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Technical Appendix 16.1

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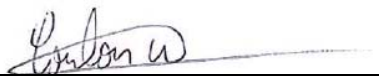
Approvers Signature:		15-01-2016

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Quality Assurance

TNEI Services Ltd operates an Integrated Management System covering Quality (ISO 9001) Environmental (ISO 14001) and Health and Safety (OHSAS 18001). TNEI was audited in 2015 and holds certification to all three standards.

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EXECUTIVE SUMMARY

TNEI Services Ltd has been commissioned by Peel Wind Farms (Yell) Ltd (PWFY) to undertake predictions of the noise that may be emitted by the construction and decommissioning phases of the proposed Beaw Field Wind Farm (the proposed development). The noise predictions were used to assess the potential impact of the construction and decommissioning noise of the proposed development on the occupiers of nearby noise sensitive dwellings.

The construction and decommissioning noise assessment has been undertaken using guidance contained in the updated BS5228: Part 1 2009+A1:2014 *'Noise and vibration control on construction and open sites- Noise'*, the calculation methodology in ISO9613: 1996 *'Acoustics - Attenuation of sound during propagation outdoors'* -Part 2: General method of calculation, together with noise data for appropriate construction plant. BS5228 provides guidance, information and practical procedures on the control of noise and vibration from construction sites. Calculations were made using CadnaA noise modelling software, a Microsoft Excel based noise assessment model and an assessment procedure that considers a worst-case scenario.

Four residential receptors neighbouring the proposed development were selected as being representative of the properties located closest to the site. Predictions have been made assuming that all plant, per construction phase, are operating both continually and concurrently throughout the assessment period, both on the access tracks and within the site itself to provide a worst-case scenario (whereas in reality only a proportion of the plant may be operating).

The predicted noise levels at all of the assessed receptors during all phases are below the 65dBA Daytime and 55dBA Weekend thresholds adopted for this project and having due regard to all circumstances the potential impact is deemed to be not significant. Notwithstanding, a series of recommendations to minimise noise impacts at all receptors have been included. These have been derived in accordance with current good practice.

Contents

1 INTRODUCTION

1.1 Brief

1.1.1 To undertake predictions of the noise levels that will be incident at neighbouring noise sensitive receptors due to the construction and decommissioning of the proposed Beaw Field Wind Farm (hereinafter referred to as the proposed development).

1.1.2 To present the noise data and assess the impact of noise from the proposed development with reference to existing Government Guidance contained within BS5228-1:2009+A1:2014 *'Code of practice for noise and vibration control on construction and open sites- Noise'*[1].

1.2 Background

1.2.1 TNEI Services Ltd was commissioned by Peel Wind Farms (Yell) Ltd (PWFY) to undertake a construction and decommissioning noise assessment for the proposed development. The proposed development is located approximately 1km north west of Burravoe and 1km south of Gossabrough on the Isle of Yell. The approximate Ordnance Survey grid reference for the site centre is 450461, 1182092. The proposal is for the installation of seventeen wind turbines and associated ancillary infrastructure.

1.2.2 Environmental, or community noise, is a broad term that encompasses noise emitted from many sources, including road, rail and air traffic, agricultural and commercial sources, together with industrial sources which at this location includes wind turbines. Construction related activities are likely to temporarily contribute adversely to the overall noise environment. It is reasonable to expect communities to be sensitive to any deterioration in noise as a result of developments and a thorough assessment of potential impacts is therefore necessary.

1.2.3 This report is intended to provide an objective assessment of the potential noise impacts associated with the construction and decommissioning phases of the proposed development, to inform regulators, the local community and other stakeholders.

2 NOISE PLANNING POLICY AND GUIDANCE

2.1 Overview of Noise Planning Policy and Guidance

2.1.1 In assessing the potential construction noise impacts of the proposed Development the following guidance and policy documents have been considered:

- Planning Advice Note (PAN) 1/2011 – '*Planning and Noise'*[2];
- BS5228-1: 2009+A1:2014 *'Code of practice for noise and vibration control on construction and open sites* – Part 1: Noise*'; and*
- ISO9613: 1996 *'Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation'*[3].

