CLOICH FOREST WIND FARM

EIA Report – Volume 1 – EIA Report Text

Chapter 11

Noise

ARCUS

11 NOISE

11.1 INTRODUCTION

1. This Chapter of the Environmental Impact Assessment Report (EIA Report) evaluates the effects of noise from the Cloich Forest Wind Farm ('the Development') upon nearby noise-sensitive receptors.

2. This assessment was undertaken by Arcus Consultancy Services Limited (Arcus).

3. This Chapter of the EIA Report is supported by the following Figures provided in Volume 2a Figures excluding LVIA:

   - Figure 11.1: Noise Contour Plot.

4. This chapter includes the following elements:

   - Legislation, Policy and Guidance;
   - Assessment Methodology and Significance Criteria;
   - Baseline Conditions;
   - Assessment of Potential Effects;
   - Mitigation and Residual Effects;
   - Cumulative Effect Assessment;
   - Summary of Effects;
   - Statement of Significance; and
   - Glossary.

11.2 LEGISLATION, POLICY AND GUIDANCE

11.2.1 Legislation

5. The following legislation documents are of particular relevance to the assessment:

   - The Control of Pollution Act 1974 (CoPA 1974)[1]; and
   - The Environmental Protection Act 1990 (EPA 1990)[2].

11.2.1.1 The Control of Pollution Act 1974

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

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

8. Section 61 of the CoPA 1974 allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works; this is not mandatory. It does not, however, prevent nuisance action under Section 82 of the EPA 1990. The Application is expected to give as much detail as possible about the works to be carried out, the methods to be used, and the measures that will be taken to minimise noise and vibration.

[1] UK Government (1974). The Control of Pollution Act 1974. [Online] Available at: http://www.legislation.gov.uk/ukpga/1974/40 (Accessed 15/06/2021)
[2] UK Government (1990). The Environmental Protection Act 1990. [Online] Available at: http://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 15/06/2021)

11.2.1.2 The Environmental Protection Act 1990

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

11.2.2 Policy and Guidance

10. The following key policy and guidance has been considered in carrying out this assessment.

11.2.2.1 Construction Noise

11. Guidance relevant to the effects of noise and vibration during construction and decommissioning is provided by BS 5228[3]. This standard:

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

11.2.2.2 Operational Noise

12. Guidance relevant to the effects of noise during operation is provided in the following guidance and information sources:

- The Scottish Government's web-based planning information on onshore wind turbines[4];
- Planning Advice Note 1/2011 (PAN 1/2011): Planning and Noise[5];
- ETSU-R-97: The Assessment and Rating of Noise from Wind Farms[6]; and
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise[7].

[3] BS 5228:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites – Part 1: Noise and Part 2: Vibration.
[4] Scottish Government (2014) Onshore Wind Turbines Planning Advice [Online] Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ (Accessed 15/06/2021)
[5] The Scottish Government (2011) Planning Advice Note PAN 1/2011 Planning and Noise and accompanying Technical Advice Note, 2011.
[6] ETSU 1996 ETSU-R-97 The Assessment and Rating of Noise from Wind Turbines, ETSU for the DTI, 1996.
[7] A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind turbine Noise, IOA, 2013.

The Scottish Government's web-based Planning Information on Onshore Wind Turbines

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

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

PAN 1/2011

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

ETSU-R-97

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

17. Both background noise and noise from wind turbines typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.

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

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

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

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

21. ETSU-R-97 recommends that the fixed lower noise limit for daytime should be set within the range 35 to 40 dB, $L_{A90,10min}$, with choice of value dependent on the following factors:

    i) The number of dwellings in the neighbourhood of the Development;
    ii) The effect of the noise limits on the number of kilo Watt hours (kWh) generated; and
    iii) The duration and level of exposure.

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

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

24. A 'simplified criterion' is also described which is applicable where there are large separation distances between the proposed turbines and nearest noise-sensitive receptors. In such cases, a fixed limit of 35 dB, $L_{A90,10min}$ applies, without reference to background noise levels.

The IOA Good Practice Guide

25. The Good Practice Guide (GPG) was published by IOA in May 2013 and has been endorsed by the Scottish Government as current industry good practice. The GPG is supported by a suite of six Supplementary Guidance Notes (SGNs)[8]. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind turbine developments at the various stages of the assessment process. The recommendations provided in the GPG been followed throughout this assessment.

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

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

[8] Institute of Acoustics, Good Practice Guide Supplementary Guidance Notes 1 – 6, 2014.

11.2.2.3 Low-Frequency Noise and Infrasound Studies

28. A study[9], published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the Department of Trade and Industry (DTI), investigated low frequency noise from wind farms. This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines, but that complaints attributed to low frequency noise were in fact, possibly due to a phenomenon known as Amplitude Modulation (AM).

