

**CHAPTER 17: NOISE**

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Technical Appendix 17.1: Operational Noise

## 17. Noise

### 17.1 Executive Summary

- 17.1.1 A noise assessment has been undertaken to determine the likely significant noise effects from the operational phase of the Proposed Development.
- 17.1.2 Due to the large separation distances between the Proposed Development and the nearest receptors the simplified assessment methodology detailed in ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* (ETSU-R-97, 1996) has been adopted for the assessment. A total of four Noise Assessment Locations (NALs) were chosen to be representative of the noise sensitive receptors surrounding the Proposed Development.
- 17.1.3 The noise assessment has been undertaken in three stages, which involved setting the Total ETSU-R-97 Noise Limits (TNL) (which are limits for noise from all wind farms in the area) at the nearest noise sensitive receptors, predicting the likely effects of the Proposed Development (undertaking a cumulative noise assessment where required) and setting Site Specific Noise Limits (SSNL) for the Proposed Development.
- 17.1.4 Predicted cumulative operational noise levels indicate that for noise sensitive receptors neighbouring the Proposed Development, cumulative wind turbine noise (which considers noise predictions from all nearby proposed, consented or operational wind turbines and the Proposed Development) would meet the TNL at all NALs.
- 17.1.5 The TNL is applicable to all operational, consented and proposed wind farms in the area so SSNL have also been derived to control the specific noise from the Proposed Development. In accordance with the guidance in the Institute of Acoustics *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG, 2013), the SSNL have been derived with due regard to cumulative noise by accounting for the proportion of the TNL which is potentially being used by other nearby developments. The SSNL have been derived in accordance with the IOA GPG and therefore were set equal to the TNL minus a cautious prediction of noise from all other nearby developments or 10dB below the Total ETSU-R-97 Noise Limit where the Total ETSU-R-97 Noise Limit could potentially be used by another existing / proposed wind farm developments.
- 17.1.6 Predictions of wind turbine noise from the Proposed Development have been made in accordance with good practice using a candidate wind turbine, the GE 3.8 130 3.8MW. Predicted operational noise levels from the Proposed Development indicate that for noise sensitive receptors neighbouring the Proposed Development, wind turbine noise from the Proposed Development would meet the SSNL at all NALs.
- 17.1.7 The use of SSNL would ensure that the Proposed Development could operate concurrently with other proposed, consented or operational turbines in the area and would also ensure that the Proposed Development's individual contribution could be measured and enforced if required.
- 17.1.8 The GE wind turbine model was chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Development receive consent, the final choice of wind turbine would be subject to a competitive tendering process. The final choice of wind turbine would, however, have to meet the SSNL presented in this assessment.

## 17.2 Introduction

17.2.1 This Chapter reports on the likely significant effects with respect to the noise associated with the operation 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 likely effects (including cumulative effects);
- Describe the mitigation measures proposed to address likely significant effects (if required); and
- Assess the residual effects remaining following the implementation of mitigation (if required).

17.2.2 This Chapter is supported by Technical Appendix 17.1: Operational Noise Report.

17.2.3 Figure 17.1: Noise Assessment Locations and Figure 17.2: Cumulative Turbine Locations are referenced in the text where relevant.

17.2.4 This Chapter was prepared by TNEI Services Ltd. TNEI is a specialist energy consultancy with an Acoustics team which has undertaken noise assessments for over 4GW of onshore wind farm developments. The noise assessment was undertaken by staff who are all members of the Institute of Acoustics.

17.2.5 The operational noise assessment has been undertaken in a number of stages, firstly to consider the cumulative noise limits ('TNL') applicable for all wind farm schemes in the area and secondly to derive 'SSNL' through apportionment of the TNL.

17.2.6 An assessment has been undertaken against both sets of limits to demonstrate that the cumulative noise predictions can meet the TNL and also to show that the noise predictions from the Proposed Development can also meet the SSNL.

## 17.3 Scope of Assessment

### Study Area

17.3.1 An initial desktop assessment was undertaken in order to identify the nearest noise sensitive receptors surrounding the Proposed Development (also referred to as the 'Site' in this Chapter) and to determine potential Noise Assessment Locations (NALs). In total, four NALs (one to the north and three to the south of the Proposed Development) were identified and considered in the assessment. The NALs are shown on Figure 17.1.