2.2 PAN 1/2011 Planning and Noise

2.2.1 PAN 1/2011: *'Planning and Noise'* provides little guidance in respect of construction noise, other than recommending that the use of planning conditions is not the preferred method for controlling temporary construction noise:

'32. While planning conditions can be used to limit noise from temporary construction sites, it is most effectively controlled through the Control of Pollution Act 1974 (COPA74) and the Pollution and Prevention Control Act 1999 for relevant installations. Notice can be served in advance of works and site conditions set to control activities.'

2.2.2 The associated Technical Advice Note 'Assessment of Noise' (p30) describes how the COPA74 has several approved codes of practice in relation to noise:

'Several codes of practice are approved under Section 72 of Control of Pollution Act 1974 for the purpose of providing guidance on how best to minimise or reduce noise. Where relevant to the noise in question, Local Authorities must consider these codes of practice when taking enforcement action under the Control of Pollution Act 1974 and the Environmental Protection Act 1990. The content of the codes is not however statutory and has no greater status than any other relevant source of best practice.'

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

2.3.1 In respect of construction and decommissioning noise, the relevant codes are contained in BS 5228:1997 Parts 1 & 3 and Part 4 1986. Although this version of the British Standard has been superseded, the 1997 version remains the relevant Approved Code of Practice (ACoP). However for the purposes of noise assessments it is deficient in several aspects, in particular:

- the sound power data included does not generally include octave band data;
- the data is based on old measurements and does not reflect current construction plant, which is generally quieter; and

- the guidance does not provide significance criteria, instead relying upon guidance in an outdated Department of Environment Note AL72, which is out of print but remains as a paper giving guidance on levels of construction noise considered acceptable in 1972.

2.3.2 This construction and decommissioning noise assessment has therefore been undertaken in accordance with the updated standard, British Standard (BS) 5228-1: 2009+A1:2014 'Noise', (hereafter referred to as BS5228) which addresses these issues, as detailed below.

2.3.3 BS5228 provides useful guidance on practical noise control. Part 1, provides recommendations for basic methods of noise and vibration control including sections on community relations, training, occupational noise effects, neighbourhood nuisance and project supervision. The annexes provide information on noise sources, mitigation measures and their effectiveness.

2.3.4 BS5228 also provides typical sound power level data for a variety of construction plant. The data was obtained from field measurements of actual plant operating on construction and open sites in the United Kingdom. Levels quoted are based on an energetic average of calculated sound power levels, and where appropriate have been derived using more than one model of similarly sized plant in order to simplify the database. The results are presented as un-weighted octave band activity L_{eq} levels, and a single figure, broadband, A-weighted activity L_{eq}.

2.3.5 Pass-by measurements were also made for moving sources, and these are presented as un-weighted octave band activity L_{max} levels, and overall A-weighted L_{max} values.

2.3.6 All provided sound pressure levels are standardised to 10 metres from the plant.

2.3.7 Weights for machines, where given, relate to the usual weight references used in the construction industry (weights for machines such as bulldozers, excavators, rollers, are the actual weights of the machines; weights for dump trucks and dumpers are the load capacity weights; and weights for cranes are the lifting capacity weights).

2.3.8 Table E.1 in Annex E part E.3.2 of BS5228 provides example thresholds of potentially significant effects at dwellings, addressing three different categories of site according to existing ambient levels and indicative thresholds for daytime, evenings and weekends and night time periods. Where significant impacts are predicted, part E.4 sets out the criteria for assessing the eligibility for noise insulation based on trigger values relating to pre-defined time periods and duration of proposed construction activities. Where trigger values are exceeded by more than 10dB, it suggests temporary re-housing or the reasonable costs thereof should be offered.

2.3.9 BS5228 Table E.1 (summarised in Table 2.1 below) has been used as the basis for establishing significance criteria used to assess the proposed construction activities.

