Coille Beith Wind Farm

Technical Appendix 10.2: Noise Modelling and Calculations

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Contents

1. Introduction

1.1.1 This Technical Appendix describes the relevant noise modelling methods and source data used to inform the operational and cumulative operational noise calculations for the noise assessment of the Proposed Development, which forms **Chapter 10** (EIA Report Volume 2).

2. Construction Noise Predictions

2.1 Construction and Modification of Access Tracks

2.1.1 Construction noise calculations are undertaken for the construction of the access track and access track widening. A set of indicative plant items have been assumed for these works. The calculations are based upon the distance between construction works and the relevant noise-sensitive receptors as set out in **Table 2.1**. For most of the construction phase, works will be at greater distances than indicated.

Table 2.1 – Construction Receptor Co-ordinates

Receptor ID	Address	Easting	Northing	Distance to Construction Areas (Approx.)
CR1	Oape, Ardgay, IV24 3DP	245302	900726	204 m to new track centreline
CR2	River House, Strathoykel, Ardgay, IV24 3DP	245499	900883	59 m to new track centreline
CR3	Creagan Cottage, Strathoykel, Ardgay, IV24 3DP	245731	900906	225 m to new track centreline
CR4	1 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	245499	900883	78 m to track widening areas
CR5	2 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	245731	900906	66 m to track widening areas
CR6	3 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	245861	900821	54 m to track widening areas
CR7	4 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238921	900419	43 m to track widening areas
CR8	5 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238915	900408	27 m to track widening areas
CR9	6 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238907	900399	22 m to track widening areas

2.1.2 Calculations are undertaken based on the methods set out in BS 5228[1] Sound power or sound pressure levels of plant items are identified in octave bands from 63 Hz to 8000 Hz. In this case the sound power levels are identified and are presented in **Table 2.2**.

Table 2.2 – Assumed Indicative Construction Plant Items and Sound Pressure Levels at 10 m Distance, dB

Name and BS 5228 Reference	No. Plant Items	On-time	Octave band centre frequency, Hz								Overall A-weighted level
			63	125	250	500	1000	2000	4000	8000	
Dump Truck C.4-1	1	100%	85	80	77	72	74	70	65	58	78
Tracked Excavator 27kW C.5-35	1	100%	82	72	71	69	69	70	61	54	75
Vibratory Roller C.2-39	1	100%	88	83	69	68	67	65	62	59	74
Wheeled Backhoe Loader C.2-8	1	100%	74	66	64	64	63	60	59	50	68

2.1.3 The sound level transmission loss over distance is calculated on the basis of 100% acoustically hard ground (e.g. concrete, water) and 100% acoustically soft ground (e.g. grass), based on the following respective formulae:

Transmissions Loss for Hard Ground = 20 × log(d_2 / d_1)

Transmission Loss for Soft Ground = 25 × log(d_2 / d_1)

where d_1 is the source sound level reference distance (10 m); and

d_2 is the distance between source and receiver.

[1] British Standards Institute (2014). BS 5228:2009+A1:2014, Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. BSI.

2.1.4 A linear interpolation is then applied based on an assumed proportion of hard ground between source and receiver, which in this case is 50%. The transmission loss is then subtracted from the sound levels.

2.1.5 Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation depends on temperature and relative humidity of the air and is frequency dependent, with greater attenuation at higher frequencies. The attenuation depends on distance on a dB per metre basis for each frequency band.

2.1.6 Atmospheric absorption coefficient values are given in **Table 2.3**, corresponding to an assumed temperature of 10 ºC and a relative humidity of 70 %.

Table 2.3 – Frequency-dependent atmospheric absorption coefficients

Atmospheric Absorption	Octave band centre frequency, Hz							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Absorption coefficient, dB/m	0.000122	0.000411	0.00104	0.00193	0.0037	0.00966	0.0328	0.117

2.1.7 For each item of equipment, the atmospheric absorption is calculated for each frequency band and, alongside the sound pressure conversion facto and the distance transmission loss, are subtracted from the relevant specified sound levels for each frequency band, and are then summed together to calculate the total A-weighted sound pressure level at the receiver location.

2.1.8 An on-time correction is then applied on the basis of:

On-time correction = 10 × log(T / T_r)

where T is the duration that the equipment will be operating in a given reference time period; and

T_r is the reference time period.

2.1.9 The total sound pressure levels for all plant items is then logarithmically added together to give the total calculated sound pressure level.

2.1.10 For the widening works, there are six discrete sections of track that require widening, which is anticipated to take 3-weeks. The overall noise level is calculated by identifying the distances between each discrete widening works area and the relevant receptors, and by applying an additional on-time correction to noise levels from each area, based on the proportion of the total combined widening surface area.

2.1.11 Construction noise predictions are set out in **Table 2.4**.

Table 2.4 – Calculated Free-Field Construction Noise Levels

Receptor ID	Distance to Construction Areas (Approx.)	Calculated Noise Level, dB
CR1	204 m to new track centreline	51
CR2	59 m to new track centreline	64
CR3	225 m to new track centreline	50
CR4	78 m to track widening areas	53
CR5	66 m to track widening areas	54
CR6	54 m to track widening areas	56
CR7	43 m to track widening areas	57
CR8	27 m to track widening areas	62
CR9	22 m to track widening areas	63

2.1.12 Average noise levels are reported for the widening works. For the closest works, worst case predicted noise levels would be 67 dB, 72 dB and 74 dB at CR7, CR8 and CR9 respectively, lasting for around two days. Noise levels are predicted to be below 65 dB for the remainder of the works and for all other receptors during all widening works. These levels assume that plant items operate for 100% of the daytime period at the minimum separation distance, which is a conservative assumption.