17.3.2 There are a number of proposed, consented and operational wind farms located in the vicinity of the Proposed Development, these include:

- Stronelairg Wind Farm (operational);
- Corriegarth Wind Farm (operational);
- Dell Wind Farm (consented); and
- Glenshero Wind Farm (proposed).

17.3.3 The wind farms detailed above are the cumulative developments which have been considered as part of the cumulative noise assessment within this Chapter. Further information on the cumulative noise assessment can be found in Section 1.2 of Technical Appendix 17.1.

**Consultation Responses**Scoping Opinion

- 17.3.4 An EIA Scoping Opinion for the Proposed Development was issued on 18 December 2018 by the Energy Consents Unit (ECU) on behalf of Scottish Ministers. A summary of consultation responses received as part of the Scoping Opinion and response / actions taken, is given in Table 17.1 below.

**Table 17.1: Summary of Scoping Consultation Responses**

Consultee	Summary of Response	Response/ Action taken
ECU / THC	Request that assessment consider the traffic and transport impacts on human receptors.	Construction-related traffic effects are in Chapter 13: Traffic and Transport. Construction traffic would be managed as part of a Construction Traffic Management Plan (CTMP) and therefore has not been considered further in this Chapter. A Framework CTMP is included within Technical Appendix 13.1: Transport Assessment.
	THC requested information be included on the predicted noise levels from the Proposed Development and cumulative noise levels.	The assessment presented in this Chapter considers the predictions from the Proposed Development and the cumulative predictions from the Proposed Development and other schemes operating concurrently.
	THC suggested a noise related planning condition may set levels could be set relative to predicted levels (e.g. 3dB above predicted levels).	In terms of suggested noise limits, these have been derived based on the methodologies detailed in ETSU-R-97 and the IOA GPG.

Pre-application Advice

- 17.3.5 In addition, on 20 December 2019, the Highland Council (THC) issued a pre-application advice document. A summary of information contained in relation to noise and response / actions taken, is given in Table 17.2 below. This additional information is outwith the official Scoping Response from THC, however for completeness the additional information has been considered in the assessment as summarised in Table 17.2 below.

**Table 17.2: Summary of Pre-application Advice**

Consultee	Summary of Response	Response/ Action taken
THC	<b>Operational</b> THC stated that a noise assessment is required to consider the cumulative noise impacts.	An assessment has been undertaken and the results are presented in this Chapter.
	The assessment should be in undertaken in accordance with ETSU-R-97 and the IOA GPG.	An operational noise assessment has been undertaken in accordance with ETSU-R-97 and the IOA GPG.

Consultee	Summary of Response	Response/ Action taken
	The target noise level should be the simplified standard of 35dB up to 10m/s and this should apply to the cumulative noise from more than one development.	The TNL have been derived based on the simplified 35dB criterion adjusted to take account of the noise limits that have already been allocated to nearby schemes.
	The cumulative assessment should take account of predicted and consented levels. If a reduction is made for a controlling property or another reason it should be made clear in the assessment.	The SSNL have been derived using the limit apportionment methodology detailed in the IOA GPG. Further information can be found in sections 17.7.4 - 17.7.7 below and within Technical Appendix 17.1.
	Consideration should be given to increased exposure time.	Given the relative location of the proposed turbines and those that are already operational, consented or proposed, it is not considered that the Proposed Development will cause an increase in exposure time.
	Amplitude modulation (AM) – current good practice does not give definitive guidance on it. Any complaints linked to AM could be investigated in terms of statutory Nuisance provisions.	A summary of the research undertaken to date and the current position on AM has been included within section 3 of Technical Appendix 17.1.
	<p><b>Construction noise</b></p> <p>Given the separation distances THC is happy for construction noise to be scoped out. The only exception THC raised is in relation to construction-related traffic on the way to site, particularly if it occurs outwith normal working hours.</p>	<p>On the basis of the separation distances a construction noise assessment has not been undertaken.</p> <p>In relation to the construction-related traffic this would be dealt with as part of the TMP and therefore has not been considered further in this Chapter.</p>

