14. Noise

14.1. Introduction

14.1.1. This chapter of the EIA Report evaluates the effects of noise from the Proposed Development on nearby noise-sensitive receptors during construction, operation and decommissioning. The aim of this assessment is to predict the levels of noise potentially produced by the Proposed Development at the nearest noise sensitive receptors and assess these against relevant standards and guidelines.

14.1.2. This chapter is structured as follows:

- Legislation, policy and guidance;
- Assessment methodology and significance criteria;
- Scoping responses and consultation;
- Baseline conditions;
- Assessment of potential effects;
- Mitigation and residential effects; and
- Summary.

14.1.3. The assessment of potential effects also includes an assessment cumulative effects.

14.1.4. This chapter is supported by the following appendices:

- **Confidential Appendix 14.1**: Performance Specification V117-4.0/4.2 MW 50/60 Hz Strong Wind
- **Appendix 14.2**: Survey Record Sheets
- **Appendix 14.3**: Calibration Certificates

14.1.5. Appendix 14.1 consists of the candidate wind turbine manufacturer's specification document which is currently restricted by Vestas for wider circulation. This document will be provided to the Council's Environmental Health Officer as a separate hard copy confidential appendix.

14.2. Legislation, Policy and Guidance

Construction Noise

14.2.1. The following legislation, guidance and standards are of particular relevance to construction noise:

- The Control of Pollution Act 1974 (CoPA 1974)[1];
- The Environmental Protection Act 1990 (EPA 1990)[2]; and
- BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites.

[1] UK Government (1974) Control of Pollution Act 1974 [Online] Available at: https://www.legislation.gov.uk/ukpga/1974/40 (Accessed 16/11/18)
[2] UK Government (1990) Environmental Protection Act 1990 [Online] Available at: http://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 16/11/18)

The Control of Pollution Act 1974 (CoPA 1974)

14.2.2. CoPA 1974 provides Local Authorities with powers to control noise and vibration from construction sites.

14.2.3. Section 60 of the CoPA 1974 enables a Local Authority to serve a notice to persons carrying out construction work of its requirements for the control of site noise. This may specify plant or machinery that is or is not to be used; the hours during which construction work may be carried out; the level of noise or vibration that may be emitted; and provide for changes in circumstances. Appeal procedures are available.

14.2.4. Section 61 of the CoPA 1974 allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works. This is not mandatory but is often advantageous for the developer, as once consent is issued, the Local Authority is no longer able to take action under Section 60 of CoPA 1974 or Section 80 of the EPA 1990, provided the works are carried out in accordance with the Section 61 consent. It does not, however, prevent nuisance action under Section 82 of the EPA 1990. The Application is expected to give as much detail as possible about the works to be carried out, the methods to be used, and the measures that will be taken to minimise noise and vibration.

The Environmental Protection Act 1990 (EPA 1990)

14.2.5. The EPA 1990 specifies mandatory powers available to Local Authorities in respect of any noise that either constitutes or is likely to cause a statutory nuisance, which is also defined in the CoPA 1974. A duty is imposed on Local Authorities to carry out inspections to identify statutory nuisances and to serve abatement notices against these. Procedures are also specified with regards to complaints from persons affected by a statutory nuisance.

BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites

14.2.6. BS 5228:2009+A1:2014 (BS 5228) refers to the need for the protection against noise and vibration of persons living and working in the vicinity of, and those working on, construction and open sites. It recommends procedures for noise and vibration control in respect of construction operations. The standard is published in two parts: Part 1- Noise and Part 2- Vibration. The discussion below relates mainly to Part 1- Noise; however, the recommendations of Part 2 in terms of vibration are broadly very similar.

14.2.7. The standard stresses the importance of community relations and states that early establishment and maintenance of these relations throughout the carrying out of site operations will go some way towards allaying people's concerns. In terms of neighbourhood nuisance, the following factors are likely to affect the acceptability of construction noise:

- site location relative to the noise sensitive premises;
- existing ambient noise levels;
- duration of site operations;
- hours of work;

- the attitude of local residents to the site operator; and
- the characteristics of the noise produced.

14.2.8. Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the operation.

