Chapter 10 Noise and Vibration

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List of Abbreviations

Abbreviation	Description
CEMP	Construction environmental management plan
dB	Decibel
DMRB	Design Manual for Roads and Bridges
ECU	Energy Consents Unit
FML	Fixed minimum limit
IoA GPG	Institute of Acoustics Good Practice Guide
km	Kilometre
NMP	Noise monitoring position
NSR	Noise sensitive receptors
ONL	Overall noise limit
RNL	Residual noise limit
NCE	No Cumulative Effect
m/s	Metres per second
SLM	Sound level meter
THC	The Highland Council

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10. Noise and Vibration

10.1. Executive Summary

10.1.1. This chapter considers potential noise impacts associated with the Proposed Development. Noise and vibration from construction activities has been scoped out, therefore only noise from operation of the turbines and other fixed plant items has been considered.

10.1.2. The assessment has comprised the adoption of an appropriate study area, characterisation of the baseline noise environment, derivation of operational noise limits, prediction of operational noise levels, and evaluation of predicted operational noise levels against derived criteria, including consideration of potential cumulative effects.

10.1.3. Predicted noise levels associated with the Proposed Development meet the adopted evaluation criteria and no mitigation will be required. Noise impacts from operation of the Proposed Development, both in isolation and alongside cumulative developments, have therefore been determined to be not significant.

10.2. Introduction

10.2.1. This chapter provides an assessment of the potential effects of the Proposed Development on receptors sensitive to noise during the construction, operation and decommissioning phases.

10.2.2. This assessment has assessed the design which considers the development layout as described in **Chapter 3: Project Description**. For the purposes of this assessment, it has been assumed that the Proposed Development turbines will not exceed 185 m to blade tip. In addition, the candidate turbine that has been used to inform the assessment has a hub height of 110 m and rotor diameter of 150 m. The candidate turbine considered as part of this assessment is the Vestas V150 6 MW.

Scope of assessment

10.2.3. The scope of this assessment has comprised the following:

- scoping consultation with The Highland Council (THC) Environmental Health Department;
- evaluation of noise effects associated with operation of the Proposed Development;
- specification of appropriate mitigation, where necessary; and
- evaluation of residual effects.

Effects scoped out

10.2.4. Given the separation distances involved between potential vibration sources and sensitive receptors of greater than 1 km, vibration associated with construction and operation of the Proposed Development at the closest sensitive receptors will be negligible, therefore vibration has been scoped out of further assessment.

10.2.5. As noted in the Scoping Response (refer to **Table 10-1**), THC considers that noise from construction activities is unlikely to be an issue, given the distance between the Proposed Development and neighbouring properties. In correspondence with THC it was agreed that there are no properties close to the road which may be affected by increased traffic noise during the construction phase, particularly given that traffic flows associated with the Proposed Development are anticipated to be low. Evaluation of construction noise and construction traffic noise has therefore been scoped out of this assessment.

10.2.6. Traffic flows associated with the operational phase of the Proposed Development will be negligible (on average <1 vehicle movement per day), therefore operational road traffic noise has been scoped out of further assessment.

10.3. Legislation, Policy and Guidelines

10.3.1. Relevant legislation and guidance documents have been reviewed and taken into account as part of this assessment. Legislation of particular relevance is outlined below.

10.3.2. In lieu of any specific legislation, assessing the effect of such a development during the construction, operational and decommissioning phases must draw on information from a variety of sources. Therefore, this assessment makes reference to a number of British Standards, official planning policy and advice notes and national guidance.

Legislation

10.3.3. For a development of this nature, there is no specific all-encompassing legislation relating to the standards associated with noise emission/effects. Noise legislation, where it does exist, tends to be either EU-derived and focussed on specific items of noise-emitting plant or on more general nuisance, such as that addressed by the provisions of the *Environmental Protection Act 199*0 (UK Government, 1990).

Environmental Protection Act 1990

10.3.4. *Section 79* of the Act defines statutory nuisance with regard to noise and determines that local planning authorities have a duty to detect such nuisances in their area and, where a complaint of a statutory nuisance is made to it by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint.

10.3.5. The Act also defines the concept of "Best Practicable Means" (BPM):

- 'practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
- the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
- the test is to apply only so far as compatible with any duty imposed by law; and
- the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

10.3.6. *Section 80* of the Act provides local planning authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence. It is a potential defence against failure to comply with an abatement notice where BPM were used to prevent or counteract the effects of the nuisance.

Planning Policy

Scottish Government Online Planning Advice: Planning Advice Note 1/2011 and Technical Advice Note

10.3.7. Published in March 2011 and last updated in 2014, *Planning Advice Note 1/2011* (Scottish Government (2014b)) (PAN 1/2011) provides advice on the role of the planning system in helping to prevent and limit adverse effects of noise. Information and advice on noise assessment methods are provided in the accompanying *Technical Advice Note: Assessment of Noise* (Scottish Government (2011b)) (TAN). Included within the PAN document and the accompanying TAN are details of the legislation, technical standards and codes of practice for specific noise issues.

10.3.8. With regard to noise from wind turbines, *paragraph 29* of PAN 1/2011 states the following:

"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 Wind Farms' (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."

10.3.9. Regarding appropriate assessment methods, the '*web-based planning advice'* referred to in *PAN 1/2011* is contained in an online document titled '*Onshore wind turbines*', published by the Scottish Government (updated 2014). The document is summarised in the corresponding section below, and also refers to the use of *ETSU-R*-97. The Assessment and Rating of Noise from Wind Farms (The Working Group on Noise from Wind Turbines, 1996) assessment guidance (discussed in **paragraphs 10.3.21 to 10.3.34**).

10.3.10. The Institute of Acoustics (IoA) has since published '*a Good Practice Guide to the application of ETSU-R-97 for the assessment rating of turbine noise'* (IoA, 2013), which is summarised in **paragraphs 10.3.35 to 10.3.43**. The Scottish Government accepts that the guide represents current industry good practice.

10.3.11. Neither *PAN 1/2011* nor the associated TAN provide specific guidance on the assessment of noise from fixed plant, but the TAN includes an example assessment scenario for '*New noisy development (incl. commercial and recreation) affecting a noise sensitive building*', which is based on BS4142:1997: '*Method for rating industrial noise affecting mixed residential and industrial areas'*. This British Standard has been superseded by BS4142:2014+A1:2019 '*Methods for rating and assessing industrial and commercial sound'* (BSi, 2019). The standard is summarised in **paragraphs 10.3.44 to 10.3.50**.

10.3.12. In summary, national planning policy on the assessment of operational noise impacts from wind farms stipulates the use of the *ETSU-R-97* assessment method and application of the *IoA Good Practice Guide* (IoA GPG). These guidance documents, and others relevant to the assessment of possible noise impacts generated by the Proposed Development, are summarised below.

Onshore wind – policy statement refresh 2021: consultative draft

10.3.13. The Scottish Government has provided a consultative draft ('the draft') seeking views on how to tackle barriers to deployment of wind turbines and securing the maximum economic benefit from developments.

10.3.14. With regard to noise the draft notes that noise is a potential environmental barrier to deployment and identifies that ETSU-R-97 may be outdated and is under review. The draft further identifies that public concern about wind turbine noise is increasing despite a lack of empirical evidence for any adverse health impacts.

Regional and Local Planning Policy

10.3.15. The legislative and policy context is discussed further in **Chapter 5: Legislative and Policy Context** of this **EIA Report**. Policies and guidance relevant to this noise chapter are discussed below.