3. Operational Noise Predictions

3.1 Overview

3.1.1 The noise prediction methodology is based on guidance in ESTU-R-97[2] and the UK Institute of Acoustics (IOA) *Good Practice Guide (GPG) to its use*[3]. These documents detail the assessment and calculation approach for wind farm noise, and advocate for the use of ISO 9613[4] as the basis for the noise predictions, with some specific assumptions and adjustments.

3.1.2 The receptors included in the operational noise assessment are set out in **Table 3.1**.

Table 3.1 – Operational Receptor Co-ordinates

Receptor ID	Address	Easting	Northing
R1	Langwell Beag, Scree Road, Ardgay, IV24 3DP	243459	900708
R2	The Cottage, Langwell, Lairg, IV27 4HE	241582	901064
R3	Langwell Lodge, Langwell, Lairg, IV27 4HE	241644	901013
R4	Lubachoinnich, Croik Manse Road, Ardgay, IV24 3 BS	241481	895426
R5	Lower Brae, Ardgay, IV24 3DP	243682	901030
R6	Brae, Ardgay, IV24 3DP	243607	900999
R7	Keepers Cottage, Oykel Bridge Road, Rosehall, IV27 4BH	239067	900004
R8	Amat Cottage, Oykel Bridge Road, Rosehall, IV27 4BH	239050	900057
R9	1 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238929	900418
R10	2 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238922	900410
R11	3 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238914	900398
R12	4 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238909	900391
R13	5 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238901	900380
R14	6 Oykel Terrace, Oykel Bridge Road, Rosehall, IV27 4BH	238897	900373
R15	Oykel Bridge Hotel, Lairg, IV27 4HE	238465	900911
R16	Old Schoolhouse, Oykel Bridge	237055	901312
R17	Tuiteam, A837, Lairg, IV27 4HE	243610	901465
R18	Tutim Cottage, Lairg, IV27 4HE	243754	901503
R19	Upper Doune, Strathoykel, Ardgay, IV24 3DP	244378	900753
R20	Wester Doune, Strathoykel, Ardgay, IV24 3DP	244339	900893
R21	Wester Doune Cottage, Strathoykel, Ardgay, IV24 3DP	244366	900845
R22	Dr Malone's, Strathoykel, Ardgay, IV24 3DP	244404	900852
R23	Doune Schoolhouse, Doune, Ardgay, IV24 3DP	244490	900796
R24	Doune Mills, Strathoykel, Ardgay, IV24 3DP	244633	900836
R25	Donackgill, Easter Oape, Ardgay, IV24 3DP	244855	900715
R26	The Steading, Strathoykel, Ardgay, IV24 3DP	244914	900764
R27	Moravia, Strathoykel, Ardgay, IV24 3DP	244953	900777
R28	Ghillies View, Strathoykel, Ardgay, IV24 3DP	245079	900781
R29	Carn Mholloch, Strathoykel, Ardgay, IV24 3DP	245118	900739
R30	Bluepool Cottage, Strathoykel, Ardgay, IV24 3DP	245140	900869
R31	Oape, Ardgay, IV24 3DP	245302	900726
R32	River House, Strathoykel, Ardgay, IV24 3DP	245499	900883
R33	Creagan Cottage, Strathoykel, Ardgay, IV24 3DP	245731	900906
R34	Tigh A Rhos, Strathoykel, Ardgay, IV24 3DP	245861	900821
R35	Oykelview, Inveroykel, Ardgay, IV24 3DP	245954	900852
R36	Inveroykel Lodge, Ardgay, IV24 3DP	246490	900881

[2] ETSU-R-97 (1996). The Assessment and Rating of Noise from Wind Farms. MM for the DTI.
[3] Institute of Acoustics (May 2013). A Good Practice Guide to the Application of ETSU R 97 for the Assessment and Rating of Wind Turbine Noise. IOA.
[4] International Organization for Standardization (1993). ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Calculation of the absorption of sound by the atmosphere. ISO.
International Organization for Standardization (2024). ISO 9613-2, Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors. ISO.

3.2 Wind Shear Correction

3.2.1 Wind turbine source sound power levels are typically specified in one of two ways. The first is in terms of 'standardised' 10 m height wind speeds, accounting for the specific hub-height to which the sound power levels relate. In some cases, the sound power levels are specified for a given hub height, but an alternative hub height is proposed or installed. In other cases, the sound power levels are specified based on the hub height wind speeds.

3.2.2 In order to allow like-for-like comparisons and appropriate usage in noise calculations, sound power levels are corrected, where applicable, to reflect the sound power level based on standardised 10 m height wind speeds, with reference to the specific hub height proposed or installed.

3.2.3 The following equation is used for the purpose of this correction:

$$V_{10} = V_h \left(\frac{\ln(\frac{10}{z_0})}{\ln(\frac{h}{z_0})} \right)$$

where: h is the hub height

V_{10} is the 10 m wind speed

V_h is the wind speed at hub height

Z_0 is the ground roughness length, standardised to 0.05 m

3.2.4 As the correction is based on the specific hub height of turbines, this accounts for the fact that different hub height turbines would experience different wind speeds at their hub heights for the same 10 m wind speed conditions. Each turbine model and hub height configuration therefore has a unique derived sound power level specification.

3.3 Details of Cumulative Wind Farms

3.3.1 The turbine sound power levels and turbine co-ordinates adopted for wind farms included in the cumulative operational noise assessment are detailed below.

Sound Power Levels

3.3.2 The sound power levels assumed for each site included in the cumulative assessment are set out below. Each set of data includes the relevant uncertainty (+2 dB) in line with the recommendations of the IOA GPG. In the case of Strath Oykel wind farm, an increased uncertainty uplift of +3.7 dB is applied to account for the potential for the site to fully utilise its consented noise limits.