Table 2.1 Example of threshold of potential significant effect at dwellings (dB(A))

Assessment Category and Threshold Value Period	Threshold Value $L_{Aeq,T}$ dB		
	Category (A)[A]	Category B[B]	Category C[C]
Night-Time (23:00 – 07:00)	45	50	55
Evenings and Weekends[D]	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	65	70	75

[A]Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values;
[B]Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values;
[C]Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values;
[D]19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

2.3.10 The threshold values are limits for the construction L_{Aeq} noise level. The limits in each category are to be used where the existing noise level at each location, rounded to the nearest 5dB is below the level given for a time of day. BS5228 provides the following advice regarding the threshold limits:

'Note1 A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.

Note 2 If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3dB due to site noise.

Note 3 Applied to residential receptors only.'

3 METHODOLOGY

3.1 Assessing the Noise Impact of Construction and Decommissioning

3.1.1 To undertake an assessment of the construction and decommissioning noise impact in accordance with the requirements of BS5228, the following steps have been followed:

- identify the noise sensitive receptors and select representative Noise Assessment Locations;
- identify the applicable threshold of significant effects from BS5228:1 2009+A1:2014;
- predict the noise levels for various construction and decommissioning noise activities;
- compare predicted noise levels against the applicable threshold; and
- where necessary, develop suitable mitigation measures to minimise any adverse effects during the construction phase;

3.2 Consultation

3.2.1 The Scoping Opinion issued by the Local Energy and Consents of the Scottish Government contains a response from Shetland Isles Council (SIC) on noise which states:

11.1 There is very little information regarding the construction phase including the construction of access roads and the extraction of materials from quarry or borrow pit operations. Clarification of borrow pit locations etc and much more information will be required.'

3.2.2 Prior to the commencement of the noise impact assessment for the proposed development, consultation was undertaken with the Environmental Health Department at Shetland Islands Council (SIC) in order to agree the approach to the noise assessments. The consultation letter stated that:

'The construction noise assessment will be undertaken in accordance with the methodology outlined in British Standard (BS) 5228-1:2009+A1:2014 and ISO9613:1996 ('Acoustics - Attenuation of sound during propagation outdoors' - Part 2: General method of calculation').'

3.2.3 The Environmental Health Officer (EHO) at SIC responded to the consultation by email and agreed with the methodology proposed for the construction noise assessment.

3.2.4 A copy of the original consultation letter and subsequent email correspondence is included in Annex 2 of Technical Appendix 16.2.

3.3 Significance Criteria

3.3.1 For the purposes of this assessment, having due regard to the existing ambient noise levels at the nearby noise sensitive receptors around the proposed development, the Category A 65dBA - Daytime and Saturdays, and 55dBA - Weekend threshold values, as detailed in Table 2.1 above, have been used as it applies to the appropriate time periods and are the most conservative categories.

3.3.2 Table 3.1 summarises the Category A significance criteria applied for this assessment.

Table 3.1 Threshold of Significant Effects at Receptors (dB(A))

Assessment Category and Threshold Value Period	Significance Level	
	Not Significant	Significant
Category A Daytime (07:00 – 19:00) and Saturdays (07:00 to 13:00)	≤65dB $L_{Aeq, 12\ hr}$	>65dB $L_{Aeq, 12\ hr}$
Category A Evenings and Weekends	≤55dB $L_{Aeq, 12\ hr}$	>55dB $L_{Aeq, 12\ hr}$

3.3.3 BS 5228 E.3.2 states:

'…If the site noise level exceeds the appropriate category value, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect'.

3.3.4 Significance or otherwise is therefore not determined solely on a numeric pass or fail of a particular threshold.

3.4 Predicting Noise levels from Construction and Decommissioning

3.4.1 Predicted noise levels have been assessed against the thresholds from Table 3.1 above. It is assumed that all construction related activity will take place within the Daytime and Weekend period.

3.4.2 At this stage, a detailed plant list is not available so a generic plant list based upon experience of similar projects has been used. All plant has been modelled assuming it is operating continuously at the closest point to each receptor, which provides a worst case scenario.

3.4.3 Machinery on site will produce noise levels that are transient in nature and fluctuate due both to the mobility of the activities and the load on any individual machine. The works generally comprise both moving and static sources. The mobile sources include mobile construction plant and HGVs, while static construction plant such as generators, lighting rigs and pumps are usually located at a fixed location for a period of time.

