Chapter 13

Noise

SCOTTISHPOWER RENEWABLES

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13.1 Introduction

1. This Chapter of the Environmental Impact Assessment (EIA) Report evaluates the effect of the proposed Hollandmey Renewable Energy Development (hereafter 'the proposed Development') summarises the assessment of the potential noise effects of the proposed Development on the residents of nearby dwellings. Full details of the noise assessment can be found in the HL Technical Report, included in the EIA Report as **Technical Appendix 13.1 - Environmental Noise Assessment**. The assessment considers both the proposed Development's construction and its operation.

2. Assessment of the operational noise effects accounts for the cumulative effect of the proposed Development with other windfarms including the Lochend Windfarm (operational and adjacent to the west), Stroupster Windfarm (operational and approximately 3.5 km south east) and Slickly Windfarm (proposed and approximately 2.5 km to the south east). Other, more distant windfarms were not considered as their potential noise contribution was considered negligible.

3. For the construction phase, details of relevant working practices, traffic routes, and proposed working hours are described in **Chapter 3: Proposed Development**. In addition, the assessment of noise and vibration from traffic associated with the construction work is based on the assessment presented in **Chapter 12: Access, Traffic & Transport**.

13.2 Approach to Assessment and Methods

13.2.1 Legislation, Policy and Guidance

4. Whilst Scottish Planning Policy (SPP) suggests noise impacts are one of the aspects that will need to be considered in the context of an application for windfarm development, it provides no specific advice with regards to noise.

5. Planning Advice Note PAN1/2011 provides general advice on the role of the planning system in preventing and limiting the adverse effects of noise without prejudicing investment in enterprise, development and transport. PAN1/2011 provides general advice on a range of noise related planning matters, including references to noise associated with both construction activities and operational windfarms. In relation to operational noise from windfarms, Paragraph 29 states that:

6. *"There are two sources of noise from wind turbines - the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for Onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Windfarms' (ETSU-R-97) published by the former Department of Trade and Industry [DTI] and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise."*

7. The Scottish Government's Online Renewables Planning Advice on Onshore wind turbines provides further advice on noise and confirms that the recommendations of 'The Assessment and Rating of Noise from Windfarms' (ETSU-R-97) *"should be followed by applicants and consultees and used by planning authorities to assess and rate noise from wind energy developments".*

8. Guidance on good practice on the application of ETSU-R-97 has been provided by the Institute of Acoustics (IOA Good Practice Guide or GPG). This was subsequently endorsed by the Scottish Government which advised in the Online Renewables Planning Advice note that the GPG 'should be used by all IOA members and those undertaking assessments to ETSU-R-97'.

9. PAN1/2011 and the Technical Advice Note accompanying PAN1/2011 note that construction noise control can be achieved through planning conditions that limit noise from temporary construction sites, or by means of the Control of Pollution Act (CoPA).

10. The Control of Pollution Act (CoPA) 1974 provides two means of controlling construction noise and vibration. Section 60 provides the Local Authority with the power to impose at any time operating conditions on the development site. Section 61 allows the Applicant to negotiate a prior consent for a set of operating procedures with the Local Authority before commencement of site works.

13.2.2 Study Area

11. The study area for the assessment of operational noise includes the noise-sensitive residential properties nearest to the proposed turbines. In addition, properties in the vicinity of the other windfarms considered in the cumulative noise analysis were also considered. The locations considered are listed below in **Table 13.2** (also shown on **Figure B1 in Annex B** of **Technical Appendix 13.1**) and are located at approximate distances of up to 1.3 km to 2.5 km from the turbines of the proposed Development.

12. The assessment of construction noise has considered the same residential properties as the operational assessment, as well as dwellings located alongside the proposed route for the Site access track and associated construction traffic routes.

13.2.3 Effects Assessed in Full

13. The proposed Development includes the construction and operation of a Renewable Energy Development, including wind turbines, an energy storage facility, solar installation and ancillary infrastructure.

14. Noise and vibration which arises from the construction of this infrastructure is a factor which should be taken into account when considering the total effect of the proposed Development. However, when assessing the effects of construction noise, the temporary nature of the associated works can be taken into account. The main work locations for construction of the proposed turbines would be distant from the nearest noise sensitive residences and would be unlikely to cause significant effects. The construction and use of access tracks and some of the required infrastructure may, however, occur at lesser separation distances. Assessment of the temporary effects of construction noise is primarily aimed at understanding the need for dedicated management measures and, if so, the types of measures that are required. If there are requirements to decommission elements of the proposed Development, the activities involved would be less intensive than the construction process and would therefore have no additional effects. This is therefore not considered further in this noise assessment.

15. Once constructed and operating, wind turbines may emit two types of noise. Firstly, aerodynamic noise is a 'broad band' noise, sometimes described as having a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. This is a less natural sounding noise which is generally characterised by its tonal content. Traditional sources of mechanical noise comprise gearboxes or generators. Due to the acknowledged lower acceptability of tonal noise in otherwise 'natural' noise settings such as rural areas, modern turbine designs have evolved to minimise mechanical noise radiation from wind turbines. Aerodynamic noise tends to be perceived when the wind speeds are low, although at very low wind speeds the blades do not rotate or rotate very slowly and so, at these wind speeds, negligible aerodynamic noise is generated. In higher winds, aerodynamic noise is generally masked by the normal sound of wind blowing through trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise determines the subjective audibility of the development. The relationship between wind turbine noise and the naturally occurring masking noise at residential dwellings lying around the project area will therefore generally form the basis of the assessment of the levels of noise against accepted standards.

