

## 14. NOISE

### Executive Summary

Hoare Lea (HL) has been commissioned by the applicant to undertake a noise assessment for the construction and operation of the proposed Tangy IV Wind Farm ('the proposed development'). Noise will be emitted by equipment and vehicles used during decommissioning of the existing Tangy I and II Wind Farm, construction and eventual decommissioning of the proposed Tangy IV Wind Farm and by the turbines during operation. The level of noise emitted by the sources and the distance from those sources to the receiver locations are the main factors determining levels of noise at receptor locations.

Construction noise has been assessed by a desk-based study of a potential construction programme and by assuming the wind farm is constructed using standard and common methods. Noise levels have been calculated for receiver locations closest to the areas of work and compared with guideline and baseline values. Construction noise, by its very nature, tends to be temporary and highly variable and therefore much less likely to cause adverse effects. Various mitigation methods have been suggested to reduce the effects of construction noise, the most important of these being restricting the hours of working to be from 07:00 to 19:00 from Monday to Friday and from 07:00 to 13:00 on Saturdays. It is concluded that noise generated through construction activities, or related to construction stage traffic movements, will not have a significant effect.

Decommissioning (including both the decommissioning of the existing Tangy I and II Wind Farm and the eventual decommissioning of Tangy IV Wind Farm) is likely to result in less noise than during construction of the proposed development. The construction phase has been considered to have minor noise effects, therefore de-commissioning will, in the worst case, also have minor noise effects.

Operational turbines emit noise as the rotating blades pass through the air. This noise can sometimes be described as having a regular 'swish'. The amount of noise emitted varies depending on the wind speed. When there is little wind the turbine rotors will turn slowly and produce lower noise levels than during high winds when the turbine reaches its maximum power output and maximum rotational speed. Background noise levels at nearby properties will also change with wind speed, increasing with wind speed due to factors such as wind in trees and around buildings.

Noise levels from the operation of the turbines have been predicted for those locations closest to the site. Noise surveys have been undertaken to establish existing baseline background noise levels at a number of properties in the area. Noise limits have been derived from the data using the measured noise levels, following the method stipulated in national planning guidance. Predicted operational noise levels have been compared to the limit values to demonstrate that turbines of the type and size which would be installed can operate within the limits. It is concluded that operational noise levels from the wind farm will be within levels deemed, by national guidance, to be acceptable for wind energy schemes and therefore **not significant** under the terms of the EIA Regulations.

## 14.1 Introduction

14.1.1 This chapter considers the potential noise effects of the proposed development on the residents of nearby dwellings resulting from impacts associated with the construction, operation and decommissioning of the proposed development. The specific objectives of the chapter are to:

- describe the noise baseline;
- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the potential effects, including direct, indirect and cumulative effects, on noise-sensitive receptors;
- describe the mitigation measures proposed to address likely significant effects; and
- assess the significance of residual effects remaining following the implementation of mitigation.

14.1.2 The assessment has been carried out by acoustics specialists of Hoare Lea in accordance with the Institute of Acoustics good practice guidelines (IOA, 2013).

14.1.3 This chapter is supported by:

- Appendix 14.1: Technical Report.

14.1.4 Figures provided in Appendix 14.1 are referenced in the text, where relevant.

## 14.2 Scope of Assessment

### *Study Area*

14.2.1 Noise and vibration which arises from the construction of a wind farm is a factor taken into account when considering the total effect of the proposed development. However, in assessing the effects of construction noise, it is accepted that the associated works are of a temporary nature. The main work locations for construction of the turbines are distant from the nearest noise sensitive residences and are unlikely to cause significant effects. The construction and use of access tracks may, however, occur at lesser separation distances. Assessment of the temporary effects of construction noise is primarily aimed at understanding the need for dedicated management measures and, if so, the types of measures that are required.

14.2.2 Once constructed and operating, wind turbines may emit two types of noise. Firstly, aerodynamic noise is a 'broad band' noise, sometimes described as having a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. This is a less natural sounding noise which is generally characterised by its tonal content. Traditional sources of mechanical noise comprise gearboxes or generators. Due to the acknowledged lower acceptability of tonal noise in otherwise 'natural' noise settings such as rural areas, modern turbine designs have evolved to ensure that mechanical noise radiation from wind turbines is negligible. Aerodynamic noise is usually only perceived when the wind speeds are fairly low, although at very low wind speeds the blades do not rotate or rotate very slowly and so, at these wind speeds, negligible aerodynamic noise is generated. In higher winds, aerodynamic noise is generally masked wind-related sources of noise in the natural noise environment of noise-sensitive locations. The level of this natural 'masking' noise relative to the level of wind turbine noise determines the subjective audibility of the wind farm. The primary objective of this noise assessment is therefore to establish the relationship between wind turbine noise and the naturally occurring masking noise at residential dwellings lying around the proposed development and to assess these levels of noise against accepted standards.