3.3.3 The wind farms included in the cumulative assessment, along with the installed or proposed turbine model, are set out in **Table 3.2**.

Table 3.2 – Cumulative Wind Farm Developments

Wind Farm	Status	Turbine Make and Model	Hub Height, m	Number of Turbines
Proposed Development	Application	Vestas V172 7.2 MW	114	11
Strath Oykel	Consented	Siemens Gamesa SG155 6.6 MW	122.5	11
Rosehall	Existing	Siemens SWT-1.3-62	59	18
Allt An Tuir	Application	Nordex 163 6.X MW (STE)	118.5	8
			98.5	1

3.3.4 The sound power levels for each turbine type are shown in **Table 3.3**, **Table 3.4** and **Table 3.5** by octave band frequency (63 Hz to 8000 Hz) against wind speed standardised to 10 m height (3 ms^{-1} to 12 ms^{-1}).

Table 3.3 – Vestas V172 7.2 MW – 114 m Hub Height Octave Band Sound Power Levels (dB L_{WA})

Standardised 10 m height wind speed, ms^{-1}	Octave band centre frequency, Hz								Broadband
	63	125	250	500	1000	2000	4000	8000	
3	90.7	93.7	92.4	90.8	91.6	90.2	82.4	69.6	99.6
4	92.0	94.8	93.5	92.0	94.1	92.7	85.2	70.9	101.2
5	93.1	97.1	97.1	96.3	98.7	97.7	92.5	78.8	105.0
6	90.4	97.3	101.0	100.4	102.7	102.5	96.8	83.7	108.5

Standardised 10 m height wind speed, ms^{-1}	Octave band centre frequency, Hz								Broadband
	63	125	250	500	1000	2000	4000	8000	
7	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
8	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
9	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
10	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
11	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
12	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8

3.3.5 Sound power levels for the Vestas V172 at 114 m hub height are taken from Vestas Technical Document DMS no.: 0128 4336_01, dated 29th November 2024, standardised to 10 m based on a hub height of 114 m, plus a 2 dB uncertainty factor.

Table 3.4 – Siemens Gamesa SG155 6.6 MW – 122.5 m Hub Height Octave Band Sound Power Levels (dB L_{WA})

Standardised 10 m height wind speed, ms^{-1}	Octave band centre frequency, Hz								Broadband
	63	125	250	500	1000	2000	4000	8000	
3	76.5	83.9	88.5	90.8	90.6	90.9	84.3	69.3	96.9
4	81.7	89.1	93.7	96.0	95.8	96.1	89.5	74.5	102.1
5	86.5	93.9	98.5	100.8	100.6	100.9	94.3	79.3	106.9
6	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
7	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
8	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
9	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
10	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
11	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7
12	88.3	95.7	100.3	102.6	102.4	102.7	96.1	81.1	108.7

3.3.1 Sound power levels for the Siemens Gamesa SG155 6.6 MW at 122.5 m hub height are taken from Siemens Gamesa Technical Document D2359800/004, dated 29th July 2021, standardised to 10 m based on a hub height of 114 m, plus a 3.7 dB uncertainty factor to bring predicted noise levels for Strath Oykel wind farm up to its consented noise limits.

Table 3.5 – Siemens SWT-1.3-62 – 59 m Hub Height Octave Band Sound Power Levels (dB L_{WA})

Measured 10 m height wind speed, ms^{-1}	Octave band centre frequency, Hz								Broadband
	63	125	250	500	1000	2000	4000	8000	
3	88.1	94.7	97.6	96.7	96.6	96.9	91.3	83.1	104.0
4	88.1	94.7	97.6	96.7	96.6	96.9	91.3	83.1	104.0
5	88.1	94.7	97.6	96.7	96.6	96.9	91.3	83.1	104.0
6	88.1	94.7	97.6	96.7	96.6	96.9	91.3	83.1	104.0
7	88.6	95.2	98.1	97.2	97.1	97.4	91.8	83.6	104.5
8	89.1	95.7	98.6	97.7	97.6	97.9	92.3	84.1	105.0
9	90.4	97.0	99.9	99.0	98.9	99.2	93.6	85.4	106.3
10	91.6	98.2	101.1	100.2	100.1	100.4	94.8	86.6	107.5
11	91.6	98.2	101.1	100.2	100.1	100.4	94.8	86.6	107.5
12	91.6	98.2	101.1	100.2	100.1	100.4	94.8	86.6	107.5

3.3.1 Sound power levels for the Siemens SWT-1.3-62 at 59 m hub height are taken from Siemens Technical Document PG-R-03-10-0000-0061-01, dated 2nd November 2005, which specifies sound power levels for wind speeds of 6 ms^{-1}, 8 ms^{-1} and 10 ms^{-1} as measured at 10 m height. Sound power levels for wind speeds below 6 ms^{-1} are assumed to have the same sound power level as at 6 ms^{-1}, and sound power levels for wind speeds above 10 ms^{-1} are assumed to have the same sound power level as at 10 ms^{-1}, as a worst-case assumption. Sound power levels at 5 ms^{-1} and 7 ms^{-1} are linearly interpolated from adjacent sound power levels. Octave band data are specified for 8 ms^{-1}, and are assumed to be applicable to all wind speeds, normalised to the applicable overall sound power levels. A 2 dB uncertainty factor is added to the values specified or calculated.