3.4.4 The relevant plant has been identified for each phase and using data from BS5228, the L_{Aeq} and octave spectra for all plant have been summed and treated as a single point source at various locations (e.g. along haul roads). This method is described in Section 5 of ISO 9613 Part 2 *'Acoustics-Attenuation of sound during propagation outdoors'* 1996 which states:

'However, a group of point sources may be described by an equivalent point sound source situated in the middle of the group, in particular if:

a) the sources have approximately the same strength and height above the local ground plane,

b) the same propagation conditions exist from the sources to the point of reception, and

c) the distance 'd' from the single equivalent point source to the receiver exceeds twice the largest dimension H_{max} of the sources ($d > 2H_{max}$).'

3.4.5 For each assessed location the $L_{Aeq,T}$ and octave band immission levels have been predicted in the CadnaA 4.4 modelling software. Whilst there are several noise propagation models available, the ISO 9613-2 model, as enabled in CadnaA 4.4, has been used to calculate the noise immission levels at the nearest receptors. The predictions take account of atmospheric absorption (temperature of 10°C and 70% relative humidity) and hard ground attenuation (G=0) for all access tracks and areas of hard standing. Mixed ground attenuation (G=0.5) has been assumed at the mid and receiver regions along with any screening effects from topographical features. A receiver height of 1.5m above local ground level is assumed. The ISO 9613-2 propagation model was chosen in preference to the calculation method in BS5228, primarily because of the significant distances from source to receptor evident on this site. BS5228 notes, in F 2.2.2.2 that at distances over 300m noise predictions (using the BS5228 methodology) should be treated with caution, especially where a soft ground correction factor has been applied, because of the increasing importance of meteorological effects whereas ISO 9613 provides equations that have been validated up to 1,000m.

3.4.6 The approach undertaken in the assessment therefore reflects a realistic propagation model for downwind atmospheric conditions or periods of moderate inversion. In practice construction plant will operate over the whole site area, so attenuation due to distance is liable to be greater than predicted here.

3.4.7 The noise from on-site traffic movements (i.e. haul routes) has been assessed as a line source in accordance with the method contained in the proprietary noise software package CadnaA. This provides the most suitable technique for assessing slow moving construction traffic and is derived from the following formulae utilised in CadnaA:

$$PWL = PWL_{Pt} + 10\lg\frac{Q}{(h^{-1})} + 10\lg\frac{l}{(m)} - 10\lg\frac{v}{(km/h)} - 30\ dB$$

Where PWL_{Pt} is the sound power level of a point source, Q is the number of events per hour, l is the length of the segment in metres and V is the speed in kilometres per hour.

4 BASELINE

4.1 Noise Assessment Locations

4.1.1 The Noise Assessment locations (NAL) refer to the position denoted by the house symbol on Figure A1.1 (Annex 1). Predictions of construction noise have been made at NAL1 to NAL4 as detailed in Table 4.1 and these were selected as they are likely to be the most sensitive noise receptors as they are located closest to the construction works.

Table 4.1 Construction Noise Assessment Locations

Receptor	Easting (m)	Northing (m)	Elevation (m AOD)
NAL1-Lower Holligarth	452188	1183917	34
NAL2-Whirliegarth	452739	1183016	30
NAL3-Easterlee	451773	1180569	56
NAL4-Hamnavoe	449726	1180866	33

*Please note the coordinates for the noise assessment locations are taken at the edge of the property the closest to the wind turbines.