- 14.2.3 The study area for the operational noise assessment extends out to the nearest residential properties to the proposed development site. Since the potential operational noise impacts of the proposed development will reduce with distance from the site, it is not necessary to consider properties beyond these nearest residential receptors. The assessment of construction noise has considered the same assessment properties as well as residential dwellings along the construction traffic route in relation to construction traffic noise.
- 14.2.4 Assessment of the operational noise effects accounts for the cumulative effect of the proposed development and the consented Beinn an Tuirc III site, approximately 4 km to the east of the proposed development. Other, more distant wind farms, including Beinn an Tuirc I (approximately 7.5 km from the proposed development) and Beinn an Tuirc II (approximately 6 km from the proposed development) were not considered. For the avoidance of doubt, the existing Tangy I and Tangy II turbines would be removed prior to the Tangy IV turbines becoming operational and therefore the operational effects of these turbines are not considered in this assessment.

### ***Scoping and Consultation***

- 14.2.5 Prior to undertaking the background surveys for the assessment of the consented Tangy III Wind Farm, a summary of the proposed monitoring locations was forwarded to the Environmental Health Department of Argyll and Bute Council for comment and were subsequently agreed to be representative for the purposes of an ETSU-R-97 assessment.
- 14.2.6 In particular, the use of proxy locations to represent baseline noise levels at various properties around the proposed development was discussed. At the time of this survey, the existing Tangy I and Tangy II turbines were operational and, as such, it was not possible to obtain measurements in the vicinity of the existing site without these measurements being influenced to some degree by noise from the existing turbines. Hence, proxy locations were discussed and agreed with Argyll and Bute Council Environmental Health Department that are far enough from the existing turbines not to be affected by noise from Tangy I and Tangy II, but can be considered representative of baseline noise levels in the vicinity of the proposed development.
- 14.2.7 Following submission of the Tangy III ES (2014), a representative of the Environmental Health Department of Argyll and Bute Council reviewed the noise assessment and agreed with the findings.
- 14.2.8 At scoping stage, it was proposed that the previous baseline survey undertaken in 2013 as part of the assessment of the Tangy III Wind Farm could still be used to assess the proposed development as it remained representative of the area. A representative of the Argyll and Bute Council Environmental Health Department confirmed that this would be acceptable (by email on 07 June 2018).

## **14.3 Methodology**

### ***Planning Policy and Advice Relating to Noise***

- 14.3.1 A number of relevant planning documents and standards have been referenced in the assessment, and a full list of references is provided at the end of this chapter:
- Scottish Planning Policy 2014 (SPP).
  - Planning Advice Note PAN1/2011: Planning and Noise.
  - Technical Advice Note: Assessment of Noise (accompanying PAN1/2011).
  - Web based planning advice on Onshore wind turbines.
  - ETSU-R-97 The Assessment and Rating of Noise from Wind Farms.

- Institute of Acoustic's (IOA) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, 2013 (GPG).
- BS 5228:2009 Noise control on construction and open sites, BS 5228-1 noise and BS 5228-2 vibration, 2009 (amended 2014).
- Planning Advice Note PAN50: Controlling the Environmental Effects of Surface Mineral Workings, 1996.
- Calculation of Road Traffic Noise, HMSO Department of Transport, 1988.
- Design Manual for Roads and Bridges, Volume 11, section 3, Part 7, Traffic Noise and Vibration, The Highways Agency, Transport Scotland, 2011.

**Construction Noise**

14.3.2 For detailed guidance on construction noise and its control, the Technical Advice Note accompanying PAN1/2011 refers to British Standard BS 5228:2009 (amended 2014) as relevant when used within the planning process. Analysis of construction noise impacts has been undertaken in accordance with BS 5228 Code of practice for noise and vibration control on construction and open sites, 2009 which provides methods for predicting construction noise levels on the basis of reference data for the emissions of typical construction plant and activities. These methods include the calculation of construction traffic along access tracks and haul routes and construction activities at fixed locations including the bases of turbines, construction compound, substation or borrow pits. The construction noise assessment has been based on indicative data for the types of plant likely to be used during the construction works, as presented in BS 5228.

14.3.3 Based on the range of guidance values set out in BS 5228, other reference criteria and in recognition of the relatively low ambient noise typically observed in rural environments, impact significance criteria have been derived (see Table 1 of Appendix 14.1) and are reproduced below.

<b>Impact</b>	<b>Condition</b>
Major	Construction noise is greater than 72 dB $L_{Aeq,T}$ for any part of the construction works or exceeds 65 dB $L_{Aeq,T}$ for more than 4 weeks in any 12 month period.
Moderate	Construction noise is less than or equal to 65 dB $L_{Aeq,T}$ throughout the construction period, with periods of up to 72 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.
Minor	Construction noise is generally less than or equal to 60 dB $L_{Aeq,T}$ , with periods of up to 65 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.
Negligible	Construction noise is generally less than or equal to 55 dB $L_{Aeq,T}$ , with periods of up to 60 dB $L_{Aeq,T}$ lasting not more than 4 weeks in any 12 month period.

