limit has been proposed, instead. The apportionment options provided in the IOA GPG were considered to determine the most appropriate option for each NAL.

11.6.11. As summarised in Table 6.8 of in Technical Appendix 11.2: Operational Noise Report, Volume 4, for seven NALs, operational noise from the other schemes would be at least 10 dB below the Total ETSU-R-97 Noise Limits established for the Proposed Development. At the receptors where cumulative wind turbine predictions for all other schemes is at least 10 dB below the Total ETSU-R-97 limits it would be appropriate to allocate the entire noise limit to the Proposed Development. This is appropriate as in such circumstances the other wind farms would use a negligible proportion of the Total ETSU-R-97 Noise Limit. As summarised in Table 6.8 of in Technical Appendix 11.2: Operational Noise Report, Volume 4, this approach was adopted at NALs 1-6 and 10.

11.6.12. At NALs 8-9, for wind speeds where the total cumulative noise predictions from all schemes (excluding the Proposed Development) were found to be within 5 dB of the Total ETSU-R-97 Noise Limits then the Site Specific Noise Limits at those wind speeds were derived to be 10 dB below.

11.6.13. At NALs 8-9 and 11-12, at wind speeds where significant headroom was available >5 dB margin between the total cumulative noise predictions from all schemes (excluding the Proposed Development), limit apportionment was required. Limit apportionment is a process whereby the Total ETSU-R-97 Limit is split with a portion allocated to the existing schemes and the remainder allocated to the Proposed Development. Where apportionment was required, cautious predicted noise levels were subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual limit' available for the Proposed Development.

11.6.14. The daytime Site Specific Noise Limits were derived based on the lesser of:

- The residual limit; and
- The lower daytime fixed minimum noise limits (35 dB) or the background noise level plus 5 dB (whichever is greater).

11.6.15. The Site Specific Noise Limits and noise predictions for the Proposed Development on its own, based on a Vestas V162, 7.2 MW, are summarised in Table 11.17 and Table 11.18.

11.6.16. The results show that the predicted wind turbine noise levels from the Proposed Development operating on its own meet the Site Specific Noise Limits under all conditions at NALs 1-2 and 4-12 during the daytime period and at all NALs during the night time period. As such there would be **no significant effects.**

11.6.17. At NAL 3, an exceedance of the Site Specific Noise Limit was predicted (1 dB at 6 ms^{-1} and 0.5 dB at 7 ms^{-1}) during the daytime period when the turbines were modelled operating in full mode. At those wind speeds, this would result in a **significant effect** for certain wind directions when the NAL is downwind of the wind turbines.

Table 11.17 Site Specific Noise Limit Compliance Table – Day time

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Langtonlees Cottages	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
	Predictions L_{A90}	-	-	27.4	28.3	32.8	37.0	38.0	38.2	38.5	38.9	38.9	38.9

