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Chapter 10

Noise

Contents

Glossary

Term	Definition
A-weighting	A frequency weighting designed to correlate measured sound levels with subjective human response. The human ear is frequency selective and our ears are most sensitive between 500 Hz to 6 kHz, particularly when compared with lower and higher frequencies. The A-weighting applies a frequency correction which reduces the effect of these low and high frequencies on the overall measured level in order to account for the subjective human response at these frequencies.
L_{Aeq}	The A-weighted (see above) equivalent energy average noise level over a given time period.
L_{A90}	The A-weighted noise level exceeded for 90% of the time, often used to describe background or wind turbine noise as it excludes transient noises that affect the LAeq.

List of Abbreviations

Abbreviation	Description
IOA	Institute of Acoustics
BS 5228	BS:5228:2009 +A1:2014, Code of practice for noise and vibration control on construction and open sites (February 2014)
PAN1/2011	Planning Advice Note PAN1/2011, Planning and Noise, Scottish Government (March 2011)
GPG	The IOA document, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Noise from Wind Turbines (May 2013).
ETSU-R-97	ETSU-R-97 The Assessment and Rating of Noise from Wind Farms, Department of Trade and Industry Working Group (September 1996)
CRTN	The Calculation of Road Traffic Noise (CRTN) (Department of Transport, Welsh Office, 1988),
dB	Decibel
m	Metres
ms-1 or m/s	Metres per second
AM	Amplitude Modulation

10.1 STATEMENT OF COMPETENCE

10.1.1 The noise assessment was undertaken by the Hayes McKenzie Partnership Ltd. The lead author is Rob Shepherd (MEng), an associate at Hayes McKenzie, who is a Member of the Institute of Acoustics (MIOA) and has worked in the field of acoustical engineering for over 15 years. Rob has specialised in the field of noise from onshore wind farms and has been involved in work on over 300 wind farm projects also appearing as an expert witness (relating to wind farm noise) in the UK and Ireland. The Hayes McKenzie Partnership Ltd are sponsor members of the Institute of Acoustics (IOA) and members of the Association of Noise Consultants (ANC).

10.2 INTRODUCTION

10.2.1 This chapter considers the potential noise effects of the Proposed Development on residential receptors in terms of the expected noise levels arising from the construction, operation, and decommissioning of the Proposed Development.

10.2.2 Construction and decommissioning noise resulting from the Proposed Development is discussed with reference to BS:5228:2009 +A1:2014,, *Code of practice for noise and vibration control on construction and open sites*.

10.2.3 An operational noise assessment has been performed in accordance with ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*, with reference to the guidance contained within the Institute of Acoustics document, *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* which is endorsed by Scottish Government. The operational noise assessment includes an assessment of cumulative noise impacts with neighbouring wind farm developments.

10.3 LEGISLATION, POLICY AND GUIDANCE

Operational Noise

Planning Advice Note PAN1/2011, Planning and Noise

10.3.1 PAN1/2011 identifies two sources of noise from wind turbines; mechanical noise and aerodynamic noise. It states that "*good acoustical design and siting of turbines is essential to minimise the potential to generate noise*". It refers to the 'web based planning advice' on renewables technologies for onshore wind turbines.

Scottish Government 2014, Web Based Planning Advice, Onshore Wind Turbines

10.3.2 The Web Based Planning Advice (The Scottish Government, 2014) on onshore wind turbines re-iterates the sources of noise as "the mechanical noise produced by the gearbox, generator and other parts of the drive train and the aerodynamic noise produced by the passage of the blades through the air" and that "there has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design". It states that "the Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available". It notes that "this gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions".

10.3.3 It introduces the Institute of Acoustics (IOA) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (GPG), and states that "The Scottish Government accepts that the guide represents current industry good practice".

10.3.4 The accompanying Technical Advice Note to PAN1/2011, *Assessment of Noise*, lists BS 5228, *Noise and Vibration Control on Construction and Open Sites* as being applicable for Environmental Impact Assessment (EIA) and planning purposes.

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

10.3.5 ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*, presents the recommendations of the Working Group on Noise from Wind Turbines, set up in 1993 by the Department of Trade and Industry (DTI) as a result of difficulties experienced in applying the noise guidelines existing at the time to wind farm noise assessments. The group comprised independent experts on wind turbine noise, wind farm developers, DTI personnel and local authority Environmental Health Officers. In September 1996 the Working Group published its findings by way of report ETSU-R-97. This document describes a framework for the measurement of wind farm noise and contains suggested noise limits, which were derived with reference to existing standards and guidance relating to noise emission from various sources.