Table 3.6 – Nordex N163 6.X MW (STE) – 138 m Hub Height Octave Band Sound Power Levels (dB L_{WA})

Standardised 10 m height wind speed, ms^{-1}	Octave band centre frequency, Hz								Broadband
	63	125	250	500	1000	2000	4000	8000	
3	83.7	87.5	90.4	91.5	91.4	87.4	77.3	55.7	97.2
4	85.7	89.5	92.4	93.5	93.4	89.4	79.3	57.7	99.2
5	90.5	94.3	97.2	98.3	98.2	94.2	84.1	62.5	104.0
6	94.9	98.7	101.6	102.7	102.6	98.6	88.5	66.9	108.4
7	95.1	98.9	101.7	102.8	102.7	98.7	88.7	67.0	108.6
8	95.1	98.9	101.8	102.9	102.8	98.8	88.7	67.1	108.6
9	95.1	98.9	101.8	102.9	102.8	98.8	88.7	67.1	108.6
10	95.1	98.9	101.8	102.9	102.8	98.8	88.7	67.1	108.6
11	95.1	98.9	101.8	102.9	102.8	98.8	88.7	67.1	108.6
12	95.1	98.9	101.8	102.9	102.8	98.8	88.7	67.1	108.6

3.3.2 Octave band sound power levels for the Nordex at 138 m hub height are taken from Nordex technical document reference no.: F008_277_A14_EN Revision 1, dated 8th July 2022. For the calculations, sound power levels are adjusted to equivalent levels standardised to 10 m height based on hub heights of 118.5 m and 98.5 m respectively for the relevant turbines, plus a 2 dB uncertainty factor. Specified levels include contributions to noise for the 31.5 Hz octave band. These levels are not typically included in wind turbine noise predictions, and have been excluded, with remaining levels normalised to retain the specified overall A-weighted levels.

3.3.3 The highest noise levels provided are for Mode 1. However, Nordex technical document reference no.: F008_277_A12_EN Revision 05, dated 18th July 2022 additionally refers to a Mode 0 with overall sound power levels 0.2 dB higher than the overall levels for Mode 1, although no octave band spectra are given for this mode. A uniform uplift of +0.2 dB has been applied to all octave band sound power levels, as a worst-case assumption.

Turbine Co-ordinates

3.3.4 Turbine co-ordinates and hub heights are presented for the Proposed Development, Strath Oykel, Rosehall and Allt An Tuir wind farms in **Table 3.7**, **Table** 3.8 , **Table 3.9 and Table 3.10** respectively.

Table 3.7 – Proposed Development Turbine Co-ordinates

Turbine ID	Easting	Northing	Hub Height (m)
T1	240449	898794	114
T2	239724	898397	114
T3	241190	898516	114
T4	240272	898052	114
T5	240479	897655	114
T6	241117	897309	114
T7	241512	896941	114
T8	242181	897379	114
T9	242675	897758	114
T10	242409	898238	114
T11	242324	898648	114

Table 3.8 – Strath Oykel Turbine Co-ordinates

Turbine ID	Easting	Northing	Hub Height (m)
S1	245075	898603	122.5
S2	244561	898262	122.5
S3	243913	898277	122.5
S4	243499	898501	122.5
S5	244456	898730	122.5
S6	243960	898788	122.5
S7	243527	899002	122.5
S8	245495	898962	122.5
S9	245030	899093	122.5
S10	244572	899232	122.5
S11	244100	899343	122.5

Table 3.9 – Rosehall Turbine Co-ordinates

Turbine ID	Easting	Northing	Hub Height (m)
RH1	249554	904526	59
RH2	248714	905127	59
RH3	248680	904783	59
RH4	248366	904780	59
RH5	249597	904258	59
RH6	248308	904235	59
RH7	248503	904538	59
RH8	248973	904253	59
RH9	249117	904710	59
RH10	249532	903923	59
RH11	249308	904138	59
RH12	250106	903895	59
RH13	249917	904053	59
RH14	249262	904440	59
RH15	248873	904475	59
RH16	248948	904977	59
RH17	248645	904230	59
RH18	249941	904370	59

Table 3.10 – Allt An Tuir Turbine Co-ordinates

Turbine ID	Easting	Northing	Hub Height (m)
AAT1	243190	905539	118.5
AAT2	243663	905278	118.5
AAT3	243868	904889	118.5
AAT4	243243	904835	118.5
AAT5	243404	904338	118.5
AAT6	244247	904540	118.5
AAT7	243850	904065	118.5
AAT8	244537	904183	118.5
AAT9	244755	903776	98.5

3.4 Noise Prediction Methodology

ISO 9613

3.4.1 The ISO 9613 standard is used for predicting sound pressure level for downwind propagation by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors. These are set out in ISO 9613-2 General method of calculation according to the following relevant parameters:

Predicted Octave Band Noise Level = $L_w + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

3.4.2 These factors are discussed in detail below together with an additional term for taking wind direction into account where required. The predicted octave band levels from each turbine are summed together to give the overall 'A' weighted predicted sound level.

L_w – Source Sound Power Level

3.4.3 The sound power level of a noise source is normally expressed in dB re: 1 pW. Noise predictions are based on sound power levels detailed in the noise chapter.

3.4.4 The octave band noise spectra used for the predictions have been taken from the technical specifications of the turbine with the results shown in the noise chapter.

D – Directivity Factor

3.4.5 The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a down wind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment.

A_{geo} – Geometrical Divergence

3.4.6 The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in an attenuation depending on distance according to:

$$A_{geo} = 20 \times \log(d) + 11$$

where d = distance from the turbine.

3.4.7 The wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A_{atm} – Atmospheric Absorption

3.4.8 Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation depends on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with greater attenuation at higher frequencies. The attenuation depends on distance according to:

$$A_{atm} = d \times \alpha$$

where d = distance from the turbine, and

α = atmospheric absorption coefficient in dB/m.

3.4.9 Values of 'α' from ISO 9613 Part 1 *Calculation of the absorption of sound by the atmosphere*, as given in Table 23, correspond to a temperature of 10 ºC and a relative humidity of 70 %, the values specified in the IOA GPG. These values give relatively low levels of atmospheric attenuation and correspondingly worst-case noise predictions.