10.3.16. THC adopted the *Highland-wide Local Development Plan* (HwLDP, THC 2012) in April 2012. A number of policies within the HwLDP are of relevance to this assessment:

10.3.17. *Policy 36* Development in the Wider Countryside states:

"Renewable energy development proposals will be assessed against the Renewable Energy Policies, the non-statutory Highland Renewable Energy Strategy and where appropriate, Onshore Wind Energy: Supplementary Guidance."

10.3.18. Policy 67 Renewable Energy Developments states:

"…..the Council will support proposals where it is satisfied that they are located, sited and designed such that they will not be significantly detrimental overall, either individually or cumulatively with other developments (see Glossary), having regard in particular to any significant effects on the following:

- *amenity at sensitive locations, including residential properties, work places and recognised visitor sites (in or out with a settlement boundary);*
- *the safety and amenity of any regularly occupied buildings and the grounds that they occupy- having regard to visual intrusion or the likely effect of noise generation….*
- *the amenity of users of any Core Path or other established public access for walking, cycling or horse riding;*

…The Onshore Wind Energy Supplementary Guidance will replace parts of the Highland Renewable Energy Strategy. "

10.3.19. The Highland Council adopted the *Onshore Wind Energy Supplementary Guidance* (OWESG) in November 2016. The OWESG states, in relation to noise assessment of onshore wind developments:

"*In assessing proposals, we will include a focus on the following key principles:*

a. Highland Council's expectation is that all proposals will seek to achieve noise limits at sensitive locations that are at the lower end of the range indicated in national guidance, and we may seek limits lower than that in certain circumstances. This is because, in effect, national guidance addresses an average and therefore does not account for Highland's generally lower level of background noise. For example, Highland has a generally low density of development and less noise-generating industry and transport infrastructure, with certain features like motorways not present. The specific limit will depend on area specific factors and applicants are strongly encouraged to engage with the Council at the earliest opportunity to discuss noise limits of their proposal.

b. Further to the above, the selection of proxy background monitoring locations should also reflect this approach. Monitoring locations should be chosen which have very similar characteristics to the properties they will represent. Where such locations do not exist or cannot be used, the expectation is that monitoring locations with the lowest background levels will be chosen to represent other properties. Applicants are advised to liaise with the Council to discuss monitoring locations prior to installation of equipment.

c. Where noise from more than one wind turbine development may have a cumulative impact at any noise sensitive location, applicants must ensure this is adequately assessed in accordance with best practice, which includes consideration of both predicted and consented levels.

d. Research into amplitude modulation is ongoing and currently there is no accepted best practice for measuring, monitoring or setting limits. Should any such guidance become available, Highland Council will expect developers to follow its recommendations."

Guidance

10.3.20. This assessment has taken cognisance of the following best practice guidelines and guidance.

ETSU-R-97: The Assessment and Rating of Noise from Windfarms (ETSU-R-97)

10.3.21. As referenced for use in *PAN/2011* and the online planning advice for renewable technologies: Onshore wind turbines, this document was written by a Noise Working Group including developers, noise consultants and environmental health officers, set up in 1995 by the Department of Trade and Industry through ETSU (the Energy Technology Support Unit).

10.3.22. *ETSU-R-97* presents a consensus view of the working group and was prepared to present a common approach to the assessment of noise from wind turbines. The document states that noise from wind turbines or wind farms should be assessed against site specific noise limits.

10.3.23. Noise limits are derived based on a series of acceptable lower limits and based on an allowable exceedance above the prevailing background noise level, including consideration of a variety of different prevailing wind speed conditions. The noise limits should be derived for external areas used for relaxation, or areas where a quiet noise environment is highly desirable. Separate limits are required for night-time and daytime periods. Night-time limits are derived drawing upon measured night-time background noise levels, whilst daytime limits are derived drawing upon the background noise levels arising during 'quiet daytime' periods.

10.3.24. Night-time is defined as the period between 23:00 and 07:00 hours, whilst quiet daytime periods are defined as:

- 18:00 to 23:00 hours on all days;
- 13:00 to 18:00 hours on Saturdays and Sundays; and
- 07:00 to 13:00 hours on Sundays.

10.3.25. For daytime, the suggested limits are 5 dB above the prevailing background noise level determined during quiet daytime periods, or 35 to 40 dB(A), whichever is the higher. The absolute criterion between the 35 to 40 dB(A) range is selected taking account of:

- the site environs (e.g. number of local receptors);
- the energy generation capacity (e.g. number of kWh that can be generated) of the proposed development; and
- the associated duration and level of exposure.

10.3.26. During night-time, the suggested limits are 5 dB above the prevailing night-time background noise level or 43 dB(A), whichever is the higher. The absolute criterion for the night-time is higher than that for the daytime, as the derivation of this limit is based on preventing sleep disturbance within a building whereas for the daytime, limits are based on occupation of external spaces used for relaxation.

10.3.27. It is required that the prevailing background noise levels be determined in terms of the $L_{A90,10min}$ noise index for both quiet daytime and night-time periods, for wind conditions ranging from 2 ms-1 to 12 ms-1.

10.3.28. The noise limits are calculated by undertaking a regression analysis of the $L_{A90,10min}$ noise levels and the prevailing average wind speed for the same 10-minute period, when measured or determined at 10 m above ground at the location of the proposed turbines. The allowable limit is then defined at +5 dB above the average noise level at each wind speed (as defined by the regression analysis), or the absolute noise level lower limit, whichever is the higher (assuming no financial involvement within the scheme).

10.3.29. ETSU-R-97 also provides a simplified noise limit of 35 dB$L_{A90,10min}$ which may be applied to avoid the need to measure background noise levels and derive. The 'simplified ETSU limit' typically applies both during the daytime and night-time period.

10.3.30. Where a property has a financial involvement in the scheme, the document allows a relaxation of the derived noise limits, stating that "*It is widely accepted that the level of disturbance or annoyance caused by a noise source is not only dependent upon the level and character of noise but also the receiver's attitude towards the noise source in general. If the residents at the noise-sensitive properties were financially involved in the project, then higher noise limits will be appropriate*". The guidance goes on to state that it is "*recommended that both the day and night-time lower fixed limits can be increased to 45 dB(A) and the consideration should be given to increasing the permissible margin above background where the occupier of the*

property has some financial involvement in the windfarm". The amount by which the permissible margin above background can be relaxed is not specified, but the allowable relaxation to 45 dB(A) of the lower limits is an increase of (at least) 5 dB during the daytime and 2 dB during the night-time, so similar levels of relaxation might also be applied to the background related element of the noise level limits.

10.3.31. The ETSU guidance states that the derived limits should be applied to noise from the proposed wind farm or turbines in terms of the $L_{A90,T}$ index, and that the $L_{A90,T}$ of the wind farm noise is typically 1.5 to 2.5 dB lower than the $L_{Aeq,T}$ measured over the same period.

10.3.32. The derived noise limits are applicable to both the aerodynamic (e.g. 'blade swish') and mechanical (e.g. generator related) components of wind farm noise.

10.3.33. Where noise from the wind farm is tonal, a correction of between 2 and 5 dB is to be applied to the wind farm noise. Guidance is provided on how to determine the level of correction required, but typically, for proposed developments, the need for any applicable correction is confirmed by the independent wind turbine-specific noise tests, following standard test procedures, provided by manufacturers.

