17 WIND FARM AIRBORNE NOISE

17.1 INTRODUCTION

1. This Section of the ES evaluates the likely significant effects of airborne noise arising from the Wind Farm. The assessment has been undertaken by ERM and includes consideration of cumulative effects.

2. This Section includes the following elements:

- Assessment Methodology – provides details of the scope of assessment, consultation undertaken ;
- Assessment of Potential Effects – provides details of the noise modelling results;
- Mitigation Measures and Residual Effects – details any mitigation required in respect of significant effects and the residual effects with mitigation;
- Statement of Significance; and
- References.

3. Calculations (referred to as scoping calculations) have been undertaken using a noise model to confirm the conclusions drawn in the Beatrice Offshore Wind Farm Scoping Report.

4. Cumulative effects from airborne noise have been scoped out as adverse effects from Beatrice are not expected to occur.

5. The calculations focus on the activities anticipated to generate the most noise during construction and operation of the Wind Farm. These are:

- Construction noise associated with piling activities; and
- Operational noise associated with the turbines.

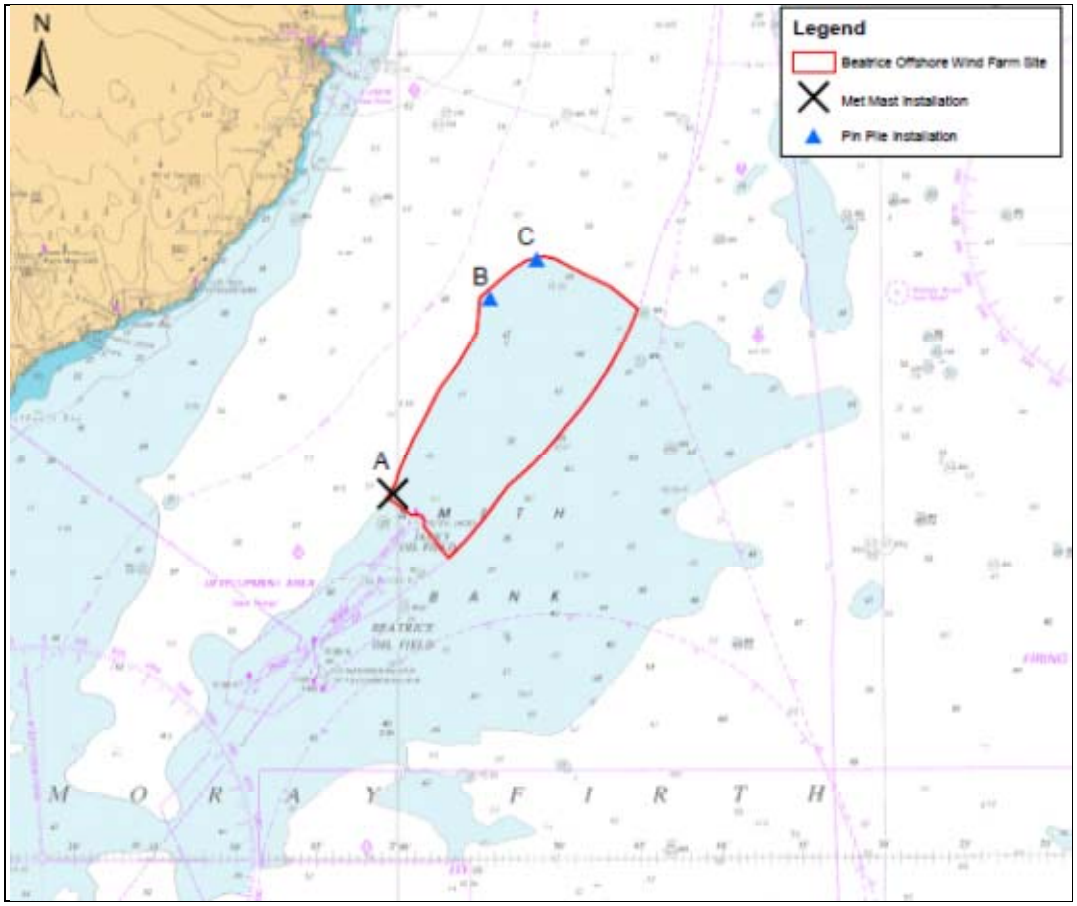
17.2 ASSESSMENT METHODOLOGY

17.2.1 SCOPE OF ASSESSMENT

17.2.1.1 Construction Noise

6. The potential effects of airborne noise during construction of the wind farm relate to the construction techniques used. In particular piling operations may give rise to increased airborne noise. Within the parameters being assessed (presented in Section 7: Project Description) there is an engineering option to pile drive up to three monopiles into the seabed for the meteorological mast components and the driving of 2.4 metre diameter pin piles for the turbine installations(shown as point A (meteorological mast piling) and points B & C (pin pile) in Plate 17.1). Therefore the two piling activities have been assessed to determine the noisiest construction activity in terms of airborne noise. It is assumed that only one meteorological mast and two pin piles would be piled simultaneously at any given time, and that meteorological masts and pin piles would not be driven at the same time.

