9 Noise

Contents

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9 Noise and Vibration

9.1 Executive Summary

9.1.1 This chapter considers 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. Planning permission in perpetuity is sought for the Proposed Development, therefore no specific decommissioning phase is proposed. It is anticipated, however, that should decommissioning be required, that associated noise effects would be similar to, but lesser than, construction phase effects.

9.1.2 The assessment of noise comprised consultation with Orkney Islands Council (OIC) Environmental Health Department, characterisation of the baseline noise environment, prediction of noise levels associated with construction activities, construction traffic, operation of wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

9.1.3 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.

9.1.4 Predicted wind turbine noise levels associated with operation of the Proposed Development meet derived noise limits at all identified representative Noise Sensitive Receptors (NSRs), both in isolation and cumulatively, with the exception of NSR 1 and 2 at 6 m/s wind speed, when a marginal exceedance of the derived noise limit is predicted during the daytime period only. The Applicant has committed to implementing appropriate mitigation such that noise limits are met during operation. Residual noise effects due to operation are therefore not significant.

9.2 Introduction

9.2.1 This chapter considers the potential noise effects of the Proposed Development on receptors sensitive to noise during the construction phase and the operational phase.

Scope of assessment

9.2.2 The scope of this assessment has comprised the following:

- scoping consultation with OIC 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.

9.2.3 Given the separation distances involved, 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.

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

9.3 Legislation, Policy and Guidelines

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

Legislation

9.3.2 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.

9.3.3 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 Planning Policy

9.3.4 The latest Scottish Planning Policy (Scottish Government, 2014a) details policies relating to renewable energy. The SPP recognises the need to facilitate the transition to a low carbon economy and supports the development of a diverse range of electricity generation from renewable energy sources, noting:

"*Development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets, giving due regard to relevant environmental, community and cumulative impact considerations.*"

9.3.5 The SPP provides guidance on where wind farms will and will not be acceptable, according to a spatial framework as follows:

- Group 1 – Areas where wind farms will not be acceptable, comprising National Parks and National Scenic Areas;
- Group 2 – Areas of significant protection where wind farms may be appropriate in some circumstances, with consideration required to demonstrate that any significant effects on the qualities of these areas can be substantially overcome by siting, design or other mitigation; and
- Group 3 – Areas with potential for wind farm development, where wind farms are likely to be acceptable, subject to detailed consideration against identified policy criteria, which may include noise.

Scottish Government Online Planning Advice: Onshore Wind Turbines

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

9.3.7 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."

9.3.8 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 assessment guidance (discussed in paragraphs 9.3.15 to 9.3.27 below).

9.3.9 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'…. The Scottish Government accepts that the guide represents current industry good practice. "With regards to the assessment and control of noise from construction sites the use of BS 5228: 2009 (Parts 1 and 2) 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.* The standard is summarised in paragraphs 9.3.48-53.

9.3.10 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.

9.3.11 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*. The standard is summarised in paragraphs 9.3.38 to 9.3.44.

9.3.12 In summary, national planning policy on 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 (GPG), whilst construction noise and vibration should be assessed with reference to BS 5228. These guidance documents, and others relevant to the assessment of possible noise and vibration impacts generated by the Proposed Development, are summarised below.

Regional & Local planning policy

9.3.13 Local planning policy is discussed in Chapter 5 of this EIAR.

Guidance

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

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

9.3.15 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).

9.3.16 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.

9.3.17 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 to 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.

9.3.18 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, as well as 13:00 to 18:00 hours on Saturdays and Sundays, and 07:00 to 13:00 hours on Sundays.

9.3.19 For daytime, the suggested limits are 5dB 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.

9.3.20 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.

9.3.21 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}.

9.3.22 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 10m above ground at the location of the proposed turbines. The allowable limit is then defined at +5dB 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).

9.3.23 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 background related element of the noise level limits.

9.3.24 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.

9.3.25 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.

9.3.26 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 turbine manufacturers.

9.3.27 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 windfarm 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 windfarm 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

9.3.28 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 50kW.

9.3.29 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.

9.3.30 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. SGN6 address prediction of noise via propagation over water and provides an equation to calculate noise levels at receptors when water accounts for more than 700 m of the distance between source and receptor.

9.3.31 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. Where the data have 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 10m 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 -2d 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.

9.3.32 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*'.

9.3.33 This guidance is relevant to the assessment of noise from the Proposed Development because it is proposed in the vicinity of a number of other operational wind turbines.

9.3.34 In the section titled '*existing windfarm/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*".

9.3.35 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.

9.3.36 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.

9.3.37 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.

<u>BS4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound</u>

9.3.38 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*".

9.3.39 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.

9.3.40 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.

9.3.41 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.

9.3.42 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.

9.3.43 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".*

9.3.44 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)

9.3.45 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 and vibration. The guidance also provides significance criteria, by which the percentage of people adversely affected by traffic noise can be related to the total noise or vibration level due to road traffic, or the increase over an existing level.

9.3.46 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.

9.3.47 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) and Part 2 (vibration)

9.3.48 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.

9.3.49 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.

9.3.50 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.

9.3.51 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.

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

9.3.53 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 Table 9.1 and the '5 dB(A) change' method as described in paragraph 9.3.54.

Table 9.1 – 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

Assessment Category and Threshold Value Period	Threshold Value, in Decibels (dB) ($L_{Aeq,T}$)		
	Category (A)	Category (B)	Category (C)
NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ 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 $L_{Aeq,T}$ 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*			

9.3.54 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."