16. The following effects have been assessed in full:

- the potential effect of noise and vibration during construction of the proposed Development (including construction traffic and potential cumulative effects); and
- the potential effect of noise during operation of the proposed Development, including cumulative effects.

13.2.4 Effects Scoped Out

17. On the basis of the desk-based work undertaken, the professional judgement of the EIA team, experience from other relevant projects and policy guidance or standards, the following effects have been 'scoped out'.

18. The results of previous research (detailed in **Annex A** of **Technical Appendix 13.1)** has demonstrated that vibration resulting from the operation of wind turbines is imperceptible at typical separation distances. Therefore, vibration effects during operation do not warrant detailed assessment and have not been considered further as part of this Chapter.

19. The proposed Development would include a substation, solar array and ancillary services/battery energy storage system (BESS) which would emit some noise during operation (e.g. electrical plant and air conditioning systems). Given the separation distances between the substation and energy storage area to the nearest residential properties, experience of similar installations and professional judgement, the associated levels of operational noise would be negligible and not significant. Therefore, assessment of the associated effects does not warrant detailed assessment and have not been considered further as part of this Chapter.

20. The application boundary of the Site includes a minor road to the north, along which site construction traffic will pass to enter/leave the site entrance. There is potential that this road may require some upgrading or repair works following and during use. Control and management of this activity would be included within the Construction Traffic Management Plan (CTMP) which will covers the main construction activities, including restrictions. These works will be **'Minor'**, temporary and unlikely to cause significant noise effects. Accordingly, this activity does not warrant detailed assessment and has not been considered further as part of this Chapter.

13.2.5 Baseline Determination

21. The study area for the assessment includes residential dwellings located in the vicinity of both the proposed Development and the proposed construction routes. The proposed Development is located in an area of relatively low population density. The noise environment in the surrounding area is generally characterised by 'natural' sources, such as wind disturbed vegetation, birds, farm animals, water flow sounds as well as existing wind energy developments. Other sources of noise are likely to include agricultural vehicle movements in the area and occasional road traffic.

22. There are a number of other wind energy developments in the area around the proposed Development, two are operational, one proposed and subsequently refused and one which is proposed; for which a planning application have been submitted but not yet determined. Each of these other wind energy developments were required to consider baseline conditions in order to derive noise limits in accordance with ETSU-R-97 and undertake an appropriate noise assessment. A review of these adjacent sites has confirmed that suitable baseline background noise levels for all relevant noise sensitive receptors around the proposed Development have already been sufficiently defined for the purposes of an assessment in accordance with ETSU-R-97, accordingly additional baseline surveys were not undertaken for the proposed Development. The resulting data remain representative of the noise environment at these receptor locations. This approach also provides consistency when considering cumulative effects of the proposed Development and the appropriate noise limits / criteria which may apply to the proposed Development. This approach is consistent with technical guidance on current good practice in the application of ETSU-R-97, as described in the IOA GPG, as recommended in the Scottish Government's Online Renewables Planning Advice on Onshore wind turbines. On the basis of this baseline information, and in accordance with the guidance in ETSU-R-97, applicable noise limits / criteria were determined as detailed in **Technical Appendix 13.1**.

23. The methodology in ETSU-R-97 includes the following steps:

- identify the locations of the nearest, or most noise-sensitive, neighbours;
- determine the background noise levels as a function of site wind speed at the nearest neighbours, or at least at a representative sample of the nearest neighbours, either through direct measurement or by reference to data already obtained during previous surveys in the area; and
- determine the daytime and night-time noise limits from the measured background noise levels at the nearest neighbours.

24. There are a number of either residential or habitable dwellings in the vicinity of the Site. Preliminary studies were undertaken, based on the scoping layout and taking into account neighbouring schemes and their potential noise emission levels. It was determined that a detailed study of the cumulative noise effects of the proposed Development in combination with other windfarms be required at several of these receivers and a full assessment including cumulative effects is required. All noise sensitive receptors are listed below in **Table 13.1** and shown on **Figure B1** of **Annex B** in **Technical Appendix 13.1**.

25. In considering baseline data to inform the assessment, it is necessary to consider ETSU-R-97 is clear that the noise limits at residential properties should be set on the basis of background noise levels without contributions from existing windfarm noise. It is therefore necessary to take into account existing windfarms operating in the area and their potential contribution to the background noise.

26. As set out in **Annex C** of **Technical Appendix 13.1**, background noise data has already been surveyed at a number of receptor locations near to the proposed Development. The results of monitoring previously undertaken and how these would be used for this assessment were set out in the Scoping Report and accordingly, new measurements were not considered necessary. Furthermore, the underlying baseline noise environment (excluding the turbine noise) is expected to be relatively unchanged at these previous baseline survey locations, thereby meaning there would be limited utility in undertaking new measurements. Some of these previous measurements were referenced to wind speeds measured at slightly lower heights above the ground than height representative of turbines on the proposed Development, however further inspection and comparison of data available shows they are reasonably representative for the purposes of an assessment of the proposed Development (detail provided in **Annex C** of **Technical Appendix 13.1)**.