## 17.4 Legislation, Policy and Guidance

17.4.1 The methods of assessment used the following combination of guidance and assessment methodologies:

- Planning Advice Note PAN 1/2011: ‘Planning and Noise’;
- Web Based Renewables Advice: ‘Onshore Wind Turbines’ (updated May 2014);
- ETSU-R-97 ‘The Assessment and Rating of Noise from Wind Farms’;
- ISO9613: 1996 ‘Acoustics - Attenuation of sound during propagation outdoors Part 2: General method of calculation’; and
- Institute of Acoustics ‘A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise’ (2013) (IOA GPG).

- 17.4.2 The above documents are discussed in detail within Section 2 of Technical Appendix 17.1: Operational Noise Assessment, where relevant.

## 17.5 Methodology

### Operational Noise Assessment Methodology

- 17.5.1 The assessment has been undertaken in accordance with ETSU-R-97 and current good practice, as specified in the Policy, Legislation and Guidance section (section 17.3). ETSU-R-97 provides a robust basis for determining acceptable noise limits for wind farm developments. Consequently, the test applied to operational noise is whether or not the calculated wind farm noise levels at nearby noise sensitive properties would be below the noise limits derived in accordance with ETSU-R-97.
- 17.5.2 ETSU-R-97 states that where there are very large separation distances between turbines and the closest receptors then a simplified noise condition may be suitable. ETSU-R-97 states *'If the noise is limited to an  $L_{A90,10min}$  of 35 dB(A) up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'* Due to the large separation distances between the Proposed Development and the nearest receptors (>5km) the simplified assessment methodology has been adopted for this assessment.
- 17.5.3 In addition to ETSU-R-97, the recommendations included in the IOA GPG have been considered in the noise assessment. These are discussed in detail within Technical Appendix 17.1.

### Cumulative Operational Noise Assessment Methodology

- 17.5.4 The Total ETSU-R-97 Noise Limit is applicable to all operational, consented and proposed (planning application submitted) wind farms in the area so a set of SSNL are derived to control the specific noise from the Proposed Development. In accordance with the guidance in the IOA GPG, the SSNL have been derived with due regard to cumulative noise by accounting for the proportion of the Total Noise Limits which are potentially being used by other nearby developments. The SSNL have therefore set equal to the Total Noise Limits minus a cautious prediction of noise from all other nearby developments, or, if the TNL are potentially being used by another scheme, the limits have been derived to be 10dB below. The cautious prediction of noise for all other nearby developments has been undertaken using the guidance in the IOA GPG.
- 17.5.5 The need for a cumulative noise assessment was considered in accordance with the guidance contained within the IOA GPG. There are a number of operational, consented and proposed wind farm developments in proximity to the Proposed Development, therefore in order to consider the likely cumulative noise impacts, the noise assessment has been undertaken in three separate stages:
- Stage 1 – establish the TNL for each NAL based on the simplified ETSU-R-97 criterion whilst also considering the noise limits that have already been allocated to other schemes in the area.
  - Stage 2 – undertake likely noise predictions to consider other nearby operational, consented and proposed schemes.
  - Stage 3 – establish the SSNL for the Proposed Development (through apportioning the TNL, where required) and compare the noise predictions from the Proposed Development on its own against the SSNL.