14.2.9. Measures to control noise are described, including:

- control of noise at source by, e.g.:
  - substitution of plant or activities by less noisy ones;
  - modification of plant or equipment to reduce noise emissions;
  - the use of noise control enclosures;
  - the siting of equipment and its method of use;
  - equipment maintenance; and
- controlling the spread of noise, e.g. by increasing the distance between plant and noise-sensitive premises or by the provision of acoustic screening.

14.2.10. The standard also includes a discussion of noise control targets and example criteria for the assessment of the significance of noise effects. These are not mandatory.

Operational Noise

14.2.11. The following guidance, legislation and information sources have been considered in carrying out this assessment:

- The Scottish Government's web-based planning information on onshore wind turbines (last updated May, 2014)[3];
- Planning Advice Note 1/2011 (PAN1/2011): Planning and Noise[4];
- ETSU-R-97: The Assessment and Rating of Noise from Wind Farms[5];
- Dumfries and Galloway Council Local Development Plan: Supplementary Guidance Part 1: Wind Energy Development[6];
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise[7];
- 'The measurement of low frequency noise at three UK wind farms', Hayes McKenzie, The Department for Trade and Industry, URN 06/1412, 2006[8]; and
- 'Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007[9].

[3] Scottish Government Online Guidance – Onshore Wind Turbines, May 2014 http://www.gov.scot/Resource/0045/00451413.pdf

[4] Planning Advice Note 1/2011: Planning and Noise, The Scottish Government, March 2011.

[5] ETSU-R-97 (1996) The Assessment and Rating of Noise from Wind Farms, ETSU: DTI.

[6] Dumfries and Galloway Council Local Development Plan: Supplementary Guidance Part 1 Wind Energy Development: Development Management Considerations June 2017.

[7] A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind turbine Noise, IOA, 2013.

[8] The measurement of low frequency noise at three UK wind farms', Hayes McKenzie, The Department for Trade and Industry, URN 06/1412, 2006

[9] Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.

Scottish Government Planning Information on Onshore Wind

14.2.12. The Scottish Government has published web-based information which provides advice to local authorities on the planning issues associated with wind farm development. With respect to noise from wind farms, it states that ETSU-R-97: The Assessment and Rating of Noise from Wind Farms:

"...describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to asses and rate noise from wind energy developments, until such time as an update is available. 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."

14.2.13. With regard to current best practice guidance, it is stated that:

"The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice"

14.2.14. The information goes on to refer to PAN 1/2011 as providing advice on the role of the planning system in controlling noise and states that the associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.

PAN 1/2011: Planning and Noise

14.2.15. PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. It promotes the principles of good acoustic design and the appropriate location of new potentially noisy development. An associated Technical Advice Note offers advice on the assessment of noise impact and includes details of the legislation, technical standards and codes of practice appropriate to specific noise issues.

14.2.16. Appendix 1 of the Technical Advice Note: Assessment of Noise describes the use of ETSU-R-97 in the assessment of wind turbine noise.

ETSU-R-97

14.2.17. ETSU-R-97 provides a framework for the assessment and rating of noise from wind turbine installations. It has become the accepted standard for wind farm developments in the UK, and the methodology has been adopted for the present assessment.

14.2.18. Both background noise and noise from wind turbines typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.

14.2.19. ETSU-R-97 specifies the use of the $LA_{90,10min}$ descriptor for both background and wind turbine noise. Therefore, unless otherwise specified, all references to noise levels within this chapter relate to this descriptor. Similarly, all wind speeds referred to relate to a height of 10 m above ground level (AGL) at the location of the Proposed Development, standardised in accordance with current good practice guidance or BS:EN (IEC) 61400-11:2003[10], as appropriate, unless otherwise stated.

14.2.20. The document recommends the application of external noise limits at the nearest noise-sensitive properties to protect outside amenity and prevent sleep disturbance inside dwellings. These limits take the form of a 5 dB margin above the prevailing background noise level, except where background noise levels are lower than certain thresholds, where fixed lower limits apply. Separate limits apply for quiet daytime and night-time periods, as outlined below.