10.3.34. It is stated within the ETSU guidance that "*The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a wind farm was constructed in the vicinity in the past which resulted in increased noise levels at some properties, that residents of those properties are now able to tolerate still higher noise levels. The existing wind farm should not be considered as part of the prevailing background noise*". Accordingly, where an existing wind farm contributes to the prevailing background noise levels, it is necessary to either include for the contribution of this wind farm when comparing against the allowable noise limit or correct for this contribution when deriving a limit applicable to the proposed development acting alone.

Good Practice Guide to the Application of ETSU-R-97 (IoA GPG)

10.3.35. The *IoA GPG* presents the report of a 'noise working group' (NWG) assembled in response to a request from the former Department of Energy & Climate Change (DECC). The guide is intended to represent current good practice in applying the *ETSU-R-97* method to assessing the noise impact of wind turbine developments with a power rating of over 50 kW.

10.3.36. In addition to detailed consideration of various issues and factors concerned with current 'state of the art' knowledge of UK wind turbine noise assessment, a series of 'summary boxes' (SBs) highlighting key guidance points are included.

10.3.37. The SBs provide clarification and updated guidance on a range of matters relating to *ETSU-R-97* noise assessments, including consultation with relevant stakeholders, background noise survey methodology, noise survey data analysis, derivation of noise limits, noise prediction model input data, algorithms and parameters, cumulative impact assessment procedures, assessment reporting, planning conditions and amplitude modulation. A set of supplementary guidance notes (SGNs) also form part of the publication and include further specific detail for different technical areas.

10.3.38. The detail of the *IoA GPG* has been considered in the preparation of this assessment. Some of the key considerations relevant to this assessment are summarised as follows:

- Background noise surveys should be carried out for sufficient duration to obtain a suitably-sized dataset; as a guideline, it is suggested that no less than 200 data points be obtained within each of the night-time and amenity hour periods for a given survey location, with no less than five data points within each contiguous wind speed integer interval (for pitch regulated turbines, up to the wind speed at which the maximum sound power level is

reached. Where the data has been filtered by wind direction the guideline values are reduced.

- Background noise survey data should be analysed, and anomalous periods of noise removed from the dataset; anomalous noise might include rain-affected periods and increased noise from water courses following rainfall, seasonal effects such as early-morning birdsong ('dawn chorus'), atypical traffic movements and other unusual noise sources affecting measured levels.
- Due to the potential for non-standard site-specific wind shear (i.e. differences in wind speed at different heights above the ground – a 'standard' profile increases logarithmically with height) background noise levels should be correlated with 10 m height wind speeds derived using a method that 'standardises' the wind speeds using the assumed shear profile. Since wind turbine sound power levels are determined using the same shear profile, this procedure ensures a link between the predicted sound levels at a given hub height wind speed and the background noise levels at receptors near the ground under the same wind speed conditions (obtained using the 'standardised' 10 m height wind speed).
- Derivation of the prevailing background noise levels should be carried out using polynomial regression analysis, of order one to four, depending on the nature of the noise environment. The regression curve used should reach minimum and maximum values at the lowest and highest wind speeds for which the dataset is valid, respectively.
- Calculations of predicted wind turbine noise may be carried out using *ISO 9613-2: Acoustics – Attenuation of Sound during Propagation Outdoors* (International Organization for Standardization, 1996); preferred receptor heights, meteorological and ground absorption input parameters for this calculation procedure are given.
- Turbine sound power level source data should include appropriate uncertainty corrections. Guidance is given for determining when such uncertainty corrections have been inherently included in turbine source emission data.
- A correction for topographic screening of a maximum -2 dB may be applied where there is no line of sight between the turbine (tip) and the receptor (4 m above ground level).
- A correction for constructive reflection within valleys of +3 dB should apply where concave topography is determined to lie between the turbine and the receptor point.
- 'Excess amplitude modulation' (i.e. where the wind turbine noise has higher variability with momentary time than the 2 – 3 dB(A) considered within *ETSU-R-97*) is still the subject of research; current practice (at the time of publishing of the *IoA GPG*) in relation to determining applications for wind turbine developments is to not impose a planning condition specific to this phenomenon.

10.3.39. In addition to the above, the *IoA GPG* confirms that the *ETSU-R-97* noise level limits should be applied cumulatively and provides guidance on appropriate assessment methods for a variety of different cumulative scenarios. These scenarios include '*concurrent applications'*, '*existing wind farm consented with less than total ETSU-R-97 limits*', '*existing wind farm/s consented to the total ETSU-R-97 limits currently operating*', and '*permitted wind farms consented to total ETSU-R-97 limits but not yet constructed'*.

10.3.40. In the section titled '*existing wind farm/s, consented to the total ETSU-R-97 limits, currently operating*' it is stated that "*In the first instance, the consented noise limits should be used within the cumulative noise impact calculations unless otherwise agreed with the local authority. Provided the sum of the noise limits derived for the proposed site when added to those already consented for the operational sites does not exceed the limits that would otherwise be within the requirements of ETSU R-97 for the cumulative impact, then the noise limits derived for the proposed site can be applied directly*".

10.3.41. In practical terms this can be achieved by ensuring that the noise limit for the Proposed Development is set 10 dB or more below that permitted to be generated by the existing development.

10.3.42. It is, however, then discussed that this may not always be necessary, e.g. where there is a 'controlling property', whereby compliance with the noise limit at that controlling property would result in noise levels never realising the noise level limit 'in full' at another property (e.g. because the second property is further removed from the existing development), thereby leaving a proportion of the limits available for use at the second property by the subsequently proposed development. Another reason that is discussed is where there is no realistic prospect of the existing wind farm producing noise levels up to the consented limit, again thereby leaving a proportion of the limit available for the subsequently proposed development.

10.3.43. In the section entitled '*concurrent applications*' it is stated that where there are no pre-existing wind farms, this scenario permits the apportionment of the *ETSU-R-97* limits between the concurrent developments, i.e. each of the developments could be subject to noise limits below the full *ETSU-R-97* guidance, such that even if the individual limits applied to each development were utilised 'in full', the combined effect would be that the ETSU-R 97 guidance would not be exceeded cumulatively.

BS4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound

10.3.44. *BS4142* is applicable for use in the assessment of control building / substation and transformer noise. It sets out a method for rating and assessing sound of an industrial and/or commercial nature, including "*sound from fixed installations which comprise mechanical and electrical plant and equipment*".

10.3.45. The assessment procedure contained within *BS4142* requires that initially the 'rating level' ($L_{Ar,Tr}$) that is (or would be) generated by the source under assessment is determined, externally, at the assessment location. Where this source does not include any acoustic features, such as tonality, impulsivity or intermittency etc., then the rating level ($L_{Ar,Tr}$) equals the specific sound level (L_s), which is the sound pressure level produced by the source using the $L_{Aeq,T}$ noise index. Where the source under assessment does include acoustic characteristics, then a series of corrections are added to the specific sound level to determine the rating level. The degree of correction applied to determine the rating level depends upon the results of either subjective or objective appraisals.

10.3.46. The background sound level at the assessment location, measured using the $L_{A90,T}$ index, is then subtracted from the rating level. The result provides an indication of the magnitude of impact, where the greater the difference, the greater the magnitude of impact.

10.3.47. The following guidance is presented with regard to the difference between the rating and background levels:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

10.3.48. It can be seen from the above that the degree of impact is also dependent upon the context in which the sound arises. Factors that are considered with respect to context include: the absolute level of sound, and the character and level of the residual sound (that in absence of the source under assessment) compared to the character and level of the specific sound.