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedence Level	-	-	-17.6	-16.7	-12.2	-8.0	-7.0	-6.8	-6.5	-7.2	-7.2	-7.2
NAL2 - Langtonlees	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	46.1	46.1
	Predictions L_{A90}	-	-	27.8	28.7	33.2	37.4	38.4	38.6	38.9	39.2	39.3	39.3
	Exceedence Level	-	-	-17.2	-16.3	-11.8	-7.6	-6.6	-6.4	-6.1	-6.9	-6.8	-6.8
NAL3 - Old Langtonlees	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	36.5	39.2	43.2	48.7	48.7	48.7
	Predictions L_{A90}	-	-	26.4	27.3	31.8	35*	36.5*	37.2	37.5	37.9	37.9	37.9
	Exceedence Level	-	-	-8.6	-7.7	-3.2	0.0	0.0	-2.0	-5.7	-10.8	-10.8	-10.8
NAL4 - Choicelee South	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	36.4	40.4	46.1	46.1	46.1
	Predictions L_{A90}	-	-	17.9	18.8	23.3	27.5	28.6	28.7	29.0	29.4	29.4	29.4
	Exceedence Level	-	-	-17.1	-16.2	-11.7	-7.5	-6.4	-7.7	-11.4	-16.7	-16.7	-16.7
NAL5 - Polwarth Mill	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	36.4	40.4	46.1	46.1	46.1
	Predictions L_{A90}	-	-	19.7	20.5	25.1	29.3	30.3	30.5	30.7	31.1	31.2	31.2
	Exceedence Level	-	-	-15.3	-14.5	-9.9	-5.7	-4.7	-5.9	-9.7	-15.0	-14.9	-14.9
NAL6 - Kettelshiel North	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	36.4	40.4	46.1	46.1	46.1
	Predictions L_{A90}	-	-	22.9	23.8	28.3	32.5	33.5	33.7	34.0	34.4	34.4	34.4
	Exceedence Level	-	-	-12.1	-11.2	-6.7	-2.5	-1.5	-2.7	-6.4	-11.7	-11.7	-11.7
NAL8 - Dronshiel	Site Specific Noise Limit L_{A90}	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.9	33.3	33.3	33.3
	Predictions L_{A90}	-	-	17.7	18.6	23.1	27.3	28.4	28.5	28.8	29.2	29.2	29.2
	Exceedence Level	-	-	-12.3	-11.4	-6.9	-2.7	-1.6	-1.5	-2.1	-4.1	-4.1	-4.1
NAL9 - Stobswood	Site Specific Noise Limit L_{A90}	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.9	33.3	33.3	33.3
	Predictions L_{A90}	-	-	16.0	16.9	21.4	25.6	26.7	26.8	27.1	27.5	27.5	27.5
	Exceedence Level	-	-	-14.0	-13.1	-8.6	-4.4	-3.3	-3.2	-3.8	-5.8	-5.8	-5.8

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL10 - Raecleugh Head	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.5	36.8	38.9	42.1	46.7	53.0	53.0	53.0
	Predictions L_{A90}	-	-	19.7	20.6	25.1	29.3	30.3	30.5	30.8	31.1	31.2	31.2
	Exceedence Level	-	-	-15.3	-14.4	-10.4	-7.5	-8.6	-11.6	-15.9	-21.9	-21.8	-21.8
NAL11 - Hardens Hill	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.4	37.6	40.0	45.3	51.4	59.2	59.2	59.2
	Predictions L_{A90}	-	-	20.7	21.5	26.0	30.3	31.3	31.4	31.7	32.1	32.2	32.2
	Exceedence Level	-	-	-14.3	-13.5	-9.4	-7.3	-8.7	-13.9	-19.7	-27.1	-27.0	-27.0
NAL12 – North East of Langton Edge	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.4	37.6	38.8	44.2	51.4	59.2	59.2	59.2
	Predictions L_{A90}	-	-	13.5	14.4	18.9	23.1	24.2	24.3	24.6	25.0	25.0	25.0
	Exceedence Level	-	-	-21.5	-20.6	-16.5	-14.5	-14.6	-19.9	-26.8	-34.2	-34.2	-34.2

**Mode management applied*

Table 11.18 Site Specific Noise Limit Compliance Table – 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 - Langtonlees Cottages	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
	Predictions L_{A90}	-	-	27.4	28.3	32.8	37.0	38.0	38.2	38.5	38.9	38.9	38.9
	Exceedence Level	-	-	-17.6	-16.7	-12.2	-8.0	-7.0	-6.8	-6.5	-6.1	-6.1	-6.1
NAL2 - Langtonlees	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
	Predictions L_{A90}	-	-	27.8	28.7	33.2	37.4	38.4	38.6	38.9	39.2	39.3	39.3
	Exceedence Level	-	-	-17.2	-16.3	-11.8	-7.6	-6.6	-6.4	-6.1	-5.8	-5.7	-5.7
NAL3 - Old Langtonlees	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	51.7	51.7
	Predictions L_{A90}	-	-	26.4	27.3	31.8	36.0	37.1	37.2	37.5	37.9	37.9	37.9
	Exceedence Level	-	-	-16.6	-15.7	-11.2	-7.0	-5.9	-5.8	-5.5	-8.2	-13.8	-13.8
NAL 4 - Choi	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	43.1	43.1

