10 Noise

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10 Noise

10.1 Executive Summary

10.1.1 This chapter considers potential noise effects associated with the construction, operation and decommissioning of the Proposed Development.

10.1.2 Planning permission is sought for the construction, operation and decommissioning of the Proposed Development.

10.1.3 The assessment of noise impacts comprised consultation with THC Environmental Health Department, characterisation of the baseline noise environment, assessment of noise effects due to construction activities, construction traffic, operation of wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

10.1.4 Noise effects from construction, including on-site activities and construction traffic, were found to be not significant. Noise effects from fixed non-turbine plant have been determined to be not significant.

10.1.5 No potential vibration effects have been identified and consideration of vibration has therefore been scoped out.

10.1.6 Predicted wind turbine noise levels associated with operation of the Proposed Development meet derived noise limits at all identified representative Noise Sensitive Receptors (NSRs). Residual noise effects due to operation are therefore not significant.

10.2 Introduction

10.2.1 This chapter considers the potential noise effects of the Proposed Development on receptors sensitive to noise during the construction, operational and decommissioning phases.

10.2.2 This assessment has assessed the design which includes turbine layout F and infrastructure layout 4 as described in Chapter 2. For the purpose of this assessment, it has been assumed that the Proposed Development turbines will not exceed 135 m to blade tip. In addition, the candidate turbine that has been used to inform the assessment has a hub height of 77.8 m and rotor diameter of 117 m. The candidate turbine considered as part of this assessment is the Vestas V117.

10.2.3 This assessment has been prepared by Alasdair Baxter BSc (Hons) Dunelm, MSc, MIOA.

Scope of assessment

10.2.4 The scope of this assessment has comprised the following:

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

10.2.5 Given the separation distances involved (>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.

10.2.6 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. This chapter considers the potential noise effects of the Proposed

Development on receptors sensitive to noise during the construction phase and the operational phase.

10.3 Legislation, Policy and Guidelines

10.3.1 Details of relevant legislation, policy and guidelines that have been taken into consideration during the assessment are provided below.

Legislation

10.3.2 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 1990 (UK Government, 1990 and Control of Pollution Act 1974 (UK Government, 1974).)

Environmental Protection Act 1990

10.3.3 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.

10.3.4 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.

10.3.5 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.

Control of Pollution Act 1974

10.3.6 Section 60 of the Act provides powers to Local Authority Officers to serve an abatement notice in respect of noise nuisance from construction works.

10.3.7 Section 61 provides a method by which a contractor can apply for 'prior consent' for construction activities before commencement of works. The 'prior consent' is agreed between the Local Authority and the contractor and may contain a range of agreed working conditions, noise limits and control measures designed to minimise or prevent the occurrence of noise nuisance from construction activities. Application for a 'prior consent' is a commonly used control measure in respect of potential noise impacts from major construction works.

10.3.8 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.

Planning Policy

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

10.3.9 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.

10.3.10 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."

10.3.11 With regard to appropriate assessment methods, the '*web-based planning advice*' referred to in PAN 1/2011 is contained in an online document entitled '*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 10.3.22 to 10.3.34 below).

10.3.12 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). The Scottish Government accepts that the guide represents current industry good practice.

10.3.13 With regards to the assessment and control of noise from construction sites the use of BS 5228: 2009 (Part 1) is discussed. BS 5228 has been superseded by BS 5228 1:2009+A1:2014: *Code of practice for noise and vibration control on construction and open sites*. *Noise* (BSi. (2009/2014). The standard is summarised in paragraphs 9.3.48-54. Of relevance to the assessment of development generated road traffic noise, it is stated that a change of 3 dB(A) is the minimum perceptible under normal conditions, and that a change of 10 dB(A) corresponds roughly to a halving or doubling of the perceived loudness of a sound.

10.3.14 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.

10.3.15 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), whilst construction noise should be assessed with reference to BS 5228. These guidance documents, and others relevant to the assessment of possible noise impacts generated by the Proposed Development, are summarised below.

Regional & Local Planning Policy

10.3.16 Local planning policy is discussed further in Chapter 5 of this EIAR. Policies and guidance relevant to this noise chapter are discussed below.

10.3.17 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:

10.3.18 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."

10.3.19 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. "

10.3.20 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

10.3.21 Cognisance has been taken of the following best practice guidelines and guidance.

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

10.3.22 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).

10.3.23 ETSU 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.

10.3.24 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.

10.3.25 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.

10.3.26 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.

10.3.27 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.

10.3.28 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}.

10.3.29 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).

10.3.30 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 less 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 this document 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

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*".