- 17.5.6 The aim of the operational noise assessment therefore is to establish the TNL, determine the likely impacts of the Proposed Development at the nearest noise sensitive receptors, derive SSNL and to demonstrate that the Proposed Development can meet the limits (i.e. noise levels will be at or below).
- 17.5.7 The exact model of wind turbine to be used for the Proposed Development will be the result of a future tendering process should consent be granted. Achievement of the noise limits determined by this assessment would be a key determining factor in the final choice of wind turbine. Predictions of wind turbine noise for the Proposed Development were based upon the sound power level data for a candidate wind turbine, the GE 3.8-130 3.8MW, as it is considered representative of the type of wind turbine likely to be installed at the development site.
- 17.5.8 All the operational, consented and proposed wind turbines modelled, inclusive of those used in the cumulative noise assessment, are summarised in Section 17.2.2 above. Uncertainty in sound power data for the Proposed Development has been accounted for using the guidance contained within Section 4.2 of the IOA GPG. The locations of the wind turbines for the Proposed Development and the cumulative turbines are shown on Figure 17.2.
- 17.5.9 Noise predictions have been undertaken using the propagation model contained within Part 2 of International Standard ISO 9613-2, 'Acoustics – Attenuation of sound during propagation outdoors'. The model calculates, on an octave band basis, attenuation due to geometric spreading, atmospheric absorption and ground effects. The noise model was set up to provide realistic noise predictions, including mixed ground attenuation ( $G=0.5$ ) and atmospheric attenuation relating to 70% Relative Humidity and 10°C.
- 17.5.10 Typically wind farm noise assessments assume all properties are downwind of all wind turbines at all times (as this would result in the highest wind turbine noise levels). However, where properties are located in between groups of wind turbines, or when turbines are spread over wide angle of view, they cannot be downwind of all wind turbines simultaneously in reality so it is appropriate to consider the effect of wind direction on predicted noise levels. Directivity has been considered using the guidance in the IOA GPG.
- 17.5.11 In line with the IOA GPG, an assessment has been undertaken to determine whether a concave ground profile correction (+3dB) or barrier correction (-2dB), is required due to the topography between the wind turbines and the noise sensitive receptors. Propagation across a valley (concave ground) increases the number of reflection paths, and in turn, has the potential to increase sound levels at a given receptor. Topographical screening effects from terrain surrounding a wind farm can result in reductions in the observed sound level between the source and receiver where no line of sight is present. A concave ground and barrier correction was found to be required for a number of wind turbines at a number of receptors (Annex 4, Technical Appendix 17.1).
- 17.5.12 Information relating to operational noise such as AM, a potential characteristic of wind turbine noise and Low Frequency Noise are also addressed in detail within Section 3 of Technical Appendix 17.1.

### **Assessment of Effects**

- 17.5.13 Planning Advice Note PAN 1/2011 'Planning and Noise' provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. PAN

1/2011 refers to the Web-based planning advice on renewable technologies for Onshore Wind Turbines which states that ETSU-R-97 should be used to assess and rate noise from wind energy developments. ETSU-R-97 does not define significance criteria, but describes a framework for the measurement of wind farm noise and gives indicative noise levels considered to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development. Achievement of ETSU-R-97 derived noise limits ensures that wind turbine noise will comply with current Government guidance.

- 17.5.14 In terms of the EIA Regulations, the use of the term “significance” in this Chapter refers to compliance / non-compliance with the ETSU-R-97 derived noise limits. For situations where predicted wind turbine noise meets or is less than the noise limits defined in ETSU-R-97, then the noise effects are deemed not significant. Any breach of the ETSU-R-97 derived noise limits due to the Proposed Development is deemed to result in a significant effect.
- 17.5.15 For the purposes of this assessment, residential properties are considered to be noise sensitive receptors.

#### **Limitations and Assumptions**

- 17.5.16 A candidate wind turbine has been used for predictions of operational noise from the Proposed Development. The final model of wind turbine to be used may differ from that presented here, however the operational noise levels from the Proposed Development would have to comply with the noise limits imposed by the Scottish Government. No other assumptions or data gaps have been identified.

### **17.6 Baseline**

#### **Current Baseline**

- 17.6.1 The Proposed Development is located within a rural location where existing background noise levels at the noise sensitive receptors are generally considered to be low. The predominant noise sources in the area are expected to be wind induced noise (wind passing through vegetation and around buildings), local watercourses and birdsong.

#### **Future Baseline**

- 17.6.2 It is possible that noise propagation and resulting noise immission levels could change over the life of the project due to climate change (as noise attenuation is influenced by air temperature, relative humidity and ground conditions). However, noise limits would be set for the lifetime of the project and the operator would be required to meet them for the duration of the consent. If climate change resulted in the exceedance of limits, turbine noise could be reduced through mode management measures. There are no other known current or predicted future processes that are likely to change the baseline conditions.

#### **Identified Sensitive Receptors**

- 17.6.3 A total of four noise sensitive receptors were chosen as representative NALs. The NALs chosen were generally the closest receptors to the Proposed Development and other wind farm developments.