29. Further, in February 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms[10]. This study measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shut downs of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.

30. Bowdler et al. (2009)[11] concludes that:

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

11.2.2.4 Research into Amplitude Modulation

31. A study[12] was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with AM. This report defined AM as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency (occasionally referred to elsewhere as 'other AM' (OAM)). Its aims were to ascertain the prevalence of AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

32. The study concluded that AM has occurred at only a small number of wind farms in the UK (4 of 133), and only for between 7% and 15% of the time. It also states that, at the time of writing, the causes of AM were not well understood and that prediction of the effect was not currently possible.

33. This research was updated in 2013 by an in-depth study undertaken by Renewable UK[13], which identified that many of the previously suggested causes of AM have little or no association to the occurrence of AM in practice. The generation of AM is based upon the interaction of a number of factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM, and the incidence of AM occurring at any particular site remains low, as identified in the University of Salford study.

[9] The measurement of low frequency noise at three UK wind farms, Hayes Mckenzie, The Department for Trade and Industry, URN 06/1412, 2006.
[10] Environment Protection authority (2013) Infrasound levels near wind farms and in other environments [Online] Available at: http://www.epa.sa.gov.au/xstd_files/Noise/Report/infrasound.pdf (Accessed 15/06/2021)
[11] Bowdler et al. (2009). Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects. Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics.
[12] Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.
[13] Renewable UK, 2013: Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects.

34. In 2016, the IOA proposed a measurement technique[14] to quantify the level of AM present in any particular sample of wind farm noise. This technique is supported by the Department of Business, Energy & Industrial Strategy (BEIS, formerly the Department of Energy & Climate Change) who have published guidance[15], which follows on from the conclusions of the IOA study in order to define an appropriate assessment method for AM, including a penalty scheme and an outline planning condition. Notwithstanding this, the suggested outline planning condition is as yet unvalidated, remains in a draft form and would require site-specific legal advice on its appropriateness to a specific development.

35. Section 7.2.1 of the GPG therefore remains current, stating:

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

36. In summary the incidence of AM occurring at any particular site is low; it is not possible to predict whether any particular site is more or less likely to give rise to AM, and no appropriate planning condition has yet been established. As such, it is not considered necessary to carry out a specific assessment of AM.

11.2.2.5 Vibration

37. Research undertaken by Snow[16] found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992[17], and were lower than limits specified for residential premises by an even greater margin.

38. Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres (km) from the wind farm site as reported by Keele University[18]. This report clearly shows that, although detectable using highly sensitive instruments, the magnitude of the vibration is orders of magnitude below the human level of perception and does not pose any risk to human health.

[14] Institute of Acoustics, (2016) A Method for Rating Amplitude Modulation in Wind Turbine Noise
[15] BEIS, (2016), Review of the evidence on the response to amplitude modulation from wind turbines.
[16] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow.
[17] BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)
[18] Microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms: recommendations on the siting of wind farms in the vicinity of Eskdalemuir, Scotland". Keele University, 2005

11.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

11.3.1 Scoping Responses and Consultations

39. Consultation for this EIA Report topic was undertaken with the organisations shown in Table 11.1.

Table 11.1 Consultation Responses

Consultee	**Scottish Borders Council (Environmental Health)**	
Type and Date	**Scoping Response 15 November 2019**	
Topic	**Comment**	**Response**
Operational Noise	A noise impact assessment should be undertaken in accordance with ETSU-R-97 and having regard to the methods described in the Institute of Acoustics Good Practice Guide to the Application of ETSU-R-97.	The stated guidance has been followed throughout this Chapter.
Operational Noise	The assessment should detail the following: (a) Accurate twelve-digit grid references for the turbines; (b) Accurate twelve digit-grid references for the noise sensitive receptors; (c) Elevations of turbines and receptors; (d) Details of any financial involvement at noise sensitive receptors; (e) Sound power level details for the turbine, in its intended mode of operation. Broadband and A-weighted octave band data required, together with uncertainty figures and any tonal penalty; (f) Ground factor used; (g) Atmospheric conditions for A_{atm}; (h) Propagation height; (i) Unless it can be shown that it would be possible to meet the simplified noise condition of 35 dB LA90 (10 min) at wind speeds up to 10m/s measured at 10m height, then a background noise survey will require to be carried out. (j) The cumulative noise effect from existing, consented or approved wind turbines. When considering the cumulative effect of other turbines, regard should be had to the consented noise levels detailed in the approval. (k) Information regarding any valley effect. It will be necessary to demonstrate whether or not, a 3 dB correction is required in respect of the valley significantly sloping ground effect.	(a) See Table 11.2 (b) See Table 11.5 (c) See Tables 11.2 and 11.5 (d) See Section 11.4.2 (e) See Tables 11.3 and 11.4 (f) – (h) See Section 11.3.6.1 (i) The noise limits applicable to the Development in isolation have been set in the planning conditions associated with existing Section 36 consent and deemed planning permission for the Cloich Forest Wind Farm (Planning and Environmental Appeals Division Reference: WIN-140-1) (the Consented Scheme). The Development has been assessed against these limits and as such, no further baseline noise surveys are required. (j) See Section 11.3.2.1 (k) Section 11.3.6.1
Background Noise	If background surveys are carried out then the following details are required: • Wind shear methodology • Best fit curve polynomials for daytime and night time (there must be sufficient data collected across the range of wind speeds from 4 m/s to 12 m/s	The noise limits applicable to the Development in isolation have been set in the planning conditions of the Consented Scheme. The Development has been assessed against these limits and as such, no