13.2.6 Data Sources

27. The following data sources have informed the assessment:

- Ordnance Survey information concerning the locations of all noise sensitive receptors in the vicinity of the Site;
- British Standard (BS) reference material for the sound emission characteristics of various construction activities associated with the proposed Development;
- manufacturer data for the candidate and operating turbines considered, as set out in **Technical Appendix 13.1;** and
- Environmental Statements and consent conditions for the different windfarms considered in the cumulative assessment.

13.2.7 Consultation

28. **Table 13.1** summarises the relevant consultation responses received and how these are considered in this Chapter.

Table 13.1: Consultation responses

Consultee	Summary of Key Issues	How this is addressed in this Chapter
The Highland Council (THC) Environmental Health Officer (EHO) 25 August 2020	Detailed consulation with the THC EHO, providing feedback on the approach proposed and aspects of the assessment to be included:-	
	• Proposed approach to baseline background noise levels would be acceptable.	Baseline data reviewed, compared and this is fully set out in the assessment.
	• A robust argument based on ETSU-R-97 criteria should be provided for the choice of the fixed part of the day-time noise limits.	Provided in the assessment (see **Technical Appendix 13.1** for detailed consideration).
	• Provide consideration of the duration and level of exposure of those nearby receptor locations which lay in between wind energy developments.	Provided in the assessment (see **Technical Appendix 13.1** for detailed consideration).

13.2.8 Approach to Assessment of Effects

Construction Noise and Vibration

30. Detailed guidance on construction noise and its control is provided by BS 5228-1 'Code of practice for noise and vibration control on construction and open sites' (2009, amended 2014). Analysis of construction noise impacts has been undertaken in accordance with the methodologies outlined in this standard, which provides methods for predicting construction noise levels on the basis of reference data for the emissions of typical construction plant and activities. These methods include the calculation of construction traffic along access tracks and haul routes, and construction activities at fixed locations including the bases of turbines, temporary construction compounds, and the substation. The construction noise assessment has been based on indicative data for the types of plant likely to be used during the construction works, as presented in BS 5228-1.

31. BS 5228-1 provides guidance on a range of considerations relating to construction noise including the legislative framework, general control measures, example methods for estimating construction noise levels and example criteria which may be considered when assessing effect significance. Similarly, BS 5228-2 provides general guidance on legislation, prediction, control and assessment criteria for construction vibration. Changes in the predicted traffic noise level on existing roads can be calculated using the Calculation of Road Traffic Noise (CRTN) methodology.

32. Planning Advice Note PAN50 'Controlling the Environmental Effects of Surface Mineral Workings' gives guidance on the environmental effects of mineral working. The main document summarises the key issues with regard to various environmental impacts relating to surface mineral extraction and processing such as road traffic, blasting, noise, dust, visual intrusion etc. In addition, several annexes to the main document have been published which consider specific aspects in more detail: Annex A, 'The Control of Noise at Surface Mineral Workings' and Annex D 'The Control of Blasting at Surface Mineral Workings'. BS 5228-1 and BS 5228-2 also provide guidance relating to surface mineral extraction including the assessment of noise and vibration effects associated with quarry blasting.

33. The noise-sensitive locations considered for the construction noise and vibration assessment include those closest to the proposed turbines and those considered in the operational noise assessment: see **Table 13.2**. Additional residential dwellings located alongside the two proposed routes for the Site access track and associated construction traffic routes, were also considered.

34. The nature of works and distances involved in the construction of the proposed Development are such that the risk of significant effects relating to ground borne vibration are very low (excluding blasting). Occasional momentary vibration can arise when heavy vehicles pass dwellings at very short separation distances, but again this is not sufficient to constitute a risk of significant effects in this instance. Accordingly, vibration impacts (excluding blasting) do not warrant detailed assessment and are therefore not discussed further in this Chapter.

35. The transmission and magnitude of ground vibrations associated with blasting operations at borrow pits are subject to many complex influences including charge type and position, and importantly, the precise nature of the ground conditions (material composition, compaction, discontinuities) at the source, receiver, and at every point along all potential ground transmission paths. Clearly any estimation of such conditions is subject to considerable uncertainty, thus limiting the utility of predictive exercises. Mitigation of potential effects of these activities is best achieved through onsite testing processes carried out in consultation with THC so as not to exceed relevant vibration levels at neighbouring properties. In accordance with the guidance in PAN50 Annex D, ground vibration caused by blasting operations would be considered acceptable if Peak Particle Velocity (PPV) levels, at the nearest sensitive locations, do not exceed 6 mm/s for 95% of all blasts measured over any six-month period, and no individual blast exceeds a PPV of 12 mm/s.

36. Because of the difficulties in predicting noise and air overpressure resulting from blasting operations at the proposed borrow pits, these activities are best controlled following the use of good practice during the setting and detonation of charges.