Plate 17.1 Indicative Piling Locations



7. The meteorological masts will be present for the operational life of the wind farm and their monopiles (if this solution is used) would have a maximum outer shaft diameter of up to five metres. The monopiles would be driven into the sea bed using a hydraulic hammer. This method of construction generates the highest level of airborne noise of all the construction options being considered for the Project. The assessment of this activity therefore presents an assessment of the worst-case scenario with regard to construction airborne noise.

17.2.1.2 Operational Noise

8. The assessment of operational airborne noise has been conducted for a layout of 142 x 7 MW wind turbines, with a hub height of 116 m. The turbine specification and turbine spacing is outlined in Section 7: Project Description of this ES.

17.2.2 CONSULTATION

9. The Scoping Exercise identified that an assessment of airborne noise could be scoped out of the ES due to there being no likelihood of significant effects. Consultation with The Highland Council is detailed in Table 17.1.

Table 17.1 Summary of Consultation Undertaken

Consultee	Summary of Consultation Response	Title
The Highland Council Environmental Health	Calculations of predicted airborne noise to be included in the ES. Further predictions at onshore sensitive receptors not required.	Calculation results presented in this Section.

10. The calculation results presented in this Section were confirmed with the Highland Council Environmental Health Officers (EHOs). The EHOs agreed that further assessment of the potential for effect from airborne noise, at any onshore noise sensitive receptor, can be scoped out and that no further assessment is required. The remainder of this Section presents the information that enabled the Highland Council to make this conclusion.

17.2.3 ASSESSMENT METHODOLOGY

17.2.3.1 Construction

11. For the purposes of the modelling it was assumed that the nearest point of the shoreline from the Wind Farm constitutes the closest noise sensitive receptor which lies within the area of Highland Council. To assess the potential for airborne noise effects from piling of the meteorological mast monopiles the following noise assessment methodologies were considered.

- British Standard BS 5228:2009: Noise and Vibration Control on Construction and Open Sites; and
- Department of Environment Advisory Leaflet 72(AL 72).

12. The construction of the Wind Farm will follow the guidance in BS5228:2009 and although this is not specifically designed for offshore construction, it is a recognised approach to noise prediction during construction.

13. BS5228:2009 Part 1 sets out indicative noise level outputs, in terms of Sound Power Levels (SWL or Lw) and Activity LAeq (the A-weighted equivalent noise level), for a wide range of construction plant and activities, including piling. The standard also gives advice on noise mitigation measures and sets out a prediction methodology. The factors that are considered in the prediction methodology include:

- Sound power levels associated with various processes and plant;
- Periods of operation of process and plant; and
- Distances between the noise source and the receptor.

14. The BS5228:2009 prediction method has been used to predict the airborne noise levels from piling. To calculate and assess the construction noise from the Wind Farm, two piling scenarios have been considered:

- Meteorological masts being piled (5 m diameter monopile) one at a time using a 2400kJ hammer; and

- Two pin piles (2.4 m diameter) being simultaneously driven at the nearest turbine locations to the shore.

15. Other factors such as meteorological conditions (e.g. wind speed and direction) and atmospheric absorption also influence the level of airborne noise received at a receptor and result in temporal variations. However, the prediction of these effects over long distances can be complex and imprecise. For the purposes of the scoping calculation undertaken for this assessment, the approach adopted assumed a worst case scenario by assuming the ocean to be a reflective surface and the consideration of attenuation only due to distance. These conditions are considered to represent a worst case scenario.

17.2.3.2 Source Terms

16. BS5228:2009 contains source noise levels for piling activities, although the data relates to piles with a diameter less than 1 m. Based on previous work carried out for assessments of wind farms, a source term sound power level (SWL) of 130dB(A) has been assumed to reflect the larger 5 m diameter of the monopiles for the meteorological masts and a SWL of 124dB(A) has been adopted for the two pin piles. These sound power levels have been used to estimate airborne noise levels ($L_{Aeq, Period}$) at the onshore noise sensitive receptor, the location of the piling works are illustrated on Plate 17.1.