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predictions L_{A90}	-	-	17.9	18.8	23.3	27.5	28.6	28.7	29.0	29.4	29.4	29.4
	Exceedence Level	-	-	-25.1	-24.2	-19.7	-15.5	-14.4	-14.3	-14.0	-13.6	-13.7	-13.7
NAL5 - Polwarth Mill	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	43.1	43.1
	Predictions L_{A90}	-	-	19.7	20.5	25.1	29.3	30.3	30.5	30.7	31.1	31.2	31.2
	Exceedence Level	-	-	-23.3	-22.5	-17.9	-13.7	-12.7	-12.5	-12.3	-11.9	-11.9	-11.9
NAL6 - Kettelshiel North	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	43.1	43.1
	Predictions L_{A90}	-	-	22.9	23.8	28.3	32.5	33.5	33.7	34.0	34.4	34.4	34.4
	Exceedence Level	-	-	-20.1	-19.2	-14.7	-10.5	-9.5	-9.3	-9.0	-8.6	-8.7	-8.7
NAL8 - Dronshiel	Site Specific Noise Limit L_{A90}	41.6	41.6	41.5	41.5	41.5	41.5	41.3	41.0	40.6	46.3	53.6	53.6
	Predictions L_{A90}	-	-	17.7	18.6	23.1	27.3	28.4	28.5	28.8	29.2	29.2	29.2
	Exceedence Level	-	-	-23.8	-22.9	-18.4	-14.2	-12.9	-12.5	-11.8	-17.1	-24.4	-24.4
NAL9 - Stobswood	Site Specific Noise Limit L_{A90}	40.3	40.3	40.1	40.1	40.1	40.1	33.0	33.0	33.0	45.3	53.6	53.6
	Predictions L_{A90}	-	-	16.0	16.9	21.4	25.6	26.7	26.8	27.1	27.5	27.5	27.5
	Exceedence Level	-	-	-24.1	-23.2	-18.7	-14.5	-6.3	-6.2	-5.9	-17.8	-26.1	-26.1
NAL10 - Raecleugh Head	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.6	49.0	49.0
	Predictions L_{A90}	-	-	19.7	20.6	25.1	29.3	30.3	30.5	30.8	31.1	31.2	31.2
	Exceedence Level	-	-	-23.3	-22.4	-17.9	-13.7	-12.7	-12.5	-12.6	-15.5	-17.8	-17.8
NAL11 - Hardens Hill	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5	50.1	55.2	59.6	59.6
	Predictions L_{A90}	-	-	20.7	21.5	26.0	30.3	31.3	31.4	31.7	32.1	32.2	32.2
	Exceedence Level	-	-	-22.3	-21.5	-17.0	-12.7	-11.7	-13.1	-18.4	-23.1	-27.4	-27.4
NAL12 – North East of Langton Edge	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	41.9	43.2	50.1	55.2	59.6	59.6
	Predictions L_{A90}	-	-	13.5	14.4	18.9	23.1	24.2	24.3	24.6	25.0	25.0	25.0

NAL	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
Exceedence Level	-	-	-29.5	-28.6	-24.1	-19.9	-17.7	-18.9	-25.5	-30.2	-34.6	-34.6

Cumulative Noise Conditioning

11.6.18. At NAL7 Henlaw Cottage, noise limits for Black Hill Wind Farm have already been established. On that basis a Cumulative Noise Condition has been proposed whereby the Proposed Development would be conditioned to ensure that the cumulative wind turbine noise (from the combined operation of Black Hill and the Proposed Development) would be below the Total ETSU-R-97 Noise Limit. At NAL7, as demonstrated in Tables 11.15 and 11.16 above, the combined cumulative noise immission remains below, or equal to, the Total ETSU-R-97 Noise Limit (which is the same as the Cumulative Noise Limit), thus indicating that both schemes can operate concurrently at this receptor. As such there would be **no significant effects**.