Operational Noise

37. The assessment of operational noise impacts has been carried out in accordance with the methodology set out in ETSU-R-97. ETSU-R-97 has become the accepted standard for such developments within the UK and is specified as the appropriate assessment and rating guidance for windfarms in current Scottish planning policy. It is described in more detail in **Technical Appendix 13.1**. Technical guidance on current good practice in the application of the ETSU-R-97 methodology, as described in the IOA GPG has also been referenced, as is recommended in the Scottish Government's Online Renewables Planning Advice on Onshore wind turbines (Scottish Government, 2014).

38. The exact model of turbine to be used at the Site would be the result of a future tendering process and therefore an indicative candidate turbine model has been assumed for the operational noise assessment. This model was determined to both fit the proposed turbine dimension parameters and also provide a representation of the typical noise emission levels for the range of turbine models which may be installed at the Site. Similarly, assessment of the substation, solar installation and ancillary services/energy storage has been made based on experience of similar installations.

39. To undertake the assessment of noise impact in accordance with the methodology in ETSU-R-97, the following steps are required:

- specify the number and locations of the wind turbines and other windfarms to be included in the assessment;
- determine the day-time and night-time noise limits from the measured background noise levels at the nearest neighbours (see above);
- specify the type and noise emission characteristics of the wind turbines;
- calculate noise immission levels from the operation of the turbines associated with the proposed Development as well as the contribution to cumulative noise immission levels from other nearby windfarms as a function of Site wind speed at the nearest neighbours; and
- compare the calculated wind turbine noise immission levels with the derived noise limits and assess in the light of planning requirements in consultation with the local planning authority.

40. Note the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the perceived noise) at any receptor location due to the combined operation of all wind turbines.

41. The noise limits defined in ETSU-R-97 relate to the total noise occurring at a dwelling due to the combined noise of all operational wind turbines. The assessment therefore needs to consider the combined operational noise of the proposed Development with other windfarms in the area to be satisfied that the combined cumulative noise levels are within the relevant ETSU-R-97 criteria. Full details of the operational noise assessment, including details of the noise output of the candidate turbine for the proposed Development and the calculation parameters on which predictions have been based, can be found in **Technical Appendix 13.1**.

42. The noise-sensitive locations considered in the operational noise assessment are set out in **Table 13.2**. Please note that this list of receptor locations is not intended to be exhaustive but sufficient to be representative of noise levels typical of those receptors closest to the Site.

Table 13.2: Table of noise-sensitive receptor locations near to the proposed Development at which noise effects have been assed.

Property	Easting	Northing	Approximate Distance to Closest Turbine (m)	Closest Turbine (ID)	Source of assessment criteria (see Annex C of Technical Appendix 13.1)
Brabstermire House	331549	969137	1424	HM10	Generic (Lyth WF)
Kevill	332398	969747	1864	HM10	Generic (Lyth WF)
Lochend 10(1)	327495	967732	1385	HM04	Syster (Lochend WF)
Lochend New Build	326879	968756	1826	HM03	Syster (Lochend WF)
Phillips Mains (Nearest)	329887	971953	1753	HM07	Generic (Lyth WF)
Slickly Croft	330192	966236	2452	HM04	Slickly Croft (Slickly WF)
Slickly (Nearest)	329471	966952	1463	HM04	Mooredge (Lyth WF)
Syster*	327028	969081	1653	HM01	Syster (Lochend WF FI) Syster (Lochend WF)

* *The Syster receptor location is financially involved with the Lochend Windfarm and accordingly has higher noise limits for a financially involved location, however reference has also been made to non-financially involved noise limits.*

44. The ETSU-R-97 day-time noise limit is derived from background noise data measured during so called 'quiet periods of the day', comprising weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of ten-minute background noise levels using the $L_{A90,10min}$ measurement index are measured contiguously over a wide range of wind speed conditions (a definition of the $L_{A90,10min}$ index is given in **Annex A** of **Technical Appendix 13.1**). The measured noise levels are then plotted against the simultaneously measured wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU-R-97 day-time noise limit is then set at a level 5 dB(A) above the best fit curve to the background noise data over a 0-12 m/s wind speed range.

45. For wind speeds where the best fit curve to the background noise data lies below a level of 30 dB(A) to 35 dB(A), the limit is set at a fixed lower level in the range 35 dB(A) to 40 dB(A). The precise choice of fixed limit within the range 35 dB(A) to

40 dB(A) depends on a number of factors: the number of noise affected properties, the likely duration and level of exposure and the consequences of the choice on the potential power generating capability of the wind turbines. These factors are discussed in **Technical Appendix 13.1** and concluded that; considering the population density of the area of the proposed Development and its immediate surroundings, the predicted noise levels for the proposed Development in relation to the measured background noise levels, the large generation capacity of the proposed Development alone and in combination with other adjacent windfarms, as well as consistency with permissions for adjacent windfarms, it is appropriate to set the day-time noise limit at 38 dB(A), within the range of 35 dB(A) to 40 dB(A).