10.3.6 ETSU-R-97 recommends that, although noise limits should be set relative to existing background and should reflect the variation of both turbine and background noise with wind speed; this can imply very low noise limits in particularly quiet areas, in which case, "*it is not necessary to use a margin above background in such low-noise environments. This would be unduly restrictive on developments which are recognised as having wider global benefits. Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to the wind farm neighbour*."

10.3.7 For day-time periods, the noise limit is 35-40 dB L_{A90} or 5 dB(A) above the 'quiet day-time hours' prevailing background noise, whichever is the greater. The actual value within the 35-40 dB(A) range depends on the number of dwellings in the vicinity; the impact of the limit on the number of kWh generated; and the duration of the level of exposure.

10.3.8 For night-time periods the noise limit is 43 dB L_{A90} or 5 dB(A) above the prevailing night-time hours background noise, whichever is the greater. The 43 dB(A) lower limit is based on an internal sleep disturbance criterion of 35 dB(A) with an allowance of 10 dB(A) for attenuation through an open window and 2 dB(A) subtracted to account for the use of L_{A90} rather the L_{Aeq}.

10.3.9 Residential properties where the occupier has some financial involvement with the wind farm are allowed higher 'financially involved' noise limits where the lower fixed limits (for both the day-time and night-time) are increased to 45 dB L_{A90}.

10.3.10 Where predicted noise levels are low at the nearest residential properties a simplified noise limit can be applied, such that noise is restricted to the minimum ETSU-R-97 level of 35 dB L_{A90} for wind speeds up to 10 m/s when measured at 10 m height. This removes the need for extensive background noise measurements for smaller or more remote schemes.

10.3.11 It is stated that the $L_{A90,10min}$ noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5 dB less than the L_{Aeq} measured over the same period. The $L_{Aeq,t}$ is the equivalent continuous 'A' weighted sound pressure level occurring over the measurement period 't'. It is often used as a description of the average ambient noise level. Use of the L_{A90} descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

10.3.12 ETSU-R-97 also specifies that a penalty should be added to the predicted noise levels, where any tonal component is present. The level of this penalty is described and is related to the level by which any tonal components exceed the threshold of audibility.

10.3.13 With regard to multiple wind farms in a given area, ETSU-R-97 specifies that the absolute noise limits and margins above background should relate to the cumulative impact of all wind turbines in the area contributing to the noise received at the properties in question. Existing wind farms should therefore be included in cumulative predictions of noise level for proposed wind turbines and not considered as part of the prevailing background noise.

A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise

10.3.14 In May 2013, the IOA published *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*, as referred to in the Web Based Planning Advice. This was subsequently endorsed by the Secretary of State for Energy and Climate Change and by the Scottish Ministers. The publication of the Good Practice Guide (GPG) followed a review of current practice carried out for the Department of Energy and Climate Change (DECC) and an IOA discussion document which preceded the GPG.

10.3.15 The GPG includes sections on Context; Background Data Collection; Data Analysis and Noise Limit Derivation; Noise Predictions; Cumulative Issues; Reporting; and Other Matters including Planning Conditions, Amplitude Modulation, Post Completion Measurements and Supplementary Guidance Notes. The Context section states that the guide "*presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine development above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published*". It adds that "*the noise limits in ETSU-R-97 have not been examined as these are a matter for Government*".

10.3.16 As well as expanding on and, in some areas, clarifying issues which are already referred to in ETSU-R-97, additional guidance is provided on noise prediction and a preferred methodology for dealing with wind shear. The guidance within the GPG has been considered and followed for this assessment.

Other Potential Operational Wind Farm Noise Impacts

Tonal Noise

10.3.17 If tonal noise is associated with a sound source it is generally then more noticeable and, in line with other noise guidance that penalises noise which is tonal, a penalty is added to measured wind turbine noise levels if there is tonal noise which is audible at residential properties. In this assessment, it has been assumed that there would be no tonal noise associated with the operation of the wind farm which would give rise to a tonal penalty as set out in ETSU-R-97 as most modern turbines operate without significant tonal noise that would require a penalty according to ETSU-R-97. A penalty is usually included with the planning conditions for wind farms, as that ensures that a tonal penalty is added to measured noise levels before comparing them with the noise limits.

Low Frequency and Infrasound

10.3.18 Work carried out in 2006 to investigate the extent of low frequency and infrasonic noise from three UK wind farms concluded that "*the common cause of complaints associated with noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night*". It is therefore considered that low frequency and infrasound can be scoped out of the assessment.

Amplitude Modulation

10.3.19 The variation in noise level associated with turbine operation, at the rate at which turbine blades pass any fixed point of their rotation (the blade passing frequency), is often referred to as blade swish and Amplitude Modulation or Aerodynamic Modulation (AM). This effect is identified within ETSU-R-97 where it is envisaged that "… modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine... " and that at distances further from the turbine where there are "… more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)". There have been instances where level of AM are higher than this, which results in the noise being perceived as more intrusive (in the same way as tonal content makes the noise more intrusive).