Table 3.11 – Frequency-Dependent Atmospheric Absorption Coefficients

	Octave band centre frequency, Hz							
	63	125	250	500	1000	2000	4000	8000
Coefficient (α, dB/m)	0.000122	0.000411	0.00104	0.00193	0.0037	0.00966	0.0328	0.117

A_{gr} – Ground Effect

3.4.10 Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depends on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0.0 for 'hard' ground (includes paving, water, ice, concrete & any sites with low porosity) and 1.0 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The IOA GPG states that where wind turbine source noise data includes a suitable allowance for uncertainty, a ground factor of G = 0.5 and a receptor height of 4 m should be used.

A_{bar} – Barrier Attenuation

3.4.11 The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under down wind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU-R-97 concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of sight between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of sight. In this case a correction of 2 dB has been applied where there is no line of sight between the source and the receiver.

A_{misc} – Miscellaneous Other Effects

3.4.12 ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Corrections for Ground Profile and Barriers

3.4.13 Sound propagation across a concave ground profile, for example valleys or where the ground falls away significantly between the turbine and the receptor, incurs an additional correction of +3 dB(A) to the overall A-weighted noise levels. This correction is calculated in order to take account of the reduced ground absorption effects and the potential for multiple reflection paths caused by the concave profile.

3.4.14 A computer programme is used to generate the ground profiles beneath each source-to-receptor path. From these plots it is possible to determine where a correction is appropriate, based upon guidance set out in the IOA GPG.

3.4.15 A mathematical condition is recommended in the IOA GPG for indicating where this correction should be applied:

$$h_m \geq 1.5 \times \left(\frac{abs(h_s - h_r)}{2}\right)$$

where h_m is the mean height above ground along the direct path between the source and the receptor,

h_s is the absolute source height above ground level, and

h_r is the absolute receptor height above ground level.

3.4.16 Whilst this condition is useful at highlighting where the ground profile beneath a source-to-receptor path may be concave, it can produce false positives. It should therefore be used in conjunction with a visual assessment of the ground profile when determining whether a correction should be applied. Concave ground effects are limited to 2000 m, beyond which distance such effects are not anticipated to occur.

3.4.17 This condition was not met for any turbine-receptor propagation path. The applicable propagation corrections are shown for the Proposed Development in **Table 3.12** and **Table 3.13**, for Strath Oykel wind farm in **Table 3.14** and **Table 3.15**, for Rosehall wind farm in **Table 3.16** and Error! Reference source not found., and for Allt An Tuir wind farm in **Table 3.18** and **Table 3.19**.

Table 3.12 – Ground Profile and Barrier Corrections for the Proposed Development, R1 to R18

Turbine ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
T1	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T2	-2	0	0	-2	0	-2	0	0	0	0	0	0	0	0	0	0	0	0
T3	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T4	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T5	0	0	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0
T6	0	0	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
T7	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
T8	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
T9	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
T10	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
T11	0	0	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0

Table 3.13 – Ground Profile and Barrier Corrections for the Proposed Development, R19 to R36

Turbine ID	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
T1	0	-2	0	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0
T2	0	-2	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0
T3	0	-2	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0
T4	0	-2	0	0	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0
T5	0	-2	0	-2	0	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0
T6	0	-2	0	-2	0	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0
T7	0	0	0	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0	0	0	0	0
T8	0	0	0	-2	0	-2	-2	-2	-2	0	0	-2	0	0	0	0	0	0
T9	0	0	0	0	0	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0
T10	0	0	0	0	0	-2	0	-2	-2	0	0	0	0	0	0	0	0	0
T11	0	0	0	0	0	-2	0	-2	-2	0	0	0	0	0	0	0	0	0

Table 3.14 – Ground Profile and Barrier Corrections for Strath Oykel, R1 to R18

Turbine ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
S1	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
S2	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
S3	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
S4	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
S5	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
S6	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
S7	0	-2	-2	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0
S8	0	0	0	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
S9	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
S10	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0
S11	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0

Table 3.15 – Ground Profile and Barrier Corrections for Strath Oykel, R19 to R36

Turbine ID	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
S1	0	0	0	-2	-2	-2	0	-2	-2	0	0	0	0	0	0	0	0	0
S2	0	0	0	0	-2	-2	0	-2	-2	0	0	-2	0	0	0	0	0	0
S3	0	0	0	0	-2	-2	0	-2	-2	0	0	-2	0	0	0	0	0	0
S4	0	0	0	0	0	-2	0	-2	-2	0	0	0	0	0	0	0	0	0
S5	0	0	0	0	-2	-2	0	0	-2	0	0	0	0	0	0	0	0	0
S6	0	0	0	0	0	-2	0	0	-2	0	0	0	0	0	0	0	0	0
S7	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0
S8	-2	0	0	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
S9	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0
S10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.16 – Ground Profile and Barrier Corrections for Rosehall, R1 to R18

Turbine ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
RH1	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH2	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH3	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH4	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH5	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH6	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH7	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH8	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH9	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH10	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH11	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH12	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH13	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH14	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH15	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH16	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH17	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
RH18	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

Table 3.17 – Ground Profile and Barrier Corrections for Rosehall, R19 to R36

Turbine ID	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
RH1	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
RH2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0
RH3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0	0	0	0	0
RH4	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0
RH5	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
RH6	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0	0	0	0	0
RH7	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0
RH8	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
RH9	-2	-2	-2	-2	-2	-2	0	-2	-2	0	0	-2	0	0	0	0	0	0
RH10	0	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RH11	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
RH12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RH13	0	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RH14	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0
RH15	-2	-2	-2	-2	-2	-2	0	-2	-2	0	0	-2	0	0	0	0	0	0
RH16	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0	0	0	0	0
RH17	-2	-2	-2	-2	-2	-2	0	-2	-2	0	0	-2	0	0	0	0	0	0
RH18	0	-2	-2	-2	0	-2	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.18 – Ground Profile and Barrier Corrections for Allt An Tuir, R1 to R18