46. The night time noise criterion curve is derived from background noise data measured during the night time periods (23:00 to 07:00) with no differentiation being made between weekdays and weekends. The ten-minute $L_{A90,10min}$ noise levels measured over these night time periods are again plotted against the concurrent wind speed data and a 'best fit' correlation is established. As with the day time limit, the night time noise limit is also based on a level 5 dB(A) above the best fit curve over the 0-12 m/s wind speed range. Where the night time noise limit is found to be below 43 dB(A) it is fixed at 43 dB(A). However, to be consistent with the preference of THC and other nearby windfarm consents, this fixed threshold has been set at 38 dB(A).

47. Where a property occupier has a financial involvement in a wind turbine development, the lower fixed portion of the noise limit at that property may be increased to 45 dB(A) during both the day time and the night time periods.

48. ETSU-R-97 also offers an alternative simplified assessment methodology: if predicted noise levels do not exceed 35 dB(A) up to 10 m/s, then they are considered acceptable and background noise surveys are not considered necessary.

Low Frequency Noise, Vibration and Iso

49. Low-frequency noise and vibration resulting from the operation of windfarms are all issues that have been discussed in detail over the past 20 years. Consequently, **Annex A** of **Technical Appendix 13.1** includes a detailed discussion of these topics. In summary of the information provided therein, the current recommendation is that ETSU-R-97 should continue to be used for the assessment and rating of operational noise from windfarms.

50. **Annex A** of **Technical Appendix 13.1** also discusses the most recently published research on the subject of wind turbine blade swish or Amplitude Modulation (or AM). The IOA has published an objective technique developed for quantifying AM noise. The UK Government also commissioned a review on subjective responses to AM noise which outlines considerations for the control of this feature based on the IOA methodology. The Scottish Government is currently reviewing this recommendation in the context of the Scottish planning system.

Noise Predictions

51. The predictions of construction noise were made using the methodology of BS 5228 and representative emission levels based on the types and number of equipment typically associated with key phases of constructing a renewable energy development. The predictions used conservative assumptions, such as considering when each activity would be closest to the neighbouring properties, and assuming the plant would operate for between 75% and 100% of the working day, on a conservative basis. This would represent the upper sound emission level during the day and actual noise levels are likely to be lower. Furthermore, the calculation has assumed there were no screening effects and the ground cover was 50% hard.

52. The level of construction noise that occurs at the surrounding properties would be highly dependent on a number of factors such as the final Site programme, equipment types used for each process, and the operating conditions that prevail during construction. It is not practically feasible to specify each and every element of the factors that may affect noise levels, therefore it is necessary to make reasonable allowance for the level of noise emissions that may be associated with key phases of the construction. The types and number of equipment associated with the key phases of constructing this proposed Development have been based on experience of similar sites. The conservative assumptions made would likely offset the uncertainty in the exact details of the construction activities.

53. For operational noise, the exact model of turbine to be used for the proposed Development would be the result of a future commercial tendering process and therefore an indicative candidate turbine model has been selected for the operational noise assessment. Specifically, the operational noise assessment is based upon the noise specification of the Siemens SG5.0 -132 wind turbine with a hub height of 84 m. Ten turbines have been modelled using the layout as indicated on the map in **Annex B** of **Technical Appendix 13.1.**

54. Assessment of the operational noise effects accounts for the cumulative effect of the proposed Development with existing windfarms nearby as set out above and in **Technical Appendix 13.1**. Other, more distant windfarms were not considered because their potential noise contribution was considered negligible and not significant.

55. **Technical Appendix 13.1** details the assumptions made for each of the cumulative sites considered. In each case, robust emission data was assumed, including an allowance for measurement uncertainty in line with IOA GPG requirements (see **Annex B** of **Technical Appendix 13.1**).

56. Operational noise predictions were made in accordance with the methodology recommended in the IOA GPG, which is based on the ISO (International Standards Organisation) 9631-2 standard, and assumes robust emission levels for the candidate turbine. The predictions are made assuming downwind propagation from every turbine, which will be over-stating noise levels in some cases, particularly in cases in which receptors are situated in between the proposed Development and a cumulative site and could not be downwind of both simultaneously. This aspect is given further consideration in **Technical Appendix 13.1** and additionally provides predicted noise immission levels which incorporate wind direction-based propagation effects (see **Annex E** of **Technical Appendix 13.1**).

13.2.9 Significance of Effect

57. BS 5228-1 indicates that a number of factors are likely to affect the acceptability of construction noise including Site location, existing ambient noise levels, duration of Site operations, hours of work, attitude of the Site operator and the noise characteristics of the work being undertaken. Based on the range of guidance values set out in BS 5228 Annex E, other reference criteria provided by the World Health Organization, the significance criteria presented in **Table 1** of **Technical Appendix 13.1** have been derived (replicated below as **Table 13.3**). The values have been chosen in recognition of the relatively low ambient noise typically observed in rural environments. The presented criteria relate to day time hours from 07:00 to 19:00 on weekdays, and 07:00 to 13:00 on Saturdays.

Table 13.3: Impact criteria for construction noise

Impact	Definition
Major	Construction noise is greater than 85 dB $L_{Aeq,T}$ for any part of the construction works or exceeds 75 dB $L_{Aeq,T}$ for more than 4 weeks in any 12 month period.
Moderate	Construction noise is less than or equal to 75 dB $L_{Aeq,T}$ throughout the construction period, with periods of up to 75 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.
Minor	Construction noise is generally less than or equal to 65 dB $L_{Aeq,T}$, with periods of up to 70 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.
Negligible	Construction noise is generally less than or equal to 60 dB $L_{Aeq,T}$, with periods of up to 65 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.