Consultee	**Scottish Borders Council (Environmental Health)**	
Type and Date	**Scoping Response 15 November 2019**	
Topic	**Comment**	**Response**
	• Location of monitoring positions • Method to record rainfall (noise data affected by rainfall or extraneous noise sources e.g. dawn chorus, agricultural activities, aircraft etc. should be excluded). • Equipment used including the type of wind shield fitted to the microphone (the preferred wind shield is a large diameter double layer item). A standard wind shield may not be suitable and it is recommended that the sound level meter manufacturer be consulted to confirm the suitability of any wind shield used.	further baseline noise surveys are required.
Cumulative Noise	When considering the cumulative impact of large and small wind turbines the preferred option is to use the ETSU-R-97 guidance for large wind and the BWEA guidance for small wind and add the two together. As mentioned in (j) above, when considering the cumulative effect of other turbines regard should be had the consented noise levels detailed in the approval.	See Section 11.3.2.1
Construction Noise	The applicant should provide information on construction noise and how this will be mitigated.	See Sections 11.3.3.1 and 11.6.1

11.3.2 Scope of Assessment

11.3.2.1 Operational Noise

40. The key issue for the assessment of potential noise effects relating to the Development is operational noise.

41. Typically, the operational noise assessment process comprises of:

    i) Identification of potential receptors, i.e. residential properties and other potentially noise-sensitive locations;
    ii) Measurement of prevailing, wind speed dependant background noise levels at nearby properties (if required);
    iii) Establishment of limits for acceptable levels of wind turbine noise;
    iv) Prediction of the likely levels of wind turbine noise received at each receptor; and
    v) Comparison of the predicted levels with the noise limits.

42. Where the distance between the Development wind turbines and nearest noise-sensitive receptors is such that predicted noise levels are no greater than the simplified criterion of 35 dB, $L_{A90,10min}$ defined in ETSU-R-97 in wind speeds measured on site of up to 10 m/s, the measurement of background noise is unnecessary, as the assessment is based on the simplified criterion.

43. With specific regard to the Development, noise limits were established as part of the EIA process for the application for a wind farm, which obtained Section 36 consent and deemed planning permission in July 2016 (Planning and Environmental Appeals Division

Reference: WIN-140-1) ('the Consented Scheme'). These were derived in full accordance with current best practice, considered in detail during the Public Local Inquiry (PLI) for the Consented Scheme and are detailed in the respective planning conditions. As such, the aim of this Chapter is to assess noise due to the Development against the extant noise limits, which remain appropriate.

11.3.2.2 Cumulative Noise Assessment

44. ETSU-R-97 states that the assessment should take account of the effect of noise from all wind turbines that may affect a particular receptor. In order to facilitate this, a cumulative search was conducted to identify any wind turbines either operational, consented, or proposed (subject of a current planning application).

45. A list of cumulative sites is provided in Table 5.7 of **Chapter 5: Landscape and Visual Impact Assessment**. The closest cumulative development either in planning, consented, or operational has been identified as Bowbeat Wind Farm, located approximately 6 km east of the Development at the closest point on the respective development boundaries (8.6 km between the respective development centres).

46. No developments have been identified within 5 km of the Development (the distance at which other developments considered to have the potential to result in cumulative noise impacts). It is also of note that the cumulative scenario in the local area (i.e., within 5 km) remains the same as that considered in the noise assessment for the Consented Scheme[19] (i.e., the scenario upon which the noise limits for the Consented Scheme were determined remains the same).

47. Given the substantial distance from the Development to cumulative developments, and in line with the noise assessment for the Consented Scheme, there is no reasonable prospect of a significant cumulative effect. It should be noted that the Development, if consented, will replace the Consented Scheme in its entirety, so there can be no cumulative effects in this regard.