9.4 Consultation

9.4.1 Table 9.2 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 9.1.

Table 9.2 – Consultation undertaken

Consultation sent	Consultation response	Applicant action
OIC Scoping Opinion (refer to Appendix 4.2)	Subject to the comments below Environmental Health are satisfied that the Scoping Report has covered all the key issues relating to potential noise impacts from the proposed development, in particular we agree with the proposed ETSU-R-97 (including Institute of Acoustics GPG/SGN) based methodology and general approach. Comments: 1. Orkney Islands Council Environmental Health does not envisage applying any local or special noise-related requirements. 2. It is considered likely that any significant impact from construction noise can be controlled by restrictions on hours of work.	Comments noted and accepted

Consultation sent	Consultation response	Applicant action
	3. It is agreed that the existing wind turbines at Rennibister and Crowness Business Park (Hatston) will need to be considered for inclusion in any assessment. For the purposes of the cumulative noise assessment the assumption must be made that these turbines are operating at their respective planning condition limits for noise impacts at nearest noise sensitive receptors and NOT, for example, based on any actual measured levels or levels calculated from manufacturer's data and modelling. 4. Dwellings at or near Quanterness Farm should not be assumed to be classed as Financially Involved just because they are part of the farm which currently owns the land the proposed turbines will be on, the key issue will be the direct financial involvement or otherwise of the occupiers of those dwellings.	
Email 09/09/2019 Supplementary consultation with Environmental Health – agreement of baseline noise survey monitoring locations	Email 11/09/2019 Environmental Health Officer (EHO) accepted locations in principle and agreed to meet on site at set up to agree micro-siting of noise monitoring positions.	Met on site, micro-siting agreed.
Email 22/10/2019 Seeking to agree use of monitoring data and use of proxy locations for characterising noise at NSRs	EHO queried candidate turbine model and method of predicting 35 dB contour. EHO queried proposed allocation of proxies to NSRs and suggested alternative and noted that logic for allocating proxies to NSRs would have to be carefully discussed in the final report.	Accepted EHO comments on use of baseline data. Confirmed candidate turbine model.
Email 02/12/2019 Seeking to agree that reported sound power data may be used for Hatston (Orkney Gateway) turbine, rather than assuming it is operating at consented simplified ETSU noise limit, given closest	EHO confirmed use of reported data is appropriate in this instance, provided turbine data treated in accordance with requirements of IoA GPG.	Reported sound power data used.

Consultation sent	Consultation response	Applicant action
receptors are >700 m away.		
Emails and phone conversations 07 - 13/12/2020 Seeking to confirm approach to setting noise limits accounting for considerationof noise limits allocated to existing single turbine developments	EHO confirmed approach taken to derivation of noise limits at NSR1 –NSR6 and NSR8 – NSR13 was acceptable, however, further consideration required of limits at NSR7, given financially-involved noise limit and contribution of the Rennibister turbine. Revised approach proposed and EHO confirmed that revised approach at NSR7 acceptable.	Agreed approach to noise limits adopted at NSR7

9.5 Assessment Methodology and Significance Criteria

Consultation

9.5.1 Details of consultation with OIC are provided in Section 9.4. Additional face-to-face discussions with Environmental Health were undertaken during site visits to install noise monitoring equipment with regard to the micro-siting of the equipment, and the audibility of existing cumulative turbines.

Study Area

9.5.2 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.

9.5.3 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.

9.5.4 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 9.1. 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.

9.5.5 Figure 9.1 shows all of the identified properties within and slightly beyond the 35 dB noise contour, comprising four potential NSRs. There is one other property which lies in close proximity to the 35 dBL_{A90} noise contour, and a further seven which have been considered in this assessment, given the potential for cumulative noise effects. The representative NSRs considered in the assessment are listed in Table 9.3.

Table 9.3 – Identified representative NSRs

NSR name	NSR ID	Grid reference (OSGB)	
		X	Y
1 Quanterness Farm Cottages	NSR1	341668	1013100
2 Quanterness Farm Cottages	NSR2	341679	1013100
Quanterness Farm (FI)	NSR3	341827	1012883
Harwood	NSR4	341958	1012838
Saverock	NSR5	342662	1012712
Cassie House, Blackhill	NSR6	342644	1011650
Rennibister	NSR7	339719	1012577
Rennibister Cottage	NSR8	339629	1012314
Ingashowe	NSR9	338841	1012535
Burness	NSR10	338812	1015786
Quoys of the Ayre	NSR11	339051	1016536
Mou Ness	NSR12	339585	1017021
Burness Cottage	NSR13	338756	1016257

FI denotes financial involvement with the Proposed Development

Baseline Noise Survey

9.5.6 A baseline 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 9.4, and shown on Figure 9.2.

Table 9.4 – Baseline noise monitoring positions

NMP name	NMP ID	Grid reference (OSGB)	
		X	Y
Cottage "Harwood" at Quanterness Farm	NMP1	341954	1012857
Mou Ness	NMP2	339413	1017064

9.5.7 The baseline survey was completed over the period 18th September to 13th October 2019.

9.5.8 The sound level meters (SLMs) used were compliant with Class 1 specification, as described in BS EN 61672-1:2003. 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 SLMs and calibrator are provided in Appendix 9.2.

9.5.9 The SLMs were installed at the monitoring positions each 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 microphones were fitted with double-skin outdoor wind shields with a minimum 200 mm diameter.

9.5.10 The monitoring locations are described as follows:

- **NMP1 Harwood –** SLM installed within garden of property, on the southern side of the house. The property was well-maintained, although uninhabited at the time of survey. The SLM was sited more than 3.5 m from the front 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 foggy, with moderate to high wind speeds.
- **NMP2 Mou Ness** – SLM installed within rear garden to south of dwelling, positioned such that the dwelling provided maximum screening to noise from existing turbines to the north. An air-source heat pump was noted on the western elevation of the dwelling, the NMP was therefore positioned such that the wall of the dwelling screened noise from the heat pump. The heat pump was noted to be operational at the time of the site visit, however, it was inaudible at the NMP. Weather conditions during installation were foggy, with moderate to high wind speeds.

9.5.11 The EHO was present during the commissioning of monitoring equipment, and the micro-siting of both NMPs was discussed and agreed with the EHO during the installation. Full details of the monitoring locations and photographs of the equipment in-situ are provided in Appendix 9.3.

Construction Phase Noise

Construction Traffic

9.5.12 Projected construction traffic flows (refer to Chapter 12) have been compared with baseline flows on the A965 and screened against the DMRB criteria (refer to para. 9.3.45), whereby an increase of ≥25 % in traffic flows equates to an increase of ≥1 dB.