59. When considering the impact of short-term changes in traffic, associated with the construction activities, on existing roads in the vicinity of the Site, reference can be made to the criteria set out in the Design Manual for Roads and Bridges (DMRB). A classification of magnitudes of changes in the predicted traffic noise level is set out: for short-term changes, such as those associated with construction activities, a difference of less than 1 dB(A) are considered **'Negligible'**, 1 to 3 dB(A) is **'Minor'**, 3 to 5 dB(A) **'Moderate'** and changes of more than 5 dB(A) constitute a **'Major'** impact. This classification can be considered in addition to the criteria of **Table 13.3**, which can be applied when considering absolute levels of noise from construction traffic alone, as can be calculated using the haul route method included in BS 5228-1.

60. **'Major'** or **'Moderate'** construction impacts are considered **'Significant'** in the context of the EIA Regulations.

61. The acceptable limits for wind turbine operational noise are clearly defined in ETSU-R-97. Consequently, the test applied to operational noise is whether or not the calculated windfarm noise immission levels at nearby noise sensitive properties lie below the noise limits derived in accordance with ETSU-R-97. If predicted noise levels are within the ETSU-R-97derived noise limits, operational noise is considered acceptable, and therefore not significant in EIA terms. If predicted noise levels are above the ETSU-R-97 noise limits, operational noise is considered unacceptable and significant in EIA terms.

13.2.10 Limitations to the Assessment

62. For construction noise, the types and number of equipment usually associated with the key phases of constructing the proposed Development have been based on experience of similar sites and assumed to operate between 75% and 100% of the working day, on a conservative basis. This would represent the upper sound emission level during the day and actual noise levels are likely to be lower. Furthermore, the calculation has assumed there were no screening effects and the ground cover was 50% hard. These conservative assumptions would likely offset the uncertainty in the exact details of the construction activities.

63. For operational noise, the exact model of turbine to be used at the proposed Development would be the result of a future commercial tendering process and therefore an indicative candidate turbine model has been selected for the operational noise assessment. The turbine model assumed are considered representative of the range of noise emissions for turbines which may be installed at the Site. For operational, proposed or consented sites, robust assumptions of the potential noise emissions which may be allowed for each of these sites under their consent was made in line with current good practice.

13.3 Baseline Conditions

64. The study area for the assessment includes residential dwellings located in the vicinity of both the proposed Development and the proposed construction route options. The proposed Development is located in an area of relatively low population density. The noise environment in the surrounding area is generally characterised by 'natural' sources, such as wind disturbed vegetation, flowing water, birds and farm animals. Other sources of noise include intermittent distant commercial aircraft and operational wind turbines on those sites which have been constructed.

65. There are a number of other wind energy developments in the area around the proposed Development, some of which are operational, some consented but not yet operational and others which are proposed; for which planning applications have been submitted but not yet determined. Each of these other wind energy developments were required to consider baseline conditions in order to derive noise limits in accordance with ETSU-R-97 and undertake an appropriate noise assessment. A review of these adjacent sites has confirmed that suitable baseline background noise levels for all relevant noise sensitive receptors around the proposed Development have already been sufficiently defined for the purposes of an assessment in accordance with ETSU-R-97, accordingly additional baseline surveys were not undertaken for the proposed Development. The resulting data remain representative of the noise environment at these receptor locations. This approach also provides consistency when considering cumulative effects of the proposed Development and the appropriate noise limits / criteria which may apply to the proposed Development. This approach is consistent with technical guidance on current good practice in the application of ETSU-R-97, as described in the IOA GPG, as recommended in the Scottish Government's Online Renewables Planning Advice on Onshore wind turbines. On the basis of this baseline information, and in accordance with the guidance in ETSUR97, applicable noise limits / criteria were determined as detailed in **Technical Appendix 13.1.**

13.3.1 Noise Limits / Criteria

66. Eight noise sensitive receptor locations have been considered at which assessment of noise from the proposed Development has been completed, as listed in **Table 13.2** and shown on the plan in **Annex C** of **Technical Appendix 13.1**. This list is not intended to be exhaustive but sufficient to be representative of noise levels typical of those receptors closest to the proposed Development. Those receptors which are further from the proposed Development would be less exposed to noise from the proposed Development, with consequently reduced effects, and are not considered further. This approach is consistent with the guidance provided by ETSU-R-97 and current good practice as set out in the IOA GPG.

13.4 Assessment of Effects

13.4.1 Construction

13.4.1.1 Potential Construction Effects

67. Predicted noise levels at the closest noise sensitive receptors for each of the key activities during construction of the proposed Development are presented in **Table 6** of **Technical Appendix 13.1**. The proposed construction activities would generally occur at large distances from the residential properties considered, such that the resulting predicted noise levels would not exceed 54 dB L_{Aeq}. With reference to the derived criteria of **Table 13.3**, the noise impact from these activities would therefore be **'Negligible'**.