17. The advice in BS5228:2009 restates the guidance in AL 72 and states that the noise level outside the noise sensitive receptor's nearest occupied room in the day time should not exceed:

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

18. These levels are generally taken as being facade levels. AL72 also suggests that in the evening period a level of 10 dB(A) below that during the day may be appropriate. A night time construction noise criterion of 45 dB $L_{Aeq, 1hr}$, at 1 m from the façade of the nearest building was therefore adopted, above which it was considered that there will be a significant effect. Construction may be carried out on a 24 hour basis, and the worst case assessment assumes that all noise sources may operate at night.

19. The level at which it is considered that a significant effect occurs is classified and assessed as :

- A daytime (07:00-19:00) construction noise criterion of 70 dB $L_{Aeq, 1hr}$, at 1 m from the façade of the nearest Noise Sensitive Receptor;
- An evening (19:00-23;00) construction noise criterion of 60 dB $L_{Aeq, 1hr}$, at 1 m from the façade of the nearest Noise Sensitive Receptor; and
- A night time (23:00-06:00) construction noise criterion of 45 dB $L_{Aeq, 1hr}$, at 1 m from the façade of the nearest Noise Sensitive Receptor.

17.2.3.3 Operational Airborne Noise

20. The assessment of noise effects from wind turbines in the UK is undertaken following the ETSU-R-97 guidance (ETSU guidance) produced by the DTI Working Group on Noise from Wind Turbines (DTI NWG). This recommends a methodology for measuring prevailing background noise at a wind farm site and for defining operational noise thresholds which can be used to identify significant adverse effects. This guidance is referenced in Planning Advice Note 1/2011: Planning and Noise.

21. The ETSU guidance also recommends a simplified assessment method where the contributed noise emission from a wind farm development can achieve a noise limit of 35 dB LA90, 10min at wind speeds up to 10 m/s (at 10 m height). This will demonstrate sufficient protection of amenity, and no further assessment is necessary.

22. The recommendation made in the ETSU guidance that is appropriate to this assessment is as follows:

> *"For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to a LA90, 10min of 35 dB(A) up to wind speeds of 10 m/s at 10 m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary."*

23. The ETSU guidance does not specify a method by which a scoping calculation should be undertaken. In many cases, the calculation procedures set out in ISO 9613 are used to perform the calculations. Noise emissions from the candidate wind turbine are often reported in independent tests undertaken in accordance with IEC 61400-11: Wind Turbine Generator Systems – Part 11.

24. A noise model of the Wind Farm layout was developed using Version 8.01 of Brüel & Kjær's Predictor 7810 computer noise modelling software package, utilising the ISO 9613 noise propagation algorithms in combination with the CONCAWE algorithms for meteorological effects. To account for the potential effects of temperature inversions over water from offshore wind farms, a comparison of predicted noise levels at 2.5km showed a 1 dB increase in noise level form the effect of source to receiver wind and temperature inversion (Pasquill stability class G). This correction has been applied to predicted levels at the nearest receptor to account for any potential enhancement that may occur from meteorological effects over water at these distances. The model used the following parameters to predict noise levels at the nearest potentially affected onshore receptors:

- Topographic data of coastline and sea;
- Spacing and heights of turbines (as detailed in Section 7: Project Description);
- Ground value of zero to represent the ocean surface as reflective; and
- Turbine sound power level at 8 m/s corrected in accordance with IEC 61400-11, as detailed in Table 17.2.

Table 17.2 Octave Band Sound Power Level Assumptions (Lw) for all Wind Turbines, in Accordance with IEC 61400-11

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	dB(A)
Lw, dB(A)	95.9	102.1	105.2	105.5	107.2	103.2	98	85.6	112.3

25. The sound power levels shown in Table 17.2 are based on a 7 MW candidate turbine with a total sound power level of 112 dB(A). The data of the warranted sound level are based on measurements according to the guideline IEC 61400-11, as well as the Technical Guideline Fördergesellschaft Windenergie e.V.

17.3 ASSESSMENT OF POTENTIAL EFFECTS

17.3.1 CONSTRUCTION

17.3.1.1 Modelling Results

26. The predicted noise level at the noise sensitive receptor as a result of piling at the nearest meteorological mast locations to shore, were predicted to range from 39 dB LAeq, 1hr for one mast, and up to 42 dB LAeq, 1hr for simultaneous piling of one met mast and two pin piles at the nearest turbine locations to the shore and are presented in Table 17.3.