14.2.21. During daytime, the guidance specifies limits designed to protect the amenity of residents whilst enjoying the external garden areas of their properties. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ESTU-R-97 as:

- 18:00 – 23:00 every day;
- 13:00 – 18:00 on Saturday; and
- 07:00 – 18:00 on Sundays.

14.2.22. ETSU-R-97 recommends that the fixed lower noise limit for daytime should be set within the range 35 to 40 dB, $L_{A90,10min}$, with choice of value dependent on the following factors:

- the number of dwellings in the neighbourhood of the Proposed Development;
- the effect of the noise limits on the number of kWh (kiloWatt hours) generated; and
- the duration and level of exposures.

14.2.23. Different standards apply at night, where potential sleep disturbance is the primary concern, rather than the requirement to protect outdoor amenity. Night-time is considered to be all periods between 23:00 and 07:00. A limit of 43 dB(A) is recommended at night at wind speeds or locations where the prevailing wind speed-related night-time background noise level is lower than 38 dB(A). At other times, the limit of 5 dB above the prevailing wind speed-related background noise level applies. The value of night-time fixed lower limit was selected in order to ensure that internal noise levels remained below those considered to have the potential to cause sleep disturbance, taking account of the attenuation of noise when passing from outdoors to indoors, and making allowance for the presence of open windows.

14.2.24. Where the occupier of the property has a financial interest in the Proposed Development, ETSU-R-97 states that the fixed lower noise limit for both daytime and night-time can be increased to 45 dB(A) and that "consideration should be given to increasing the permissible margin above background".

[10] BS EN (IEC). 61400-11:2003 Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques

Dumfries and Galloway Council Local Development Plan Supplementary Planning Guidance: Wind Energy Development

14.2.25. Dumfries and Galloway Council has produced Supplementary Planning Guidance relating to wind energy developments.

14.2.26. The guidance states that:

'The Council will support development proposals for all renewable energy provided they do not individually or in combination have a unacceptable significant adverse impact on … environmental and other impacts associated with the construction and operational phases of the development including details of any visual impact, noise and odour issues'.

14.2.27. The guidance goes on to state that *"For all large and medium turbines a full site-specific noise impact assessment following ETSU-R-97 and Institute of Acoustics methodology (or subsequent accepted national guidelines), which includes cumulative impact, would be required for all appropriate noise sensitive properties as agreed with Environmental Standards. Manufacturers noise information data should be provided for all schemes which include turbines below 50m in height to blade tip'.*

14.2.28. This has been addressed through the use of ETSU-R-97 as the agreed assessment methodology for operational noise due to the Proposed Development, as agreed in consultation with Dumfries and Galloway Council.

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

14.2.29. The Good Practice Guide (GPG) was published by the Institute of Acoustics (IOA) in May 2013 and has been endorsed by the Scottish Government as current industry good practice. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind turbine developments at the various stages of the assessment process. The recommendations provided in the GPG been followed throughout this assessment.

14.2.30. In addition, the IOA published a suite of six Supplementary Guidance Notes (SGNs) in 2014, intended to support the GPG and provide additional clarification where considered necessary. The recommendations of the SGNs have been followed where relevant in this assessment.

14.2.31. The GPG provides advice on the assessment of cumulative noise impact, detailing a number of possible cumulative scenarios and recommended approaches. Advice is also provided with regard to the geographical scope of a cumulative noise assessment, to determine the area within which a cumulative noise assessment is necessary.

14.2.32. Where a new noise source is introduced to a given scenario with a noise level which is predicted to be 10 dB or more below the existing level, the increase in the total noise level is considered to be negligible. On this basis, the necessary extents of a cumulative noise assessment can be determined. Paragraph 5.1.4 of the GPG states…*"If the proposed wind farm produces noise*

levels within 10 dB of any existing wind farm(s) at the same receptor location, then a cumulative noise impact assessment is necessary".

14.2.33. As noted in ETSU-R-97, noise from existing wind turbines should not form part of the background noise level from which noise limits for new wind energy developments are derived.

Low Frequency Noise and Infrasound

14.2.34. A study, published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the DTI, investigated low frequency noise from wind farms. This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines, but that complaints attributed to low frequency noise were in fact, possibly due to a phenomenon known as Amplitude Modulation (AM).