10.3.20 The Department of Energy & Climate Change commissioned a Wind Turbine AM Review report that was published in two phases: Phase 1 in September 2015 and Phase 2 in October 2016 (although the Phase 2 report is dated August 2016). Phase 1 of the report sets out the approach and methodology, and the Phase 2 report includes a

literature review, research into human response to AM, and recommends how excessive AM might be controlled through the use of a planning condition. The report includes recommendations on how AM should be addressed when quantified according to the recommendations of a separate Institute of Acoustics (IOA) working group document, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016).

10.3.21 The AM Review reports recommend a two-tier approach whereby the first tier seeks a reduction in the depth and/or occurrence of AM with a rating level (according to the IOA AMWG method) ≥3 dB. Whether remedial action is required depends on the prevalence of any complaints, and how often AM rating levels ≥3 dB occur. The second tier is that if AM is deemed to be a significant issue, and if nothing can be done to reduce the level of AM, then a penalty scheme has been proposed whereby a penalty ranging from 3 dB (for a rating level of 3 dB) up to a maximum of 5 dB (for a rating level of 10 dB and above) could be added to the measured level before measured levels are compared with the relevant noise limits.

10.3.22 It should be noted that most wind farms operate without significant AM, and that it is not possible to predict the likely occurrence of AM. At the time of writing there has been no official response to those recommendations from the IOA Noise Working group or endorsement from any Scottish Government Minister or Department. The IOA GPG, states that '*the evidence in relation to "Excess" or "other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM*'.

Construction Noise

10.3.23 The Scottish Government's Technical Advice Note, Assessment of Noise, states that, for planning purposes, construction noise should be assessed according to BS 5228:2009+A1:2014, *Noise and Vibration Control on Construction and Open Sites*. The standard provides example criteria for the assessment of the significance of construction noise effects and a method for the prediction of noise levels from construction activities. Two example methods are provided for assessing significance.

10.3.24 The first is based on the use of criteria defined in Department of the Environment Advisory Leaflet (AL) 72, *Noise Control On Building Sites* (1976) which sets a fixed limit of 70 dB(A) in rural suburban and urban areas away from main roads and traffic. Noise levels are generally taken as façade L_{Aeq} values with free-field levels taken to be 3 dB lower, giving an equivalent noise criterion of 67 dB L_{Aeq}.

10.3.25 The second is based on noise change, with a 5 dB increase in overall noise considered to be significant. However, when existing noise levels are low, such as at this site, and construction activities continue for more than one month, minimum criteria are applicable. These are 45, 55 and 65 dB L_{Aeq}, for night-time (2300-0700), evening and weekends, and daytime (0700-1900) including Saturdays (0700-1300) respectively. This is referred to the ABC method in BS 5228-1 and is described at paragraph E.3.2 and Table E.1 of the standard.

10.3.26 Road traffic noise from construction vehicles accessing the site has been assessed by calculating the increase in road traffic noise caused by construction vehicles above that caused by the existing traffic flow. Predictions were undertaken using The Calculation of Road Traffic Noise (CRTN) (Department of Transport, Welsh Office, 1988),

10.3.27 In terms of increases in noise levels for similar sounds, a 10 dB increase is perceived as a doubling of loudness, a 3 dB increase is typically the minimum perceptible for environmental sounds outdoors, and 1 dB is the minimum change in noise level perceptible under laboratory test conditions.

Noise Limits for Existing Wind Farms

10.3.28 There are several existing wind farms within 10 km of the Proposed Development. Each consented development has noise limits set out in their planning conditions. A summary of the operational noise limits for each neighbouring wind farm are set out at Table 10.1 below.

Table 10.1: Nearby Wind Farm Noise Limits

Wind Farm	Day Limits	Night Limits
Lion Hill (same limits apply at all times)	Greater of 40 dB L_{A90} or plus 5 dB above background	Greater of 40 dB L_{A90} or plus 5 dB above background
Clyde	Greater of 40 dB L_{A90} or plus 5 dB above background	Greater of 43 dB L_{A90} or plus 5 dB above background
Clyde Extension (Limits apply to cumulative noise from Clyde and Clyde Extension)	Greater of 40 dB L_{A90} or plus 5 dB above background	Greater of 43 dB L_{A90} or plus 5 dB above background
Crookedstane (same limits apply at all times)	Greater of 40 dB L_{A90} or plus 5 dB above background	Greater of 40 dB L_{A90} or plus 5 dB above background
Harestanes	Greater of 40 dB L_{A90} or plus 5 dB above background	Greater of 43 dB L_{A90} or plus 5 dB above background
Minnygap	Greater of 37.5 dB L_{A90} or plus 5 dB above background	Greater of 43 dB L_{A90} or plus 5 dB above background

10.4 METHOD OF ASSESSMENT

Operational Noise

10.4.1 Operational noise has been assessed by comparing predicted operational noise levels with relevant noise limits based on the noise limits that are already imposed on residential properties in the vicinity of consented wind farm developments, and supplemented by baseline noise monitoring carried out at the nearest residential properties to the Proposed Development.