14.3.4 When considering the impact of short-term changes in traffic, associated with the construction activities, on existing roads in the vicinity of the proposed development, reference can be made to the criteria set out in the Design Manual for Roads and Bridges (DMRB). A classification of magnitudes of changes in the predicted traffic noise level calculated using the by the Calculation of Road Traffic Noise (CRTN) methodology is set out for short-term changes, such as those associated with construction activities: changes of less than 1 dB(A) are considered negligible, 1 to 3 dB(A) is minor, 3 to 5 dB(A) moderate and changes of more than 5 dB(A) constitute a major impact. This classification can be considered in addition to the criteria of Table 14.1.

14.3.5 Moderate and Major impacts are considered 'significant' in the context of the EIA Regulations.

- 14.3.6 Some of the dwellings considered are financially involved with the proposed development and are as a result much less likely to be affected in practice by noise from the construction activities associated with the proposed development, and this will be taken into account in this chapter.

### ***Operational Noise***

- 14.3.7 The ETSU-R-97 assessment procedure has been used as advised in the Scottish Government's Online Renewables Planning Advice: it specifies noise limit criteria at the nearest properties based on existing background noise levels and their variation with wind speed.
- 14.3.8 Noise limits are defined in terms of the  $L_{A90,10min}$  noise indicator (a definition of the  $L_{A90,10min}$  index is given in Appendix 14.1, Annex A). The ETSU-R-97 assessment procedure generally prescribes separate day-time limits and night-time limits which are determined in part based on measured baseline background noise levels.
- 14.3.9 The noise limits defined in ETSU-R-97 relate to the total wind farm noise occurring at a dwelling owing to the combined noise of all operational wind turbines in the vicinity. The assessment therefore considers the combined operational noise of the proposed development with other wind farms in the area, to be satisfied that the combined cumulative noise levels are within the relevant ETSU-R-97 criteria.
- 14.3.10 To undertake the assessment of noise impact in accordance with the methodology in ETSU-R-97, the following steps are required:
- specify the number and locations of the wind turbines;
  - identify the locations of the nearest, or most noise sensitive, neighbours;
  - measure the background noise levels as a function of site wind speed at the nearest neighbours, or a representative sample of the nearest neighbours;
  - determine the day time and night time noise limits from the measured background noise levels at the nearest neighbours;
  - specify the type and noise emission characteristics of the wind turbines;
  - calculate noise immission levels due to the operation of the turbines on the proposed development as well as the contribution to cumulative noise immission levels from other nearby wind farms as a function of site wind speed at the nearest neighbours; and
  - compare the calculated wind farm noise immission levels with the derived noise limits and assess in the light of planning requirements.
- 14.3.11 This methodology has therefore been adopted for the present assessment and is described in more detail in Appendix 14.1. Technical guidance on best practice in the application of the ETSU-R-97 methodology, as described in an Institute of Acoustics Good Practice Guide has also been referenced.
- 14.3.12 Note that in the above, and subsequently in this chapter, the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the perceived noise) at any receptor location due to the combined operation of all wind turbines on the proposed development.
- 14.3.13 The acceptable limits for wind turbine operational noise are defined in ETSU-R-97. Consequently, the test applied to operational noise is whether or not the calculated cumulative wind farm noise immission levels at nearby noise sensitive properties are within the noise limits derived in accordance with ETSU-R-97. If predicted noise levels are within the ETSU-R-97 criteria, operational noise is considered acceptable; if predicted noise levels are above the ETSU-R-97 criteria, operational noise is considered unacceptable. Unacceptable noise levels are considered 'significant' in the context of the EIA Regulations.

- 14.3.14 Full details of the operational noise assessment, including details of the noise output of the wind turbine that has been assumed for this project and the calculation parameters on which predictions have been based, can be found in Appendix 14.1.
- 14.3.15 Operational noise modelling has been undertaken using predictions which accord with guidance on best practice published in the IOA GPG using the ISO 9613-2 (1996) standard. The noise model accounts for geometric spreading, atmospheric and ground attenuation, as well as barrier and ground effects.
- 14.3.16 The IOA GPG also allows for directional effects to be taken into account within the noise modelling: under upwind propagation conditions between a given receiver and the windfarm the noise immission level at that receiver can be as much as 10 dB(A) to 15 dB(A) lower than the level predicted using the ISO 9613-2 model. Whilst these directional effects would result in lower predicted noise immission levels in some wind directions, predictions have been made assuming downwind propagation from every turbine to every receptor at the same time. This will give a worst-case, in some cases conservative, estimation of noise levels, as in practice receptors will not necessarily be downwind of all turbines under all wind conditions.
- 14.3.17 Appendix 14.1 details the assumed noise emission levels for the turbines on the proposed development and the Beinn An Tuirc III Wind Farm. For the proposed development, the Siemens SWT-DD-120 was assumed as a candidate turbine model, with a hub height of 90 m. This model is considered representative of the upper end of the noise emissions for the type of turbine which could be installed at the site. This was determined following a review of five potential candidate turbines which would be available to install within the dimensions of the proposed development: predictions for the Siemens SWT-DD-120 model were higher than the other candidates considered and it was therefore retained on a conservative basis.
- 14.3.18 The predictions for the Beinn An Tuirc III Wind Farm are based on a 2.3 MW Siemens 2.3-VS93 turbine, with an additional factor of +3 dB added to the emission data to account for potential increases allowed under the consent for that wind farm. These assumptions are in line with guidance in the IOA GPG on robust emission levels as input to these predictions.