- 17.6.4 The NALs refer to the position in the curtilage of a property as detailed in Table 17.3 and shown on Figure 17.1. This approach ensures that the assessment considers the worst case (loudest) noise immission level expected at the noise sensitive receptor.

**Table 17.3: Operational Noise Assessment Locations**

Receptor	Easting	Northing	Elevation (m AOD)	Approximate Distance to Nearest Cloiche Turbine (m)
NAL1 – Killin Lodge	252673	808997	330	5,800
NAL2 – Crathie	258349	794404	299	7,566
NAL3 - Garvabeg	252766	794886	297	6,458
NAL4 – Melgarve	246328	796097	351	5,030

## 17.7 Potential Effects

### Setting the Total ETSU-R-97 Noise Limits (Stage 1)

- 17.7.1 The TNL have been established for each of the NALs detailed in Table 17.3 above. The TNL were derived based on the simplified 35dB criteria detailed in ETSU-R-97 whilst also considering the noise limit that has already been allocated to other schemes in the area.
- 17.7.2 The TNL are summarised in Table 17.4 below. For NAL1, the Total ETSU-R-97 Noise limit is 38dB as both Stronelairg and Dell Wind Farms have both been allocated 35dB noise limits at the receptor. At the three receptors to the south the Total ETSU-R-97 Noise limit has been set at 35dB(A).

**Table 17.4: Total ETSU-R-97 Noise Limit – applicable to all times of the day**

Receptor	Wind Speed (ms <sup>-1</sup> ) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Killin Lodge	38	38	38	38	38	38	38	38	38	38	38	38
NAL2 – Crathie	35	35	35	35	35	35	35	35	35	35	35	35
NAL3 – Garvabeg	35	35	35	35	35	35	35	35	35	35	35	35
NAL4 – Melgarve	35	35	35	35	35	35	35	35	35	35	35	35

### Predicting the Likely Effects and the Requirement for a Cumulative Noise Assessment (Stage 2)

- 17.7.3 A cumulative noise assessment was undertaken at the four NALs detailed in Table 17.3 above. The results are shown in Table 17.5 below and are summarised on Figures A1.2a-d included within Annex 1 of Technical Appendix 17.1. Figures A1.2a-d show the predicted noise levels from each individual scheme as well as their combined cumulative predicted levels. Table 17.5 shows a comparison between the TNL and predicted cumulative wind turbine noise levels. The Table shows the exceedance level which is the difference between the predicted wind turbine noise level and the TNL at a given wind speed. A negative exceedance level indicates satisfaction of the noise limit.

The result of the cumulative noise assessment show that the Proposed Development can operate concurrently with the operational, consented or proposed wind farm developments near to the NALs, whilst still meeting the TNL established in accordance with ETSU-R-97 at the four NALs.

**Table 17.5: Compliance Table – Comparison of predicted cumulative noise levels (all schemes) against the Total ETSU-R-97 Noise Limits at each receptor**

Receptor		Wind Speed (ms <sup>-1</sup> ) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Killin Lodge	Total ETSU-R-97 Noise Limit	38	38	38	38	38	38	38	38	38	38	38	38
	Predicted Cumulative Wind Turbine Noise L <sub>A90</sub>	-	-	-	-	-	31.5	33.7	34	34.1	34.1	34.1	34.1
	Exceedance Level L <sub>A90</sub>	-	-	-	-	-	-6.5	-4.3	-4	-3.9	-3.9	-3.9	-3.9
NAL2 – Crathie	Total ETSU-R-97 Noise Limit	35	35	35	35	35	35	35	35	35	35	35	35
	Predicted Cumulative Wind Turbine Noise L <sub>A90</sub>	-	-	-	-	-	24.9	26.9	27.1	27.1	27.1	27.1	27.1
	Exceedance Level L <sub>A90</sub>	-	-	-	-	-	-10.1	-8.1	-7.9	-7.9	-7.9	-7.9	-7.9
NAL3 - Garvabeg	Total ETSU-R-97 Noise Limit	35	35	35	35	35	35	35	35	35	35	35	35
	Predicted Cumulative Wind Turbine Noise L <sub>A90</sub>	-	-	-	-	-	29	30.9	31.1	31.1	31.1	31.1	31.1
	Exceedance Level L <sub>A90</sub>	-	-	-	-	-	-6	-4.1	-3.9	-3.9	-3.9	-3.9	-3.9
NAL4 – Melgarve	Total ETSU-R-97 Noise Limit	35	35	35	35	35	35	35	35	35	35	35	35
	Predicted Cumulative Wind Turbine Noise L <sub>A90</sub>	-	-	-	-	-	28.9	30.7	31	31	31	31	31
	Exceedance Level L <sub>A90</sub>	-	-	-	-	-	-6.1	-4.3	-4	-4	-4	-4	-4