Design Manual for Roads and Bridges (DMRB)

10.3.51 DMRB (Highways Agency, 1989) provides standards and advice regarding the assessment, design and operation of roads in the UK. DMRB provides screening criteria, by which percentage changes in traffic flow can be related to a predicted change in road traffic noise. The guidance also provides significance criteria, by which the percentage of people adversely affected by traffic noise can be related to the total noise level due to road traffic, or the increase over an existing level.

10.3.52 DMRB provides screening criteria whereby a change in noise level of 1 $dBL_{A10,18hr}$ is equivalent to a 25% increase or 20% decrease in traffic flow, and a change in noise level of 3 $dBL_{A10,18hr}$ is equivalent to a 100% increase or 50% decrease in traffic flow.

10.3.53 The threshold criteria used for traffic noise assessment during the daytime is a permanent change in magnitude of 1 dB $L_{A10,18hr}$ in the short term (i.e. on opening) or a 3 dB $L_{A10,18hr}$ change in the long term (typically 15 years after project opening). For night time noise impacts, the threshold criterion of a 3 dB $L_{night,outside}$ noise change in the long term should also apply but only where an $L_{night,outside}$ greater than 55 dB is predicted in any scenario.

BS5228:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 1 (noise)

10.3.54 Part 1 of the standard sets out techniques to predict the likely noise effects from construction works, based on detailed information on the type and number of plant items being used, their location and the length of time they are in operation.

10.3.55 The noise prediction methods can be used to establish likely noise levels in terms of the $L_{Aeq,T}$ over the core working day. This standard also documents a database of information, including previously measured sound pressure level data for a variety of different construction plant undertaking various common activities.

10.3.56 Three example methods are presented for determining the significance of construction noise impacts. In summary, these methods adopt either a series of fixed noise level limits, are concerned with ambient noise level changes as a result of the construction operations or a combination of the two.

10.3.57 With respect to absolute fixed noise limits, those detailed within *Advisory Leaflet 72: 1976: Noise control on building sites* are presented. These limits are presented according to the nature of the surrounding environment, for a 12-hour working day. The presented limits are:

- 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise; and
- 75 dB(A) in urban areas near main roads and heavy industrial areas.

10.3.58 The above noise level limits are applicable at the façade of the receptor in question (not free field).

10.3.59 The standard goes on to provide methods for determining the significance of construction noise levels by considering the change in the ambient noise level that would arise as a result of the construction operations. Two example assessment methods are presented, these are the 'ABC

method' as summarised within **Error! Reference source not found.** and the '5 dB(A) change' method as described in paragraph 10.3.60.

Table 10.1 – Example threshold of potential significant effect at dwellings (construction noise) – ABC method

Assessment Category and Threshold Value Period	Threshold Value, in Decibels (dB) ($L_{Aeq,T}$)		
	Category (A)	Category (B)	Category (C)
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends (D)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
NOTE 1: A potential significant effect is indicated if the LAeq,T noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. *NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total LAeq,T noise level for the period increases by more than 3 dB due to site noise.* *NOTE 3: Applied to residential receptors only*			
A) Category A: threshold values to use when ambient levels (when rounded to the nearest 5 dB) are less than these values. *B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.* *C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.* *D) 19.00-23.00 weekdays, 13.00-23.00 Saturdays and 07.00-23.00 Sundays*			

10.3.60 With respect to the '5 dB(A) change' method, the guidance states:

"Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB L_{Aeq}, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact."

10.4 Consultation

10.4.1 Table 10.2 provides details 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 10.2 – Consultation undertaken

Consultation sent	Consultation response	Applicant action
THC (1 March 2018) Scoping response	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. It should be noted that there are areas of the guidance which are not prescriptive and some matters are open to interpretation and discussion. It is recommended that the developer engages with the Council's Environmental Health Officer at an early stage to discuss any such grey areas.	Post Scoping consultation undertaken in 2020 (as below). See Section 10.3 for details of the ETSU-R-97 and IoA GPG methodology adopted.
	The target noise levels are either a simplified standard of 35dB L_{A90} at wind speeds up to 10m/s or a composite standard of 35dB L_{A90} (daytime) and 38dB L_{A90} (night time) or up to 5dB above background noise levels at up to 12m/s. The night time lower limit of 43dB L_{A90} as suggested in ETSU is not considered acceptable. These limits would apply to cumulative noise levels from more than one development.	Section 10.6 gives details of the adopted noise limits.
	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. Where applications run concurrently, developers and consultants are advised to consider adopting a joint approach with regard to noise assessments. The noise assessment must take into account predicted and consented levels from such developments. The good practice guide offers guidance on how to deal with cumulative issues.	Post Scoping consultation with THC allowed the scoping out of cumulative turbine noise.
	The assessment must include a compliance monitoring mitigation scheme which will demonstrate how noise levels from the development will be identified should a complaint arise.	Section 10.10 gives details of the proposed compliance monitoring.
	Any background noise surveys should be undertaken in accordance with ETSU-R-97 and the Good Practice	Section 10.6 gives details of