11.6.19. If the situation arose whereby noise levels from Black Hill increased to use a greater amount of the noise limits than predicted, then the Proposed Development may then need to implement mitigation to reduce noise levels to ensure that the Cumulative Noise Limit is met. In the event that noise from Black Hill Wind Farm used all of the Cumulative Noise Limit noise from the Proposed Development would need to be reduced such that it has a negligible additional contribution. For the proposed wind farm development to have a negligible additional contribution it would need to comply with Backstop Noise Limits which have been derived to be 10 dB below the Cumulative Noise Limits (see Annex 8 of Technical Appendix 11.2: Operational Noise Report, Volume 4). Further information on the Backstop Noise Limits is included within Section 6.7 of Technical Appendix 11.2: Operational Noise Report, Volume 4. In the event that the Proposed Development needed to operate to the Backstop Noise Limits, mitigation in the form of low noise modes would be required during the daytime and night time period. Mitigation would only be required for certain wind speeds and wind directions due to directivity attenuation and that the information presented in Annex 8 is based on a worst case wind direction.

11.6.20. A set of suggested Noise Conditions are presented within Annex 9 of Technical Appendix 11.2: Operational Noise Report, Volume 4 which present Site Specific Noise Limits for all NALs except NAL7, where Cumulative Noise Limits and Backstop Noise Limits are presented.

BESS and Solar Noise Assessment

11.6.21. The BESS and Solar Farm predictions show that the operational noise levels are significantly below the BS 8233 guideline noise levels. In addition, the operational noise levels will be below the proposed 35 dB $L_{Aeq(1hour)}$ noise limit at all NSRs for all time periods. Accordingly, there would be **no significant effects**. Full details of the modelling and assessment can be found in Technical Appendix 11.3: Battery Energy Storage System and Solar Farm Noise Report, Volume 4.

11.7. Mitigation and Residual Effects

Mitigation during Construction and Decommissioning

11.7.1. No significant effects resulting from construction noise are predicted. Nevertheless, a range of good practice measures would be detailed in a Construction Environmental Management Plan (CEMP) and employed to minimise noise impacts.

11.7.2. Good site practices would be implemented to minimise the likely effects to a minimum. Section 8 of BS5228 recommends a number of simple control measures as summarised below that would 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;
- Ensure that any extraordinary site work continuing throughout 24 hours of a day (for example, crane operations lifting components onto the tower) would be programmed, when appropriate, so that haulage vehicles would not arrive at or leave the site between 19:00 and 07:00, with the exception of abnormal loads that would be scheduled to avoid significant traffic flows;
- Ensure all vehicles and mechanical plant would be fitted with effective exhaust silencers and be subject to programmed maintenance;
- Select inherently quiet plant where appropriate - all major compressors would be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which would be kept closed whenever the machines are in use;
- Ensure all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Instruct that machines would be shut down between work periods or throttled down to a minimum;
- Regularly maintain all equipment used on site, including maintenance related to noise emissions;
- Vehicles would be loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and
- Ensure all ancillary plant such as generators and pumps would be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures should be provided.

Mitigation during Operation

11.7.3. The exact make and model of wind turbine to be used at the Proposed Development 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 wind turbines for the Site. For this assessment, predictions of wind turbine noise have been based upon sound power level data for the Vestas V162, 7.2 MW with serrated blades, and a noise prediction model procedure that can be considered to provide a realistic impact assessment. The assessment shows an exceedance of the derived noise limits for a limited range of wind speeds and wind directions at NAL3 during the daytime period (1 dB at 6 ms^{-1} and 0.5 dB at 7 ms^{-1}) and as a result, the assessment presented here assumes the targeted use of mode management[13] for a limited range of wind speeds and directions for the daytime period in order to demonstrate that the noise limits can be adhered to. Depending on the final turbine selected for the Site, blade type and confirmation of final warranted levels from the chosen manufacturer, mode management may or may not be required. It is anticipated that noise limits would be secured by an appropriately worded planning condition.

11.7.4. No specific mitigation measures are proposed for the BESS or Solar Farm.

[13] *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.*

Residual Construction Effects

11.7.5. Predicted wind farm construction noise 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 may 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 from construction noise.

Residual Operational Effects

11.7.6. For the purpose of demonstrating the effectiveness of a potential noise mitigation measure for the candidate wind turbine considered here, the predicted noise levels have been reduced to ensure that the limits are met, this would be achieved by the adoption of low noise modes, but this would only be required for a limited range of wind speeds and directions.