68. For the main access track upgrades and associated forestry work, these activities are closest to West Lodge (328899, 972263) near the site entrance, resulting in increased noise levels predicted on a worst-case basis (84 dB L_{Aeq} for the track upgrades and 79 dB L_{Aeq} for associated forestry works). These noise levels are likely to represent those for a very short-term period of around one week. Noise levels would quickly diminish as track upgrading progresses, quickly moving the activity further from the property. Considering the short duration of the work, along with the likelihood of the levels being lower in practice and the criteria of **Table 13.3**, the associated effects are predicted to result in a temporary **'Minor'** effect, which is '**Not Significant'** in EIA terms.

69. If blasting is employed to win stone from the proposed borrow pits, there is a potential for this to affect the nearest properties. These activities are best controlled through a monitoring programme and following the use of good practice during the setting and detonation of charges, as set out in this Chapter and in the proposed mitigation section (**Section 13.5.2.3**).

70. In addition to onsite activities, construction-related traffic passing to and from the Site would also represent a potential source of noise to surrounding properties. Based on the prediction methodology in BS 5288, the worst-case predicted noise level, due to heavy vehicles moving on the site access track, at the closest dwelling is 56 dB L_{Aeq}. This corresponds to a **'Negligible'** impact. The effect of traffic on existing roads was assessed using the CRTN methodology, with a maximum predicted increase of 1.3 dB(A) in the day-time average noise level. Based on the criteria set out in the DMRB, this predicted short-term change in traffic noise levels corresponds to a **'Negligible'** impact. For those roads with low traffic flows (less than 100 vehicles per day), the CRTN methodology cannot be directly applied, however based on the predicted noise levels that CRTN suggests for the lowest flow value, it can be deduced that noise related to construction vehicle would be below 60 dB L_{Aeq} and would correspond to a temporary **'Minor'** effect at most. In conclusion, noise from construction activities has been assessed and is predicted to result in a temporary **'Minor'** effect, which is'**Not Significant'** in EIA terms.

13.4.1.2 Embedded Mitigation Measures

71. An outline Construction Environment Management Plan (CEMP) is provided in **Appendix 3.1**. The final CEMP would be secured through a planning condition. This would include measures to control construction noise including:

- as proposed in **Chapter 3: Proposed Development,** construction works that may give rise to audible noise at the surrounding properties and heavy goods vehicle deliveries to the Site would be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays, unless otherwise approved in advance by THC (except in case of an emergency);
- all construction activities shall adhere to good practice as set out in BS 5228;
- all equipment would be maintained in good working order and any associated noise attenuation such as engine casing and exhaust silencers shall remain fitted at all times;
- where flexibility exists, activities would be undertaken away from residential properties, set back by the maximum possible distances;
- a Construction Traffic Management Plan would be developed to control the movement of vehicles to and from the Site, including the above described restrictions for Access Route B;
- construction plant capable of generating high noise and vibration levels would be operated in a manner to restrict the duration of the higher magnitude levels; and
- in particular, if noise-generating activities could occur outside of the stated working hours, this could potentially lead to increased effects of potentially **'Minor'** significance, but it is considered unlikely that significant effects could arise due to construction due to the large distances involved for the proposed activities in the wide majority of cases.

13.4.1.3 Proposed Mitigation

72. Unless otherwise agreed in consultation with THC, for example due to large separation distances, if blasting is to be employed at some of the borrow pits, the potential noise and vibration effects of blasting operations would be reduced (unless otherwise agreed with THC due to important separation distances) according to the guidance set out in the relevant BS and PAN50 Annex D:

- blasting should take place under controlled conditions with the agreement of the relevant authorities, at regular times within the working week, that is, Mondays to Fridays, between the hours of 10:00 and 16:00. Blasting on Saturday mornings should be a matter for negotiation between the contractor and THC;

- vibration levels at the nearest sensitive properties are best controlled through onsite testing processes carried out in consultation with THC. This site testing-based process would include the use of progressively increased minor charges to gauge ground conditions both in terms of propagation characteristics and the level of charge needed to release the requisite material. If required, the use of onsite monitoring at neighbouring sensitive locations during the course of this preliminary testing can then be used to define upper final charge values that would ensure vibration levels remain within the criteria set out previously, as described in BS 5228-2 and BS 6472-2;
- blasting operations would adhere to good practice as set out in BS 5228-2, and in PAN50, Annex D, Paragraph 95 in order to control air overpressure; and
- a scheme would be submitted to THC for approval of blasting details, which would outline the mitigation measures to be adopted.

13.4.1.4 Residual Construction Effects

73. The adoption of the identified mitigation measures would reduce the potential noise and vibration effects during construction and restrict noisy activities occurring outside of the range of hours on which the construction criteria were based. Comparing the predicted noise levels to the typical background noise levels measured for other developments around the proposed Development suggests that the noisier construction activities could be audible at various times throughout the construction phase. However, based on the considerations presented above, the associated effects would be a **'Negligible'** to **'Minor'** temporary adverse impact and therefore '**Not Significant'**.