### **Baseline Conditions**

#### *Field Survey*

- 14.3.19 The baseline background noise monitoring was conducted from 13<sup>th</sup> September 2013 to the 6<sup>th</sup> October 2013, a period of 3 weeks. Since then, there have not been significant changes to the noise environment in the study area and these measurements therefore remain representative of background noise levels in the area, as agreed in consultation with Argyll and Bute Council.
- 14.3.20 The following monitoring locations were agreed as being appropriate with the Environmental Health Department of Argyll and Bute Council. Representatives of Argyll and Bute Environmental Health also attended during the installation of the noise monitoring equipment to agree final installed monitoring locations.
- Killocrew (166031, 630687).
  - Drum Farm (167140, 625475).
  - Gobagrennan (170591, 628598).
  - Corrylach (170526, 630384).
- 14.3.21 The potential effects of the existing Tangy I and II wind farms on measured baseline background data were suitably excluded by selecting survey locations that were at sufficiently large distances from the existing turbines. The resulting separation distance of approximately 2 km or more was considered, based on professional judgement and site observations, sufficient to exclude a measurable influence of the existing Tangy turbines on the measured background noise levels. This

methodology and the monitoring locations selected were discussed and agreed with Argyll and Bute Council prior to the monitoring being undertaken.

- 14.3.22 Due to equipment failure, the survey period at Gobagrennan was extended until the 5<sup>th</sup> November 2013. Two weeks of data were hence obtained at Gobagrennan, with three weeks of data obtained at all other monitoring locations. The total survey period is in excess of the minimum of one week required by ETSU-R-97, and a suitably representative range of wind conditions was obtained.
- 14.3.23 Full details of the monitoring locations and equipment used can be found in Appendix 14.1. In some instances, the results obtained from the survey positions have been used to represent the background environment expected to occur at other nearby assessment locations. This approach is consistent with the guidance provided by ETSU-R-97. Locations where such representations have been made, and the source of the representations, are given in Table 3 of Appendix 14.1.
- 14.3.24 At some of the monitoring locations, a variation in baseline noise levels with wind direction was apparent. At Killoch, this was due to the more exposed character of the location in westerly winds. At Drum Farm, marginally higher levels were experienced when downwind of the small wind turbines located on the other side of the farm. As such, the survey data were filtered to exclude these wind directions which resulted in elevated noise levels. The data were also filtered to remove the effects of rain. All excluded data points are shown in charts E.1 to E.8 in Annex E of Appendix 14.1.

#### *Limitations and Assumptions*

- 14.3.25 The derived noise limits were based on previous baseline measurements, as agreed in consultation with the local authority. As described above, these are still considered representative of the area in the absence of any significant changes and therefore represent a suitable basis for the assessment.

## **14.4 Baseline Conditions**

- 14.4.1 The ETSU-R-97 assessment method requires noise data to be related to wind speed data at a standardised height of ten metres. Wind speeds were measured on an 80-metre-high meteorological mast located within the boundary of the site during the baseline noise survey. Values of wind speed at 80 m and 60 m above ground level were used to derive wind shear values, which in turn were used to calculate the wind speeds at the hub height of 90m. These hub height wind speeds were then 'standardised' to a height of 10 metres, as per the GPG's recommendations. Full details of the calculation method are given in Appendix 14.1 (Annex F).
- 14.4.2 Figures D1 to D4 in Appendix 14.1 show the range of wind conditions experienced during the noise survey period. During the quiet daytime and night time periods wind speeds were of up to 18 m/s. The wind was observed to be directed most frequently from the north-west during the survey period, with a wind direction from the south-east also being common. This is generally in line with the long-term wind rose for the site.
- 14.4.3 Figures E.1 to E.8 contained in Appendix 14.1 show the results of the background noise measurements at each of the four monitoring locations. The background noise data are presented in terms of  $L_{A90,10min}$  noise levels plotted as a function of standardised wind speed. Two plots are shown for each location, one for quiet daytime periods and the other for night time periods, both derived in accordance with ETSU-R-97.
- 14.4.4 Data from all survey locations were inspected to identify periods which may have been influenced by extraneous noise sources, giving rise to atypical and elevated levels, which were excluded. ETSU-R-97 also suggests that any data that may have been affected by rainfall be excluded from the analysis. The meteorological mast had a rain gauge installed during the noise survey period; data from this gauge were therefore used to exclude those periods where rain was indicated.