Consultation sent	Consultation response	Applicant action
	Guide. It is recommended that monitoring locations be agreed with the Council's Environmental Health Officer however, it is unlikely that they will be able to attend the installation of equipment. Where possible, sites must avoid other noise sources such as boiler flues, wind chimes, squeaking gate, rustling leaves etc. Otherwise, the results may not be valid for any other property.	the baseline noise survey.
	Difficulties can arise where a location is already subject to noise from an existing wind turbine development. ETSU states that background noise must not include noise from an existing wind farm. The GPG offers advice on how to approach this problem and in some cases, it may be possible to utilise the results from historical background surveys. It is advised that the developer consults the Councils Environmental Health Officer at an early stage to discuss the proposed methodology.	Post Scoping consultation with THC allowed the scoping out of cumulative turbine noise.
	Planning conditions are not used to control the impact of construction noise as similar powers are available to the Local Authority under Section 60 of the Control of Pollution Act 1974. However, where there is potential for disturbance from construction noise the application will need to include a noise assessment. A construction noise assessment will be required in the following circumstances: - ▪ Where it is proposed to undertake work which is audible at the curtilage of any noise sensitive receptor, out with the hours Mon-Fri 08:00 to 19:00; Sat 08:00 to 13:00 OR ▪ Where noise levels during the above periods are likely to exceed 75dB(A) for short term works or 55dB(A) for long term works. Both measurements to be taken as a 1hr L_{Aeq} at the curtilage of any noise sensitive receptor. *(Generally, long term work is taken to be more than 6 months)*	Section 10.5 gives detail of the construction noise assessment.
	If an assessment is submitted it should be carried out in accordance with BS 5228- 1:2009 "Code of	Section 10.6gives detail

Consultation sent	Consultation response	Applicant action
	practice for noise and vibration control on construction and open sites – Part 1: Noise". Details of any mitigation measures should be provided including proposed hours of operation.	of the construction noise assessment. Section 10.7gives details of proposed mitigation measures.
	Regardless of whether a construction noise assessment is required, it is expected that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. Attention should be given to construction traffic and the use of tonal reversing alarms.	Section 10.7gives details of proposed mitigation measures.
Email 20 July 2020. Consultation with THC Environmental Health Officer (EHO).	The EHO agreed with the proposed approach to the assessment, set out in the email correspondence	No action

10.5 Assessment Methodology and Significance Criteria

Consultation

10.5.1 Details of consultation with THC are provided in Section 10.4. Consultation was undertaken in July 2020.

Study Area

10.5.2 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 have 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.

10.5.3 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.

10.5.4 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.

10.5.5 Figure 10.1 shows all the identified properties within and slightly beyond the 35 dB noise contour, comprising three potential NSRs. The representative NSRs considered in the assessment are listed in Table 10.3.

Table 10.3 – Identified representative NSRs

NSR name	NSR ID	Grid reference (OSGB)	
		Easting	Northing
Blarbuie	NSR1	256259	913938
Dalmichy	NSR2	257561	913053
Rhian Bridge	NSR3	256305	916514

Baseline Noise Survey

10.5.6 A baseline survey was undertaken at one location to characterise baseline noise levels at representative NSRs within the study area. The noise monitoring position (NMP) used is provided in Table 10.4, described and detailed within Appendix 10.2 and shown on Figure 10.1.

Table 10.4 – Baseline noise monitoring positions

NMP name	NMP ID	Grid reference (OSGB)	
		Easting	Northing
Blarbuie	NMP1	256238	913884

10.5.7 The baseline survey was completed over the period 17 August to 22 September 2020.

10.5.8 The sound level meter (SLM) used was compliant with Class 1 specification, as described in BS EN 61672-1:2003 *Electroacoustics, Sound Level Meters, Part 1 Specifications* (BSi 2003). The calibration of the SLM was checked in the field, before and after each measurement and no significant drift in calibration was noted. The SLM 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 SLM was installed at the monitoring position 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 monitoring location is described as follows:

- **NMP1 Blarbuie –** SLM installed within garden of property, on the north-western side of the house. The SLM was sited more than 3.5 m from the façade of the house, and as distant from trees and bushes as could be achieved. A rain gauge was installed adjacent to the SLM. Weather conditions during installation were dry, with light to moderate wind speeds.