14.2.35. Further, in February 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms[11]. This study measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shut-downs of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.

14.2.36. Bowdler *et al.* (2009)[12] concludes that:

"...there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours".

Research into Amplitude Modulation

14.2.37. A further study[13] was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with AM. This report defined AM as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency. Its aims were to ascertain the prevalence of AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

14.2.38. The study concluded that AM has occurred at only a small number (4 of 133) of wind farms in the UK, and only for between 7% and 15% of the time. It also states that, at present, the causes of AM are not well understood and that

[11] Environment Protection authority (2013) Infrasound levels near wind farms and in other environments [online] Available at: http://www.epa.sa.gov.au/xstd_files/Noise/Report/infrasound.pdf
[12] Bowdler *et al*. (2009). Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects. Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics
[13]'Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.

prediction of the effect is not currently possible. The Government decided against conducting further research into the phenomenon, and as such, no revision to the current guidelines (ETSU-R-97) on wind farm noise assessment has been recommended.

14.2.39. This research was updated in 2013 by an in-depth study undertaken by Renewable UK[14], which has identified that many of the previously suggested causes of AM have little or no association to the occurrence of AM in practice. The generation of AM is based upon the interaction of a number of factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM, and the incidence of AM occurring at any particular site remains low, as identified in the University of Salford study.

14.2.40. In 2016, the IOA proposed a measurement technique[15] to quantify the level of AM present in any particular sample of windfarm noise. This technique is supported by the Department of Business, Energy & Industrial Strategy (BEIS, formerly The Department of Energy & Climate Change) who have published guidance[16], which follows on from the conclusions of the IOA study in order to define an appropriate assessment method for AM, including a penalty scheme and an outline planning condition. Notwithstanding this, the suggested outline planning condition is as yet un-validated, remains in a draft form, and would require site-specific legal advice on its appropriateness to a specific development.

14.2.41. Section 7.2.1 of the GPG, therefore, remains current, stating: "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".

14.2.42. It is therefore not considered necessary to carry out a specific assessment of AM.

Vibration

14.2.43. Research undertaken by Snow in 1996[17] found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS6472:1992 *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, and were lower than limits specified for residential premises by an even greater margin.

14.2.44. Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres from the wind farm site as reported by Keele University[18]. This report clearly shows that, although detectable using highly

[14] Renewable UK (2013).'Wind Turbine Amplitude Modulation: Research to improve understanding as to its Cause and effects', Renewable UK, 2013.
[15] Institute of Acoustics, (2016) A Method for Rating Amplitude Modulation in Wind Turbine Noise,
[16] BEIS, (2016), Review of the evidence on the response to amplitude modulation from wind turbines.
[17] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow.
[18] Microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms: recommendations on the siting of wind farms in the vicinity of Eskdalemuir, Scotland". Keele University, 2005

sensitive instruments, the magnitude of the vibration is orders of magnitude below the human level of perception and does not pose any risk to human health.

14.3. Assessment Methodology and Significance Criteria

14.3.1. This assessment has involved the following elements, further details of which are provided in the relevant sections:

- consultation with relevant statutory and non-statutory bodies;
- identification of potential receptors;
- measurement of existing (baseline) background noise levels at a representative selection of the potential receptors;
- establishment of limits for acceptable levels of wind turbine noise, based on the measured background noise and as specified in ETSU-R-97;
- prediction of the likely levels of wind turbine noise received at each receptor;
- comparison of the predicted levels with noise limits;
- input to design process to minimise effects;
- evaluation of the significance of these effects;
- assessment of residual effects;
- evaluation of potential cumulative effects; and
- statement of significance.

Construction Noise Assessment Methodology

Construction Noise

14.3.2. Due to the substantial separation distance between the Proposed Development and nearby noise receptors (approximately 800 m to the closest receptor from the nearest turbine), rather than assessing the effects of construction noise in terms of noise level, the mitigation measures outlined in Section 14.8 are to be adopted, which are considered to be Best Practice, as advocated in BS 5228.

14.3.3. Construction noise will be limited in duration and confined to working hours as specified by Dumfries and Galloway Council which can be adequately controlled through planning condition. On this basis, no further assessment of construction noise is considered necessary.