- 14.4.5 Following removal of these data points, best fit lines were generated using a polynomial of a maximum of 3rd order. These lines of best fit were then used to derive the noise limits required by ETSU-R-97 that apply during the daytime and night time periods up to 12 m/s. To assess the potential noise impact of the proposed development, the noise limits have been set either at the prevailing measured background level plus 5 dB, or at the relevant fixed lower limit, whichever is the greater, in accordance with the ETSU-R-97 methodology.
- 14.4.6 During daytime, a fixed limit value of 38 dB(A) has been adopted, approximately in the middle of the possible range of daytime fixed limit values referenced in ETSU-R-97. This is considered wholly appropriate for this scheme, based on the relatively large potential generating capacity of the proposed development and the relatively low number of receptor locations that would be affected by noise from the proposed development. The majority of the receptor locations are to the south of the proposed development and would therefore be infrequently downwind of the proposed development. The daytime noise limits in the consent for the Tangy III Wind Farm had a lower fixed limit of 38 dB(A). The proposed development represents an increase to the already significant energy output of the Tangy III Wind Farm, reinforcing the case that a 38 dB(A) lower fixed limit is appropriate for the proposed development.
- 14.4.7 During night-time, the ETSU-R-97 limit of 43 dB(A) has been adopted as specified in ETSU-R-97. For financially involved properties, the lower absolute limit becomes 45 dB(A) during both day and night. The resulting ETSU-R-97 noise limits are summarised in Table 4 and Table 5 of Appendix 14.1.

## 14.5 Potential Effects

### *Predicted Construction Noise and Vibration Effects*

- 14.5.1 The level of construction noise that occurs at the surrounding properties will be highly dependent on a number of factors such as the final construction programme, equipment types used for each process, and the plant operating conditions that prevail during construction. It is not practically feasible to specify each and every element of the factors that may affect noise levels, therefore it is necessary to make reasonable allowance for the level of noise emissions that may be associated with key phases of the construction.
- 14.5.2 In order to determine representative emission levels for this study, reference has been made to the scheduled sound power data provided in BS 5228. Based on experience of the type and number of plant usually associated with the key phases of constructing a wind farm, the scheduled sound power data have been used to deduce the upper sound emission level over the course of a working day. In determining the rating applicable, it has generally been assumed that the plant will operate for between 75% and 100% of the working day. In many instances, the plant would actually be expected to operate for a reduced percentage of the day, thus resulting in noise levels lower than predicted in this assessment.
- 14.5.3 Table 6 of Appendix 14.1 lists the key construction activities, the associated type of plant normally involved, the expected worst-case sound power level over a working day for each activity, the property which would be closest to the activity, and the predicted noise level. Comparing the predicted noise levels to the range of background noise levels measured around the proposed development suggests that the noisier construction activities would be audible at various times throughout the construction phase. During the construction of the initial upgrade of a portion of the site access track and extraction of rock from the nearest borrow pit, noise levels of up to 63 dB(A) were predicted at Tangy Farm. The likely short-term nature of these activities, combined with the financially involved nature of this location, mean that the effects are likely to be **minor adverse** at most in practice and **not significant**.

- 14.5.4 Other receptor locations are located further from the construction activities; for example, Tangylee (which is also financially involved) is approximately 520 m and Hazels Cottage approximately 720 m from the nearest borrow pit, with predicted noise levels from the use of the borrow pit being 60 dB(A) and 57 dB(A) respectively, and therefore equating to a **minor adverse impact (not significant)**. The above impacts are similar to those assessed in the 2014 ES for the consented Tangy III Wind Farm.
- 14.5.5 Calculations have also been undertaken to establish the potential noise impacts of construction traffic on local roads. The results of these calculations are presented in section 5.1 of Appendix 14.1 and demonstrate that the noise impacts of construction traffic on the local road network will be, at worst, minor.
- 14.5.6 The nature of works and distances involved in the proposed construction activities are such that the risk of significant effects relating to ground borne vibration are very low (excluding blasting, which is considered below). Occasional momentary vibration can arise when heavy vehicles pass dwellings at very short separation distances, but again this is not sufficient to constitute a risk of significant impacts in this instance.

#### ***Construction Noise and Vibration Effects – Blasting***

- 14.5.7 Because of the difficulties in predicting noise and air overpressure resulting from blasting operations, these activities are best controlled with the use of good practice during the setting and detonation of charges, as set out in Appendix 14.1.
- 14.5.8 The transmission and magnitude of ground vibrations associated with blasting operations at borrow pits are subject to many complex influences including charge type and position, and importantly, the precise nature of the ground conditions (material composition, compaction, discontinuities) at the source, receiver, and at every point along all potential ground transmission paths. Clearly any estimation of such conditions is subject to considerable uncertainty, thus limiting the utility of predictive exercises. Mitigation of potential effects of these activities is best achieved through on site testing processes carried out in consultation with the Local Authorities, as described in Appendix 14.1 and set out below in the proposed mitigation measures (section 14.6).