10.5.11 The rationale for selection of the monitoring location considered the GPG and THC guidance as follows, and the location was:

- within the study area;
- considered, of the three 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;
- 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.

10.5.12 Full details of the monitoring locations and photographs of the equipment in-situ are provided in Appendix 10.2.

Construction Phase Noise

Construction Traffic

10.5.13 Projected construction traffic flows (refer to Chapter 12) have been compared with baseline flows on the A836 and screened against the DMRB criteria (refer to para. 10.3.51), whereby an increase of ≥25 % in traffic flow equates to an increase of ≥1 dB.

On-site Construction Activities; Method of Prediction

10.5.14 A detailed breakdown of the construction schedule and plant for the Proposed Development is currently unavailable. Drawing on our experience of previous wind farm developments, the following assumptions have been made in the prediction of construction noise:

Working hours

- 07.00-18.00 Monday – Friday;
- 07.00-13.00 Saturdays; and
- No working Sundays and Bank holidays.

Construction plant:

Phase 1 – Access tracks and turbine hardstandings

- 2 x Backhoe mounted rock breaker (BS 5228 Table C5, Item 1)
- 2 x tracked mobile crusher (BS 5228 Table C9, Item 14)
- 4 x road wagons (BS 5228 Table C11, Item 4)
- 1 x 35T excavator (BS 5228 Table C6, Item 7)
- 2 x 6T dump trucks (BS 5228 Table C4, Item 3)
- 1 x 12T bulldozer (BS 5228 Table C2, Item 13)
- 1 x 12T roller (BS 5228 Table C2, Item 38)

Phase 2 – Turbine bases

- 1 x 35T excavator (BS 5228 Table C6, Item 7)

- 1 x concrete pump (BS 5228 Concrete pump)
- 2 x cement trucks (BS 5228 Table C4, Item 27)

Phase 3 – Turbine installation

- 1 x 400T crane (BS 5228 Table C4, Item 38)
- 1 x road wagon (BS 5228 Table C11, Item 4)

Other assumptions

- all plant has been assumed to operate continuously (100 % utilisation) throughout the working hours;
- all plant has been placed at the closest approach of construction works to the closest NSR;
- noise levels have been predicted in accordance with the BS5228 prediction method; and
- construction plant has been assumed to have an effective height of 2 m above local ground level.

Derivation of Construction Phase Noise Limits

10.5.15 The predicted site preparation / construction noise levels have been assessed based on noise level criteria determined following a worst-case interpretation of the guidance contained within BS5228. As detailed within Section 10.3, BS5228 details three example methods for determining the significance of potential construction noise impacts. With regard to the presented absolute noise level criteria (example method 1), following a worst-case approach, the lowest absolute noise level criterion for the daytime period (07:00 to 19:00) is 70 dB(A) façade, (equivalent to 67 dB(A) free-field), which is stated to apply in rural areas.

10.5.16 Following the ABC assessment method, the most stringent assessment criterion (Category A), applies during the daytime (07:00 to 19:00 weekdays and 07:00 to 13:00 Saturdays) where the prevailing ambient noise levels are below 65 dB $L_{Aeq,T}$. Where Category A applies, the allowable noise levels arising from site construction noise is 65 dB(A). Assuming an average ambient noise level of 49 dB(A), the allowable 'construction only' noise level is 65 dB(A) $L_{Aeq,T}$.

10.5.17 With regards to the 5 dB(A) change method, the allowable construction noise level during the daytime is 65 dB(A), or higher where the resulting ambient noise level change would be less than +5 dB(A). Accordingly, the most stringent allowable 'construction only' noise level following this approach is 65 dB(A). With regard to the above, it can be seen that applying the ABC method or the 5 dB change method gives rise to the most stringent daytime construction noise level criteria of 65 dB$L_{Aeq,T}$.

10.5.18 Criteria have been derived drawing on the above and are provided in Table 10.6 within the Impact Magnitude section below.

Operational Phase Noise

General Method of Prediction

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 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.

10.5.21 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 2dB 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%.

10.5.22 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. Where topographic screening has been determined to be applicable, no valley correction has been applied, since it is assumed that if the turbine is not visible at the NSRs, then any concavity determined to lie between the turbine and the NSR will not result in constructive acoustic reflections.

10.5.23 It has been determined that neither valley correction nor topographic screening apply at any NSRs.

Assessment of Potential Effect Significance

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 10.5.

Table 10.5 – 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.

Impact Magnitude - Construction Noise

10.5.26 The construction noise impact magnitude has been determined according to the threshold levels provided in Table 10.6 derived from guidance contained within BS 5228:2009+A1:2014.