10.3.49. With regard to the absolute level, it is stated, amongst other points, that "where background sound levels and rating levels are low, absolute levels might be as, or more relevant than the margin by which the rating level exceeds the background. This is especially true at night".

10.3.50. The 1997 version of *BS4142* stated that rating levels below 35 dB and background noise levels below 30 dB(A) were considered to be "*very low*".

10.4. Consultation

10.4.1. **Table 10-1** provides a summary of consultations undertaken with relevant regulatory bodies, together with action undertaken by the Applicant in response to consultation feedback. Copies of relevant consultation correspondence are included in **Appendix 4.4**.

Table 10-1: List of Consultee Responses

Consultee	Consultation Response	Applicant Action
THC / Energy Consents Unit (ECU) – Scoping	The applicant will be required to submit a noise assessment with regard to the operational phase of the development. The assessment should be carried out in accordance with ETSU-R-97 "The Assessment and Rating of Noise from Wind Farms" and the associated Good Practice Guide published by the Institute of Acoustics. The target noise levels are either a simplified standard of 35 dBL_{A90} at wind speeds up to 10m/s or a composite standard of 35 dBL_{A90} (daytime) and 38 dBL_{A90} (night-time) or up to 5 dB above background noise levels at up to 12m/s. The night time lower limit of 43 dBL_{A90} as suggested in ETSU is not considered acceptable in many areas of the highlands due to very low background levels. These limits would apply to cumulative noise levels from more than one development. The noise assessment must take into account the potential cumulative effect from any other existing or consented or, in some cases, proposed wind turbine developments. The noise assessment must take into account predicted and consented levels from such developments. The assessment should include a map showing all wind farm developments which may have a cumulative impact and all noise sensitive properties including any for which a financial involvement relaxation is being claimed. Given the location, construction noise at the turbines sites is unlikely to be an issues at any noise sensitive properties, however, consideration will need to be given to construction traffic. Research has been carried out in recent years on the phenomenon of amplitude modulation arising from some wind turbine developments. However at this time, the Good Practice guide does not provide definitive Planning guidance on this subject. That being the case, any complaints linked to amplitude modulation would be investigated in terms of the Statutory Nuisance provisions of the Environmental Protection Act 1990.	Comments noted and assessment undertaken accordingly
THC – Direct communication with Environmental Health Department	27/01/20 - ITPE requested consented noise limits for identified potentially cumulative wind farms. 28/01/21 - THC Environmental Health directed ITPE to the Planning department and the Council's ePlanning website.	ITPE reviewed available information provided by ePlanning website

Consultee	Consultation Response	Applicant Action
	25/02/21 – ITPE provided indicative 35 dBL_{A90} noise contour and proposed baseline survey locations 26/02/21 – THC provided comment on proposed survey locations and noted that noise exposure of receptors should be considered in the assessment 11/03/21 – ITPE confirmed installation of noise monitoring equipment at baseline survey locations and provided a record of the installation. ITPE noted that no permission had been sought / obtained to monitor at a property to the north-west of the Proposed Development, which lies beyond the 35 dBL_{A90} indicative noise contour. 12/03/21 – THC confirmed receipt and noted that a flat limit at properties where no baseline survey had been undertaken could be considered in due course.	ITPE acknowledged THC's comments and confirmed exposure would be considered.
	22/09/21 – ITPE provided representation seeking to scope out consideration of construction phase road traffic impacts, given absence of receptors and anticipated small volume of traffic movements. 23/09/21 – THC confirmed that construction traffic noise may be scoped out, however information demonstrating that Best Practicable Means have been implemented will be required	Construction phase road traffic noise assessment scoped out

10.5. Assessment Methods and Significance Criteria

Definition of study area

Standalone operation

10.5.1. The study area for this assessment has been informed by maps and aerial images of the Proposed Development site and its surroundings, as well as site visits undertaken during the baseline noise survey. A sample of the closest, and therefore potentially worst-affected, noise sensitive receptors (NSRs) to the Proposed Development has been identified and adopted for the evaluation of noise impacts. These have been selected to represent a geographic spread across the local area, including those located between the Proposed Development and the considered cumulative developments. NSRs at which noise limits have been set for cumulative developments have been identified for the evaluation of potential cumulative effects. NSRs identified are either single dwellings or representative of a group or cluster of dwellings.

10.5.2. Determination of the study area for a wind farm typically requires that the 35 dBL_{A90} noise contour is predicted, and NSRs which lie beyond the contour are assumed to meet the most stringent ETSU noise limit and are therefore scoped out and discounted from further consideration. NSRs which are identified within the 35 dBL_{A90} noise contour are scoped in, and noise impacts are assessed further.

10.5.3. The 35 dBL_{A90} operational noise contour for the Proposed Development in isolation (i.e. without cumulative developments) at the wind speed at which the proposed turbines generate their maximum sound power level, is shown in **Figure 10.1**. This predicted contour does not include any corrections for concave topography or for the visibility of the turbines from receptor locations and is intended only as a screening tool. **Figure 10.1** shows that no potential NSRs lie within the 35 dB noise contour.

10.5.4. The representative NSRs considered in the assessment are listed in **Table 10-2** and shown in **Figure 10.1**.

Table 10-2: Identified representative NSRs

NSR name	NSR ID	Grid reference (OSGB)	
Little Banchor	NSR1	291166	840555
Banchor	NSR2	291189	840711
Dunearn Lodge	NSR3	294020	840067
Keeper's Cottage	NSR4	294601	839950

10.5.1. The identified NSRs are the closest properties in each direction from the Proposed Development. We note that there are no NSRs to the south or west of the Proposed Development; this area comprises undeveloped open moorland.

10.5.2. The property 'Lynemore' (292470,839927) has been confirmed to be uninhabitable so has not been considered as a potential NSR. Furthermore, the landownder has confirmed that these buildings will not be reinstated and will remain derelict.

Cumulative operation

10.5.3. Potentially cumulative wind farms Cairn Duhie (consented, with a revised layout currently submitted to planning and currently under consideration) and Tom nan Clach (operational, with application for a proposed extension currently at Scoping stage) have been identified within the vicinity of the Proposed Development. These developments lie substantially distant from each other, and no cumulative effects are anticipated between them, however, cumulative effects may occur at NSRs which lie between them and the Proposed Development.

10.5.4. Cumulative noise has therefore been considered at a selection of representative NSRs which are evaluated in the noise assessments of identified cumulative developments. Where the difference in noise level at a given NSR between the Proposed Development and other wind farms is 10 dB or greater, cumulative effects will be negligible.

10.5.5. The cumulative developments and the representative NSRs are shown in **Figure 10.1** and listed in **Table 10-3**.

Table 10-3: NSRs considered in noise assessments of potentially cumulative developments

NSR name	NSR ID	Potential cumulative effects with	Grid reference (OSGB)	
Little Aitnoch	NSR5	Cairn Duhie	296872	840800
Refouble	NSR6	Cairn Duhie	295180	839996
Milltown	NSR7	Cairn Duhie	294488	841264
Quilichan	NSR8	Tom nan Clach	285458	837820
Daless	NSR9	Tom nan Clach	286062	838501
Balvraid	NSR10	Tom nan Clach	282934	831420

Baseline survey method

10.5.6. A noise survey was undertaken at two locations to characterise baseline noise levels at representative NSRs within the study area. The noise monitoring positions (NMPs) used are

provided in **Table 10-4**, described and detailed within **Appendix 10.1** and shown on **Figure 10.1**.