Construction Vibration

14.3.4. Occupants of residential properties near construction sites sometimes express concerns about vibration resulting from construction activities. For the Proposed Development, no scoping responses or other consultation responses have expressed concerns about vibration effects.

14.3.5. BS 5228-2 states…"*In general, the longer the duration of activities on a site, the more likely it is that vibration from the site will prove to be an issue. In this context, good public relations and communication are important. Local residents might be willing to accept higher levels of vibration if they know that such levels will only last for a short time".*

14.3.6. Given the large separation distance to the closest receptor, no significant vibration effects are anticipated and this has not been considered further in this Chapter.

Decommissioning

14.3.7. Noise produced during decommissioning of the Proposed Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with. On this basis, no further assessment of decommissioning noise is considered necessary.

Operational Noise Methodology

14.3.8. In summary, the assessment process comprises:

- identification of potential receptors, i.e. residential properties and other potentially noise-sensitive locations;
- establishment of limits for acceptable levels of wind turbine noise, based on the measured background noise levels (if applicable) and appropriate fixed lower limits as specified in ETSU-R-97;
- prediction of the likely levels of wind turbine noise received at each receptor; and
- comparison of the predicted levels with the noise limits.

Baseline Measurements

14.3.9. The method of measuring background noise is described in Chapter 7 of ETSU-R-97. In brief, it involves continuous measurement of both background noise levels at the receptors and wind speeds at the location of the turbines for a period of at least one week. The resulting data is then sorted into quiet daytime and night-time periods, and the relationship between wind speed and background noise established for each location.

Noise Limits

14.3.10. The method of deriving operational noise limits specified by ETSU-R-97 is described in Section 14.2. The most stringent ETSU-R-97 fixed lower limit has been adopted for both the assessment of noise from the Proposed Development and the cumulative noise assessment as a conservative assumption. Noise limits derived from ETSU-R-97 for this assessment are therefore:

- daytime: The higher of 35 dB(A) or 5 dB(A) above the prevailing day-time background noise level; and
- night-time: The higher of 43 dB(A) or 5 dB(A) above the prevailing night-time background noise level.

14.3.11. None of the identified potential receptors identified have a financial interest in the Proposed Development and are not subject to the increased fixed lower limit, as stated in ETSU-R-97.

Noise Predictions

14.3.12. Noise predictions have been made using the ISO 9613-2 noise model, taking account of the specific data and parameters recommended in the GPG, as summarised below:

- The turbine sound power levels should be stated and these should include an appropriate allowance for measurement uncertainty. If the data provided contains no allowance for measurement uncertainty, or uncertainties are not stated, an additional 2 dB should be included.
- Atmospheric absorption should be calculated based on conditions of 10°C and 70% relative humidity.
- The ground factor assumed should be G=0.5 (mixed ground) except in urban areas or where noise propagates across large bodies of water, where G=0 (hard ground) should be assumed.
- A receiver height of 4.0 m should be assumed.
- Barrier attenuation should not be included, unless there is no line of sight from the receptor, in which case a 2 dB barrier effect may be included.
- An additional 3 dB should be added to noise immission levels at properties located across a valley or with heavily concave ground between the property and the wind turbine(s), no such penalties are required in this assessment.
- The predicted noise levels ($L_{Aeq,t}$) may be converted to the required $L_{A90,10min}$ by subtracting 2 dB.

14.3.13. ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, *i.e.* down-wind, or under a moderate, ground-based temperature inversion, as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the GPG have been shown to provide good correlation with levels of wind turbine noise measured at operational wind farms[19,20].

14.3.14. The GPG notes that most sites at planning stage will not have selected a preferred turbine; therefore, a candidate turbine representative of a range of turbines should be selected to provide an appropriate estimate of noise levels. Once noise levels have been predicted at the potentially affected properties, compliance with noise limits can be assessed and design advice provided, if compliance with the limits is considered unlikely.

14.3.15. The Vestas V117 4.2 MW, with a rotor diameter of 117 m and a hub height of 91.5 m has been used for 17 of the 19 turbines. The remaining two turbines (units 1 and 3) are assessed as the Vestas V105 3.6 MW, with a rotor diameter of 105 m and a hub height of 72.5 m.