#### ***Predicted Decommissioning Noise and Vibration Effects***

- 14.5.9 Decommissioning works (both of the existing Tangy I and II turbines and the future decommissioning of the Tangy IV turbines) would be expected to generate noise and vibration impacts of a similar or lesser magnitude to the proposed construction works. The construction phase has been considered to have minor noise effects at most, therefore de-commissioning will, in the worst case, also have minor noise effects.

#### ***Predicted Wind Farm Operational Noise Effects***

- 14.5.10 Appendix 14.1 sets out the details of operational noise predictions for the proposed development. These predictions assume the use of noise-reduced operation for three of the turbines of the proposed development.
- 14.5.11 Table 11 in Appendix 14.1 sets out the calculated wind farm noise immission levels at the 16 noise assessment locations. The calculated noise immission levels are also shown in Figures E1 to E32 in Appendix 14.1 overlaid on the daytime and night time noise limit curves. The assessment shown in tabular form in Table 14.2 and 14.3 below shows that the predicted wind farm noise immission levels meet the ETSU-R-97 derived noise limits under all wind speeds and at all locations.

**Table 14.2: Comparison of the ETSU-R-97 Derived Daytime Noise Limits with the Predicted  $L_{A90,T}$  Wind Farm Noise Immission Levels from the Proposed Development Only at Each Noise Assessment Location. Negative values indicate the predicted immission level is below the limit.**

Property	Standardised Ten Metre Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
Breakachy	-12.4	-8.1	-4.4	-3.4	-3.5	-5.1	-6.9	-8.8	-10.7
Corrylach	-19.1	-14.8	-10.6	-7.2	-6.7	-9.1	-11.7	-14.2	-16.3
Drumalea	-17.2	-12.9	-8.8	-6.0	-4.3	-4.2	-6.4	-8.9	-11.8
Gobagrennan	-16.3	-12.0	-7.8	-4.5	-2.0	-3.3	-5.5	-7.7	-9.7
Hazels Cottage	-10.7	-6.4	-2.7	-1.8	-2.0	-3.5	-5.3	-7.2	-9.1
High Ballevain Cottage	-18.8	-14.5	-10.4	-7.6	-5.8	-5.7	-7.9	-10.4	-13.3
Killarow	-20.0	-15.7	-11.6	-8.8	-7.2	-7.1	-7.1	-7.1	-7.7
Killocrow	-17.5	-13.2	-9.0	-5.7	-3.3	-3.1	-5.3	-7.8	-10.7
South Lagalgarve	-16.6	-12.3	-8.1	-5.0	-2.8	-2.6	-4.8	-7.3	-10.2
Tangy Farm	-12.1	-7.8	-3.6	-1.3	-0.4	-0.3	-0.7	-2.6	-4.5
Tangy Glen Cottages	-15.3	-11.0	-6.9	-4.1	-2.5	-2.3	-4.5	-7.0	-9.9
Tangy Mill	-13.8	-9.5	-5.4	-2.7	-1.3	-1.1	-3.3	-5.8	-8.7
Tangy Mill Croft	-15.3	-11.0	-6.9	-4.1	-2.5	-2.4	-4.6	-7.1	-10.0
Tangylee	-14.3	-10.0	-5.8	-3.4	-2.3	-2.2	-2.6	-4.5	-6.4
Tangymoil	-19.2	-14.9	-10.7	-7.7	-5.9	-5.7	-5.7	-5.7	-6.3
Tigh na Mara	-14.1	-9.8	-5.6	-2.7	-1.0	-0.9	-3.1	-5.6	-8.5

**Table 14.3: Comparison of the ETSU-R-97 Derived Night-time Noise Limits with the Predicted  $L_{A90,T}$  Wind Farm Noise Immission Levels from the Proposed Development Only at Each Noise Assessment Location. Negative values indicate the predicted immission level is below the limit.**

Property	Standardised Ten Metre Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
Breakachy	-17.4	-13.1	-8.9	-6.2	-4.6	-4.5	-5.9	-8.5	-11.3
Corrylach	-24.1	-19.8	-15.6	-12.2	-9.7	-9.5	-11.1	-14.6	-18.4
Drumalea	-22.2	-17.9	-13.8	-11.0	-9.3	-9.2	-9.2	-9.2	-9.2
Gobagrennan	-21.3	-17.0	-12.8	-9.5	-7.0	-6.8	-6.8	-6.8	-7.8
Hazels Cottage	-15.7	-11.4	-7.2	-4.6	-3.1	-2.9	-4.3	-6.9	-9.7
High Ballevain Cottage	-23.8	-19.5	-15.4	-12.6	-10.8	-10.7	-10.7	-10.7	-10.7
Killarow	-20.0	-15.7	-11.6	-8.8	-7.2	-7.1	-7.1	-7.1	-7.1
Killocrow	-22.5	-18.2	-14.0	-10.7	-8.3	-8.1	-8.1	-8.1	-8.1
South Lagalgarve	-21.6	-17.3	-13.1	-10.0	-7.8	-7.6	-7.6	-7.6	-7.6
Tangy Farm	-12.1	-7.8	-3.6	-1.3	-0.4	-0.3	-0.3	-2.3	-5.1
Tangy Glen Cottages	-20.3	-16.0	-11.9	-9.1	-7.5	-7.3	-7.3	-7.3	-7.3