Table 10-4: Baseline survey NMPs

NMP name	NMP ID	Grid reference (OSGB)	
Dunearn Lodge	NMP1	294050	840060
Keepers Cottage	NMP2	294594	839973

10.5.7. The baseline survey was completed over the period 09 March to 29 March 2021.

10.5.8. Monitoring was undertaken using sound level meters (SLMs) complying with Class I specification, *BS EN 61672-1:2003 Electroacoustics, Sound Level Meters, Part 1 Specifications* (BSi 2003). The calibration of the SLMs was checked in the field before and after each measurement and no significant drift in calibration was noted. The SLMs and the calibrator used were within their accredited laboratory calibration period of two years and one year, respectively. Calibration certificates for the SLM and calibrator are provided in **Appendix 10.1**.

10.5.9. The SLMs were installed at the monitoring positions with a microphone at a height of approximately 1.5 m above ground in a free-field location, i.e. at least 3.5 m from any vertical sound reflective surfaces. The microphone was fitted with a double-skin outdoor wind shield with a minimum 200 mm diameter.

10.5.10. The rationale for selection of the monitoring locations considered the *IoA GPG* and THC guidance and fulfilled the following criteria:

- within the study area;
- considered, of the identified NSRs, to experience the lowest background noise levels (in accordance with THC guidance) and to be furthest removed from the influence of roads, watercourses and other noise sources;
- within the curtilage of the property;
- >3.5m from any façade;
- away from watercourses, where these are not representative of the noise environment of the NSR;
- away from the nearest road;
- away from vegetation (as much as possible); and
- away from the boiler flue and drains etc associated with the property.

10.5.11. The NMPs and the ambient noise environment are described below, and full details of the monitoring locations and photographs of the equipment in-situ are provided in **Appendix 10.1**:

- **NMP1 Dunearn Lodge** – SLM installed within grassed area between lodge building and the adjacent forestry, remote from any possible noise sources such as watercourses and boiler flues. At the time of installation and collection it was moderately windy and the noise environment was dominated by wind-blown vegetation from the forestry approximately 100 m away. The watercourse was not audible at the monitoring location and, although very infrequent vehicles passing on the B9007 were visible to the north of the NMP, road traffic was not a significant contributor to ambient noise levels.
- **NMP2 Dunearn Lodge** – SLM installed within grassed area between house and dog kennel, as remote as possible from noise sources such as the nearby forestry, watercourse and from the boiler flue of the property. At the time of installation and collection it was moderately windy, however the noise environment was dominated by continuous bird calls, with wind-blown vegetation from the forestry approximately 30 m away a lesser contributor. The

watercourse was not audible at the monitoring location and, although infrequent vehicle passes on the B9007 to the east were occasionally audible, road traffic was not a significant contributor to ambient noise levels. Steam from the boiler flue approximately 25 m away was visible, however, it was inaudible at the NMP and remained inaudible even when approached more closely.

10.5.12. Rainfall data was collected using a tipping bucket rain gauge at NMP2.

10.5.13. Wind speed and direction data was collected over the baseline survey period using two LiDAR (Light Detection and Ranging) devices located within the site at a range of heights, including the hub height of the proposed turbines. The LiDAR locations are shown in **Figure 10.1**.

Evaluation of baseline data and derivation of noise limits

Operational phase noise limits

10.5.14. Measured background and ambient noise levels, rainfall and wind speed were plotted for the survey period to produce a time-history chart to investigate potentially non-representative events, such as dawn chorus and rush hour traffic, in accordance with *ETSU-R-97* and the *IoA GPG*. Baseline data was screened to remove rainfall affected data; treatment of baseline data is discussed in **Section 10.6**.

10.5.15. Measured background noise levels were correlated with derived 10 m wind speed assuming a hub height of 110 m and a surface roughness factor of 0.05, in accordance with the IoA GPG. Wind speed data from the LiDAR was first screened for errors and erroneous readings removed. The LiDAR with the most data was selected for use within the analysis and derivation of noise limits (LiDAR unit 992, shown in **Figure 10.1**).

10.5.16. The influence of wind direction on measured noise levels has been investigated to determine whether wind coming from the direction of the forestry affected measured levels at the NMPs.

10.5.17. The wind speed correlated background data has been used to determine operational noise limits in accordance with *ETSU-R-97* and THC's supplementary guidance, and the noise limits have been agreed with THC (refer to **Table 10-1**).

Approach to evaluation of cumulative effects

10.5.18. The evaluation of potential cumulative effects is considered in **Section 10.10**. Screening analysis has been undertaken based on reported predictions provided in the noise assessments undertaken in support of the applications for neighbouring developments Tom nan Clach and Cairn Duhie wind farms. Where predicted noise levels at NSRs due to the Proposed Development are ≥10 dB below the simplified *ETSU* noise limit, no cumulative effect has been determined.

Prediction method

10.5.19. A detailed noise model has been prepared for the site and surrounding area, including the adopted NSRs. This model was prepared using the CadnaA® noise modelling software. The model was set to use the *ISO 9613* prediction method, which includes prescribed methods for accounting for the effects of geometric divergence, ground absorption, and atmospheric absorption, in accordance with the requirements of *ETSU-R-97* and the *IoA GPG*.

10.5.20. Predictions have been undertaken using sound power data provided by Vestas for the V150 6.0 MW candidate turbine, with appropriate corrections to standardised. The maximum sound power level of the V150, including a +2 dB correction for uncertainty, is 106.9 dB, developed at standardised wind speeds of 8 m/s and above. The turbines have been modelled within the prediction software using the 1/3 octave band data for each wind speed, corrected for uncertainty and standardised to 10 m height wind speed values in accordance with the method provided in the *IoA GPG* and presented in **Table 10.5**.

Table 10-5: Sound power level of Vestas V150 6.0MW including uncertainty

10m wind speed, m/s	3	4	5	6	7	8	9	10	11	12
Sound Power Level, dB(A)	94.8	98.3	102.6	106.1	106.8	106.9	106.9	106.9	106.9	106.9

10.5.21. Whilst the *IoA GPG* presents methodologies for the determination of additional corrections to account for propagation directivity, which could be used, for example, to account for the effects of wind direction where a receptor is located between two developments, such corrections have not been included within this assessment. The predicted operational noise levels can therefore be considered worst-case in this regard.

10.5.22. The noise model was configured to ensure noise level predictions in compliance with the IoA GPG, including the following:

- Ground absorption: G=0.5;
- Uncertainty factor of 2 dB was added to the turbine noise source terms;
- Receptor Height: 4 m;
- A correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 dB was applied;
- No acoustic screening from buildings or topography was included in the calculated noise levels (worst-case);
- Temperature: 10°C; and
- Humidity: 70%.

10.5.23. The requirement to apply valley corrections and topographic screening corrections was determined with reference to the *IoA GPG*. Valley corrections have been determined on a turbine-by-turbine basis for all identified NSRs using proprietary software within Geographic Information System (GIS) software. It has been determined that neither valley correction nor topographic screening apply at any NSRs for the Proposed Development.

Significance Criteria

10.5.24. The impact magnitude and effect significance have been determined following the criteria described in the assessment of potential effect significance section below.

Receptor Sensitivity

10.5.25. The guidance contained within Technical Advice Note to *PAN 1/2011* has been drawn upon in the generation of an appropriate set of significance criteria. The receptor sensitivity criteria for both the construction, operational and decommissioning phases of the Proposed Development are considered to be the same. These are presented within **Table 10-6**.