11.7.7. The results of the noise assessment show that, subject to the adoption of mitigation measures in the form of low noise mode operation when required for the candidate wind turbine, the predicted wind turbine noise levels would meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night time periods. There are a number of wind turbine makes and models that would be suitable for the Proposed Development and that may not require the use of low noise modes.

11.7.8. As detailed in Table 11.19 below for NAL 3, the predicted wind farm operational noise levels for Vestas V162, 7.2 MW turbine including implementation of mode management lie below the daytime noise limits at NAL3 and there would be **no significant residual effects** from operational noise.

Table 11.19 Residual Operational Noise Levels Compliance Table – Daytime

NAL		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL3 - Old Langtonlees	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	36.5	39.2	43.2	48.7	48.7	48.7
	Predictions L_{A90}	-	-	26.4	27.3	31.8	**35.0 ***	**36.5 ***	37.2	37.5	37.9	37.9	37.9
	Exceedence Level	-	-	-8.6	-7.7	-3.2	**0.0**	**0.0**	-2.0	-5.7	-10.8	-10.8	-10.8

** Mode managed*

11.7.9. At some locations, under some wind conditions and for a certain proportion of the time operational wind farm noise would be audible; however, it would be at an acceptable level in relation to the ETSU-R-97 guidelines and there would be **no significant residual effects**.

11.7.10. The candidate wind turbine used for this assessment was chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Development receive consent, the final choice of wind turbine would be subject to a competitive tendering process. The final choice of wind turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

Residual Cumulative Effects

11.7.11. The predicted construction noise levels at all CNALs are significantly below the threshold levels (by at least 10 dB) such that any contribution from the Proposed Development would not increase the received noise levels attributable to other nearby construction activities above

the threshold levels at any CNAL. Accordingly, there would be **no significant residual construction noise effects.**

11.7.12. Predicted cumulative wind farm operational noise levels at all the NALs lie below the Total ETSU-R-97 daytime and night-time Noise Limits. There would be **no significant residual operational noise effects.**

11.8. Conclusions

11.8.1. Predicted construction noise levels compared with the Category A criteria outlined in BS5228 indicate that construction noise levels are below the guidelines considered acceptable at all receptors for all construction phases and therefore **no significant effects** are anticipated.

11.8.2. The guidance contained within ETSU-R-97 was used to assess the likely operational noise impact of the Proposed Development. Predicted levels and measured background noise levels indicate that for dwellings neighbouring the Site, wind turbine noise would meet the noise criteria established in accordance with ETSU-R-97, therefore the operational noise impact is **not significant**.

11.8.3. There are a range of wind turbine models that would be appropriate for the Proposed Development. The candidate wind turbine used for this assessment was chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Development receive consent, the final choice of wind turbine would be subject to a competitive tendering process. The final choice of wind turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

11.8.4. Predicted BESS and Solar Farm noise levels will be below the BS 8233 guideline levels, as well as the more stringent proposed noise level limit of 35 dB $L_{Aeq(1hour)}$. Therefore **no significant effects** are anticipated.

11.9. Statement of Competence

11.9.1. This Chapter was prepared by TNEI Services Ltd (TNEI). TNEI is a specialist energy consultancy with an Acoustics team which has undertaken noise assessments for over five gigawatts (GW) of onshore wind farm developments, 4 GW of BESS developments and several hundred Megawatts of solar projects.

11.9.2. The construction and BESS/ solar noise assessments have been reviewed and approved by Jim Singleton. Jim is a Principal Consultant who has over 16 years experience in undertaking a wide variety of noise assessments. Jim holds the Diploma in Acoustics and Noise Control and is a full member of the institute of Acoustics.

11.9.3. The operational assessment has been reviewed and approved by James Mackay. James is the Director of the Environment and Engineering team and has been undertaking operational noise assessments for wind farms for over 17 years. James Mackay is a Full Member of the Institute of Acoustics and holds the Diploma in Acoustics and Noise Control.