Turbine ID	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
AAT1	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT2	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT3	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT4	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT5	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	0	-2	-2	-2	-2
AAT6	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT7	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	0	0	-2	-2	-2	-2
AAT8	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT9	0	-2	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

Table 3.19 – Ground Profile and Barrier Corrections for Allt An Tuir, R19 to R36

Turbine ID	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
AAT1	0	0	0	0	0	-2	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2
AAT2	0	0	0	-2	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
AAT3	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2
AAT4	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2
AAT5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2
AAT6	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2
AAT7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2
AAT8	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2
AAT9	0	0	0	0	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2

3.5 Noise Prediction Results

3.5.1 Prediction noise levels for each individual cumulative wind farm are presented in **Table 3.20** to

3.5.2 **Table** 3.23.

Table 3.20 – Proposed Development Predicted Downwind Operational Noise Levels, dB L_{A90}

Location	Standardised 10 m Height Wind Speed (ms-1)									
	3	4	5	6	7	8	9	10	11	12
R1	23.9	25.1	27.6	29.2	31.1	31.1	31.1	31.1	31.1	31.1
R2	24.2	25.4	27.9	29.7	31.5	31.5	31.5	31.5	31.5	31.5
R3	24.0	25.2	27.7	29.4	31.3	31.3	31.3	31.3	31.3	31.3
R4	25.9	27.2	29.9	32.1	33.8	33.8	33.8	33.8	33.8	33.8
R5	22.8	24.1	26.4	27.9	29.7	29.7	29.7	29.7	29.7	29.7
R6	22.9	24.1	26.5	28.0	29.9	29.9	29.9	29.9	29.9	29.9
R7	25.8	27.0	29.7	31.8	33.5	33.5	33.5	33.5	33.5	33.5
R8	25.6	26.8	29.4	31.5	33.3	33.3	33.3	33.3	33.3	33.3
R9	24.3	25.5	28.0	29.9	31.7	31.7	31.7	31.7	31.7	31.7
R10	24.3	25.5	28.0	29.9	31.7	31.7	31.7	31.7	31.7	31.7
R11	24.3	25.5	28.0	29.9	31.7	31.7	31.7	31.7	31.7	31.7
R12	24.3	25.5	28.1	29.9	31.7	31.7	31.7	31.7	31.7	31.7
R13	24.3	25.5	28.1	29.9	31.7	31.7	31.7	31.7	31.7	31.7
R14	24.3	25.6	28.1	30.0	31.8	31.8	31.8	31.8	31.8	31.8
R15	22.7	23.9	26.2	27.7	29.5	29.5	29.5	29.5	29.5	29.5
R16	19.9	21.1	23.2	24.0	25.9	25.9	25.9	25.9	25.9	25.9
R17	22.0	23.2	25.5	26.8	28.7	28.7	28.7	28.7	28.7	28.7
R18	21.8	23.0	25.2	26.5	28.3	28.3	28.3	28.3	28.3	28.3
R19	22.3	23.5	25.8	27.2	29.1	29.1	29.1	29.1	29.1	29.1
R20	21.4	22.6	24.9	26.3	28.2	28.2	28.2	28.2	28.2	28.2
R21	22.1	23.4	25.6	27.0	28.9	28.9	28.9	28.9	28.9	28.9
R22	21.5	22.7	25.0	26.4	28.3	28.3	28.3	28.3	28.3	28.3
R23	21.9	23.1	25.4	26.7	28.6	28.6	28.6	28.6	28.6	28.6
R24	20.4	21.6	23.8	25.0	26.9	26.9	26.9	26.9	26.9	26.9
R25	20.8	22.0	24.3	25.5	27.4	27.4	27.4	27.4	27.4	27.4
R26	19.6	20.8	23.0	24.2	26.1	26.1	26.1	26.1	26.1	26.1
R27	19.3	20.5	22.7	23.9	25.7	25.7	25.7	25.7	25.7	25.7
R28	20.7	21.9	24.2	25.3	27.2	27.2	27.2	27.2	27.2	27.2
R29	20.8	22.1	24.3	25.4	27.3	27.3	27.3	27.3	27.3	27.3
R30	20.5	21.7	23.9	24.9	26.8	26.8	26.8	26.8	26.8	26.8
R31	20.8	22.0	24.2	25.2	27.1	27.1	27.1	27.1	27.1	27.1
R32	20.3	21.5	23.6	24.6	26.5	26.5	26.5	26.5	26.5	26.5
R33	19.9	21.1	23.2	24.1	26.0	26.0	26.0	26.0	26.0	26.0
R34	19.8	21.0	23.1	23.9	25.8	25.8	25.8	25.8	25.8	25.8
R35	19.6	20.9	22.9	23.7	25.6	25.6	25.6	25.6	25.6	25.6
R36	18.8	20.0	22.1	22.7	24.5	24.5	24.5	24.5	24.5	24.5

Table 3.21 – Strath Oykel Predicted Downwind Operational Noise Levels, dB LA90

Location	Standardised 10 m Height Wind Speed (ms-1)									
	3	4	5	6	7	8	9	10	11	12
R1	23.4	28.6	33.4	35.2	35.2	35.2	35.2	35.2	35.2	35.2