10.4.2 The lowest noise limit applied to individual neighbouring wind farm developments is 37.5 dB L_{A90} for Minnygap Wind Farm during the daytime, but at all other nearby wind farms the lowest limit is 40 dB $L_{A90.}$ A lower limit of 40 dB L_{A90} is therefore appropriate as being the lowest limit applicable to cumulative noise from all developments. Therefore, if predicted noise levels from the Proposed Development acting alone at noise sensitive receptors are at least 10 dB below this (i.e. 30 dB L_{A90}) then the noise impact can be considered to be negligible. This in line with the IOA GPG, and because a sound that is 10 dB lower than another adds insignificantly to the overall combination of the two sounds.

10.4.3 Where predicted noise levels at noise sensitive receptors from the Proposed Development acting alone are above 30 dB L_{A90} a cumulative assessment will be carried out. The cumulative assessment will include all wind farms within 10 km of the proposed development which have a predicted noise level acting alone of at least 25 dB L_{A90}. Where cumulative predicted noise levels meet 40 dB L_{A90} or plus 5 dB above background limits then the relevant noise limits are met.

10.4.4 Operational noise is assessed against the relevant noise limits. Where the relevant noise limits are met, operational noise levels are determined to be acceptable and therefore **not significant**.

Construction Noise

10.4.5 Daytime construction activities with a duration of one month or longer are assessed against the 65 dB L_{Aeq} noise limit, and if noise levels from predicted construction activities are below this then no significant noise impacts are predicted. Where construction activities have a duration of less than one month, noise levels above 65 dB L_{Aeq} are considered to be acceptable as long as mitigation is implemented to reduce the impact as much as reasonably practicable.

10.4.6 In respect of road traffic noise, a doubling of road traffic would, see a 3 dB increase in noise level at receptor locations above existing road traffic noise levels. It is considered that if road traffic noise increases (predicted using CRTN) during the construction phase are below 3 dB then no significant impacts are predicted, and if the predicted increase is less than 1 dB then no impact is predicted. There will be no impact from road traffic noise during the operational phase of the wind farm as the daily increase in road traffic noise during the operational phase would be less than 1 dB.

Consultation

10.4.7 The Scoping Report described the approach to construction and operational noise. It was agreed by the Environmental Health department of South Lanarkshire Council that construction noise could be scoped out of the EIA report. A detailed construction noise assessment has therefore not been undertaken due to the separation distances between construction activities and residential receptors, although an assessment of the noise impact from construction vehicles on the road network has been presented.

10.4.8 There are potential noise sensitive receptors in both Dumfries & Galloway and South Lanarkshire, and therefore both councils were contacted to agree the operational and construction noise assessment methodologies. Letters were sent by email to the planning officers at each council on 05 February 2020 which included details of the wind farms that would be considered in the cumulative operational noise assessment, a description of how the operational noise assessment would be carried out, including the proposed baseline noise measurement locations and approach to cumulative noise. There are two bothies known as Brattleburn (301571, 606931) and Burlywhag (297114, 600111) which the letters specified would not be considered as noise sensitive receptors. In addition, the letters described that construction noise would be assessed according to BS 5228.

10.4.9 It was confirmed by email on 02 February 2020 that the methodology was acceptable to South Lanarkshire Council, and, similarly, on 25 February 2020 Dumfries & Galloway Council confirmed that they were happy with the approach.

10.5 BASELINE

10.5.1 Baseline noise measurements were undertaken at five residential properties in the vicinity of the Proposed Development to enable operational noise limits to be derived. This section sets out the baseline noise environment at the nearest residential properties to the development, and it is considered that the baseline noise levels presented here are likely to also reasonably represent the future baseline without the Proposed Development.

10.5.2 It was originally proposed that equipment would be installed at Daerhead (296379, 603041), however at the time of the survey, measurements were no longer required at this location as predicted cumulative noise levels had been carried out and were below 35 dB L_{A90} which is below the ETSU-R-97 simplified limit (that applies irrespective of background noise levels). Additional measurements were carried out at Daerbank as agreed between the resident and the Applicant, although the results are not necessarily required for this assessment as this location is sufficiently distant from the Proposed Development. The baseline noise measurement locations are shown at Table 10.2 below and graphically at Figure 10.1.