### Operational Phase - Derivation of Site Specific Noise Limits for the Proposed Development (Stage 3)

17.7.4 As requested by THC modelling has been undertaken to consider the other nearby schemes operating at their consented levels. In order to consider each scheme in isolation a comparison was undertaken of the predictions from the individual schemes against their individual noise limits. The apportionment options provided in the IOA GPG were then considered to determine the most appropriate option for each scheme. The findings are summarised below:

- Stronelairg Wind Farm - the difference between the predicted levels and the 35dB noise limit was less than 5dB. The smallest margin between the limit and predictions was a difference of 3dB at the most sensitive property). Therefore

there was not significant headroom and on that basis the predicted levels were set at the consented levels for that scheme by adding 3dB to the predictions);

- Dell Wind Farm – there was significant headroom (at least 7.3 dB) between the likely predicted levels and the 35dB noise limit therefore a +2dB buffer was added to the predicted levels;
- Corriegarth Wind Farm – there was significant headroom (at least 10.8 dB) between the likely predicted levels and the 35dB noise limit therefore a +2dB buffer was added to the predicted levels; and
- Glenshero Wind Farm – in accordance with the suggested noise limits for the scheme a +3dB buffer has been added to the predicted levels.

17.7.5 The addition of the buffers listed in 17.7.4 resulted in the cautious predictions of wind farm noise which took account of the proportion of the Total ETSU-R-97 Noise Limit which the cumulative developments have been allocated / could realistically use.

17.7.6 At all NALs, limit apportionment was undertaken. Limit apportionment is a process whereby the Total ETSU-R-97 Limit is split with a portion allocated to the existing schemes and the remainder allocated to the Proposed Development. Where apportionment was required, cautious predicted noise levels were subtracted from the Total ETSU-R-97 Noise Limit to determine the residual limit available for the Proposed Development. Further information on the approach is included within Table 6.5 of Technical Appendix 17.1.

17.7.7 The Proposed Development SSNLs were compared to the predictions from the Proposed Development and the results are summarised in Table 17.6. The SSNL and predictions are also shown on Figures A1.4a - 4ac in Annex 1 of Technical Appendix 17.1: Operational Noise Report.

**Table 17.6: Compliance Table – Comparison of predicted noise levels from the Proposed Development against the Site Specific Noise Limits at each receptor**

Receptor		Wind Speed ( $\text{ms}^{-1}$ ) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Killin Lodge	Site Specific Noise Limit	35.0	35.0	35.0	35.0	35.0	35.0	33.5	32.7	32.7	32.7	32.7	32.7
	Predicted Wind Turbine Noise $L_{A90}$	-	-	11.9	13.9	18.2	21.7	23.1	23.1	23.1	23.1	23.1	23.1
	Exceedance Level $L_{A90}$	-	-	-	-	-	-	-	-9.6	-9.6	-9.6	-9.6	-9.6
NAL2 – Crathie	Site Specific Noise Limit	35.0	35.0	35.0	35.0	35.0	34.4	33.9	33.8	33.8	33.8	33.8	33.8
	Predicted Wind Turbine Noise $L_{A90}$	-	-	8.2	10.2	14.5	18.0	19.4	19.4	19.4	19.4	19.4	19.4
	Exceedance Level $L_{A90}$	-	-	-	-	-	-	-	-	-	-	-	-
NAL3 - Garvabeg	Site Specific Noise Limit	33.8	33.8	33.8	33.8	33.8	32.9	31.0	30.5	30.5	30.5	30.5	30.5
	Predicted Wind Turbine Noise $L_{A90}$	-	-	11.8	13.8	18.1	21.6	23.0	23.0	23.0	23.0	23.0	23.0
	Exceedance Level $L_{A90}$	-	-	-	-	-	-	-8.0	-7.5	-7.5	-7.5	-7.5	-7.5