Location	Standardised 10 m Height Wind Speed (ms^{-1})									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
R2	15.4	20.6	25.4	27.2	27.2	27.2	27.2	27.2	27.2	27.2
R3	15.7	20.9	25.7	27.5	27.5	27.5	27.5	27.5	27.5	27.5
R4	11.8	17.0	21.8	23.6	23.6	23.6	23.6	23.6	23.6	23.6
R5	21.9	27.1	31.9	33.8	33.8	33.8	33.8	33.8	33.8	33.8
R6	22.1	27.3	32.0	33.9	33.9	33.9	33.9	33.9	33.9	33.9
R7	9.2	14.4	19.1	21.0	21.0	21.0	21.0	21.0	21.0	21.0
R8	9.1	14.3	19.1	20.9	20.9	20.9	20.9	20.9	20.9	20.9
R9	8.9	14.1	18.9	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R10	8.9	14.1	18.9	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R11	8.9	14.1	18.9	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R12	8.9	14.1	18.9	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R13	8.9	14.1	18.9	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R14	8.9	14.1	18.8	20.7	20.7	20.7	20.7	20.7	20.7	20.7
R15	8.5	13.7	18.5	20.4	20.4	20.4	20.4	20.4	20.4	20.4
R16	6.2	11.4	16.2	18.1	18.1	18.1	18.1	18.1	18.1	18.1
R17	19.8	25.0	29.8	31.6	31.6	31.6	31.6	31.6	31.6	31.6
R18	19.8	25.0	29.7	31.6	31.6	31.6	31.6	31.6	31.6	31.6
R19	24.1	29.3	34.1	35.9	35.9	35.9	35.9	35.9	35.9	35.9
R20	23.3	28.5	33.3	35.2	35.2	35.2	35.2	35.2	35.2	35.2
R21	23.6	28.8	33.6	35.5	35.5	35.5	35.5	35.5	35.5	35.5
R22	23.4	28.5	33.3	35.2	35.2	35.2	35.2	35.2	35.2	35.2
R23	23.2	28.4	33.2	35.0	35.0	35.0	35.0	35.0	35.0	35.0
R24	22.7	27.9	32.7	34.5	34.5	34.5	34.5	34.5	34.5	34.5
R25	24.2	29.4	34.2	36.0	36.0	36.0	36.0	36.0	36.0	36.0
R26	23.5	28.7	33.4	35.3	35.3	35.3	35.3	35.3	35.3	35.3
R27	23.1	28.3	33.0	34.9	34.9	34.9	34.9	34.9	34.9	34.9
R28	23.5	28.7	33.4	35.3	35.3	35.3	35.3	35.3	35.3	35.3
R29	23.6	28.8	33.6	35.5	35.5	35.5	35.5	35.5	35.5	35.5
R30	22.7	27.9	32.7	34.5	34.5	34.5	34.5	34.5	34.5	34.5
R31	23.4	28.6	33.4	35.2	35.2	35.2	35.2	35.2	35.2	35.2
R32	22.1	27.3	32.1	34.0	34.0	34.0	34.0	34.0	34.0	34.0
R33	21.5	26.7	31.5	33.3	33.3	33.3	33.3	33.3	33.3	33.3
R34	21.6	26.7	31.5	33.4	33.4	33.4	33.4	33.4	33.4	33.4
R35	21.2	26.4	31.1	33.0	33.0	33.0	33.0	33.0	33.0	33.0
R36	19.5	24.7	29.4	31.3	31.3	31.3	31.3	31.3	31.3	31.3

Table 3.22 – Rosehall Predicted Downwind Operational Noise Levels, dB LA90

Location	Standardised 10 m Height Wind Speed (ms $^{-1}$)									
	3	4	5	6	7	8	9	10	11	12
R1	18.4	18.4	18.4	18.4	18.9	19.4	20.7	21.9	21.9	21.9
R2	16.0	16.0	16.0	16.0	16.5	17.0	18.2	19.5	19.5	19.5
R3	16.0	16.0	16.0	16.0	16.5	17.0	18.3	19.5	19.5	19.5
R4	11.4	11.4	11.4	11.4	11.9	12.4	13.6	14.9	14.9	14.9
R5	19.1	19.1	19.1	19.1	19.6	20.1	21.4	22.6	22.6	22.6
R6	19.0	19.0	19.0	19.0	19.5	20.0	21.2	22.5	22.5	22.5
R7	14.3	14.3	14.3	14.3	14.8	15.3	16.6	17.8	17.8	17.8
R8	14.3	14.3	14.3	14.3	14.8	15.3	16.6	17.8	17.8	17.8
R9	12.4	12.4	12.4	12.4	12.9	13.4	14.6	15.9	15.9	15.9
R10	12.3	12.3	12.3	12.3	12.8	13.3	14.6	15.8	15.8	15.8
R11	12.3	12.3	12.3	12.3	12.8	13.3	14.6	15.8	15.8	15.8
R12	12.3	12.3	12.3	12.3	12.8	13.3	14.6	15.8	15.8	15.8
R13	12.3	12.3	12.3	12.3	12.8	13.3	14.6	15.8	15.8	15.8
R14	12.3	12.3	12.3	12.3	12.8	13.3	14.6	15.8	15.8	15.8
R15	12.1	12.1	12.1	12.1	12.6	13.1	14.3	15.6	15.6	15.6
R16	10.7	10.7	10.7	10.7	11.2	11.7	13.0	14.2	14.2	14.2
R17	19.4	19.4	19.4	19.4	19.9	20.4	21.7	22.9	22.9	22.9
R18	19.7	19.7	19.7	19.7	20.2	20.7	22.0	23.2	23.2	23.2
R19	20.4	20.4	20.4	20.4	20.9	21.4	22.6	23.9	23.9	23.9
R20	20.2	20.2	20.2	20.2	20.7	21.2	22.4	23.7	23.7	23.7
R21	20.1	20.1	20.1	20.1	20.6	21.1	22.4	23.6	23.6	23.6
R22	20.2	20.2	20.2	20.2	20.7	21.2	22.5	23.7	23.7	23.7
R23	20.6	20.6	20.6	20.6	21.1	21.6	22.9	24.1	24.1	24.1
R24	20.8	20.8	20.8	20.8	21.3	21.8	23.1	24.3	24.3	24.3
R25	22.0	22.0	22.0	22.0	22.5	23.0	24.3	25.5	25.5	25.5
R26	21.8	21.8	21.8	21.8	22.3	22.8	24.1	25.3	25.3	25.3
R27	21.9	21.9	21.9	21.9	22.4	22.9	24.2	25.4	25.4	25.4
R28	22.5	22.5	22.5	22.5	23.0	23.5	24.7	26.0	26.0	26.0
R29	22.8	22.8	22.8	22.8	23.3	23.8	25.1	26.3	26.3	26.3
R30	22.4	22.4	22.4	22.4	22.9	23.4	24.6	25.9	25.9	25.9
R31	23.4	23.4	23.4	23.4	23.9	24.4	25.6	26.9	26.9	26.9
R32	24.0	24.0	24.0	24.0	24.5	25.0	26.2	27.5	27.5	27.5
R33	24.4	24.4	24.4	24.4	24.9	25.4	26.6	27.9	27.9	27.9
R34	24.4	24.4	24.4	24.4	24.9	25.4	26.7	27.9	27.9	27.9
R35	24.7	24.7	24.7	24.7	25.2	25.7	26.9	28.2	28.2	28.2
R36	25.6	25.6	25.6	25.6	26.1	26.6	27.8	29.1	29.1	29.1