Table 10.6 – Evaluation criteria for noise from construction activities (predicted façade level), weekday daytimes (08:00 – 18:00) and Saturdays 08:00 – 12:30

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

Impact Magnitude – Construction Traffic Noise

10.5.27 The DMRB states that "*In the period following a change in traffic flow, people may find benefits or disadvantages when the noise changes are as small as 1 dB(A) – equivalent to an increase in traffic flow of 25% or a decrease in flow of 20%. These effects last for a number of years*", whilst PAN1/2011 advises that a change of 3 dB(A) is the minimum perceptible under normal conditions. Criteria for the evaluation of road traffic noise effects based on these changes are provided in Table 10.7.

Table 10.7 – Evaluation criteria for noise from construction traffic

Increase (i) over existing road traffic noise level due to construction traffic flows, dB	Impact magnitude
i ≥+5	High
3 ≤ i < +5	Medium
1 ≤ i < +3	Low
0 ≤ i < +1	Negligible

Impact Magnitude - Operational Wind Turbine Noise

10.5.28 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 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 falls ≥10 dB below the applicable limits, the impact magnitude is considered to be negligible. Where cumulative wind turbine noise exceeds the applicable limits by up to 5 dB, an impact magnitude of medium is considered to arise. Where the there is an exceedance of limit by >5 dB, an impact magnitude of high is considered to arise. These criteria are summarised in Table 10.8.

Table 10.8 – 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

10.5.29 For noise from any fixed (non-turbine) plant such as the Energy Storage System, 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.

10.5.30 The impact magnitudes associated with noise generated from fixed plant are presented in Table 10.9.

Table 10.9 – Impact Magnitude for Fixed (non-turbine) Plant Noise

Difference between Rating Level ($L_{Ar,Tr}$) and Background Sound Level (L_{A90})	BS4142 Guidance	Impact Magnitude
≥+10	Indication of significant adverse impact	High
+5	Indication of adverse impact	Medium
0	Indication of low Impact	Low
-10	-	Negligible

Difference between Rating Level ($L_{Ar,Tr}$) and Background Sound Level (L_{A90})	BS4142 Guidance	Impact Magnitude
Where the rating level ($L_{Ar.Tr}$) is below 35dB 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*		

Effect Significance

10.5.31 The effect significance has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in Table 10.10 which is derived from that presented in Chapter 4 Approach to EIA, Table 4.1.

Table 10.10 – Effect Significance Matrix

Impact Magnitude	Receptor Sensitivity		
	High	Medium	Low
High	Major	Moderate	Minor
Medium	Moderate	Minor	Negligible
Low	Minor	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible

10.5.32 This assessment considers all identified NSRs to be of "high" sensitivity in accordance with Table 10.5, given that they are residential dwellings. This assessment considers that effects with a significance of "moderate" and "major" are significant and effects with a significance of "negligible" and "minor" are not significant.

Requirements for Mitigation

10.5.33 Consideration has been given to available mitigation measures in order to reduce adverse effects and enhance beneficial effects. Where mitigation measures are detailed, these are committed to by the Applicant and have been determined through professional judgement and the implementation of best practice.

Assessment of Residual Effect Significance

10.5.34 Residual effects have been assessed following the methodologies described above but taking into account the committed mitigation measures.

Limitations to Assessment

10.5.35 Detailed information on techniques and equipment for the construction phase of the Proposed Development is not currently available. Consequently, appropriate and robust assumptions have been made regarding the nature of likely construction activities and plant, and noise predictions made accordingly. It is therefore anticipated that predicted noise levels represent the "worst case" potential construction noise levels.

10.5.36 The assessment of operational impacts associated with the wind turbines has been undertaken adopting source noise levels for the candidate turbine models. Following completion of the tendering process, it is possible that the precise turbine make / model adopted and / or the

operational mode will change from that adopted within the assessment. It should be noted, however, that the final turbine model chosen will be selected to ensure compliance with the derived noise level limits.

10.6 Baseline Conditions

Description of Baseline Noise Environment

10.6.1 Time-history charts of the measured ambient (L_{Aeq}) and background (L_{A90}) noise levels at the monitoring location are provided in Appendix 10.3. Periods of rainfall-affected data, which have been screened out of subsequent analysis, are shown in dark blue.

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 10.3. The charts show the wind-dependent background noise level, the "background +5 dB" criterion and the derived noise limits. Rainfall-affected data has been screened out, in accordance with the GPG.

NMP1 - Blarbuie

10.6.3 The dominant noise source was wind-induced rustling of vegetation. Road traffic noise from the A836 was occasional and barely audible.