48. Cumulative effects therefore do not require further consideration in this assessment.

11.3.3 Elements Scoped Out of Assessment

11.3.3.1 Construction and Decommissioning Noise / Vibration

49. Construction noise effects resulting from the Consented Scheme were found to be not significant, and are controlled through planning conditions requiring the application of best practice noise management measures. Construction noise effects due to the Development are likely to be less than those of the Consented Scheme, given the reduced number of turbines.

50. Substantial sections of infrastructure remain the same as those assessed as part of the Consented Scheme, and any new infrastructure proposed as part of the Development will be located further from residential dwellings than that already consented.

51. Given the above, there is no reasonable prospect of a significant impact arising from construction noise effects. Notwithstanding this, and as requested in Scottish Borders Council's ('the Council') Scoping Response, best practice mitigation measures are outlined in Section 11.6.1 and are to be adopted as advocated in BS 5228.

52. Construction noise will be limited in duration and confined to working hours as specified by the Council which can be adequately controlled through planning condition. On this basis, no further assessment of construction noise is considered necessary.

[19] Hoare Lea Acoustics (2012) Cloich Forest Wind Farm Environmental Assessment - Noise & Vibration. Document Reference REP-1004308-MMC-280812-Appendix 12.1-2.

53. Noise produced during decommissioning of the Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with. On this basis, no further assessment of decommissioning noise is considered necessary.

54. Given the large separation distances to the closest receptors, no significant vibration effects are anticipated and this has not been considered further in this Chapter.

11.3.3.2 Battery Energy Storage System

55. As described in **Chapter 3: Project Description**, the Development includes a battery energy storage system (BESS). Based upon Arcus' substantial experience of such facilities, they emit relatively low levels of noise; the BESS is likely to comprise of eight battery containerised modules, forming four units in total. The primary noise source of the BESS is considered to be the air conditioning units used to regulate the temperature of the BESS. Given this, coupled with the substantial (approximately 1.7 km) separation distance between the BESS facility and the closest noise-sensitive receptor, there is no reasonable prospect of a significant effect. This element has therefore not been considered further.

11.3.4 Study Area / Survey Area

56. The Study Area comprises the area where worst-case noise levels from the Development are greater than 35 dB, $L_{A90,10min}$, being the most stringent ETSU-R-97 noise limit (i.e., the simplified assessment criterion). The study area is illustrated on Figure 11.1 by the purple 35 dB, $L_{A90,10min}$ contour line.

11.3.5 Design Parameters

11.3.5.1 Development Layout

57. The Development turbine layout is presented in Figure 11.1, with grid references and elevations of each turbine detailed in Table 11.2.

Table 11.2 Development Layout

Turbine Number	Easting	Northing	Elevation Above Ordnance Datum (AOD), metres (m)
1	319967	646980	489
2	320015	645991	484
3	320558	646130	485
4	320947	646570	473
5	321167	647062	465
6	320149	647527	525
7	320425	646942	466
8	320616	647950	532
9	320830	647414	477
10	320594	648446	531
11	320190	648389	501
12	320212	648875	521

11.3.5.2 Micrositing

58. As set out in **Chapter 3: Project Description**, a 50 m micro-siting allowance has been included to avoid any further as yet unknown environmental or technical constraints. In the event that a turbine is required to be micro-sited closer to any noise-sensitive receptor identified in Table 11.5 of this Chapter than is currently proposed, predicted noise levels will be updated, and assessed against the noise limits specified in the Development's planning conditions. In the unlikely event that an exceedance of noise limits is identified as a result of micrositing, a noise mitigation scheme will be developed, operating one or more turbines in a reduced-noise mode under the required wind speeds and / or wind directions in order to ensure compliance with noise limits is maintained.

11.3.5.3 Candidate Turbine Emission Data

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

60. The Nordex N133 4.8 Megawatt (MW) wind turbine, with a hub height of 83 m, has been selected as the candidate turbine for this assessment. This assessment assumes the turbines are fitted with the serrated trailing edge (STE) blades, and operates at full power (Mode 0) at all times. The manufacturer's noise emission documentation excludes any margin for uncertainty; therefore, in accordance with the GPG, an additional 2 dB has been included in the sound power levels in this assessment, as detailed in Table 11.3.

Table 11.3: Manufacturer's Noise Emission Data – Nordex N133 4.8 MW, 83m hub height

	Standardised 10 m Wind Speed, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Sound Power Level, dB(A)								
Sound Power Level, dB LWA	94.2	99.7	103.9	104.5	104.5	104.5	104.5	104.5	104.5
Sound Power Level, dB, LWA, inc. 2 dB allowance for uncertainty	96.2	101.7	105.9	106.5	106.5	106.5	106.5	106.5	106.5

61. The octave-band frequency spectrum at the wind speed for which the maximum sound power level (including uncertainty) is achieved (7 ms^{-1}), is detailed in Table 11.4.