Table 10.2: Baseline Noise Measurement Locations

Location Name	Easting	Northing
Sweetshaw Foot	298310	609080
Kirkhope Farm	296330	605455
Kirkhope Cleugh Cottage	296661	607203
Blairmack	301289	603152
Daerbank	296539	609817

Baseline Noise Measurement Results

10.5.3 A full description of the baseline noise measurements is included in Appendix 10.1 with the results presented at Table 10.3 and Table 10.4 below.

Table 10.3: Baseline Noise Measurement Results - Night (Prevailing L_{A90})

	Standardised 10 m height wind speed (m/s)									
Location Name	3	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	23	24	26	28	31	33	36	38	39	39
Kirkhope Farm	38	38	38	38	38	39	40	41	43	45
Kirkhope Cleugh Cottage	29	29	30	31	33	35	37	39	42	44
Blairmack	33	34	35	36	37	39	42	45	48	53
Daerbank	33	34	35	36	37	39	41	44	47	51

Table 10.4: Baseline Noise Measurement Results – Quiet Daytime (Prevailing L_{A90})

	Standardised 10 m height wind speed (m/s)									
Location Name	3	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	23	25	27	29	31	34	36	38	40	42
Kirkhope Farm	38	38	38	38	38	39	40	41	42	43
Kirkhope Cleugh Cottage	28	29	30	32	34	36	38	40	43	44
Blairmack	34	34	35	37	39	41	44	46	49	51
Daerbank	33	34	36	37	39	41	43	46	48	51

10.5.4 The results of the baseline noise measurements have been used to derive ETSU-R-97 noise limits which are set at 40 and 43 dB L_{A90} or plus 5 dB above background during the daytime and night-time respectively. The derived noise limits are shown at **Table 10.5** below. Sweetshaw Foot is financially involved with the scheme, and therefore the lower limiting value is increased to 45 dB L_{A90}.

Table 10.5: Derived Noise Limits (L_{A90})

		Standardised 10 m height wind speed (m/s)									
Location Name	Time Period	3	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	Night	45	45	45	45	45	45	45	45	45	45
	Day	45	45	45	45	45	45	45	45	45	47
Kirkhope Farm	Night	43	43	43	43	43	44	45	46	48	50
	Day	43	43	43	43	43	44	45	46	47	48
Kirkhope Cleugh Cottage	Night	43	43	43	43	43	43	43	44	47	49
	Day	40	40	40	40	40	41	43	45	48	49
Blairmack	Night	43	43	43	43	43	44	47	50	53	58
	Day	40	40	40	42	44	46	49	51	54	56
Daerbank	Night	43	43	43	43	43	44	46	49	52	56
	Day	40	40	41	42	44	46	48	51	53	56

10.6 ASSESSMENT OF POTENTIAL EFFECTS

Operational Noise

10.6.1 Operational noise predictions have been carried out according to the methodology described in the IOA GPG, with the full methodology set out in Appendix 10.2. Predictions were carried out for the layout shown at Table 10.**6** below.

Table 10.6**:** Proposed Development Turbine Locations

Turbine ID	Easting	Northing	Turbine ID	Easting	Northing
1	299455	608292	10	298185	605881
2	300111	607970	11	298439	605196
3	299851	607249	12	298839	604642
4	299329	606646	13	299505	604105
5	298901	607099	14	299818	603575
6	299494	605398	15	298729	603082
7	298138	607804	16	297818	603681
8	297970	607086	17	297325	604275
9	298166	606462			

10.6.2 Predictions are based on a candidate wind turbine that fits the dimensions of the Proposed Development; the Siemens Gamesa SG155 turbine with a hub height of 102.5 m. This is not necessarily the turbine that will be installed at the site, but any turbines chosen for the Proposed Development would comply with the noise limits that would be set out in the planning conditions for the site. The candidate turbine sound power level and octave band levels assumed are shown at Table 10.7 below. The predictions are based on sound power levels that are likely to be warranted by the manufacturer with 2 dB added to account for uncertainty.

Table 10.7: Candidate Turbine Sound Power Levels – Siemens Gamesa SG155 102.5 m hub height (dB LWA)

Standardised 10 m height Wind Speed (m/s)	Overall (dB L_{WA})	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
3	95.9	78.4	84.0	87.5	88.5	90.3	89.9	83.7	70.2
4	98.5	81.0	86.6	90.1	91.1	92.9	92.5	86.3	72.8
5	103.8	86.3	91.9	95.4	96.4	98.2	97.8	91.6	78.1
6	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
7	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
8	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
9	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
10	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
11	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0
12	107.7	90.2	95.8	99.3	100.3	102.1	101.7	95.5	82.0

10.6.3 The results of the predictions for the nearest noise sensitive receptors to the Proposed Development, where predicted noise levels from the Proposed Development acting alone are above 25 dB L_{A90}, are shown at Table 10.8 below, and graphically as noise contours at Figure 10.1.