On-site Construction Activities; Method of Prediction

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

Working hours

- 08.00-18.00 Monday – Fridays;
- 08.00-12.30 Saturdays; and
- No working Sundays and Bank holidays.

Construction plant:

Access tracks and turbine hardstandings

- 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)

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)

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

9.5.14 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 9.3, 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.

9.5.15 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 the combined effect of both the prevailing ambient noise and the 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) $L_{Aeq,T}$.

9.5.16 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$L_{Aeq,T}$.

9.5.17 Criteria have been derived drawing on the above and are provided in Table 9.9 within the Impact Magnitude section below.

Operational Phase Noise

General Method of Prediction

9.5.18 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.

9.5.19 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.

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

- Ground absorption: G=0.5 (note: separate calculation was undertaken for propagation over water, see paragraph 9.3.30);
- 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%.

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

9.5.22 Prediction of propagation over water at NSR10, NSR11, NSR12 and NSR13 has been undertaken in accordance with SGN6.

Proposed Development

9.5.23 The noise assessment is based on the candidate turbine model for the Proposed Development. This is the Vestas 136 4.2 MW, which has a serrated trailing edge of the turbine blades to reduce noise. The source noise terms of the proposed turbine model has been provided by Vestas as 1/3 octave band data, quoted as sound power levels over a range of operational hub-height wind speeds. This may not be the final turbine chosen for the Proposed Development, but the Applicant will ensure any change in turbine meets the noise levels detailed within this assessment.

9.5.24 The 1/3 octave band data has been accumulated into octave-band data and standardised to 10 m height wind speeds, and an appropriate uncertainty correction of 2 dB has been applied to the sound power levels in accordance with the requirements of the IoA GPG. The resultant source noise terms for the candidate turbine are provided in Table 9.5.

Table 9.5 – Sound power levels of the Proposed Development candidate turbine

Wind speed, m/s	Sound power level standardised to 10 m height wind speed, dB(A)
3	93.4
4	96.7
5	101.5
6	105.3
7	105.9
8	105.9
9	105.9

Wind speed, m/s	Sound power level standardised to 10 m height wind speed, dB(A)
10	105.9
11	105.9
12	105.9

9.5.25 The candidate turbine model operates at its maximum sound power level at wind speeds of 7m/s and above.

9.5.26 Octave-band data for the turbine at 10 m wind speed of 9 m/s is provided in Table 9.6.

Table 9.6 –Octave band sound power levels at 9 m/s wind speed

Octave band centre frequency, Hz	31.5	63	125	250	500	1000	2000	4000	8000
Sound power level, dB(A)	76.2	86.8	94.5	99.2	101.0	99.9	95.8	88.9	78.8

9.5.27 The proposed turbine layout is shown in Figure 9.1.

Cumulative noise

Identification of Cumulative Developments

9.5.28 A review was undertaken of existing and proposed wind energy developments in the vicinity of the site, using information available on the OIC planning portal and in consultation with Environmental Health. This review has been completed to identify those developments which have the potential to give rise to a cumulative noise impact when operating simultaneously with the Proposed Development. The results of this desk-based review have been used to inform the assessment of operational turbine noise.

9.5.29 Where two predicted noise levels differing by 10 dB or more are summed, the total level is the same as the larger of the two levels; i.e. the lower level contributes a negligible amount to the total. This principle has been used to determine the cumulative study area for this assessment, and to identify which turbines contribute cumulatively to the Proposed Development.

9.5.30 The model assumed each turbine operates at its maximum sound power level, as reported in the relevant planning application. For small turbines, where no source noise data was available associated with the planning application, appropriate assumptions were made regarding the sound power level, based on turbines of similar dimensions and included appropriate corrections for uncertainty.

9.5.31 Using the modelling predictions, a "noise contour" was produced which identifies the area in which predicted noise levels exceed 35 dBL_{A90} and where the contribution of the Proposed Development is within 10 dB of the predicted level from cumulative developments. This enabled the identification of NSRs at which cumulative effects may occur. The cumulative noise contour is shown in Figure 9.2. The pink shaded area identifies NSRs at which noise levels exceed 35 dBL_{A90} and at which predicted noise levels due to the Proposed Development are within 10 dB of noise from cumulative turbines.

9.5.32 With reference to Figure 9.2, NSRs at which cumulative effects may occur are NSR5 Saverock and NSR8 Rennibister Cottage. At NSR1, NSR2, NSR3, NSR4, NSR6, NSR7 and NSR9, either noise from the Proposed Development exceeds all other contributions by 10 dB or more, or noise from other turbines exceeds noise contributions from Quanterness by 10 dB or more and therefore no cumulative operational noise effects will occur.

9.5.33 At NSR10, NSR11, NSR12 and NSR13 noise from the Proposed Development has been calculated using a spreadsheet in accordance with the calculation method provided in SGN6 of the GPG. Predicted noise contours from the modelling software at these NSRs may be regarded as indicative only, due to the slight variation in calculation methods. Potential cumulative effects arising between the Proposed Development and the closest potentially cumulative turbines (shown on Figure 9.2) have therefore been considered by alternative methods (refer to para. 9.5.39 - 9.5.40).

9.5.34 In the final stage of the cumulative screening process, predicted partial levels (the noise level due to individual turbines) were reviewed for all NSRs within the cumulative study area. All potentially-cumulative turbines whose contribution to total noise levels was more than 10 dB below the contribution of the Proposed Development were screened out, and these have been excluded from detailed calculations. A cautious approach was maintained in the screening-out process, and where turbine contributions were only marginally above 10 dB below the Proposed Development these turbines were retained. The remaining cumulative developments are listed in Table 9.7 and shown in Figure 9.2.