Table 10-6: Noise Receptor Sensitivity Criteria

Receptor Sensitivity	Description	Examples
High	Receptors where people or operations are particularly susceptible to noise.	Residential, quiet outdoor recreational areas, schools and hospitals.
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance.	Offices and restaurants.
Low	Receptors where distraction or disturbance from noise is minimal.	Buildings not occupied, factories and working environments with existing levels of noise.

10.5.26. All identified NSRs are residential and therefore have high sensitivity to noise.

Impact magnitude – operational wind turbine noise

10.5.27. For noise from the proposed wind turbines once operational, the impact magnitude scale has been derived based on the guidance contained with *ETSU-R-97*. It is considered that where cumulative wind turbine noise falls ≥10 dB below the applicable limits, the impact magnitude is considered to be negligible. Where cumulative wind turbine noise meets the applicable noise limits (and is up to 10 dB below the limits), an impact magnitude of low would arise. Where cumulative wind turbine noise exceeds the applicable limits by up to 5 dB, an impact magnitude of medium is considered to arise. Where there is an exceedance of limit by >5 dB, an impact magnitude of high is considered to arise. These criteria are summarised in **Table 10-7**.

Table 10-7: Impact magnitude scale – wind turbine noise

Difference (d) between predicted turbine noise level and applicable limit, dB	Impact magnitude
d ≥+5	High
0 ≤ d < +5	Medium
-10 ≤ d < 0	Low
<-10	Negligible

Impact magnitude – fixed (non-turbine) plant noise

10.5.28. For noise from any fixed (non-turbine) plant such as substations and transformers, it is appropriate to determine significance criteria based on the guidance contained within *BS4142*, i.e. by consideration of the difference between the rating level from the plant noise and the prevailing background sound levels, but also with respect to context and the resulting sound levels in absolute terms.

10.5.29. The impact magnitudes associated with noise generated from fixed plant are presented in **Table 10-8**.

Table 10-8: Impact Magnitude for Fixed (non-turbine) Plant Noise

Difference (d) between predicted turbine noise level and applicable limit, dB	Impact magnitude
+5 ≤ d < +10	Medium / High
-10 ≤ d < +5	Low
< -10	Negligible

Where the rating level ($L_{Ar,Tr}$) is below 35 dB the impact magnitude is classified as 'Negligible' regardless of the relationship to the background noise level.

+ indicates rating level above background noise level

- indicates rating level below background noise level

Significance of Effect

10.5.30. The effect significance has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in **Table 10.9** which is derived from that presented in **Table 4-1, Chapter 4: Approach to EIA.**

Table 10.9 – Effect significance matrix

Magnitude of Impact	Sensitivity of Receptor / Receiving Environment to Change			
	High	**Medium**	**Low**	**Negligible**
High	Major	Moderate	Minor	Negligible
Medium	Moderate	Moderate	Minor	Negligible
Low	Minor	Minor	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

10.5.31. This assessment considers all identified NSRs to be of "high" sensitivity (refer to **Table 10-6**), given that they are residential dwellings. This assessment therefore considers that effects with a significance of "moderate" and "major" are significant and effects with a significance of "negligible" and "minor" are not significant.

10.6. Baseline Conditions

Analysis of baseline noise environment

10.6.1. Time-history charts showing the measured ambient (L_{Aeq}) and background (L_{A90}) noise levels as well as rainfall events and wind speed at the monitoring locations are provided in **Appendix 10.2**.

10.6.2. Charts showing the measured background noise levels correlated with wind speed, and divided into Quiet Daytime and Night-time periods, in accordance with ETSU, are provided in **Appendix 10.2**. The charts show the wind-dependent background noise level, the "background +5 dB" criterion and the derived noise limits.

NMP1 – Dunearn Lodge

10.6.3. A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events for the full duration of the survey is provided as **Chart 1** in **Appendix 10.2**. With reference to **Chart 1**, the following observations are noted regarding measured baseline noise levels:

- The ambient and background levels show a relatively close correlation throughout the majority of the measurement period; this is indicative of a fairly constant noise source, such as wind-induced noise, rather than intermittent anthropogenic activities or sporadic wildlife noise;
- There is a clear diurnal variation on some days, with declining noise levels during the evening, the lowest noise level in the middle of the night and increasing noise levels towards the morning;
- the diurnal variation does not occur every day;
- noise levels show little or no decrease during the night-time period on some days, attributed to wind noise being dominant during times of high wind speeds; and
- during periods of heavy rainfall, the ambient and background levels exhibit lower consistency, attributed to rain-induced noise on the microphone wind shield (note – rain-affected noise data has been screened out of further consideration in the assessment).

10.6.4. A snapshot of a two-day period with no rainfall is provided in **Chart 2**, allowing a closer investigation of trends in the data at NMP1. **Chart 2** shows no diurnal variation in noise levels and noise levels vary in a pattern consistent with wind speed.

10.6.5. The measured daytime and night-time background noise levels for NMP1, correlated to wind speed, and with rain-affected data excluded (but shown in the chart as 'rain affected data'), are provided in **Appendix 10.2**. **Chart 3** shows the daytime period and **Chart 4** shows the night-time period. The following observations are noted regarding the correlation of noise and wind speed data, and the derivation of noise limits:

- There are a substantial number of datapoints across the full range of operational wind speeds, both during the daytime and night-time period, meeting the minimum requirement provided in the *IoA GPG* at all wind speeds;
- With reference to **Chart 3**, there is a positive correlation between wind speed and measured background noise level;
- With reference to **Chart 4**, there is a positive correlation between wind speed and measured background noise level. There are a large number of datapoints in the range 15 – 20 dB; this is representative of the "noise floor" of the SLM, where noise levels are so low it cannot accurately measure, even at fairly high wind speeds. Low noise levels at high wind speeds are attributed to wind directions when the NMP was sheltered by the building.

NMP2 – Keepers Cottage

10.6.6. A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events for the full duration of the survey is provided as **Chart 5** in **Appendix 10.2**. With reference to **Chart 5**, the following observations are noted regarding measured baseline noise levels:

- The ambient and background indices show a similar pattern of variation throughout the majority of the measurement period, however, the difference between the ambient and background levels during the daytime periods is substantially greater than at NMP1. This is indicative of a variable daytime noise environment, where short-duration noisy events (such as bird calls and passing traffic) affect the ambient level while the background noise level is comparatively unaffected;
- There is a clear diurnal variation on most days, with declining noise levels during the evening, the lowest noise level in the middle of the night and increasing noise levels towards the morning, this is shown in greater detail in Chart 6, which provides a snapshot over a 24-hour period; and
- The ambient and background indices are consistent during the night-time period (shown in **Chart 5** and **Chart 6**), indicative of a fairly constant noise level. This is attributed to noise from the watercourse running past the edge of the property in the absence of noise from bird calls and road traffic.

10.6.7. The measured daytime and night-time background noise levels for NMP1, correlated to wind speed, and with rain-affected data removed, are provided in **Appendix 10.2**; **Chart 7** shows the daytime period and **Chart 8** the night-time period. The following observations are noted regarding the correlation of noise and wind speed data, and the derivation of noise limits:

- There are a substantial number of datapoints across the full range of operational wind speeds, both during the daytime and night-time period, meeting the minimum requirement provided in the IoA GPG at all wind speeds;
- With reference to **Chart 7**, there is a positive correlation between wind speed and measured background noise level;
- During the daytime and the night-time periods the measured background level is generally above 30 dB, attributed to continuous noise from the watercourse; and
- With reference to **Chart 8**, there is a positive correlation between wind speed and measured background noise level.