Table 10.8: Operational Noise Predictions for Proposed Development Acting Alone (dB LA90)

Location	Easting	Northing	Standardised 10 m height wind speed (m/s)							
			3	4	5	6	7	8	9	>10
Kirkhope	296337	605455	22	24	30	34	34	34	34	34
Crookburn	296607	605627	23	26	31	35	35	35	35	35
Daerhead	296379	603041	21	23	29	33	33	33	33	33
Kirkhope Cleuch Cottage*	296669	607218	25	28	33	37	37	37	37	37
Sweetshaw Foot	298356	609066	23	26	31	35	35	35	35	35
Daerbank	296580	609796	16	19	24	28	28	28	28	28
Hitteril	296194	609629	16	18	24	28	28	28	28	28
Wintercleugh House	296534	609999	16	18	23	27	27	27	27	27
Rivox	303091	605320	15	18	23	27	27	27	27	27
Mosshope	302268	606965	18	20	26	30	30	30	30	30
Blairmack	301259	603158	20	23	28	32	32	32	32	32
Bracadale	296490	610118	15	18	23	27	27	27	27	27

** Predictions for Kirkhope Cleugh Cottage used a ground factor of G=0 (for the source, middle, and receiver areas) to represent hard ground between source and receiver due to the propagation over Daer Reservoir which can be considered to be propagation over hard ground.*

10.6.4 The results of the predictions indicate that the maximum predicted noise level from the Proposed Development is 37 dB L_{A90}, and that there are 6 locations where predicted noise levels are above 30 dB L_{A90} such that a cumulative noise assessment is required. The cumulative operational noise assessment is presented at section 10.7 below. Predicted noise levels at all noise sensitive receptors are below the 40 and 43 dB L_{A90} daytime and night time lower limiting values (discussed at section 10.4 above), and therefore the **noise impact is considered to be not significant**. **The financially involved noise limits are also met at Sweetshaw Foot**.

Operational Noise at Non-Residential Locations

10.6.5 At this site the Southern Upland Way runs adjacent to the site boundary along the northern edge. Operational noise is normally assessed at residential locations only and the noise limits set out in ETSU-R-97 apply to noise sensitive receptors, and paths and rights of way are not treated as noise sensitive. There is no guidance on allowable operational wind turbine noise levels along rights of way, however there is guidance on noise from surface mineral workings in PAN 50 on footpaths which states that ‘Open spaces which the public uses for relaxation may be considered to be noise-sensitive in some circumstances, for example, if extensively used during likely periods of operation, and if there would be an adverse impact from noise. In such cases, the nominal noise limit should normally be calculated from the perimeter of the area. The limits would not be expected to be as low as at dwellings, and it is suggested that 65 dB $L_{Aeq,1h}$ during the normal working day and 55 dB $L_{Aeq,1h}$ at other times would be reasonable’. It is not considered that a footpath or right of way would normally be considered to be an open space used for relaxation, and therefore the limits described could be considered to be conservative. Nevertheless, as can be seen at Figures 10.1 and 10.2, operational noise levels from the wind farm would not exceed 55 dB L_{Aeq} along the Southern Upland Way, and therefore no significant noise effects are predicted on footpaths and rights of way.

Construction Noise

10.6.6 Detailed construction noise predictions have been scoped out due to the large separation distances between on-site construction activities and noise sensitive residential receptors. It is highly likely that on-site track construction that is further than 200 m from residential properties would be below the 65 dB L_{Aeq} criterion. There is no on-site track construction proposed within 200 m of residential properties. All other on-site construction activities are likely to generate lower levels of noise.

10.6.7 It is possible that blasting would be required at one or more of the four proposed borrow pit locations to extract rock. It is not possible to carry out meaningful predictions as the frequency, duration and noise levels from blasting all depend very much on the type of rock, depth of charge and surrounding ground conditions onsite, together with the amount of rock that is required.

10.6.8 Where highways and cabling works are required along the route to the grid connection point, noise may be generated at times that is above the 65 dB L_{Aeq} proposed criterion, although the duration of the works is likely to be relatively short (i.e. less than one month). Specific predictions of likely noise levels have not been carried out as the likely noise levels are dependent on the specifics of the works required which are not known at this stage.

10.6.9 Road traffic noise predictions have been undertaken by calculating the increase in noise levels generated by the construction traffic along the delivery route. Predictions were undertaken using The Calculation of Road Traffic Noise (CRTN) (Department of Transport, Welsh Office, 1988), and the predicted daily traffic increases detailed at Tables 11.6 and 11.7 of the Traffic and Transport Assessment chapter. The predicted increase in noise level was calculated for the peak of the construction phase, as this is the most intensive month of construction deliveries. The results of the predictions are detailed below at Table 10.9.