Table 9.7 – Cumulative developments considered

Development	Planning reference	Status	Turbine type, hub height
Crowness Business Park, Hatston Ind. Est. (Orkney Gateway 1)	09/092/PPF	Operational	Enercon E44, 45 m hub
Rennibister	12/108/TPP	Operational	Enercon E44, 45 m hub
Haughhead	11/009/TPP	Operational	Proven 35,18 m hub
South Breck, three turbines covered by two planning applications	11/451/TPP and 12/369	Operational	Evance 9000, 18m max height (assumed to tip)
Peedie House	11/527/TPP	Operational	C&F Green Energy CF20, 21m hub
Burness	11/775/TPP	Operational	C&F Green Energy CF20, 21m hub

9.5.35 Cumulative noise levels have been predicted using the available information, however, for the majority of smaller turbines sound power level data is only available at their maximum output. As agreed with Environmental Health, existing single turbine developments have been assumed to be operating at their consented noise limit, typically the 'flat' simplified ETSU limit of 35 dB regardless of wind speed or whether daytime or night-time.

9.5.36 There are no residential receptors identified close to the Crowness turbine, and assuming that it is operating at its consented noise limit at the closest residential receptor (Saverock) results in predicted levels 5 dB higher than using the reported sound power levels. As agreed with Environmental Health on 02/12/19 the cumulative contours use the predicted levels based on sound power data. The approach to setting noise limits (see paragraph 9.6.14) uses the consented noise limit for the Crowness turbine, therefore no additional allowance for headroom considerations is required in prediction of cumulative noise levels.

9.5.37 The modelled source noise terms assumed for identified cumulative turbines are provided in Appendix 9.6.

Review of Cumulative Noise Limits

9.5.38 Noise limits for the majority of identified cumulative developments were in accordance with the "simplified ETSU" approach, whereby noise levels due to small individual turbines or clusters of

small turbines are conditioned to a simplified noise limit of a 'flat' 35 dB across the range of wind speeds at all properties. Where properties own a specific turbine or cluster of turbines, noise limits at these properties have been assumed to be the financially-involved limit of '45 $dBL_{A90,10min}$ or background +5dB' as provided in ETSU.

Derivation of noise limits at NSRs

9.5.39 Appropriate noise limits for the operational phase of the Proposed Development have been determined at each NSR by identifying what the controlling noise limit is, based on evaluation of existing noise limits applicable to cumulative developments. The following approach has been taken to derive appropriate noise limits, in the following order of preference:

1. **Consented noise limits at named NSRs for cumulative developments.** Noise limits apply only at the NSRs named in the consented cumulative developments, and noise from the Proposed Development should not result in an exceedance of these limits. Given the simplified ETSU noise limits applicable to existing/consented turbines within the study area, no noise limits have been determined for named NSRs in their planning conditions.

2. **No cumulative effect - noise limits derived using measured 2019 baseline noise levels.** At NSRs where it has been determined through prediction that no cumulative effects will occur, i.e. noise levels due to the Proposed Development are >10 dB above the noise levels from existing and consented cumulative turbines, then the assumed noise limit applicable to the Proposed Development is the ETSU limit derived from measured baseline noise levels, assuming a fixed minimum limit of '35 $dBL_{A90,10min}$ or background +5dB, whichever is the higher'

3. **Potential cumulative effect – derived noise limits using measured 2019 baseline noise levels minus the existing consented noise limits applicable to other turbines.** At NSRs where potential cumulative effects have been identified, noise limits have been adopted such that the Proposed Development does not exceed any available 'headroom' in consented noise limits. Given the use of 'simplified ETSU' flat noise limits for cumulative turbines within the study area, NSRs at which cumulative effects may have assumed noise limits which do not vary with wind speed, and for which there is no existing baseline data. This assessment therefore relies on measured 2019 baseline noise levels; where 'background +5 dB' does not exceed 35 dB, the resultant noise limit has been set at 10 dB below the assumed noise limit of 35 dB. At higher wind speeds, where 'background +5 dB' exceeds 35 dB, the available headroom has been determined by logarithmic subtraction of the assumed (consented) contribution of cumulative turbines from the 'background +5 dB' noise limit.

9.5.40 We note that the small turbines may potentially operate at noise levels of up to 45 dB at properties with which they have financial involvement. This assessment has determined through prediction that operation of cumulative small turbines identified within the study area would result in exceedance of the 35 dB simplified ETSU limit at the closest non-FI properties, therefore it is considered that assuming that cumulative turbines do not exceed 35 dB at the closest non-FI property is appropriately robust.

9.5.41 The derivation of noise limits is shown in detail in Table 9.14 in Section 9.6 of this chapter. The process to derive noise limits has been agreed with OIC to provide a robust approach to protecting residential amenity. This includes the adoption of the lower ETSU limit value i.e. 35 dB or 'background + 5 dB' in preference to the higher 40 dB ETSU or 'background + 5 dB' limit, and an approach to cumulative noise that ensures no cumulative exceedence of ETSU limits, to maximise protection of residential amenity.

Impact Magnitude and Effect Significance Criteria

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

Receptor Sensitivity

9.5.43 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 9.8 and are applicable to both noise and vibration effects.

Table 9.8 – Noise and vibration Receptor sensitivity criteria

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

Impact Magnitude - Construction Noise

9.5.44 The construction noise impact magnitude has been determined according to the threshold levels provided in Table 9.9.

Table 9.9 – 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

9.5.45 The design manual for roads and bridges 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 9.10.

Table 9.10 – 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

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

Impact Magnitude - Operational Wind Turbine Noise

9.5.46 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 9.11.

Table 9.11 – 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

9.5.47 For noise from any fixed (non-turbine) plant such as any transformers, control buildings or substations, 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.

9.5.48 The impact magnitudes associated with noise generated from fixed plant are presented in Table 9.12.

Table 9.12 – 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

9.5.49 The effect significance has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in Table 9.13.

Table 9.13 – Effect Significance Matrix

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

9.5.50 This assessment considers all identified NSRs to be of "high" sensitivity in accordance with Table 9.8, 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 "neutral" and "minor" are not significant.

Requirements for Mitigation

9.5.51 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

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

Limitations to Assessment

9.5.53 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.

9.5.54 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.

9.6 Baseline Conditions

Description of Baseline Noise Environment

9.6.1 Time-history charts of the measured ambient (L_{Aeq}) and background (L_{A90}) noise levels for each monitoring location are provided in Appendix 9.6. Periods of rainfall-affected data, which have been screened out of subsequent analysis, are shown in dark blue.