Table 11.4: Octave-band Spectra

	Octave-band Centre Frequency, f, Hz							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
	Octave-band Sound Power Level, dB, $L_{WA,f}$							
Sound Power Level, dB, LWA, Scaled to 106.5 dB(A)	89.4	95.1	97.4	98.2	100.0	100.6	98.2	87.6

62. As with the vast majority of modern wind turbines, the candidate turbine type is considered to be non-tonal in terms of ETSU-R-97. Therefore, no additions for such effects are required. Warranted noise emission data will be sought from the manufacturer of the turbine ultimately selected for construction.

11.3.6 Methodology for the Assessment of Effects

11.3.6.1 Noise Predictions

63. Noise predictions have been made using SoundPLAN software (v8.1), which implements the ISO 9613-2[20] methodology and takes account of the specific data and parameters recommended in the GPG, as summarised below.

- The turbine emission data includes a 2 dB addition for measurement uncertainty;
- Atmospheric absorption has been calculated based on conditions of 10°C and 70% relative humidity;
- The ground factor assumed is G=0.5 (mixed ground);
- A receiver height of 4.0 m has been applied;
- Barrier attenuation is limited to 2 dB where there is no line of sight from the receptor to a given turbine;
- An additional 3 dB has been added to noise immission levels at properties located across a valley or with heavily concave ground between the receptor location and the wind turbine(s)[21]; and
- The predicted noise levels ($L_{Aeq,t}$) have been converted to the required $L_{A90,10min}$ by subtracting 2 dB.

64. Corrections for valley and barrier effects in accordance with the GPG are incorporated within the modelling software using site-specific Digital Terrain Model (DTM) data, and are therefore included in the predicted noise levels presented in this Chapter.

65. ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e., down-wind or under a moderate, ground-based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the GPG have been shown to provide good correlation with levels of wind turbine noise measured at operational wind farms[22,23].

11.3.6.2 Significance of Effect

66. The acceptable limits for wind turbine operational noise are clearly defined in ETSU-R-97 and the GPG, the methodology for assessment of wind turbine noise recommended by Government guidance. Therefore, this assessment determines whether the calculated immission levels at nearby noise-sensitive receptors are acceptable in terms of ETSU-R-97 and the GPG. Where the noise immission levels at noise-sensitive receptors are shown to be compliant with ETSU-R-97 and the GPG, the effect is considered to be not significant in terms of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017[24] ('the EIA Regulations').

67. As such, the approach to assessment followed in other technical chapters within this EIA Report is not applicable to the effects of noise, and effects are not considered in terms

[20] ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation.
[21] Equation to determine concave ground as presented in Section 4.3.9 of the GPG.
[22] Bullmore et al. (2009). Wind Farm Noise Predictions and Comparison with Measurements, Third International Meeting on Wind Turbine Noise, Aalborg, Denmark 17 – 19 June 2009.
[23] Cooper & Evans (2013). Effects of different meteorological conditions on wind turbine noise.
[24] The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 [Online] Available at: https://www.legislation.gov.uk/ssi/2017/101/contents/made (Accessed 15/06/2021)

of their magnitude and the sensitivity of receptors as these factors are implicit in the ETSU-R-97 and GPG methodology.

11.3.7 Assessment Limitations

68. No significant assessment limitations have been identified.

11.3.8 Embedded Mitigation

69. Noise effects were taken into consideration in the design of the Development, with the distance of the proposed turbines from residential properties being maximised as far as practicable. Further detail in the design process in provided in **Chapter 2: Site Selection and Design**.

11.4 BASELINE CONDITIONS

11.4.1 Identification of Receptors

70. Potential noise-sensitive receptors have been identified using Ordnance Survey MasterMap AddressBase, a database which combines the locations of buildings and other features from large-scale digital mapping with the Royal Mail's address database, along with aerial photography. The most noise-sensitive receptors remain the same as those detailed in Condition 19 (noise limits) for the Consented Scheme; the same receptors have therefore been assessed in this chapter. No other habitable properties were identified.

71. Names, grid references and elevations of each assessed receptor are presented in Table 11.5. Where the noise limits for the Consented Scheme refer to a group of dwellings, the grid reference in Table 11.5 relates to the dwelling in that group which is closest to the Development, as a worst-case.

Table 11.5 Assessed Receptors

Receptor	Easting	Northing	Elevation AOD (m)
Cloich Farm	321649	649079	336
Harehope Farm	320071	644357	319
Nether Stewarton	321893	645638	291
Ruddenleys	320456	651000	339
Upper Stewarton	321692	646054	311

72. Providing noise limits are met at the most noise-sensitive receptors, limits will therefore also be achieved at all other receptors.