Table 10.9: Road Traffic Predicted Increase in Noise Levels

	Existing Baseline Traffic Flow		Baseline + Construction Traffic Flow			
Location	Total Traffic Flow	Total HGV	Total Traffic Flow	Total HGV	Baseline + Construction Traffic Flow	Assessment of Impact
A701 Site Access	4032	635 (16%)	4080	679 (17%)	0.2 dB(A)	No Impact
B7076 Between Junctions 14 and 15	362	88 (24%)	362	88 (24%)	0.0 dB(A)	No Impact
A701 South of Moffat	5186	238 (5%)	5210	238 (5%)	0.0 dB(A)	No Impact
M74 South of Junction 15	36219	7473 (21%)	36231	7493 (21%)	0.0 dB(A)	No Impact
M74 North of Junction 15	32363	8232 (25%)	32375	8240 (25%)	0.0 dB(A)	No Impact

10.6.10 The results of the road traffic noise impact assessment during the peak period of construction indicates a maximum increase in noise levels due to construction traffic of 0.2 dB at properties assessed along the access route. This level of increase is below the level of perception and therefore no impact is predicted. It follows that the construction traffic noise impact is **not significant**.

10.6.11 Noise predictions have not been undertaken for decommissioning activities, but the large separation distance between breaking up of the concreate foundations (likely to be the noisiest activity) and residential properties would result in noise levels at residential properties that are likely to be significantly below the proposed construction noise limit.

10.7 CUMULATIVE EFFECTS

Cumulative Operational Effects

10.7.1 The Proposed Development is within 10 km of 5 wind farm developments, and consideration has been given to the cumulative effects of the following wind farms:

- Lion Hill Wind Farm
  - This is a 4 turbine consent, which has not been built out, close to the north of the Proposed Development Area.
- Clyde Wind Farm
  - Clyde Wind Farm is a 152 turbine operational site, located further to the north of the Proposed Development Area.
- Crookedstane Wind Farm
  - This is another 4 turbine consent, which has not been built out, again located to the north of the Proposed Development Area, and to the west of the Clyde Wind Farm.
- Harestanes Wind Farm
  - Harestanes Wind Farm is a 68 turbine operational site, located to the south east of the Proposed Development Area, being found to the south of the Kinnelhead Land Portion.
- Minnygap Wind Farm
  - Minnygap Wind Farm is a 10 turbine operational site, located again to the south east of the Proposed Development Area on open ground to the east of the Harestanes Wind Farm.

10.7.2 The approach to the cumulative noise assessment was agreed with Dumfries & Galloway and South Lanarkshire Councils whereby nearby wind farms with a predicted noise level of more than 25 dB L_{A90} at any of the noise sensitive receptors would be included in the cumulative noise assessment. Initial predictions were carried out to determine the wind farms to be included in the cumulative assessment, and the following wind farms had a predicted noise level above 25 dB L_{A90}. at a noise sensitive receptor listed at Table 10.11.

- Lion Hill
- Clyde
- Harestanes

10.7.3 Cumulative noise predictions were based on the sound power levels detailed at Table 10.10 below, with the octave band levels normalised to the sound power level at each integer wind speed. The sound power levels used in the predictions are based on data from the manufacturers that is likely to be warranted with 2 dB added. The octave band spectra are presented at Table 10.11 below.

Table 10.10: Turbine Sound Power Levels for Cumulative Schemes (dB L_{WA})

	Wind Farm and Turbine Type		
Standardised 10 m height Wind Speed (m/s)	Lion Hill Siemens SWT-2.3-82 (80 m hub)	Clyde Siemens SWT-2.3-82 (80 m hub)	Harestanes Gamesa G90 (80 m hub)
3	-	94.8	94.8
4	92.3	99.3	99.3
5	100.5	104.1	104.1
6	105.2	108.0	108.0
7	106.5	108.4	108.4
8	106.5	108.4	108.4
9	106.5	108.4	108.4
10	106.5	108.4	108.4
11	106.5	108.4	108.4
12	106.5	108.4	108.4

Table 10.11: Turbine Octave Band Levels for Cumulative Schemes (dB L_{WA})

	Overall	Octave Band Centre Frequency (Hz)							
Wind Farm	(dB L_{WA})	63	125	250	500	1k	2k	4k	8k
Lion Hill	106.5	79.8	89.8	98.5	100.6	100.9	98.3	96.4	90.6
Clyde	108.4	89.4	97.0	102.0	103.8	101.6	97.2	92.0	93.6
Harestanes	108.4	89.4	97.0	102.0	103.8	101.6	97.2	92.0	93.6