9.6.2 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 9.6 for both NMPs. 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 - Harwood

9.6.3 The dominant noise source was wind-induced rustling of vegetation, although the property and its surroundings are sparsely vegetated. Road traffic on the A965 was occasionally and barely audible, however, infrequent Heavy Goods Vehicles (HGVs) were more clearly audible.

9.6.4 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events is provided as Chart 9.1 in Appendix 9.6. With reference to Chart 9.1, the following observations are noted with regard to measured baseline noise levels:

- the ambient and background levels show a 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).

9.6.5 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 9.6, Chart 9.2 shows the daytime period and Chart 9.3 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 by a substantial margin at all wind speeds;
- With reference to Chart 9.2, there is a strong correlation between wind speed and measured background noise level with no outliers and no banding of datapoints;
- During the daytime period the measured background level exceeds the fixed minimum daytime noise level (35 dB) even at low wind speeds, this is attributed to the exposed setting of the NMP (and its surrounding NSRs);
- With reference to Chart 9.3, there is a strong 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.

NMP2 - Mou Ness

9.6.6 The dominant noise source was the wind, with wave noise from the sea barely audible. No noise was audible from the existing turbines[1] to the north-west of the property at the NMP during the installation of the noise monitoring equipment.

9.6.7 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events is provided as Chart 9.4 in Appendix 9.6. With reference to Chart 9.4 the following observations are noted with regard to measured baseline noise levels:

- The ambient and background levels show a generally 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;
- Where peaks in the noise levels occur, the difference between the ambient level and the background level is greater than at matching peaks noted at NMP1. This is attributed to wave noise from the sea, which was not audible at NMP1 and which will also be dependent on wind speed and direction; and
- As with NMP1, there is a clear diurnal variation on some days, however, the primary control on noise levels can be attributed to wind conditions, rather than time of day.

9.6.8 The measured daytime and night-time background noise levels for NMP2, correlated to wind speed, and with rain-affected data removed, are provided in Appendix 9.6, Chart 9.5 shows the daytime period and Chart 9.6 the night-time period including all wind directions. 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 by a substantial margin at all wind speeds;
- With reference to Chart 9.5 and Chart 9.6, there is a strong correlation between wind speed and measured background noise level with no outliers, however, some banding of datapoints is noted at wind speeds of 7 m/s and above; and
- Noise levels are slightly lower than at NMP1; during the daytime period the measured background level exceeds the fixed minimum daytime noise level (35 dB) only at wind speeds above 7 m/s.

9.6.9 Given the presence of existing wind turbines close to NMP2, directional filtering has been undertaken to consider the potential effect of noise from these turbines on measured baseline noise levels. The results of directional filtering are presented in Chart 9.7 and Chart 9.8; with datasets split between broadly easterly wind conditions (0^o – 180^o), when the NMP was up-wind of the closest existing wind turbines, and broadly westerly wind conditions (180^o – 360^o), when the NMP was down-wind of the turbines. The show that for both the daytime and the night-time periods there is little difference between the datasets at low wind speeds. At wind speeds above 7 m/s the background level is higher when the NMP was up-wind of the turbines. Under such conditions the NMP was down-wind of the sea. This is a positive indication that noise from existing wind turbines

9.1.1

[1] *Turbine planning references: 11/527/TPP Peedie House turbine, and 11/451/TPP, 12/369/TPP South Breck turbines. Consented noise limits are simplified ETSU-R-97 of 35 dB$L_{A90,10min}$ at wind speeds not exceeding 10m/s as measured at not less than 10 m from the façade of any noise sensitive property.*

does not contribute significantly to background levels at NMP2, and that other noise sources, such as the sea, are the dominant control on noise levels.

9.6.10 Noise from the sea is a part of the baseline noise environment, and it is considered that no data requires to be excluded from Chart 9.5 or Chart 9.6 for the derivation of noise limits at NMP2. The derived noise limits shown in Chart 9.5 and Chart 9.6 have therefore been adopted as representative of this location.

Adopted noise limits

Construction and decommissioning noise limits

9.6.11 With reference noise levels presented in Appendix 9.6, specifically in Chart 9.1 and Chart 9.4, the baseline ambient level is below 65 dB throughout 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

9.6.12 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 and NMP2. 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 form 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 9.1 and Chart 9.4 the measured background level during the night-time period at NMP1 and NMP2 was 25 $dBL_{A90,T}$ and 20 $dBL_{A90,T}$, respectively.

Operational noise limits – wind turbine noise

9.6.13 The derived noise limits at Harwood and Mou Ness are provided in Table 9.14 for the range of operational wind speeds of the candidate turbine. The noise limits derived from measurements at NMPs have been allocated to NSRs on the basis of observations of the noise environment while setting up the SLMs.

9.6.14 As discussed in 9.5.39, allowance has been made within the noise limits for noise from cumulative turbines. Noise levels from cumulative turbines operating at their consented noise limits have been used to determine at which NSRs cumulative effects may occur. This is shown graphically in Figure 9.2. The results of this evaluation are as follows:

- NSR1, NSR2, NSR3, NSR4, NSR6, NSR9 – no potential cumulative effect;
- NSR5 – potential cumulative effects with Crowness turbine;
- NSR7 – predicted noise level due to Rennibister turbine >10 dB above predicted level due to Proposed Development, therefore no cumulative effect, however, noise limit for Proposed Development to be set such that residential amenity at NSR7 is preserved. Detailed approach to setting appropriate cumulative limits agreed with EHO and is provided in para. 9.6.16.
- NSR8 – potential cumulative effects with Rennibister turbine; and
- NSR10, NSR11, NSR12, NSR13 – potential cumulative effects with multiple small turbine developments.

9.6.15 This assessment has determined through prediction that the Rennibister turbine cannot use the full 45 dB FI limit at NSR7 Rennibister while also meeting the 35 dB simplified ETSU noise limit at NSR8 Rennibister Cottage. The applicable noise limit at NSR7 has therefore been derived as follows:

- To meet a 'flat' 35 dB at NSR8 the Rennibister turbine cannot exceed a noise level of 41 dB at NSR7;
- For the preservation of residential amenity at NSR7, it has been agreed with Environmental Health that the Rennibister turbine should be assumed to be using 41 dB of the available noise limit at NSR7 Rennibister;
- The derived noise limit available for the Proposed Development at NSR7 is the 'background +5 dB' noise limit, minus the assumed 41 dB contribution of the Rennibister turbine; and
- Where 'background +5 dB minus 41 dB' is below 35 dB, the noise limit has been set at 10 dB below the FI noise limit of 45 dB (i.e. 35 dB).