Table 3.23 – Allt An Tuir Predicted Downwind Operational Noise Levels, dB LA90

Location	Standardised 10 m Height Wind Speed (ms[1])									
	3	4	5	6	7	8	9	10	11	12
R1	17.2	19.0	23.4	27.8	28.6	28.6	28.6	28.6	28.6	28.6
R2	14.2	16.0	20.4	24.8	25.6	25.6	25.6	25.6	25.6	25.6
R3	14.1	16.0	20.4	24.8	25.5	25.5	25.5	25.5	25.5	25.5
R4	5.0	6.8	11.2	15.6	16.4	16.4	16.4	16.4	16.4	16.4
R5	18.3	20.1	24.5	28.9	29.7	29.7	29.7	29.7	29.7	29.7
R6	18.1	19.9	24.4	28.7	29.5	29.5	29.5	29.5	29.5	29.5
R7	11.1	12.9	17.3	21.7	22.5	22.5	22.5	22.5	22.5	22.5
R8	11.1	12.9	17.4	21.7	22.5	22.5	22.5	22.5	22.5	22.5
R9	9.4	11.2	15.6	20.0	20.8	20.8	20.8	20.8	20.8	20.8
R10	9.3	11.2	15.6	20.0	20.7	20.7	20.7	20.7	20.7	20.7
R11	9.3	11.1	15.6	19.9	20.7	20.7	20.7	20.7	20.7	20.7
R12	9.3	11.1	15.6	19.9	20.7	20.7	20.7	20.7	20.7	20.7
R13	9.6	11.4	15.9	20.2	21.0	21.0	21.0	21.0	21.0	21.0
R14	9.9	11.7	16.2	20.5	21.3	21.3	21.3	21.3	21.3	21.3
R15	9.2	11.1	15.5	19.9	20.7	20.6	20.6	20.6	20.6	20.6
R16	7.6	9.4	13.9	18.2	19.0	19.0	19.0	19.0	19.0	19.0
R17	17.8	19.6	24.1	28.4	29.2	29.2	29.2	29.2	29.2	29.2
R18	18.0	19.9	24.3	28.6	29.4	29.4	29.4	29.4	29.4	29.4
R19	17.4	19.2	23.7	28.0	28.8	28.8	28.8	28.8	28.8	28.8
R20	17.9	19.7	24.1	28.5	29.3	29.3	29.3	29.3	29.3	29.3
R21	17.7	19.5	23.9	28.3	29.1	29.1	29.1	29.1	29.1	29.1
R22	17.6	19.4	23.8	28.2	29.0	29.0	29.0	29.0	29.0	29.0
R23	17.5	19.3	23.8	28.1	28.9	28.9	28.9	28.9	28.9	28.9
R24	17.4	19.2	23.6	28.0	28.8	28.8	28.8	28.8	28.8	28.8
R25	17.1	18.9	23.3	27.7	28.5	28.5	28.5	28.5	28.5	28.5
R26	17.2	19.0	23.5	27.8	28.6	28.6	28.6	28.6	28.6	28.6
R27	17.1	18.9	23.4	27.7	28.5	28.5	28.5	28.5	28.5	28.5
R28	17.1	18.9	23.3	27.6	28.4	28.5	28.5	28.5	28.5	28.5
R29	16.9	18.7	23.1	27.5	28.3	28.3	28.3	28.3	28.3	28.3
R30	16.0	17.8	22.2	26.5	27.3	27.4	27.4	27.4	27.4	27.4
R31	16.7	18.5	22.9	27.3	28.1	28.1	28.1	28.1	28.1	28.1
R32	15.6	17.4	21.9	26.2	27.0	27.0	27.0	27.0	27.0	27.0
R33	14.9	16.7	21.1	25.4	26.3	26.3	26.3	26.3	26.3	26.3
R34	15.0	16.8	21.3	25.6	26.4	26.4	26.4	26.4	26.4	26.4
R35	14.5	16.3	20.7	25.0	25.8	25.9	25.9	25.9	25.9	25.9
R36	13.8	15.6	20.0	24.4	25.2	25.2	25.2	25.2	25.2	25.2