11.4.2 Noise Limits

73. Background noise monitoring was undertaken as part of the EIA for the Consented Scheme, and was in accordance with what is now current best practice guidance (i.e., the GPG). In the interest of completeness, these background noise levels are presented in Table 11.6, overleaf.

Table 11.6: Background Noise Levels

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Prevailing Background Noise Level, dB, $L_{A90,10min}$								
Quiet Daytime									
Cloich Farm	24.7	25.7	27.1	28.9	31.0	33.5	36.3	39.5	43.0
Harehope Farm	22.4	24.2	27.1	30.4	33.8	36.9	39.7	42.0	43.9
Nether Stewarton	24.5	25.1	26.6	28.4	30.6	32.8	34.8	36.3	37.2
Ruddenleys	22.9	24.2	26.2	28.6	31.2	33.7	36.0	37.8	39.0
Night-time									
Cloich Farm	20.3	22.5	25.1	27.8	30.3	32.6	34.4	35.7	36.7
Harehope Farm	17.6	20.0	23.2	26.8	30.6	34.4	37.9	41.3	44.4
Nether Stewarton	19.2	20.3	21.9	23.9	26.3	29.1	32.3	35.8	39.6
Ruddenleys	19.1	21.1	23.8	26.8	29.8	32.5	34.7	36.2	36.6

74. As part of the EIA for the Consented Scheme, noise limits for day time and night-time periods were derived from the results of the background noise monitoring above, for each assessed receptor. These limits were discussed and agreed during the PLI for the Consented Scheme, including the ETSU-R-97 fixed lower limits applicable to each receptor (rounded to the nearest 1 dB), and the use of proxy locations where appropriate (i.e. confirming that background noise levels measured at Nether Stewarton were representative of those at Upper Stewarton).

75. As discussed in Section 11.2.2.2, ETSU-R-97 allows for an increase in the daytime fixed lower limit to 45 dB, $L_{A90,10min}$ for properties where the occupant has a direct financial interest in the Development. The occupant of Cloich Farm has such an interest in the Development; however, as the Development is able to comply with the requirements of ETSU-R-97 without requiring such an increase, this increase is not being sought in this assessment in order to maintain consistency with the extant noise limits for the Consented Scheme.

76. The noise limits as detailed in Condition 19 of the Consented Scheme therefore remain suitable for the assessment of the Development, and are presented in Table 11.7, overleaf.

Table 11.7: Noise Limits

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Noise Limit, dB, $L_{A90,10min}$								
Daytime (0700 – 2300)									
Cloich Farm	35.0	35.0	35.0	35.0	36.0	38.0	41.0	44.0	48.0
Harehope Farm	35.0	35.0	35.0	35.0	39.0	42.0	45.0	47.0	49.0
Nether Stewarton	37.0	37.0	37.0	37.0	37.0	38.0	40.0	41.0	42.0
Ruddenleys	35.0	35.0	35.0	35.0	36.0	39.0	41.0	43.0	44.0
Upper Stewarton	39.0	39.0	39.0	39.0	39.0	39.0	40.0	41.0	42.0
Night-time (2300 – 0700)									
Cloich Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Harehope Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.0	49.0
Nether Stewarton	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.0
Ruddenleys	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Upper Stewarton	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.0

11.5 ASSESSMENT OF POTENTIAL EFFECTS

77. Table 11.8 details the predicted noise immission levels due to the operation of the Development, following the methodology described in Section 11.3.6.1, and using the noise emission data presented in Section 11.3.5.2. Worst-case predicted noise levels are also presented graphically as a series of noise contours in Figure 11.1.

78. As shown in Figure 11.1, only one receptor (Upper Stewarton) is predicted to experience worst-case noise levels in excess of the ETSU-R-97 simplified assessment criterion of 35 dB, $L_{A90,10min,}$ and is therefore the only receptor requiring assessment. However, in the interest of completeness, all receptors specified in the noise limits for the Consented Scheme have been assessed, to facilitate an effective comparison.

Table 11.8: Predicted Operational Noise Levels due to the Development

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Predicted Noise Level, dB, $L_{A90,10min}$								
Cloich Farm	23.9	29.4	33.6	34.2	34.2	34.2	34.2	34.2	34.2
Harehope Farm	20.0	25.5	29.7	30.3	30.3	30.3	30.3	30.3	30.3
Nether Stewarton	23.2	28.7	32.9	33.5	33.5	33.5	33.5	33.5	33.5
Ruddenleys	18.8	24.3	28.5	29.1	29.1	29.1	29.1	29.1	29.1
Upper Stewarton	26.0	31.5	35.7	36.3	36.3	36.3	36.3	36.3	36.3

79. Table 11.9, overleaf, details the difference (margin) between predicted noise immission levels (Table 11.8) and the noise limits (Table 11.7) for the assessed receptors. A negative margin indicates that the predicted noise level is below the derived noise limit.