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

Table 9.14 – 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 – Harwood baseline-derived 'background +5 dB noise limit'										
Daytime	37.1	37.5	38.2	39.3	40.7	42.2	43.7	45.2	46.6	47.7
Night-time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.6	47.4	49.9
Limit applicable at: **NSR1 & NSR2 Quanterness Cottages, NSR4 Harwood, NSR6 Cassie House, NSR9 Ingashowe**										
NMP1 - Harwood – baseline-derived 'background +5 dB' noise limit, minus 35 dB assumed contribution from cumulative turbines										
Daytime	33.8	33.8	35.4	37.3	39.3	41.2	43.1	44.8	46.3	47.5
Night-time	42.3	42.3	42.3	42.3	42.3	42.3	42.3	44.2	47.1	49.7
Limit applicable at: **NSR5 Saverock and NSR8 Rennibister Cottage**										
NMP1 - Harwood – baseline-derived 'background +5 dB' noise limit, minus 41 dB assumed contribution from Rennibister turbine										
Daytime	35.0	35.0	35.0	35.0	35.0	35.9	40.4	43.1	45.2	46.7
Night-time	38.7	38.7	38.7	38.7	38.7	38.7	38.7	42.2	46.2	49.3
Limit applicable at: **NSR7 Rennibister**										
Financially-Involved noise limit, derived from NMP1 Harwood baseline data										
Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.6	47.7
Night-time	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.4	49.9
Limit applicable at: **NSR3 Quanterness Farm**										

Wind speed, m/s	Derived noise limit, $dBL_{A90,10min}$									
	3	4	5	6	7	8	9	10	11	12
NMP2 - Mou Ness – baseline-derived background +5 dB noise limit.										
Daytime	35.0	35.0	35.0	35.8	39.4	43.1	46.5	49.4	51.6	53.0
Night-time	43.0	43.0	43.0	43.0	43.0	43.0	46.2	48.9	50.7	51.7
Limit not applicable directly at any NSRs, given potential cumulative contributions from small turbines										
NMP2 - Mou Ness – background +5 dB noise limit, minus 35 dB contribution assumed from cumulative turbines.										
Daytime	25.0	25.0	25.0	28.3	37.5	42.4	46.2	49.2	51.5	53.0
Night-time	42.3	42.3	42.3	42.3	42.3	42.3	45.9	48.7	50.5	51.6
Limit applicable at: **NSR10 Burness, NSR11 Quoys of the Ayre, NSR12 Mou Ness, NSR13 Burness Cottage**										

9.6.17 The occupiers of NSR3 Quanterness Farm will be financially involved in the Proposed Development, therefore the higher Financially Involved (FI) noise limit applies at this NSR.

9.6.18 Where it has been identified that no headroom is available (text in red) the cumulative noise limit has been set at 10 dB below the consented limit for cumulative turbines.

9.7 Receptors Brought Forward for Assessment

9.7.1 The NSRs considered in this assessment are provided in Table 9.3 and shown in Figure 9.1.

9.8 Standard Mitigation

Construction phase

9.8.1 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

9.8.2 Noise from non-turbine operational plant will comprise noise from substations only. The sound power level and final location of the substation(s) are yet to be finalised, however, noise from the final type and location of the substation will be attenuated by acoustic enclosure (if required), such that it meets the derived non-turbine noise limits (se Section 9-24). A sound power level of 90 dB(A), equivalent to a sound pressure level of 62 dB(A) at 10 m, would enable the noise limit to be met. The installed substation will meet these criteria.

9.9 Potential Effects

Construction

Construction traffic

9.9.1 Projected construction traffic flows on the A965 indicate a maximum increase of 104 vehicles per day on the most-affected link, over a baseline flow of 4,641 vehicles, equivalent to an increase of 2.3 percent. With reference to Table 9.10 the projected increase of less than 1 dB corresponds to a **negligible** impact magnitude, and a **neutral** effect significance, and is therefore **not significant**.

On-site Construction

9.9.2 The predicted noise levels at NSR1 and NSR2, the closest properties to the Proposed Development site, due to the three stages of construction considered are provided and evaluated against the adopted noise limits in Table 9.15.

Table 9.15 – Evaluation of worst-case construction phase noise levels at closest NSRs (NSR1 & NSR2)

Scenario	Predicted level, $dBL_{Aeq,T}$	Exceedance of noise limit, dB
Construction of access tracks	55	-10
Construction of turbine bases	46	-19
Installation of turbines	46	-19

9.9.3 At NSR1, predicted worst-case noise levels due to construction activities meet the derived noise limits by a margin of 10 dB or more. With reference to Table 9.9 the impact magnitude is **negligible**, therefore with reference to Table 9.13 the effect significance is **neutral**, and is therefore **not significant**.

Operation

Fixed (non-turbine) plant noise

9.9.4 The Proposed Development will include a substation which will generate noise, which will potentially be tonal in nature. No details are currently available on the source noise levels of the substation, and it is therefore considered appropriate that suitable noise control limits will 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.

9.9.5 This assessment adopts the rating level noise limit of 25 dB at any identified NSR, equivalent to the baseline background noise levels at NMP1. Provided that the noise limit is met by all non--turbine plant, including the substation, with reference to Table 9.12 the impact magnitude will be **low**. At high sensitivity NSRs, the resultant effect significance will be **minor** and therefore **not significant**.

Wind turbine noise

9.9.6 Predicted noise levels due to operation of the Proposed Development are provided in Table 9.16 across the range 4 m/s – 12 m/s.