10.7.4 The results of the predictions are presented at Table 10.12 below for the 6 residential properties where predicted noise levels from the Proposed Development are above 30 dB L_{A90}. Cumulative noise prediction results are also shown as a noise contour plot at Figure 10.2 for a standardised 10 m height wind speed of 10 m/s,

Table 10.12: Cumulative Operational Noise Prediction Results (dB L_{A90})

			Standardised 10 m height wind speed (m/s)								
Location	Easting	Northing	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	298356	609066	28	34	38	39	39	39	39	39	39
Kirkhope Farm	296337	605455	25	31	35	35	35	35	35	35	35
Kirkhope Cleuch Cottage*	296669	607218	28	33	37	38	38	38	38	38	38
Blairmack	301259	603158	27	32	36	36	36	36	36	36	36
Crookburn	296607	605627	26	32	36	36	36	36	36	36	36
Daerhead	296379	603041	25	30	34	34	34	34	34	34	34

** Predictions for Kirkhope Cleugh Cottage used a ground factor of G=0 (for the source, middle, and receiver areas) to represent hard ground between the Dear wind turbines and the receptor location due to the propagation over Daer Reservoir which can be considered to be propagation over hard ground. For all other wind farms a ground factor of G=0.5 was used.*

10.7.5 The margin between the cumulative predicted noise levels and the day and night noise limits are shown at Table 10.13 and Table 10.14 below. As no baseline noise measurements were carried out at Daerhead or Crookburn, cumulative noise levels have been assessed against the fixed noise limits of 43 dB L_{A90} (at night) and 40 dB L_{A90} (during the daytime) that apply irrespective of baseline noise levels. At all other locations, the predicted cumulative noise levels are assessed against the limits presented at **Table 10.5**.

Table 10.13: Cumulative Operational Noise Margin to Night Limits (dB L_{A90})

	Standardised 10 m height wind speed (m/s)								
Location	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	17	11	7	6	6	6	6	6	6
Kirkhope Farm	18	12	8	9	9	10	11	13	16
Kirkhope Cleuch Cottage	15	10	6	5	5	5	6	9	12
Blairmack	16	11	7	7	8	11	14	17	22
Crookburn	17	11	7	7	7	7	7	7	7
Daerhead	18	13	9	9	9	9	9	9	9

Table 10.14: Cumulative Operational Noise Margin to Daytime Limits (dB L_{A90})

	Standardised 10 m height wind speed (m/s)								
Location	4	5	6	7	8	9	10	11	12
Sweetshaw Foot	17	11	7	6	6	6	6	6	8
Kirkhope Farm	17	12	8	9	9	10	11	12	14
Kirkhope Cleuch Cottage	12	7	3	2	3	6	8	10	12
Blairmack	13	9	6	8	11	13	15	18	20
Crookburn	14	8	4	4	4	4	4	4	4
Daerhead	15	10	6	6	6	6	6	6	6

10.7.6 The results of the cumulative noise assessment show that predicted cumulative operational noise levels are below the relevant noise limits by at least 2 dB. at the assessed locations. At all other noise sensitive properties, predicted noise levels from the Proposed Development are at least 10 dB below the noise limits and therefore no significant cumulative noise effects are predicted.

Cumulative Construction Effects

10.7.7 Construction stage noise effects have been scoped out. No significant cumulative construction impacts are envisaged for on-site construction works as it is very unlikely that there would be any other on-site construction that would cause a breach of the relevant construction noise limits. In terms of off-site construction impacts, the only potential noise impacts would be from cumulative construction road traffic with other developments or infrastructure projects, however the increase in road traffic from construction associated with the Proposed Development is not significant (see section 10.6.10), and it is unlikely that any significant cumulative noise impacts would arise.

10.8 CONCLUSION

10.8.1 An operational noise assessment has been undertaken by comparing predicted noise levels for a candidate turbine for the Proposed Development with the noise limits derived from baseline noise measurements carried out at a number of properties in the vicinity of the Proposed Development. Predicted noise levels are below these noise limits under all wind speed and wind direction conditions, and therefore the operational noise impacts are not significant.

10.8.2 Noise from traffic during the construction and decommissioning phases were assessed against the noise limits set out in BS 5228. Noise from construction activities will be below this noise limit and therefore the noise from such activities is not significant.

10.8.3 The increase in noise levels due to construction traffic accessing the site was assessed by comparing the noise levels generated including the construction traffic with the predicted road traffic noise levels in the absence of construction activities. The predicted increase is less than 1 dB and therefore there will be no perceptible impact.

10.8.4 The cumulative operational noise assessment shows that there are no significant cumulative noise impacts predicted, and no significant cumulative construction noise impacts are expected.