Table 11.9: Margin between Predicted Turbine Noise and Noise Limits

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Margin, dB								
Daytime									
Cloich Farm	-11.1	-5.6	-1.4	-0.8	-1.8	-3.8	-6.8	-9.8	-13.8
Harehope Farm	-15.0	-9.5	-5.3	-4.7	-8.7	-11.7	-14.7	-16.7	-18.7
Nether Stewarton	-13.8	-8.3	-4.1	-3.5	-3.5	-4.5	-6.5	-7.5	-8.5
Ruddenleys	-16.1	-10.6	-6.4	-5.8	-6.8	-9.8	-11.8	-13.8	-14.8
Upper Stewarton	-16.2	-10.7	-6.5	-5.9	-6.9	-9.9	-11.9	-13.9	-14.9
Night-time									
Cloich Farm	-19.1	-13.6	-9.4	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8
Harehope Farm	-23.0	-17.5	-13.3	-12.7	-12.7	-12.7	-12.7	-15.7	-18.7
Nether Stewarton	-19.8	-14.3	-10.1	-9.5	-9.5	-9.5	-9.5	-9.5	-11.5
Ruddenleys	-24.1	-18.6	-14.4	-13.8	-13.8	-13.8	-13.8	-13.8	-13.8
Upper Stewarton	-24.2	-18.7	-14.5	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9

80. As Table 11.9 shows, worst-case noise levels due to the Development are below the respective limits at all assessed receptors and wind speeds. Therefore, noise due to the operation of Development has been shown to be compliant with the requirements of ETSU-R-97.

81. Furthermore, it has been found that the predicted noise levels due to the operation of the Development are lower than those presented in the 2012 Environmental Statement at all assessed receptors and wind speeds, and lower than those of the 2014 Supplementary Environmental Information (i.e. the layout which was ultimately consented) at the large majority of receptors and wind speeds. Further information on a comparison between the Development and the Consented Scheme is provided in the Project Comparison Report, which accompanies this EIA Report.

11.6 MITIGATION AND RESIDUAL EFFECTS

11.6.1 Construction and Decommissioning Phases

82. The Development infrastructure has been located as far as practicable from residential dwellings in order to minimise the effect of noise during construction. The good practice measures detailed below will be implemented to manage the effects of noise during construction operations, and will be required of all contractors:

- Operations shall be limited to times agreed with the Council;
- Deliveries of turbine components, plant and materials by HGV to site shall only take place by designated routes and within times agreed with the Council;
- The site contractors shall be required to employ the best practicable means of reducing noise emissions from plant, machinery and construction activities, as advocated in BS 5228;
- Where practicable, the work programme will be phased, which would help to reduce the combined effects arising from several noisy operations;
- Where necessary and practicable, noise from fixed plant and equipment will be contained within suitable acoustic enclosures or behind acoustic screens;

- All sub-contractors appointed by the main contractor will be formally and legally obliged, and required through contract, to comply with all environmental noise conditions and / or Construction Environmental Management Plans;
- Where practicable, night-time working will not be carried out. Local residents shall be notified in advance of any night-time construction activities likely to generate significant noise levels, e.g., turbine erection; and
- Any plant and equipment normally required for operation at night (23:00 - 07:00), e.g., generators or dewatering pumps, shall be silenced or suitably shielded to ensure that the night-time lower threshold of 45 dB, $L_{Aeq,night}$ shall not be exceeded at the nearest noise-sensitive receptors.

83. In the event that stone is required to be extracted from borrow pits by blasting, the following process would be employed to ensure that the effects of blasting noise and vibration on nearby properties are adequately controlled:

- Compliance with planning conditions specifying limits to vibration resulting from blasting, restrictions on times of blasting, and a requirement for vibration monitoring;
- Trial blasting, using progressively larger charge loads, to establish suitable acceptable charge; and
- Provision of information on blasting to neighbouring residents.

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

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

11.6.2 Operational Phase

86. No mitigation beyond the embedded mitigation set out in Section 11.3.8 is necessary to meet the requirements of guidance and avoid significant effects, and none is proposed.

11.7 CUMULATIVE EFFECT ASSESSMENT

Cumulative effects have been considered, as described in Section 11.3.2.2. Given the substantial distance from the Development to cumulative wind farm developments, and in line with the noise assessment for the Consented Scheme, there is no reasonable prospect of a significant cumulative effect. It should be noted that the Development, if consented, will replace the Consented Scheme in its entirety, so there can be no cumulative effect in this regard.