Table 9.16 – 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	30.8	35.6	39.4	40.0	40.0	40.0	40.0	40.0	40.0
NSR2	30.8	35.6	39.4	40.0	40.0	40.0	40.0	40.0	40.0
NSR3	28.6	33.4	37.2	37.8	37.8	37.8	37.8	37.8	37.8
NSR4	28.2	33.0	36.9	37.5	37.5	37.5	37.5	37.5	37.5
NSR5	24.8	29.6	33.4	34.0	34.0	34.0	34.0	34.0	34.0
NSR6	17.0	21.8	25.6	26.2	26.2	26.2	26.2	26.2	26.2
NSR7	19.7	24.5	28.3	28.9	28.9	28.9	28.9	28.9	28.9
NSR8	17.8	22.6	26.5	27.1	27.1	27.1	27.1	27.1	27.1
NSR9	14.6	19.4	23.2	23.8	23.8	23.8	23.8	23.8	23.8
NSR10	16.9	23.1	26.6	29.6	32.1	32.1	32.1	32.1	32.1
NSR11	16.3	22.6	26.1	29.2	31.7	31.7	31.7	31.7	31.7
NSR12	16.1	22.5	26.0	29.1	31.6	31.6	31.6	31.6	31.6
NSR13	16.2	22.6	26.1	29.1	31.6	31.6	31.6	31.6	31.6

Note – noise levels due to operation of the Proposed Development at NSR10, NSR11, NSR12 and NSR13 have been predicted in accordance with 'SGN6 – Propagation over water' and are therefore higher than predicted levels at some closer NSRs.

Assessment of wind turbine noise – NSRs where cumulative effects will not occur

9.9.7 The predicted noise levels due to the Proposed Development, NSRs at which no potential cumulative effects are identified, are evaluated against the applicable noise limits for in Table 9.17. The predicted levels are evaluated against the noise limits graphically in Appendix 9.6 in Chart 9.9 (daytime period) and Chart 9.10 (night-time period).

Table 9.17 – Evaluation of compliance at NSRs at which no cumulative effects identified

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	-6.7	-2.6	0.1	-0.7	-2.2	-3.7	-5.2	-6.6	-7.7
NSR2	-6.7	-2.6	0.1	-0.7	-2.2	-3.7	-5.2	-6.6	-7.7
NSR3	-16.4	-11.6	-7.8	-7.2	-7.2	-7.2	-7.4	-8.8	-9.9

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Exceedance (predicted level minus noise limit), dB								
NSR4	-9.3	-5.2	-2.4	-3.2	-4.7	-6.2	-7.7	-9.1	-10.2
NSR6	-20.5	-16.4	-13.7	-14.5	-16.0	-17.5	-19.0	-20.4	-21.5
NSR9	-22.9	-18.8	-16.1	-16.9	-18.4	-19.9	-21.4	-22.8	-23.9
Night-time									
NSR1	-12.2	-7.4	-3.6	-3.0	-3.0	-3.0	-4.6	-7.4	-9.9
NSR2	-12.2	-7.4	-3.6	-3.0	-3.0	-3.0	-4.6	-7.4	-9.9
NSR3	-16.4	-11.6	-7.8	-7.2	-7.2	-7.2	-7.2	-9.6	-12.1
NSR4	-14.8	-10.0	-6.1	-5.5	-5.5	-5.5	-7.1	-9.9	-12.4
NSR6	-26.0	-21.2	-17.4	-16.8	-16.8	-16.8	-18.4	-21.2	-23.7
NSR9	-28.4	-23.6	-19.8	-19.2	-19.2	-19.2	-20.8	-23.6	-26.1

9.9.8 Predicted noise levels are marginally above the derived limit at two receptors; occurring at NSR1 and NSR2 at 6 m/s. The predicted noise level at these receptors exceeds the derived noise limit by 0.1 dB during the daytime period (shown in red text). The predicted noise levels meet the derived noise limits at NSR1 and NSR2 at all other wind speeds during the daytime period, and at all wind speeds during the night-time period.

9.9.9 At all other representative NSRs at which no cumulative effects have been identified, predicted noise levels meet the derived noise limits at all wind speeds, both during the daytime and the night-time period.

Assessment of wind turbine noise – NSRs at which potential cumulative effects have been identified

9.9.10 Predicted noise levels due to the proposed development, at NSRs where the potential for cumulative effects has been identified, are evaluated against the derived noise limits in Table 9.18. Evaluation of predicted levels against noise limits is shown graphically for NSR5, NSR7 and NSR8 in Chart 9.11 (daytime) and Chart 9.12 (night-time). For NSR10, NSR11, NSR12 and NSR13, predicted levels are evaluated graphically in Chart 9.13 (daytime) and Chart 9.14 (night-time), all of which are provided in Appendix 9.6.

Table 9.18 – Evaluation of compliance at NSRs at which potential cumulative effects identified

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Exceedance (predicted level minus noise limit), dB								
Daytime Period									
NSR5	-9.0	-5.8	-3.9	-5.3	-7.2	-9.1	-10.8	-12.3	-13.5
NSR7	-15.3	-10.5	-6.7	-6.1	-7.0	-11.5	-14.2	-16.3	-17.8
NSR8	-16.0	-12.8	-10.8	-12.2	-14.1	-16.0	-17.7	-19.2	-20.4
NSR10	-8.1	-1.9	-1.7	-7.9	-10.3	-14.1	-17.1	-19.4	-20.9

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Exceedance (predicted level minus noise limit), dB								
NSR11	-8.7	-2.4	-2.2	-8.3	-10.7	-14.5	-17.5	-19.8	-21.3
NSR12	-8.9	-2.5	-2.3	-8.4	-10.8	-14.6	-17.6	-19.9	-21.4
NSR13	-8.8	-2.4	-2.2	-8.4	-10.8	-14.6	-17.6	-19.9	-21.4
Night-time Period									
NSR5	-17.5	-12.7	-8.9	-8.3	-8.3	-8.3	-10.2	-13.1	-15.7
NSR7	-19.0	-14.2	-10.4	-9.8	-9.8	-9.8	-13.3	-17.3	-20.4
NSR8	-22.6	-17.8	-14.0	-13.4	-13.4	-13.4	-15.7	-18.5	-21.0
NSR10	-24.5	-19.7	-15.8	-15.2	-15.2	-15.2	-17.1	-20.0	-22.6
NSR11	-28.4	-23.6	-19.8	-19.2	-19.2	-19.2	-20.8	-23.6	-26.1
NSR12	-25.4	-19.2	-15.7	-12.7	-10.2	-13.8	-16.6	-18.4	-19.5
NSR13	-26.0	-19.7	-16.2	-13.1	-10.6	-14.2	-17.0	-18.8	-19.9

9.9.11 At all NSRs where potential cumulative effects have been identified, predicted noise levels meet the derived noise limits at all wind speeds, both during the daytime and the night-time period.