13.4.2 Operation

13.4.2.1 Potential Operational Effects

74. The predictions of operational noise for the proposed Development in isolation at the noise-sensitive locations of **Table 13.2** are detailed in **Table 8** of **Technical Appendix 13.1.** These varied between 21-27 dB(A) at low wind speeds and 30-36 dB(A) at high wind speeds. Similarly, tabular values of predicted noise levels are provided for the other windfarms included in the cumulative assessment. Cumulative predicted noise levels are shown in **Table 12** of **Technical Appendix 13.1**. The full ETSU-R-97 cumulative assessment accounted for operational noise of the proposed Development together with the adjacent operating Lochend Windfarm, the operational Stroupster Windfarm as well as the proposed Slickly Windfarm. This cumulative assessment is based upon assuming Slickly Windfarm operates with constraints required to meet the noise limits recommended by THC (see **Annex C** of **Technical Appendix 13.1**).

75. Predicted cumulative operational noise levels varied between 28-34 dB(A) at low wind speeds and 37-42 dB(A) at high wind speeds. These predictions are also overlaid on the ETSU-R-97 derived noise limits in the charts of **Annex D** in **Technical Appendix 13.1**. The assessment presented within **Table 14** and **Table 15** of **Technical Appendix 13.1** demonstrates that the derived ETSU-R-97 noise limits (**Table 4** and **Table 5** of **Technical Appendix 13.1**) are predicted to be achieved in the cumulative case at all wind speeds and all assessment locations except at three receptors, where marginal excesses were predicted of a maximum of 0.7 dB(A) for wind speeds of 7 m/s and 8 m/s.

76. The marginal predicted excesses above the cumulative noise limits can be mitigated by application of some constraints to the proposed Development. These constraints are defined by deriving site-specific noise limits, which if applied to the proposed Development alone would result in cumulative noise levels being compliant with the cumulative criteria. Satisfactory control of cumulative noise immission levels would then be achieved through enforcement of the individual consent limits for each of the individual windfarms. Specific noise limits for the proposed Development are set out in **Table 16** and **Table 17** of **Technical Appendix 13.1**, with relevant limit values assuming, on a precautionary basis, that the adjacent Slickly Windfarm is consented. Relevant limits values were determined such that compliance of the proposed Development with these noise limits would maintain the conclusion of the cumulative assessment and result in cumulative levels which do not exceed the derived ETSU-R-97 noise criteria. Should the adjacent Slickly Windfarm not be consented then apportioned limits could still be applied to the proposed Development, but these should be revised accordingly.

77. Revised predicted noise levels are provided (**Table 18** of **Technical Appendix 13.1**) for the three receptor locations where an excess above the cumulative criteria was predicted and which show how constraints applied on the proposed Development would yield noise levels compliant with the site-specific noise limits (see **Table 19** and **Table 20** of **Technical Appendix 13.1**). The selection of the final turbine to be installed at the proposed Development would be made on the basis of enabling these derived site-specific noise limits to be achieved at surrounding properties, including any relevant character corrections.

78. Conditions attached to the planning consent should include the requirement that, in the event of a noise complaint, noise levels resulting from the operation of the proposed Development are measured in order to demonstrate compliance with the noise limits. Such monitoring should be done in full accordance with ETSU-R-97 and current good practice and include penalties for characteristics of the noise (if present).

13.4.2.2 Embedded Measures

79. The layout of the proposed Development has been iteratively developed so as to achieve an acceptable noise impact on local residential amenity, based on a representative candidate turbine model, whilst maintaining as far as possible the generation capacity of the proposed Development (in addition to other design considerations). This included consideration of including for the cumulative effects of neighbouring windfarms where relevant as well as consideration of the significant reduction in the energy generating potential that could be accommodated, were the fixed threshold of the ETSU-R-97 day-time limit set at 35 dB(A). Specifically, the process involved the calculation of noise emission levels for the original outline scheme configuration, and layout design advice was provided on this basis to the design team to demonstrate compliance with successive iterations, based on the fixed threshold of the ETSU-R-97 noise limit set at 38 dB(A) during both day-time and night-time periods.

13.4.2.3 Proposed Mitigation

80. The selection of the final turbine to be installed at the Site would be made on the basis of enabling the ETSU-R-97 noise limits to be achieved at surrounding properties, including any relevant tonality corrections. This could be by application of site-specific noise limits which would apply to the proposed Development alone (see **Table 16** and **Table 17** of **Technical Appendix 13.1)**. Some constraints are predicted to be required for the proposed Development when deriving site-specific noise limits (which would apply to the proposed Development alone), when these are derived from cumulative noise limits based on the choice of 38 dB(A) for the fixed part of the day-time and night-time limits. These constraints would not be required if site-specific noise limits were alternatively derived from limits allowed in accordance with ETSU-R-97, of 40 dB(A) day-time and 43 dB(A) night-time.

13.4.2.4 Residual Operational Effects

81. The basis of the ETSU-R-97 method is to define acceptable noise limits thought to offer reasonable protection to residents in areas around windfarm developments. At some locations under some wind conditions and for a certain proportion of the time, the proposed Development noise may be audible; however, operational noise immission levels are acceptable in terms of the guidance commended by planning policy for the assessment of windfarm noise, and therefore considered '**Not Significant'** in EIA terms.

13.5 Summary and Statement of Significance

82. On the basis of the embedded measures and proposed mitigation set out, any residual significant noise or vibration effects are predicted to be '**Not Significant'**.

13.6 References

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