11.8 SUMMARY OF EFFECTS

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

88. Construction noise will be limited in duration and confined to working hours as specified by the Council and therefore can be adequately controlled through the application of good practice measures and secured by planning conditions, in line with the Decision Notice for the Consented Scheme. This will ensure that any noise from the Development Site during construction will be adequately controlled.

89. Operational noise has been assessed in accordance with ETSU-R-97 and in line with current best practice. It has been shown that the Development would comply with the requirements of ETSU-R-97 at all receptor locations. It is anticipated that the planning

conditions related to operational noise for the Consented Scheme will be retained, and applied to any consent for the Development.

90. Noise during decommissioning will be of a similar nature to that of construction and will be managed through best practice or other guidance or legislation relevant at the time.

11.9 STATEMENT OF SIGNIFICANCE

91. Construction noise will be limited in duration and confined to working hours as agreed with the Council and can therefore be adequately controlled through planning condition. The application of mitigation measures where applicable will also ensure that any noise from site will be adequately controlled such that construction noise effects are **not significant** in terms of the EIA Regulations.

92. The effect of operational noise has been assessed using the methodology described in ETSU-R-97. Predictions made based on the candidate turbine type, and assessed against the appropriate noise limits. The predicted noise levels are calculated to be below the respective limits and therefore the effect of operational noise is **not significant** in terms of the EIA Regulations.

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

11.10 GLOSSARY

AGL: Above Ground Level

Background Noise: The background noise level is the underlying level of noise present at a particular location for the majority (usually 90%) of a period of time. As such it excludes any short-duration noises, such as individual passing cars (but not continuous traffic), dogs barking or passers-by. Sources of background noise typically include such things as wind noise, traffic and continuously operating machinery (e.g. air conditioning or generators).

Decibel (dB): The decibel is the basic unit of noise measurement. It relates to the cyclical changes in air pressure created by the sound (Sound Pressure Level) and operates on a logarithmic scale, ranging upwards from 0 dB. 0 dB is equivalent to the normal threshold of human hearing at a frequency of 1000 Hz. Each increase of 3 dB on the scale represents a doubling in the Sound Pressure Level, and is typically the minimum noticeable change in sound level under normal listening conditions. For example, while an increase in noise level from 32 dB to 35 dB represents a doubling in sound pressure level, this change would only just be noticeable to the majority of listeners.

dB(A): Environmental noise levels are usually discussed in terms of dB(A). This is known as the A-weighted sound pressure level, and indicates that a correction factor has been applied, which corresponds to the human ear's response to sound across the range of audible frequencies. The ear is most sensitive in the middle range of frequencies (around 1000-3000 Hertz (Hz)), and less sensitive at lower and higher frequencies. The A-weighted noise level is derived by analysing the level of a sound at a range of frequencies and applying a specific correction factor for each frequency before calculating the overall level. In practice this is carried out automatically within noise measuring equipment by the use of electronic filters, which adjust the frequency response of the instrument to mimic that of the ear.

Frequency: The frequency of a sound is equivalent to its pitch in musical terms. The units of frequency are Hertz (Hz), which represents the number of cycles (vibrations) per second.

Noise Emission: The sound power level emitted from a given source.

Noise Immission: The sound pressure level detected at a given location (e.g. nearest dwelling).

$L_{A90,t}$: This term is used to represent the A-weighted sound pressure level that is exceeded for 90% of a period of time, t. This is used as a measure of the background noise level.

$L_{Aeq,t}$: This term is known as the A-weighted equivalent continuous sound pressure level for a period of time, t. It is similar to an average, and represents the sound pressure level of a steady, continuous noise which has the same energy as the actual measured noise.

Low-frequency noise: Noise at the lower end of the range of audible frequencies (20 Hz – 20 kHz). Usually refers to noise below 250 Hz. Should not be confused with infrasound, which is sound below the lowest normally audible frequency, 20 Hz.

Noise: Unwanted sound. May refer to both natural (e.g. wind, birdsong etc.) and artificial sounds (e.g. traffic, noise from wind turbines, etc.).

Noise-sensitive receptors: Locations that may potentially be adversely affected by the addition of a new source of noise (typically residential dwellings).

Sound power (W): The sound energy radiated per unit time by a sound source, measured in watts (W).

Sound power level (Lw): Sound power measured on the decibel scale, relative to a reference value (W_o) of 10^{-12} W.

Sound pressure (P): The fluctuations in atmospheric pressure relative to atmospheric pressure, measured in Pascals (Pa).

Sound pressure level (L_p): Sound pressure measured on the decibel scale, relative to a sound pressure of 2×10^{-5} Pa.

Tonal element: A characteristic of a sound where the sound pressure level in a particular frequency range is greater than in those frequency ranges immediately above higher or lower. This would be perceived as a humming or whining sound.

Vibration: In this context, refers to vibration carried in structures such as the ground or buildings, rather than airborne noise.