**Table 14.3: Comparison of the ETSU-R-97 Derived Night-time Noise Limits with the Predicted  $L_{A90,T}$  Wind Farm Noise Immission Levels from the Proposed Development Only at Each Noise Assessment Location. Negative values indicate the predicted immission level is below the limit.**

Tangy Mill	-18.8	-14.5	-10.4	-7.7	-6.3	-6.1	-6.1	-6.1	-6.1
Tangy Mill Croft	-20.3	-16.0	-11.9	-9.1	-7.5	-7.4	-7.4	-7.4	-7.4
Tangylee	-14.3	-10.0	-5.8	-3.4	-2.3	-2.2	-2.2	-4.2	-7.0
Tangymoill	-19.2	-14.9	-10.7	-7.7	-5.9	-5.7	-5.7	-5.7	-5.7
Tigh na Mara	-19.1	-14.8	-10.6	-7.7	-6.0	-5.9	-5.9	-5.9	-5.9

## 14.6 Mitigation

### *Proposed Construction Noise Mitigation Measures*

14.6.1 To reduce the potential effects of construction noise, the following types of mitigation measures are proposed:

- Those activities that may give rise to audible noise at the surrounding properties and heavy goods vehicle deliveries to the site would be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. Turbine deliveries would only take place outside these times with the prior consent of the local authority and the Police. Those activities that are unlikely to give rise to audible noise at the site boundary may continue outside of the stated hours.
- All construction activities shall adhere to good practice as set out in BS 5228.
- All equipment will be maintained in good working order and any associated noise attenuation such as engine casing and exhaust silencers shall remain fitted at all times.
- Where flexibility exists, activities will be separated from residential neighbours by the maximum possible distances.
- A site management regime will be developed to control the movement of vehicles to and from the proposed development site.
- Construction plant capable of generating significant noise and vibration levels will be operated in a manner to restrict the duration of the higher magnitude levels.

14.6.2 The potential noise and vibration effects of blasting operations will be reduced according to the guidance set out in the relevant British Standards PAN50 Annex D and discussed below:

- Blasting should take place under strictly controlled conditions with the agreement of the relevant authorities, at regular times within the working week, that is, Monday to Friday, between the hours of 10.00 and 16.00. Blasting on Saturday mornings shall be a matter for negotiation between the contractor and the local authorities;
- Vibration levels at the nearest sensitive properties are best controlled through on site testing processes carried out in consultation with the Local Authorities. This site testing based process would include the use of progressively increased minor charges to gauge ground conditions both in terms of propagation characteristics and the level of charge needed to release the requisite material. The use of onsite monitoring at neighbouring sensitive locations during the course of this preliminary testing can then be used to define upper final charge values that will ensure vibration levels remain within the criteria set out previously, as described in BS 5228 2 and BS 6472 2 2008;
- Blasting operations shall adhere to good practice as set out in BS 5228 2 and in PAN50, Annex D, Paragraph 95, in order to control air overpressure.

### **Proposed Operational Noise Mitigation Measures**

14.6.3 The selection of the final turbine to be installed at the site would be made on the basis of enabling the relevant noise limits (Tables 14.4 and 15.5 below) to be achieved at the surrounding properties. Satisfactory control of cumulative noise immission levels would be achieved through enforcement of individual consent limits for each of the individual wind farms.

## **14.7 Monitoring**

14.7.1 It is proposed that if planning consent is granted for the proposed development, conditions attached to the planning consent should include the requirement that, in the event of a valid noise complaint, noise levels resulting from the operation of the wind farm are measured in order to demonstrate compliance with the conditioned noise limits. Such monitoring should be done in full accordance with ETSU-R-97 and include penalties for any relevant characteristics of the noise (e.g. tones).

14.7.2 The relevant noise limits which are considered appropriate for the proposed development are those set out in Tables 15 and 16 of Appendix 14.1, reproduced below in Tables 14.4 and 14.5. These were determined to maintain compliance with the overall ETSU-R-97 noise limits, taking into account the consented limits for the Beinn An Tuirc III Wind Farm, as detailed in Appendix 14.1. Satisfactory control of cumulative noise immission levels would be achieved through enforcement of individual consent limits for each of the individual wind farms.