Summary of significance

9.9.12 At NSR6 and NSR9, predicted noise levels meet the derived noise limits by a margin of more than 10 dB, across the full range of wind speeds, both during the daytime and the night-time- period. With reference to Table 9.11 the impact magnitude is **negligible**, therefore with reference to Table 9.13 the effect significance is **neutral**, and is therefore **not significant**.

9.9.13 At NSR3, NSR4, NSR5, NSR7, NSR8, NSR9, NSR10, NSR11, NSR12 and NSR13 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 9.11 the impact magnitude is **low**, therefore with reference to Table 9.13 the effect significance is **minor**, and is therefore **not significant**.

9.9.14 At NSR1 and NSR2 predicted noise levels exceed the derived daytime noise limit 6 m/s wind speed by 0.1 dB. With reference to Table 9.11 the impact magnitude of the exceedance is **medium**, therefore with reference to Table 9.13 the effect significance is **moderate**, and is therefore **significant**.

9.9.15 At NSR1 and NSR2 at all wind speeds other than 6 m/s during the daytime period, and at all wind speeds during the night-time period the Proposed Development meets the derived noise limits by a margin smaller than 10 dB. With reference to Table 9.11 the impact magnitude is **low**, therefore with reference to Table 9.13 the effect significance is **minor**, and is therefore **not significant**.

Decommissioning

9.9.16 The Applicant is seeking in-perpetuity consent for the Proposed Development. However, should the planning authority decide to limit the consent, at the eventual time of decommissioning the Applicant will decommission the Proposed Development following the operational lifespan. It is anticipated that the mitigation required and the significance of the residual effects of decommissioning the Proposed Development will be similar to, or lesser than, those identified within this chapter for the construction phase.

9.10 Additional Mitigation and Enhancement

9.10.1 A significant effect has been identified at NSR1 and NSR2 (1 and 2 Quanterness Farm Cottages). The predicted noise level exceeds the derived noise limit by a small margin (0.1 dB), and mitigation may be require to enable the noise limit to be met.

9.10.2 There are a variety of methods by which compliance with the noise limit could be achieved, including the use of low-noise mode operation of one or more of the closest turbines to NSR1 under particular wind conditions; it is likely that operation of the closest turbine in "-1 dB mode" at 6 m/s when the Proposed Development is up-wind of the NSR. When the NSR is up-wind of the Proposed Development it is unlikely that the exceedance would occur. Given the inherent conservatism in the prediction method, it is likely that in reality no exceedance will occur, however, this would require to be demonstrated through compliance monitoring following commission.

9.10.3 Final turbine selection will be undertaken with a view to achieving compliance. This assessment has been undertaken using the Vestas V136 candidate turbine. Should a different turbine model be chosen then a supplementary noise assessment will be undertaken to confirm compliance with the derived noise limits. A warranty covering the noise emissions of the selected turbine will be obtained from the turbine supplier/manufacturer.

9.10.4 Following first operation of the Proposed Development a noise assessment 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. The Applicant proposes that the requirement to undertake a compliance noise assessment is a condition of planning consent for the Proposed Development.

9.11 Residual Effects

Construction

9.11.1 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

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

Noise from wind turbines

9.11.3 Following selection and procurement of the final turbine model, and implementation of an appropriate turbine noise management plan, if required, 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 9.11 the resultant impact magnitude at NSR1 and NSR2 will be **low**, therefore with reference to Table 9.13 the effect significance will be **minor**, and noise effects will therefore be **not significant**.

9.11.4 At all other NSRs, noise effects will be unchanged, and will therefore remain **not significant**.

9.12 Cumulative Assessment

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

9.12.2 Cumulative operational effects are considered within the assessment and accounted for in the derivation of noise limits. Cumulative effects have been determined to be **not significant**.

9.13 Summary

9.13.1 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.

9.13.2 The assessment of noise comprised consultation with OIC, characterisation of the baseline noise environment, prediction of noise levels associated with construction activities, construction traffic, operational wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

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

9.13.4 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**.

9.13.5 The predicted change in road traffic noise levels associated with construction traffic is less than 1 dB, and has therefore been assessed as being of neutral significance. Noise effects from construction activities are therefore **not significant**.

9.13.6 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**.

9.13.7 Predicted wind turbine noise levels associated with operation of the Proposed Development meet derived noise limits at all identified representative NSRs, with the exception of at NRS1 and NSR2 at 6 m/s wind speed when a marginal exceedance of the derived daytime noise limit is predicted. The Applicant has committed to implementing appropriate mitigation such that noise limits are met during operation. Noise effects due to operation are therefore **not significant**.

Table 9.19 – 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	Neutral	Adverse	None required	Neutral	Adverse
Noise from construction activities	Minor	Adverse	Implementation of good practice during construction works	Minor	Adverse
Operation					
Noise from fixed non-turbine plant	Minor	Adverse	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.	Minor	Adverse
Noise from wind turbines at all NSRs except NSR1 and NSR2	Neutral to Minor	Adverse	None required	Neutral to Minor	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Noise from wind turbines at NSR1 and NSR2	Moderate	Adverse	Selection of turbine model, implementation of turbine noise management plan and post-commissioning compliance noise assessment	Minor	Adverse
Decommissioning					
N/A					

Table 9.20 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
All NSRs	Cumulative wind turbine noise	Rennibister, Hatston and Haughhead wind turbines. South Breck, Peedie House and Burness wind turbines (NSR10, NSR11, NSR12 and NSR13 only)	Minor	Adverse

9.14 References

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