10.6.4 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events is provided as Chart 1 in Appendix 10.3. With reference to Chart 1, the following observations are noted with regard to 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;
- 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 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).

10.6.5 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 10.3; Chart 2 shows the daytime period and Chart 3 the night-time period. The following observations are noted with regard to 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 GPG at all wind speeds;
- With reference to Chart 2, there is a positive correlation (R^2 of 0.5887) between wind speed and measured background noise level;
- During the daytime period the measured background level is generally below the fixed minimum daytime noise level (35 dB). Periods when the measured background is above the fixed minimum daytime noise level correspond to periods of high wind;

10.6.6 With reference to Chart 3, there is a positive correlation (R^2 of 0.6636) 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.

Adopted noise limits

Construction and decommissioning noise limits

10.6.7 With reference noise levels presented in Appendix 10.3, specifically in Chart 1, the baseline ambient level is below 65 dB throughout the majority of the survey. The construction phase noise limit for weekday daytimes and Saturdays, in accordance with the ABC method provided in BS 5228, is therefore Category A; 65 $dBL_{Aeq,T}$.

Operational noise limits – fixed non-turbine plant

10.6.8 Operational noise limits for fixed non-turbine plant, such as transformers and substations, have been derived in accordance with BS4142, with reference to measured background noise levels at NMP1. It is assumed that such plant will operate at a constant level, therefore noise limits will be determined by the night-time background level, when noise from road traffic and other anthropogenic sources is at a minimum. At wind speeds lower than 5 m/s and in the absence of rainfall (as required by BS4142), as shown in Chart 1 the measured background level during the night-time period at NMP1 was typically 20 $dBL_{A90,T}$.

10.6.9 This assessment adopts the rating level noise limit of 25 dB at any identified NSR, equivalent to the baseline background noise levels at NMP1 +5dB.

Operational noise limits – wind turbine noise

10.6.10 The derived noise limits at Blarbuie are provided in Table 10.11 for the range of operational wind speeds of the candidate turbine. The noise limits derived from measurements at the NMP have been allocated to NSRs on the basis of observations of the noise environment while setting up the SLMs.

10.6.11 Background noise data was filtered for quiet daytime and night periods, to remove rain affected data (in accordance with the GPG, any potentially rain affected data was removed, including the 10 minute period before and after recorded rainfall) and to remove noise data recorded when the monitoring position was downwind of the property (to remove potentially low noise levels during high winds which may affect the veracity of the limit derivation).

10.6.12 As discussed in Section 10.4, it has been agreed with THC that the existing small wind turbine at NSR3 Rhian Bridge can be excluded from further consideration of cumulative effects. Investigations of the THC planning portal confirmed that there are no other existing, consented or proposed wind turbines within 5km of the Proposed Development. No further consideration of cumulative effects is, therefore, proposed.

10.6.13 The approach to the allocation of NMP-derived noise limits has been agreed with THC Environmental Health.

Table 10.11 – Derivation of noise limits, $dBL_{A90,10min}$

Wind speed, m/s	Derived noise limit, $dBL_{A90,10min}$									
	3	4	5	6	7	8	9	10	11	12
NMP1 – Blarbuie baseline-derived 'background +5 dB noise limit'										
Daytime	35.0	35.0	35.0	35.0	35.0	37.2	40.7	44.9	44.9	44.9
Night-time	38.0	38.0	38.0	38.0	38.0	38.0	40.8	43.0	44.0	44.0
Limit applicable at: **NSR1 Blarbuie, NSR2 Dalmichy & NSR3 Rhian Bridge.** **Night-time fixed minimum limit 38dB in accordance with THC consultation** **Flat daytime and night-time limit applied from 11m/s onwards to account for influence on derived background of smaller number of data points at higher wind speeds.**										

10.7 Standard Mitigation

Construction phase

10.7.1 The following good practice measures will be implemented during construction to limit unnecessary noise:

- avoid unnecessary revving of engines and switching off plant when not required (i.e. no idling);
- haul routes to be kept well maintained, with no steep gradients;
- minimising the drop height of materials during delivery to, and movement around, site;
- starting up plant and vehicles sequentially, rather than all together;
- specification of plant with white-noise or directional reversing alarms, rather than beeper-type alarms;
- where possible, selection of quiet / noise reduced plant;
- vehicles accessing the site will have regard to the normal operating hours of the site and the location of nearby NSRs; and
- use and siting of equipment will be considered such that noise is minimised. For example, any generators or powered cabins within the construction compound will be sited such that noise from the generator exhaust is directed away from the closest NSRs, and cabins and other infrastructure are used to screen noise from such plant wherever possible.