Table 17.3 Calculated Onshore Noise Level dB(A)

Scenario	Predicted Onshore Noise Level, LAeq dB(A)	Daytime construction noise criterion, LAeq dB(A)	Evening construction noise criterion, LAeq dB(A)	Night time construction noise criterion, LAeq dB(A)	Exceedance of Day Time Criterion, LAeq dB(A)	Exceedance of Evening Criterion, LAeq dB(A)	Exceedance of Night Time Criterion, LAeq dB(A)
Scenario 1- piling of one mast	39	70	60	45	-31	-21	-6
Scenario 2- simultaneous piling of two pin piles	38	70	60	45	-32	-22	-7
Scenario 1 and 2 occurring simultaneously	42	70	60	45	-28	-18	-3

27. The predicted noise levels fall below the daytime, evening and night time noise assessment criterion and noise effects are anticipated to be not significant during any time periods.

17.3.2 OPERATION

17.3.2.1 Modelling Results

28. The calculated airborne noise level contributions from the wind farm layout at the nearest point on the shoreline are presented in Table 17.4. The predicted levels are

the contribution from the Wind Farm and are not inclusive of any other onshore noise, such as existing industrial or transportation noise sources.

Table 17.4 Predicted Onshore Noise Level

Scenario	**Predicted Onshore Noise Level, dB(A) $L_{A90, 10min}$[1]**		
	Calm	**Source – receiver wind 3m/s**	**G class temperature inversion**
7 MW wind turbines	26	27	27

29. Wind has the potential to increase noise impacts at a receiver when it is light and stable and blows from the direction of the noise source. A wind speed of 3m/s has been applied to the maximum sound power level emitted by the turbine, which would occur at speeds greater than 3 m/s and therefore represents a conservative assessment. As the strength of the wind increases the noise produced by the wind (such as windblown vegetation) usually obscures noise from discrete sources.

30. Figure 17.1 shows the 35 dB(A) noise contour from the 7 MW wind farm scenario. Only the 35 dB(A) noise contour line has been illustrated given the 35 dB(A) reference within the ETSU guidance.

31. Given these calculation results it is predicted that airborne noise effects from the operating turbines will not exceed the ETSU guidelines at receptors on the shore and are therefore considered not significant.

17.4 MITIGATION MEASURES RESIDUAL EFFECTS

32. It can be concluded from the assessment that the noise levels at the nearest onshore receptors during construction and operation are expected to be less than the relevant respective criteria. Therefore, no mitigation is required and the effects are as predicted in Section 17.3.1 and 17.3.2.

33. On this basis it is concluded that no further assessment of airborne noise effects arising from construction and operational activities at potential noise sensitive (onshore) receptors is required and can be 'scoped out' of this EIA as agreed with the Highland Council EHOs.

17.5 STATEMENT OF SIGNIFICANCE

34. The assessment of potential airborne noise effects presented in this Section confirms that no significant effects are likely during the construction and operational phases of the Wind Farm. This is primarily due to the distance of the wind farm from the shore. This confirms the assertion outlined in the Scoping Report.

[1] The noise level limit of 35 dB is based on the LA90 noise level. LA90 levels can be derived from the predicted LAeq levels by subtracting 2 dB as specified by ETSU.

35. During construction the activity generating the most airborne noise would be piling of the meteorological masts. An assessment of this activity concluded that noise levels at the nearest onshore receptor would be less than noise criteria published in the applicable guidance.

36. Airborne noise levels at the nearest onshore receptor have been calculated and was predicted not to result in significant noise effects at the closest noise sensitive receptors.

37. Based on these results it is concluded that no significant effects will result and that no further assessment of airborne noise from the Wind Farm is required. This data has been presented to the Highland Council who has agreed with this conclusion.

17.6 REFERENCES

38. The Working Group on Noise from Wind Turbines (1996) ETSU-R-97, The Assessment and Weighting of Noise From Wind Farms, Final Report, September 1996

39. The Scottish Government (2011) PAN 01/2011 Planning and Noise

40. FGW: Technische Richtlinien für Windenergieanlagen(2008) Teil 1: Bestimmung der Schallemissionswerte, Revision 18, 2008-02-01. Hrsg.: Fördergesellschaft Windenergie e.V. (FGW). Technical guideline for wind turbines – Part 1: Determining the noise emission values, Fördergesellschaft Windenergie e.V. (FGW) ed.

41. Department of the Environment. Advisory Leaflet 72. Noise Control on Building Sites. 1976.