Property (* indicates financial involvement)	Standardised Ten Metre Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
Breakachy	38.0	38.0	38.5	40.2	41.9	43.6	45.4	47.3	49.2
Corrylach	35.0	35.0	35.0	35.0	37.0	39.6	42.2	44.7	46.8
Drumalea	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Gobagrennan	37.0	37.0	37.0	37.0	37.0	38.5	40.7	42.9	44.9
Hazels Cottage	38.0	38.0	38.5	40.2	41.9	43.6	45.4	47.3	49.2
High Ballevain Cottage	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Killarow*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6
Killocrow	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
South Lagalgarve	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Tangy Farm*	45.0	45.0	45.0	45.0	45.0	45.0	45.4	47.3	49.2
Tangy Glen Cottages	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Tangy Mill	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Tangy Mill Croft	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6
Tangylee*	45.0	45.0	45.0	45.0	45.0	45.0	45.4	47.3	49.2
Tangymoil*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6
Tigh na Mara	38.0	38.0	38.0	38.0	38.0	38.0	40.2	42.7	45.6

<b>Table 14.5: Night-time L<sub>A90</sub> Noise Limits Applicable to the proposed development (only)</b>									
<b>Property (* indicates financial involvement)</b>	<b>Standardised Ten Metre Wind Speed, m/s</b>								
	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
Breakachy	43.0	43.0	43.0	43.0	43.0	43.0	44.4	47.0	49.8
Corrylach	40.0	40.0	40.0	40.0	40.0	40.0	41.6	45.1	48.9
Drumalea	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Gobagrennan	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	43.0
Hazels Cottage	43.0	43.0	43.0	43.0	43.0	43.0	44.4	47.0	49.8
High Ballevain Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Killarow*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Killocrow	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
South Lagalgarve	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tangy Farm*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.0	49.8
Tangy Glen Cottages	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tangy Mill	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tangy Mill Croft	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tangylee*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.0	49.8
Tangymoil*	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Tigh na Mara	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

## 14.8 Residual Effects

### *Residual Construction Noise Effects*

- 14.8.1 With the application of the mitigation measures outlined in Section 14.6 of this Chapter, residual construction noise impacts are predicted to be, at worst, **minor adverse** and therefore, **not significant** in the context of the EIA Regulations.

### *Residual Operational Noise Effects*

- 14.8.2 Operational noise levels are predicted to comply with noise limits derived in accordance with ETSU-R-97 at all properties. The basis of the ETSU-R-97 method is to define acceptable noise limits to offer reasonable protection to residents in areas around wind farm developments. At some locations under some wind conditions and for a certain proportion of the time, the wind farm noise may be audible; however, operational noise immission levels are acceptable in terms of the guidance recommended by planning policy for the assessment of wind farm noise. As such, operational noise effects from the proposed development are considered to be **not significant** in the context of the EIA Regulations.

## 14.9 Cumulative Effects

- 14.9.1 The cumulative operational noise effects of the proposed development and Beinn an Tuirc III Wind Farm have been considered in detail in Appendix 14.1. These calculations have demonstrated that, even assuming downwind propagation from all turbines to all receptor locations, cumulative operational noise levels would only be marginally higher (of the order of 0.5 dB or less) than noise levels predicted due to the operation of the Tangy IV at the majority of receptor locations. This represents a negligible increase according to relevant guidance on the subject.

- 14.9.2 The exceptions to this are the receptor locations at Gobagrennan and Corrylach. The predictions at these locations are particularly conservative as they assume simultaneous downwind propagation from all turbines. As the Tangy IV turbines are to the west of both Gobagrennan and Corrylach, whereas the proposed Beinn an Tuirc III turbines are to the east of these properties, these receptor locations are unlikely to be downwind of both the proposed Tangy IV and Beinn an Tuirc III turbines simultaneously.
- 14.9.3 In any case, even on this conservative basis, the predicted cumulative noise levels at these locations remained compliant with the derived ETSU-R-97 limits (as shown in the assessment of Tables 13 and 14 of Appendix 14.1).
- 14.9.4 In conclusion, cumulative operational noise levels remained within the relevant ETSU-R-97 criteria and therefore **not significant**.

## 14.10 Statement of Significance

- 14.10.1 The significance of the predicted noise impacts is summarised in Table 14.6.

Table 14.6: Summary Table of Effects	
Potential Effect	Evaluation of Effect
Construction Noise	Noise levels have been predicted using the methodology set out in BS 5228. Based on assessment criteria derived and supported by a range of noise policy and guidance, overall construction noise levels are considered to represent at worst a <b>minor adverse</b> impact, and therefore considered <b>not significant</b> in EIA terms. Decommissioning works (both of the existing Tangy I and II turbines and the future decommissioning of the Tangy IV turbines) would be expected to generate noise impacts of a similar or lesser magnitude to construction works and therefore are again considered <b>not significant</b> in EIA terms.
Operational Noise	Noise criteria have been established in accordance with ETSU-R-97. It has been shown that these criteria are achievable with a commercially available turbine suitable for the site. The basis of the ETSU-R-97 method is to define acceptable noise limits thought to offer reasonable protection to residents in areas around wind farm developments. At some locations under some wind conditions and for a certain proportion of the time, the wind farm noise may be audible; however, operational noise immission levels are acceptable in terms of the guidance commended by planning policy for the assessment of wind farm noise, and therefore considered <b>not significant</b> in EIA terms.

## 14.11 References

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