Operational phase

Fixed (non-turbine) plant noise

10.7.2 Noise from non-turbine operational plant will comprise noise from the energy storage system, switching station and control room. The sound power level and location of the these elements are yet to be finalised, however, noise from the final type and location of the energy storage system, switching station and control room will be attenuated by acoustic enclosure (if required), such that it meets the derived non-turbine noise limits (see Section 10-22). A combined sound power level not exceeding 95 dB(A) would enable the noise limit to be met. The installed non-turbine operational plant would meet this criterion.

10.8 Receptors Brought Forward for Assessment

10.8.1 The NSRs considered in this assessment are provided in Table 10.3 and shown in Figure 10.1.

10.9 Potential Effects

Construction

Construction traffic

10.9.1 Projected construction traffic flows on the A836 at the site access during the peak construction month total 66 vehicles per day, including 46 HGVs, equivalent to increases over the projected baseline flows of 20.3% with HGVs increasing from 9.2% of flows to 19.4% of flows. Basic noise level (BNL) calculations, in accordance with CRTN, show that the BNL of the A836 at the site access increases by a maximum of 0.9dB.

10.9.2 With reference to Table 10.7, an increase of up to 1 dB corresponds to a **negligible** impact magnitude. With reference to Table 10.10, the resultant effect significance is **negligible**, and is therefore not significant.

On-site Construction

10.9.3 The predicted noise levels at NSR2, the closest property to the Proposed Development site, due to the three stages of construction considered are provided and evaluated against the adopted noise limits in Table 10.12.

Table 10.12 – Evaluation of worst-case construction phase noise levels at closest NSR (NSR2)

Scenario	Predicted level, $dBL_{Aeq,T}$	Exceedance of noise limit, dB
Construction of access tracks	40.1	-24.9
Construction of turbine bases	29.2	-35.8
Installation of turbines	28.4	-36.6

10.9.4 At NSR2, predicted worst-case noise levels due to construction activities meet the derived noise limits by a margin of 25 dB or more. With reference to Table 10.6 the impact magnitude is **negligible**, therefore with reference to Table 10.10 the effect significance is **negligible**, and is therefore **not significant**.

Operation

Fixed (non-turbine) plant noise

10.9.5 The Proposed Development will include an energy storage system, a switching station and a control room, all of which will generate noise, which may potentially be tonal in nature. No details are currently available on the source noise levels of these elements, 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.

10.9.6 This assessment adopts the rating level noise limit of 25 dB at any identified NSR, equivalent to the baseline background noise levels at NMP1 +5dB. Provided that the noise limit is met by all non--turbine plant, including the substation, with reference to Table 10.9 the impact magnitude will be **low**. At high sensitivity NSRs, the resultant effect significance will be **minor** and therefore **not significant**.

Wind turbine noise

10.9.7 Predicted noise levels due to operation of the Proposed Development are provided in Table 10.13 across the range 4 m/s – 12 m/s.

Table 10.13 – Predicted turbine noise levels due to Proposed Development

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level, dBL_{A90}								
NSR1	22.7	26.9	30.6	32.8	33.1	33.0	33.0	33.0	32.6
NSR2	24.0	28.2	31.9	34.1	34.4	34.4	34.3	34.3	34.4
NSR3	18.6	22.7	26.4	28.5	28.8	28.8	28.8	28.8	28.2

Assessment of wind turbine noise

10.9.8 The predicted noise levels due to the Proposed Development are evaluated against the applicable noise limits in Table 10.14. The predicted levels are evaluated against the noise limits graphically in Appendix 10.3 in Chart 4.

Table 10.14 – Evaluation of compliance at NSRs

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Exceedance (predicted level minus noise limit), dB								
Daytime period									
NSR1	-12.3	-8.1	-4.4	-2.2	-4.1	-7.7	-11.9	-11.9	-12.3
NSR2	-11.0	-6.8	-3.1	-0.9	-2.8	-6.3	-10.6	-10.6	-10.5
NSR3	-16.4	-12.3	-8.6	-6.5	-8.4	-11.9	-16.1	-16.1	-16.7
Night-time									
NSR1	-15.3	-11.1	-7.4	-5.2	-4.9	-7.8	-10.0	-11.0	-11.4
NSR2	-14.0	-9.8	-6.1	-3.9	-3.6	-6.4	-8.7	-9.7	-9.6
NSR3	-19.4	-15.3	-11.6	-9.5	-9.2	-12.0	-14.2	-15.2	-15.8

10.9.9 Predicted noise levels meet the derived noise limits at all NSRs, for all wind speeds, both during the daytime and the night-time period.