5 ASSESSMENT RESULTS

5.1 Construction Phases

5.1.1 The assessment for the construction activities has been based on a construction period of approximately twenty-four months. During each phase the location and amount of plant, equipment and associated traffic will influence the noise generated. The selection of plant and equipment to be used will be determined by the main contractor and detailed arrangements for on site management will be decided at that time. This assessment has therefore been based upon a typical selection of plant for a wind farm project of this size. In view of this, the plant has been modelled operating at the closest point to each receptor for a given activity in each construction phase whereas in reality only certain plant will be working at the closest point. The hours of operation are anticipated to be 07:00 to 19:00 weekdays and Saturdays 07:00 to 18:00

5.1.2 For the purposes of this noise assessment the construction programme has been split into separate phases in order to provide results for representative noise activities:

- Phase 1 - involves soil handling, and distribution of hardcore required for the construction of the site compound(s);
- Phase 2 - construction of the temporary site compound(s), borrow pit construction removal of soil and importation of hardcore material (if required);
- Phase 3 - construction of the site tracks, borrow pit activity, installation of cables, soil handling, and distribution of hardcore material;
- Phase 4 - construction of the crane hardstandings, borrow pit activity, soil handling and distribution of hardcore material;
- Phase 5 - construction of the turbine foundations which involves borrow pit activity, soil handling, on-site concrete batching and distribution of hardcore material;
- Phase 6 - delivery and erection of the wind turbines;
- Phase 7 – construction of the substation and distribution of hardcore material; and
- Phase 8 – decommissioning.

5.1.3 The equipment and machinery likely to be used during each of the above phases are detailed in Tables 1 to 8 of Annex 2. The Tables provide noise data for each noise source split into octave bands. All data has been sourced from tables included in BS5228-1: 2009+A1:2014, and were converted to sound power levels for input into CadnaA. Where octave band data was not available and only A-weighted sound power levels of the sources were known, the attenuation coefficients for 500 Hz were used to estimate the resulting attenuation.

5.2 Assessment Results

5.2.1 Table 5.1 below shows the predicted construction noise levels at each location for each phase.

Table 5.1 Predicted construction noise levels

Location	Predicted daytime noise levels $L_{Aeq\ 12h}$ for each phases in (dB)							
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
NAL1-Lower Holligarth	20	23	34	32	28	20	32	26
NAL2-Whirliegarth	23	21	37	33	29	24	34	28
NAL3-Easterlee	36	34	40	39	39	29	35	32
NAL4-Hamnavoe	51	41	45	44	40	29	33	38

5.2.2 Table 5.1Table 5.2 below shows the results of the noise impact assessment, following comparison of predicted levels against the Category A Threshold Values for each receptor and each phase.

Table 5.2 Noise impact assessment results

Location	Category A Daytime Threshold dB	Category A Weekend Threshold dB	Significance rating (Predicted levels compared to Threshold)							
			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
NAL1-Lower Holliegarth	65	55	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
NAL2-Whirliegarth	65	55	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
NAL3-Easterlee	65	55	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
NAL4-Hamnavoe	65	55	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

5.2.3 The predicted noise levels at all of the receptors during all phases are below the 65dBA Daytime and 55dBA Weekend thresholds. Having due regard to all circumstances the potential impact is deemed to be not significant.

5.2.4 It should be noted that the proposed construction and decommissioning phases are temporary and short term and are therefore unlikely to give rise to any long-term effects. In practice, for much of the working day the noise associated with construction and decommissioning activities will be less than predicted as the predictions assume that all plant is operating concurrently and continuously, whereas in reality only a certain proportion of plant will be operating at any one time, while others maybe idling or turned off. As such, for the majority of the time, the impacts will be less than indicated in the above tables.

5.3 Mitigation Measures

5.3.1 At this stage of the project, the assessment is based on a worst-case scenario. Once a main contractor is appointed, careful consideration will be given to the type of plant to be used for each phase of construction. Contractors will inform the residents when particularly noisy activities are likely to take place to ensure any disruption is kept to a minimum.

5.3.2 Good site practices can be implemented to minimise the potential effects. Section 8 of BS5228 recommends a number of simple control measures as summarised below.