Other considerations

10.6.8. The closest turbine of the operational Tom nan Clach wind farm is more than 8 km from the monitoring locations; at such a separation distance noise from operational turbines at NMP1

and NMP2 will be negligible and will not affect measured baseline noise levels. No correction has therefore been made to the measured baseline levels to account for operational turbine noise.

10.6.9. Measured data at NMP1 and NMP2 was split by wind direction seeking to determine whether higher noise levels were experienced when NMPs were down-wind of nearby forestry. Given the prominence of south-westerly winds during the survey period, the results were inconclusive. The dominant wind direction was such that measured noise levels at NMP1 were predominantly under conditions when the NMP was up-wind of the closest forestry, representative of worst-case (quietest) conditions. At NMP2 the property is enclosed on all sides by trees, therefore no significant difference in wind-induced noise is expected at this location according to wind direction.

Derived ETSU noise limits

10.6.10. Daytime and night-time noise limits have been derived from measured background noise levels in accordance with *ETSU* and the *IoA GPG*. The derived limits are shown in **Chart 3** and **Chart 4** for NMP1 and **Chart 7** and **Chart 8** for NMP2 and provided in **Table 10-10**.

Table 10-10: Noise limits derived from baseline data

NMP ID	Noise limit, $dBL_{A90,10min}$										
Wind speed, m/s	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Daytime period (07:00 – 23:00)											
NMP1	35.0	35.0	35.0	35.0	35.6	37.7	40.0	42.5	45.0	47.5	49.8
NMP2	39.3	40.2	40.5	40.6	40.9	41.4	42.3	43.6	45.3	47.1	48.8
Night-time period (23:00 – 07:00)											
NMP1	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.1	40.0	40.9	42.0
NMP2	38.0	38.8	39.4	40.0	40.4	40.8	41.2	41.6	42.1	42.7	43.6

Application of noise limits at NSRs

10.6.11. Given the presence of noise from the nearby watercourse and the surrounding forestry, derived noise limits at NMP2 are considered non-representative of other NSRs and have been applied at this location (NSR4) only.

10.6.12. Noise limits derived from measured levels at NMP1 (NSR3) could be considered representative of NSRs further from the Proposed Development, based on observations made by the surveyor during the site visit, however, this assessment takes a robust approach and adopts the 'simplified ETSU' limit of 35 $dBL_{A90,10min}$ at NSRs more distant from the Proposed Development. The applicable noise limits at each identified NSR are provided in **Table 10-11**.

Table 10-11: Adopted noise limits at NSRs

NSR ID	Noise limit, $dBL_{A90,10min}$										
Wind speed, m/s	2	3	4	5	6	7	8	9	10	11	12
Daytime period (07:00 – 23:00)											
NSR1	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NSR2	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NSR3	35.0	35.0	35.0	35.0	35.6	37.7	40.0	42.5	45.0	47.5	49.8
NSR4	39.3	40.2	40.5	40.6	40.9	41.4	42.3	43.6	45.3	47.1	48.8
Night-time period (23:00 – 07:00)											
NSR1	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NSR2	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
NSR3	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.1	40.0	40.9	42.0
NSR4	38.0	38.8	39.4	40.0	40.4	40.8	41.2	41.6	42.1	42.7	43.6

10.7. Potential Effects

Operational noise from fixed (non-turbine) plant

10.7.1. The Proposed Development will include a substation which will generate noise. No details are currently available on the source noise levels of this element, and it is therefore considered appropriate that suitable noise control limits be set to which any such ancillary plant items will be required to conform. The noise limits apply to the rating level, which includes any corrections for acoustic characteristics, such as tonality and intermittency, in accordance with the *BS4142* method.

10.7.2. This assessment adopts the rating level noise limit of 28 dB at any identified NSR, equivalent to the baseline background noise levels at NMP1 +5 dB. Provided that the noise limit is met by all non-turbine plant, including the substation, with reference to **Table 10-8** the impact magnitude will be low. At high sensitivity NSRs, with reference to **Table 10-9** the resultant effect significance will be **minor** and therefore **not significant**.

Operational noise from wind turbines

10.7.3. Predicted noise levels due to operation of the Proposed Development are provided in **Table 10-12** across the range 4 m/s – 12 m/s at all NSRs.

Table 10-12: Predicted operational noise levels at NSRs due to Proposed Development

NSR ID	Predicted noise level, dBL_{A90}								
Wind speed, m/s	4	5	6	7	8	9	10	11	12
NSR1	17.5	21.7	25.2	25.9	26.0	25.9	25.9	25.9	26.1
NSR2	17.7	21.9	25.4	26.1	26.2	26.2	26.1	26.2	26.3
NSR3	20.3	24.6	28.1	28.8	28.9	28.8	28.8	28.8	29.0
NSR4	19.8	24.1	27.6	28.3	28.4	28.3	28.3	28.4	28.5
NSR5	14.1	18.3	21.8	22.5	22.6	22.5	22.5	22.6	22.8
NSR6	18.6	22.8	26.3	27.0	27.1	27.1	27.0	27.1	27.2
NSR7	16.3	20.5	24.0	24.7	24.8	24.7	24.7	24.8	24.9
NSR8	11.3	15.5	19.0	19.7	19.8	19.7	19.7	19.8	20.0
NSR9	12.0	16.2	19.7	20.4	20.5	20.4	20.4	20.5	20.7
NSR10	6.4	10.6	14.1	14.8	14.9	14.8	14.7	14.8	15.1

10.7.4. The predicted levels are evaluated against the adopted noise limits at NSRs where no noise limits for cumulative developments apply (NSR1 to NSR4) in **Table 10-13**.

Table 10-13: Evaluation of Proposed Development operational noise levels against noise limits (predicted level minus noise limit)

NSR ID	Predicted noise level minus adopted noise limit, dB								
Wind speed, m/s	4	5	6	7	8	9	10	11	12
Daytime period (07:00 – 23:00)									
NSR1	-17.5	-13.3	-9.8	-9.1	-9.0	-9.1	-9.1	-9.1	-8.9
NSR2	-17.3	-13.1	-9.6	-8.9	-8.8	-8.8	-8.9	-8.8	-8.7
NSR3	-14.7	-10.4	-7.5	-8.9	-11.1	-13.7	-16.2	-18.7	-20.8
NSR4	-20.7	-16.5	-13.3	-13.1	-13.9	-15.3	-17.0	-18.7	-20.3
Night-time period (23:00 – 07:00)									
NSR1	-17.5	-13.3	-9.8	-9.1	-9.0	-9.1	-9.1	-9.1	-8.9
NSR2	-17.3	-13.1	-9.6	-8.9	-8.8	-8.8	-8.9	-8.8	-8.7
NSR3	-17.7	-13.4	-9.9	-9.2	-9.4	-10.3	-11.2	-12.1	-13.0
NSR4	-19.6	-15.9	-12.8	-12.5	-12.8	-13.3	-13.8	-14.3	-15.1

10.7.5. The predicted noise levels meet the adopted daytime and night-time noise limits across the full range of wind speeds by a substantial margin.

10.7.6. With reference to **Table 10-7** the magnitude of impact at NSRs ranges from negligible to low. With reference to **Table 10-9** the resultant significance of effect ranges from negligible to minor.

10.7.7. Noise effects at NSRs from the operation of the Proposed Development in isolation (i.e. excluding cumulative effects) are therefore **not significant**.