Summary of significance

10.9.10 At all NSRs predicted noise levels meet the derived noise limits at all wind speeds, both during the daytime and the night-time period. With reference to Table 10.8 the impact magnitude is negligible to **low**, therefore with reference to Table 10.10 the effect significance is negligible to **minor**, and is therefore **not significant**.

Decommissioning

10.9.11 The Applicant will decommission the Proposed Development after the operational lifespan has ceased. It is anticipated that the mitigation required and the significance of the residual effects of

decommissioning the Proposed Development will be similar to, or less than, those identified within this chapter for the construction phase.

10.10 Additional Mitigation and Enhancement

10.10.1 No significant effects have been identified; compliance with the conditioned limits could be verified by undertaking a compliance test following commissioning.

10.10.2 Final turbine selection will be undertaken with a view to achieving compliance. This assessment has been undertaken using the Vestas V117 candidate turbine (see Appendix 10.4).

10.10.3 Following first operation of the Proposed Development a noise compliance test will be commissioned by the Applicant to determine compliance with the consented noise limits. Should any exceedances of noise limits attributable to the Proposed Development be identified the Applicant will put in place an operational noise management plan, such that noise limits are met. If deemed necessary, the Applicant would propose that a compliance test and submission of an operational noise management plan could be secured as a condition of planning consent for the Proposed Development.

10.11 Residual Effects

Construction

10.11.1 No requirement for specific additional mitigation (beyond good practice measures) has been determined for the construction phase, therefore no additional mitigation is proposed, and residual effects remain unchanged, and are therefore **not significant**.

Operation

Fixed non-turbine plant

10.11.2 No additional mitigation is required for fixed non-turbine plant, therefore residual effects remain unchanged, and are therefore **not significant**.

Noise from wind turbines

10.11.3 Following selection and procurement of the final turbine model (and implementation of an appropriate turbine noise management plan, if required following final turbine selection) it is anticipated that operational wind turbine noise levels will meet the derived noise limits at all NSRs across the full range of wind speeds, both during the daytime and the night-time periods. With reference to Table 10.8 the resultant impact magnitude at all NSRs will be **low**, therefore with reference to Table 10.10 the effect significance will be **minor**, and noise effects will therefore be **not significant**.

10.12 Cumulative Assessment

10.12.1 No cumulative effects are anticipated during the construction phase, and cumulative noise effects are therefore considered to be **not significant**.

10.12.2 In accordance with THC consultation cumulative operational effects are not considered within the assessment. Cumulative effects have been determined to be **not significant**.

10.13 Summary

10.13.1 This chapter has considered potential noise effects associated with construction and operation of the Proposed Development. No potential vibration effects have been identified and consideration of vibration has therefore been scoped out.

10.13.2 The assessment of noise comprised consultation with THC, characterisation of the baseline noise environment, assessment of construction traffic noise effects, prediction of noise levels associated

with construction activities, operational wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

10.13.3 Baseline noise levels in the study area are typically dominated by the wind and show a strong correlation with wind speed. Noise from anthropogenic sources, such as road traffic, is a minor contributor to total noise levels.

10.13.4 Predicted noise levels associated with construction activities meet threshold noise levels set out in the relevant guidance at all identified representative NSRs, during weekday daytimes and Saturday mornings. Noise effects from construction activities are therefore **not significant**.

10.13.5 The predicted change in road traffic noise levels associated with construction traffic is **not significant**.

10.13.6 Noise limits have been derived for non-turbine fixed plant associated with operation of the Proposed Development. Items of fixed plant will be specified such that they meet the derived noise limits at all representative NSRs. Noise effects from fixed plant are therefore **not significant**.

10.13.7 Predicted wind turbine noise levels associated with operation of the Proposed Development meet derived day and night-time noise limits at all the identified representative NSRs, for all wind speeds. Noise effects due to operation are therefore **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 from road traffic	Negligible	n/a	None required	Negligible	n/a
Noise from construction activities	Negligible	n/a	Implementation of good practice during construction works	Negligible	n/a
Operation					
Noise from fixed non-turbine plant	Negligible	n/a	Selection of plant which complies with specified maximum sound power level, or installation of appropriate acoustic enclosure where plant sound power level is above maximum specified, such that the derived noise limits are met.	Negligible	n/a
Noise from wind turbines at all NSRs	Negligible to Minor	Adverse	None required	Negligible to Minor	Adverse

Table 10.16 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
All NSRs	Cumulative wind turbine noise	Small turbine at NSR3 Rhian Bridge scoped out of consideration	Minor	Adverse

10.14 References

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