5.3.3 At this stage it is proposed that construction and decommissioning activities on site shall only take place between the hours of 07:00 to 19:00 on Monday to Friday inclusive and 07:00 to 18:00 on Saturday with no construction works on site on Sundays or Bank Holidays. However, there may be the requirement for extended operating hours to minimise traffic disruptions, for example during the movement of abnormal loads. The principal contractor will:

- keep local residents informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern;
- ensure site work continuing throughout 24 hours of a day shall be programmed, when appropriate, so that haulage vehicles will not arrive at or leave the site between 19.00 and 07.00 hours, with the exception of abnormal loads that will be scheduled to avoid significant traffic flows;
- ensure all vehicles and mechanical plant will be fitted with effective exhaust silencers and ‘smart’ reversing alarms and be subject to programmed maintenance;
- select inherently quiet plant where appropriate - all major compressors will be ‘sound reduced’ models fitted with properly lined and sealed acoustic covers, which will be kept closed whenever the machines are in use;
- review the options to utilise close boarded fencing as acoustic screens whenever works are in close proximity to dwellings;
- ensure all ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;
- instruct that machines will be shut down between work periods or throttled down to a minimum;
- ensure regular maintenance of all equipment used on site, including maintenance related to noise emissions;
- ensure that vehicles are loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and
- ensure all ancillary plant such as generators and pumps will be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures should be provided.

6 CONCLUSIONS

6.1.1 This report has assessed the potential impact of the construction and decommissioning noise from the proposed development on the residents at nearby receptors, following the guidance contained within BS5228.

6.1.2 Four residential receptors neighbouring the proposed development were selected as being representative of the properties located closest to the proposed development.

6.1.3 All predictions assume that all plant is operating continuously in full operational mode at the closest point to each receptor in order to provide a worst-case scenario (whereas in reality only a proportion of the plant may be operating for a small proportion of time). It should be noted that the proposed construction and decommissioning activities are short term and temporary in nature and are not likely to cause any long-term impacts.

6.1.4 The predicted noise levels at all of the assessed receptors during all phases are below the 65dBA Daytime and 55dBA Weekend thresholds adopted for this project and having due regard to all circumstances the potential impact is deemed to be not significant.

6.1.5 To protect the amenity of local residents, the construction noise activities can be controlled under The Control of Pollution Act 1974 (COPA) which is specifically concerned with the control of noise pollution. In particular Section 60, Part III of the COPA refers to the control of noise on construction sites. It provides legislation by which a Local Planning Authority can control noise from construction sites to prevent noise disturbance occurring. In addition, it recommends that guidance provided by BS5228 be implemented to ensure compliance with Section 60.

7 GLOSSARY OF TERMS

Attenuation: the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

Background Noise: the noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods. The L_{A90} indices (see below) is often used to represent the background noise level.

Broadband Noise: noise with components over a wide range of frequencies.

Decibel (dB): the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

dB(A): the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate noise in the same way as the ear, and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Some typical subjective changes in noise levels are:

- a change of 3dB(A) is just perceptible;
- a change of 5dB(A) is clearly perceptible;
- a change of 10dB(A) is twice (or half) as loud.

Frequency: the pitch of a sound in Hz or kHz. See Hertz.

Ground Effects: the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).

Hertz (Hz): sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_w: is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The L_{WA} is the A-weighted sound power level.

L_{eq}: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $LA_{eq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).

L_{90}: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level.

The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

Noise emission: the noise energy emitted by a source (e.g. a wind turbine).

Noise immission: the sound pressure level detected at a given location (e.g. the nearest dwelling).

Sound Level Meter: an instrument for measuring sound pressure level.

Sound Power Level: the total sound power radiated by a source, in decibels.

Sound Pressure Level: a measure of the sound pressure at a point, in decibels**.**

Tonal Noise: noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise can be more annoying than broadband noise.

8 REFERENCES

[1] British Standard BS5228-1:2009+A1:2014 *'Code of practice for noise and vibration control on construction and open sites' – Part 1: Noise*

[2] Planning Advice Note (PAN) 1, 2011. *'Planning and Noise'* Scottish Government

[3] International Standards Organisation, ISO9613: 1996 *'Acoustics - Attenuation of sound during propagation outdoors' -Part 2: General method of calculation*

ANNEX 1 - Figure

ANNEX 2 - Equipment and machinery modelled for each of the Construction and Decommissioning Phases

ANNEX 1 - Figure

Legend

- Noise Assessment Location
- Proposed Turbine Location
- Indicative Borrow Pit Location
- Indicative Construction Compound Location
- Indicative Substation Location
- Infrastructure Layout