10.8. Mitigation

Construction phase

10.8.1. Consideration of noise from on-site construction activities and construction traffic has been scoped out of this assessment on the basis that it can be controlled by implementation of appropriate controls and Best Practicable Means.

10.8.2. A Construction Environmental Management Plan (CEMP) will be prepared detailing measures used to control noise from construction works, which will be submitted to THC for approval prior to commencement of construction works. The CEMP will detail hours of work and include a traffic management plan, to minimise noise from works traffic accessing the site. An outline CEMP is provided in **Appendix 3.1**.

Operational phase - non-wind turbine fixed plant noise

10.8.3. Noise from fixed plant at NSRs will meet the criteria provided in **paragraph 10.7.2**. No specific mitigation is proposed, however, predicted compliance with the criterion will be confirmed during procurement of the substation and other fixed plant.

Operational phase - wind turbine noise

10.8.4. Predicted operational noise levels meet the derived noise limits across the full range of wind speeds. No specific mitigation is therefore proposed, however, at turbine procurement the sound power level of the selected model will be confirmed and further modelling will be undertaken to confirm that the Proposed Development will meet the consented noise limits.

10.9. Residual Effects

Operational non-wind turbine fixed plant noise

10.9.1. Noise from fixed plant at NSRs will meet the criteria provided in **paragraph 10.7.2**. No specific mitigation is anticipated, however, predicted compliance with the criterion will be confirmed during procurement of the substation and other fixed plant.

Operational wind turbine noise

10.9.2. No mitigation is proposed, therefore residual effects will remain unchanged and are not significant.

10.10. Cumulative Effects

Evaluation of potential cumulative effects

10.10.1. Noise levels due to the Proposed Development have been predicted at NSRs lying between the Proposed Development and neighbouring developments Tom nan Clach and Cairn Duhie Wind Farms. The predicted levels have been used in a screening process to determine the potential for cumulative effects at NSRs at which noise limits have been proposed for the neighbouring developments (NSR5 – NSR10).

10.10.2. Where predicted noise levels due to the Proposed Development are below 25 dB across the range of wind speeds, no cumulative effect will occur, since this is 10 dB below the simplified *ETSU* limit of 35 dB (daytime and night-time). With reference to **Table 10-12**, predicted noise levels due to the Proposed Development are below 25 dB at NSR7, NSR8, NSR9 and NSR10. At NSR6 Refouble, potential cumulative effects may theoretically arise with Cairn Duhie wind (predicted levels exceed 25 dB at 6 m/s and above). No potential cumulative effects will occur between Tom nan Clach and the Proposed Development at any NSR.

10.10.3. Potential cumulative effects at NSR6 are considered further in **Table 10-14**, where the predicted levels due to the Proposed Development and reported predicted levels due to Cairn Duhie, as provided in their *2021 EIA Report* (LUC, 2021), are summed, and compared with the simplified *ETSU* limit.

Table 10-14: Consideration of potential cumulative effect at NSR6

Scenario	Noise level, dBL_{A90}								
Wind speed, m/s	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Predicted levels due to the Proposed Development and Cairn Duhie									
Prop. Dev.	18.6	22.8	26.3	27.0	27.1	27.1	27.0	27.1	27.2
Cairn Duhie	19.2	23.4	27.2	29.1	29.2	29.2	29.2	29.2	29.2
Resultant	21.9	26.1	29.8	31.2	31.3	31.3	31.2	31.3	31.3
Comparison with simplified ETSU limit	-13.1	-8.9	-5.2	-3.8	-3.7	-3.7	-3.8	-3.7	-3.7

10.10.4. The predicted worst-case cumulative noise level (i.e. assuming down-wind propagation) due to the Proposed Development and Cairn Duhie Wind Farm is below the simplified *ETSU* noise limits across the full range of wind speeds. Given that NSR6 lies between the Proposed Development and Cairn Duhie Wind Farm, it can never be simultaneously down-wind of both developments; the resultant cumulative noise levels will therefore be lower.

10.10.5. On the basis of the above, no cumulative effects will arise between the Proposed Development and neighbouring developments. Cumulative effects have therefore been determined to be **not significant**.

10.10.6. This assessment notes that NSR3 and NSR4 lie close to NSR6, but further from Cairn Duhie Wind Farm, however, the Cairn Duhie noise assessment does not provide predicted noise levels or propose noise limits at these NSRs. The findings regarding NSR6 are taken as a positive indication that no significant cumulative effects will arise at more distant receptors where the noise level due to Cairn Duhie will be lower.

Consideration of Respite

10.10.7. As requested by THC and in the ECU's Scoping Response (refer to **Appendix 4.2**), this assessment provides a qualitative evaluation of 'respite', or how the duration of exposure of NSRs to wind turbine noise may change as a result of the Proposed Development.

10.10.8. Firstly, with reference to **Table 10-12**, predicted noise levels at the closest NSRs to the Proposed Development are objectively low (<30 dB) across the full range of wind speeds. At NSRs most distant from the Proposed Development it is unlikely that the turbines of the Proposed Development would be audible against the residual ambient noise from other sources.

10.10.9. There are no NSRs lying between Tom nan Clach (or its planned extension) and the Proposed Development, therefore the Proposed Development will not result in wind turbine noise being received at NSRs currently affected by Tom nan Clach under substantially different wind directions than currently; the duration of exposure at these NSRs will therefore not significantly increase.

10.10.10. NSRs which lie between the Proposed Development and Cairn Duhie, including Quilichan, Refouble, Ballindore and Milltown are to the north and east of the Proposed Development. Predicted noise levels due to the Proposed Development at these NSRs are low, and as discussed above, are unlikely to be identifiably audible against the residual noise environment. The prevailing wind in the study area comprises southerlies and south-westerlies (refer to wind roses in **Appendix 10.3**); these NSRs will therefore predominantly be down-wind of the Proposed Development and up-wind of Cairn Duhie.

10.10.11. Given that wind turbines are directional sources and noise propagation towards up-wind receptors is substantially reduced compared to down-wind receptors (up to 10 dB, depending on distance from the turbine), the duration over which these NSRs are likely to be exposed to potentially audible levels of wind turbine noise is therefore limited.

10.10.12. On the basis of the above, this assessment considers that the level of respite from wind turbine noise at NSRs in the study area will not significantly reduce as a result of the Proposed Development.

10.11. Summary

10.11.1. This assessment has considered potential noise impacts associated with the Proposed Development. The consideration of construction noise and vibration, including construction traffic noise, has been scoped out through consultation with THC on the basis that it is unlikely to be significant and will be controlled by implementation of Best Practicable Means. A CEMP will be produced detailing methods by which construction noise will be controlled, which will include a traffic management plan.

10.11.2. Noise from wind turbines has been evaluated against derived noise limits at NSRs where cumulative effects are not anticipated and NSRs where cumulative effects may occur. Predicted noise levels due to operation of the proposed development meet the derived noise limits by a comfortable margin at all NSRs, and noise effects have therefore been determined to be **not significant**.

10.11.3. Noise limits for non-turbine fixed plant have been derived and plant will be specified accordingly, such that noise impacts at NSRs are **not significant**.

Table 10.15 – Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/Adverse		Significance	Beneficial/Adverse
Construction noise including construction traffic	Scoped out of assessment	-	Production and implementation of CEMP and traffic management plan	Not significant	-
Operational noise from wind turbines	Not significant	Adverse	None proposed	Not significant	Adverse
Operational noise from non-turbine fixed plant	Not significant	Adverse	Specification of plant such that noise limits are met at NSRs	Not significant	Adverse

10.12. References

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