Receptor		Wind Speed ( $\text{ms}^{-1}$ ) as standardised to 10m height											
				22.0	20.0	15.7	11.3						
NAL4 – Melgarve	Site Specific Noise Limit	34.1	34.1	34.1	34.1	34.1	33.4	32.2	31.9	31.9	31.9	31.9	31.9
	Predicted Wind Turbine Noise $L_{A90}$	-	-	14.2	16.2	20.5	24.0	25.4	25.4	25.4	25.4	25.4	25.4
	Exceedance Level $L_{A90}$	-	-	-	-	-	-9.4	-6.8	-6.5	-6.5	-6.5	-6.5	-6.5

17.7.8 The assessment shows that the predicted wind turbine noise immission levels for the Proposed Development meet the SSNL under all conditions and at all locations for both daytime and night-time periods at all receptors.

## 17.8 Mitigation

17.8.1 The exact model of wind turbine to be used for the Proposed Development would be the result of a future tendering process. Achievement of the noise limits determined by this assessment would be a key determining factor in the final choice of wind turbines for the site. Predictions of wind turbine noise have been based upon sound power level data for a typical wind turbine model which could be considered for the site, the GE 3.8-130 3.8MW, and a noise prediction model procedure that can be considered to provide a realistic impact assessment.

## 17.9 Residual Effects

17.9.1 At all NALs cumulative noise predictions from the Proposed Development and other operational, consented and proposed wind farms are below the TNL. Predicted wind farm operational noise levels from the Proposed Development lie below the SSNL at all the NALs. There would be no significant residual effects resulting from the Proposed Development after the SSNL are adopted.

17.9.2 At some locations, under some wind conditions and for a certain proportion of the time wind farm noise from the Proposed Development may be audible; however, it would be at an acceptable level in relation to the ETSU-R-97 guidelines.

## 17.10 Cumulative Effects

17.10.1 Predicted cumulative wind turbine noise is less than the TNL at all NALs, accordingly the Proposed Development would not result in any significant effects.

## 17.11 Conclusion

17.11.1 The guidance contained within ETSU-R-97 and the IOA GPG was used to assess the likely operational noise impact of the Proposed Development. Predicted levels indicate that for dwellings neighbouring the Site the operational noise impact is not significant after the SSNL are adopted.

17.11.2 There are a range of wind turbine models that may be appropriate for the Proposed Development. If the Proposed Development receives consent, further data would be obtained from the supplier for the final choice of wind turbine model to demonstrate compliance with the operational noise limits derived in this report.

- 17.11.3 Should the Scottish Ministers be minded to grant consent for the Proposed Development it would be appropriate to include a set of noise conditions for the Proposed Development. A set of suggested noise conditions are included within Annex 5 of Technical Appendix 17.1: Operational Noise Report.

**17.12 References**

ISO (1996). ISO 9613-2:1996 Acoustics – Attenuation of Sound during Propagation Outdoors: Part 2 – General Method of Calculation. Geneva: International Organization for Standardisation.

IOA (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'. UK: Institute of Acoustics.

The Scottish Government (2011). PAN 1/2011 Planning and Noise. Scotland: The Crown

The Scottish Government (2011). Technical Advice Note Assessment of Noise. [online] Available at: <http://www.gov.scot/Publications/2011/03/02104659/0>. [Accessed 15 May 2018]

The Scottish Government, Web Based Renewables Advice: 'Onshore Wind Turbines' – updated May 28th 2014. [online] Available at: <http://www.scotland.gov.uk/Resource/0045/00451413.pdf> [Accessed 19 February 2020]

The Working Group on Noise from Wind Turbines (1996). ETSU-R-97 The Assessment and Rating of Noise from Wind Farms. UK: Energy Technology Support Unit