N

Rev.	DETAILS	DRAWN	CHK'D	APP'D	DATE
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Project:	Beaw Field Wind Farm
Client:	Peel Energy
Figure Title:	Noise Assessment Locations
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Peel Energy

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ANNEX 2 - Equipment and machinery modelled for each of the Construction and Decommissioning Phases

Annex 2: Equipment and Machinery Modelled for each of the Construction and Decommissioning Phases

Table 1 Proposed Construction Plant Data for Phase 1 (Site preparation)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.5	12	Dozer	104	14 t	80	78	71	70	74	68	65	61	77
C.2	32	Articulated Dump Truck (Tipping Fill)	187	23t	80	76	73	70	69	66	63	58	74
C.2	34	Lorry	-	4-axle wagon	73	78	78	78	74	73	68	66	80
C.2	40	Vibratory Roller	20	3t	82	78	67	71	67	64	60	57	73

Table 2 Proposed Construction Plant Data for Phase 2 (constructing temporary site compound)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	16*	Tracked Excavator	170	30t	72	71	74	73	69	66	63	58	75
C.4	53	Lorry with lifting boom	50	6t	81	78	76	74	72	69	64	56	77
C.11	4	Lorry movements on access road	350	44t	82	80	78	75	76	78	75	69	83
C.4	75**	Tractor (towing trailer)	71	5 t	93	86	76	76	73	72	64	59	79
C.1	12	Tracked Excavator	228	44 t	79	81	83	79	77	75	70	62	82
C.2	1	Dozer	142	20 t	79	77	76	74	68	67	60	59	75
C.9	26	Wheeled Loader	320	45 t	89	90	86	82	83	77	75	64	87

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.9	15	Tracked Semi-Mobile Crusher	250	38 t	98	98	97	74	91	88	82	72	96
C.10	15	Screen Stockpiler	51	17 t	84	82	79	79	74	74	71	64	81

Table 3 Proposed Construction Plant Data for Phase 3 (constructing site access tracks, borrow pit activity, installation of cables, soil handling) and distribution of hardcore material)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.5	12	Dozer	104	14 t	80	78	71	70	74	68	65	61	77
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	32	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	33	Articulated Dump Truck	187	23 t	85	87	77	75	76	73	69	62	81
C.2	34	Lorry	-	4-axle wagon	73	78	78	78	74	73	68	66	80
C.5	26	Vibratory Roller	20	3 t	82	78	67	71	67	64	60	57	73
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.2	1	Dozer	142	20 t	79	77	76	74	68	67	60	59	75
C.9	26	Wheeled Loader	320	45 t	89	90	86	82	83	77	75	64	87

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.9	15	Tracked Semi-Mobile Crusher	250	38 t	98	98	97	74	91	88	82	72	96
C.10	15	Screen Stockpiler	51	17 t	84	82	79	79	74	74	71	64	81

Table 4 Proposed Construction Plant Data for Phase 4 (constructing crane hardstandings)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.5	12	Dozer	104	14 t	80	78	71	70	74	68	65	61	77
C.2	32	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	32	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	33	Articulated Dump Truck	187	23 t	85	87	77	75	76	73	69	62	81
C.2	34	Lorry	-	4-axle wagon	73	78	78	78	74	73	68	66	80
C.1	12	Tracked Excavator	228	44 t	79	81	83	79	77	75	70	62	82
C.2	1	Dozer	142	20 t	79	77	76	74	68	67	60	59	75
C.9	26	Wheeled Loader	320	45 t	89	90	86	82	83	77	75	64	87
C.9	15	Tracked Semi-Mobile Crusher	250	38 t	98	98	97	74	91	88	82	72	96
C.10	15	Screen Stockpiler	51	17 t	84	82	79	79	74	74	71	64	81