14.3.16. Whilst the candidate turbines are capable of operating in a number of noise-reduced modes (as are the majority of modern wind turbines), this assessment is based upon all turbines operating at full power (Mode 0). The sound power levels for serrated blades have been used.

14.3.17. The GPG states that: *"Warranted or specified manufacturer data can be used provided that a margin to account for uncertainty has been included"*. It goes on to say that if no data on uncertainty or test reports are available, then a factor of +2 dB should be added.

[19] Bullmore *et al.* (2009). Wind Farm Noise Predictions and Comparison with Measurements, Third International Meeting on Wind Turbine Noise, Aalborg, Denmark 17 – 19 June 2009.
[20] Cooper & Evans (2013). Effects of different meteorological conditions on wind turbine noise.

14.3.18. The Vestas V117 and V105 noise emission documentation is restricted by the manufacturer; however, it can be presented to the Council separately of this report, if required. This documentation excludes any margin for uncertainty, and as such, an additional 2 dB has been included in the sound power levels in this assessment, as detailed in Table 14.1.

Table 14.1: Noise Emission Data of Candidate Turbine

	Standardised 10 m Wind Speed, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Sound Power Level, dB(A)								
Vestas V117 4.2 MW									
Sound Power Level, dB LWA	92.8	94.7	100.0	102.8	105.1	106.0	106.0	106.0	106.0
Modelled Sound Power Level, dB, LWA, inc. 2 dB allowance for uncertainty	94.8	96.7	102.0	104.8	107.1	108.0	108.0	108.0	108.0
Vestas V105 3.6 MW									
Sound Power Level, dB LWA	93.0	93.5	95.6	98.6	101.5	103.9	104.7	104.9	104.9
Modelled Sound Power Level, dB, LWA, inc. 2 dB allowance for uncertainty	95.0	95.5	97.6	100.6	103.5	105.9	106.7	106.9	106.9

14.3.19. The spectrum for both the Vestas V117 4.2 MW and V105 3.6 MW measured at the wind speed for which the maximum sound power level is achieved (9 ms^{-1} and 11 ms^{-1} respectively) has been scaled to the maximum sound power level.

Table 14.2: Octave-band Spectra

	Octave-band Centre Frequency, f, Hz							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
	Octave-band Sound Power Level, dB, $L_{WA,f}$							
Vestas V117 4.2 MW								
Sound Power Level, dB, LWA	88.6	96.1	99.1	100.8	101.4	98.8	94.8	83.3
Sound Power Level, dB, LWA, Scaled to 108.0 dB(A)	89.6	97.1	100.1	101.8	102.4	99.8	95.8	84.3
Vestas V105 3.6 MW								
Sound Power Level, dB, LWA	84.1	93.9	97.6	99.7	98.4	95.8	90.9	75.0

Sound Power Level, dB, LWA, Scaled to 106.9 dB(A)	86.3	96.1	99.8	101.9	100.6	98.0	93.1	77.2

Cumulative Noise Assessment

14.3.20. ETSU-R-97 states that the assessment should take account of the effect of noise from all wind turbines that may affect a particular receptor. In order to facilitate this, a search conducted by Pegasus Group was used to identify any wind turbines, either operational, consented, or part of a current planning application, considered likely to result in cumulative noise impacts, when assessed in conjunction with the Proposed Development.

14.3.21. The assessment of cumulative noise effects is detailed in Section 14.6.

Apportioned Noise Limits

14.3.22. Apportioned noise limits are created by logarithmically subtracting the worst case cumulative noise scenario (i.e. excluding noise due to the Proposed Development), from the cumulative noise limits. All developments either in planning, approved or operational are considered as part of this assessment. The result is the remaining noise budget available to the Proposed Development. Should no additional noise budget be available at a given property, limits at that property for noise due to the Proposed Development are set 10 dB below the cumulative noise limit, ensuring that any contribution to operational noise due to the Proposed Development is negligible and immaterial in terms of the Proposed Development.