Table 5 Proposed Construction Plant Data for Phase 5 (constructing turbine foundations)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.5	12	Dozer	104	14 t	80	78	71	70	74	68	65	61	77
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.4	33	Poker Vibrator	-	-	82	80	80	73	69	72	70	65	78
C.5	26	Vibratory Roller	-	4 t	84	84	78	70	70	70	67	61	77
C.4	32	Concrete Mixer Truck + Truck Mounted Concrete Pump + Boom Arm	-	-	73	73	77	76	72	70	65	62	78
C.4	32	Concrete Mixer Truck + Truck Mounted Concrete Pump + Boom Arm	-	-	73	73	77	76	72	70	65	62	78
C.4	50	Tracked Mobile Crane	390	600 t / 125 m	68	71	68	62	66	66	55	46	71
C.4	88	Water Pump (Diesel)	10	100 kg	70	65	66	64	64	63	56	46	68
C.4	75	Tractor (Towing Trailer)	71	3.5 t	93	86	76	76	73	72	64	59	79
C.4	76	Diesel Generator	6.5	-	80	74	57	54	53	48	45	37	61
C.2	33	Articulated Dump Truck	187	23 t	85	87	77	75	76	73	69	62	81
C.2	34	Lorry	-	4-Axle Wagon	73	78	78	78	74	73	68	66	80

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.1	12	Tracked Excavator	228	44 t	79	81	83	79	77	75	70	62	82
C.2	1	Dozer	142	20 t	79	77	76	74	68	67	60	59	75
C.9	26	Wheeled Loader	320	45 t	89	90	86	82	83	77	75	64	87
C.9	15	Tracked Semi-Mobile Crusher	250	38 t	98	98	97	74	91	88	82	72	96
C.10	15	Screen Stockpiler	51	17 t	84	82	79	79	74	74	71	64	81

Table 6 Proposed Construction Plant Data for Phase 6 (erecting turbines)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.4	52	Tracked Mobile Crane	240	105 t	73	71	66	67	74	66	58	49	75
C.4	50	Tracked Mobile Crane	390	600 t	68	71	68	62	66	66	55	46	71
C.4	76	Diesel Generator	6.5	-	80	74	57	54	53	48	45	37	61
D.7	24	Compressor	-	-	-	-	-	95	-	-	-	-	61
C.6	19	Road Lorry (Empty)	320	39 t	81	79	75	70	70	70	68	65	76

Table 7 Proposed Construction Plant Data for Phase 7 (Construction of Substation)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	14	Tracked Excavator	226	40 t	85	78	77	77	73	71	68	63	79
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.4	33	Poker Vibrator	-	-	82	80	80	73	69	72	70	65	78
C.4	32	Concrete Mixer Truck + Truck Mounted Concrete Pump + Boom Arm	-	-	73	73	77	76	72	70	65	62	78
C.4	32	Concrete Mixer Truck + Truck Mounted Concrete Pump + Boom Arm	-	-	73	73	77	76	72	70	65	62	78
C.2	34	Lorry	-	4-axle wagon	73	78	78	78	74	73	68	66	80

Table 8 Proposed Construction Plant Data for Phase 8 (decommissioning turbines)

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.4	52	Tracked Mobile Crane	240	105 t	73	71	66	67	74	66	58	49	75
C.4	50	Tracked Mobile Crane	390	600 t	68	71	68	62	66	66	55	46	71
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74

Table	Ref No	Equipment	Power Rating kW	Size, Weight, Capacity	Octave Band Centre Frequency (Hz) (dB(Z)) at 10m								
					63	125	250	500	1000	2000	4000	8000	L_{Aeq}
C.2	33	Articulated Dump Truck (Tipping Fill)	187	23 t	80	76	73	70	69	66	63	58	74
C.1	9	Breaker Mounted on Excavator	121	(15t) 1 650kg Breaker	88	88	86	89	83	83	80	76	90
C.1	10	Tracked Excavator (Loading Dump Truck)	228	44 t	82	78	82	81	81	78	72	64	85
C.1	14	Tracked Crusher	172	47 t	93	86	79	81	75	71	66	59	82
C.2	33	Articulated Dump Truck	187	23 t	85	87	77	75	76	73	69	62	81
C.6	19	Road Lorry (Empty)	320	39 t	81	79	75	70	70	70	68	65	76