Significance Criteria

14.3.23. The acceptable limits for wind turbine operational noise are clearly defined in ETSU-R-97, the methodology for assessment of wind turbine noise recommended by Government guidance. Therefore, this assessment determines whether the calculated immission levels at nearby noise sensitive properties lie below the noise limits derived in accordance with ETSU-R-97. Where the noise immission levels at noise sensitive properties are shown to be below derived noise limits, the impact is considered to be not significant in terms of the EIA Regulations.

Assessment Limitations

14.3.24. Noise monitoring locations were selected to provide a conservative representation of the background noise levels in the local area.

14.3.25. Valid background noise measurements were obtained during the baseline noise survey for the full range of wind speeds required by ETSU-R-97 for both daytime and night-time periods, after exclusions were taken into account.

14.3.26. Wind speeds were measured at a height of 80 m and standardised to a height of 10 m in accordance with the GPG. It is therefore concluded that the no notable assessment limitations exist.

14.4. Scoping Responses and Consultation

14.4.1. Throughout the scoping exercises, and subsequently, during the ongoing EIA process, relevant organisations were contacted with regards to the Proposed Development. Table 14.3 outlines the consultation responses received in relation to noise.

Table 14.3: Consultation

Consultee	Details	Response	Where Addressed in EIA Report
Dumfries and Galloway Council Planning Department	2013 Scoping Opinion	The assessment should be undertaken in line with ETSU-R-97	The assessment follows the guidance specified in ETSU-R-97, as summarised in Section 14.3 of this report.
		The Proposed Development should consider whether the lower limits in ETSU-R-97 can be met	**Figure 14.1** of this report shows all receptors around the Proposed Development, along with the 35 dB contour. As can be seen, several properties fall within the 35 dB contour line, and as such monitoring has been undertaken to calculate noise limits in accordance with ETSU-R-97.
		A method statement should be produced for construction	The requirement for a construction method statement can be secured by planning condition, to be implemented by the appointed contractor. Construction best practice and mitigation detailed in Section 14.8 will be included in the method statement to minimise the impact of noise during construction
Dumfries & Galloway Council Environmental Health Department	Nov 2013 – Email to EHO detailing methodology including monitoring locations	EHO replied stating that they are happy with approach and monitoring locations	Monitoring details presented in Section 14.5 of this report.

Consultee	Details	Response	Where Addressed in EIA Report
Dumfries and Galloway Council	March 2018 Scoping Report	Scoping Response from Dumfries and Galloway Council did not include consideration of noise issues. Follow up email sent to EHO June 2018. No correspondence received from EHO.	N/A

14.5. Baseline Conditions

Noise Survey

Potential Receptors

14.5.1. The minimum noise limit specified in ETSU-R-97 is 35 dB, $L_{A90,10min}$, which applies to the cumulative effect of noise from all wind turbines that affect a particular location. Where noise levels are greater than this minimum limit, it is necessary to take background noise levels into consideration in the assessment, and conversely, where the predicted noise levels are lower it is not necessary to consider background noise levels in order to determine whether the level of noise from a wind farm would comply with the requirements of ETSU-R-97.

14.5.2. Potential noise sensitive receptors in the area around the Proposed Development were identified from Ordinance Survey 1:25,000 scale digital mapping, freely available aerial photography, local planning applications and AddressBase; a database which combines Royal Mail address data with buildings identified on large-scale Ordnance Survey mapping and provides addresses, descriptions and grid references. Receptor locations were then confirmed through site visits. The following potentially noise-sensitive locations were identified, as shown in **Figure 14.1**.

- Smittons;
- 1 Muirdrochwood;
- 2 Muirdrochwood;
- Marscalloch Cottage;
- Nether Loskie
- Furmiston;
- Marbrack Cottage;
- Moorbrock;
- Craigengillan Cottage;
- Craigengillan.

Selection of Monitoring Locations

14.5.3. Following consultation with the Dumfries and Galloway Environmental Health Department, it was agreed that noise monitoring would be undertaken at the following representative locations;

- Smittons;

- 1 Muirdrochwood;
- Furmiston
- Nether Loskie;
- Marbrack;
- Craigengillan Cottage; and
- Moorbrock.

Survey Details

14.5.4. Noise monitoring commenced on 21st November 2013 and was concluded on the 9th January 2014.

14.5.5. The survey was carried out in accordance with the method specified in ETSU-R-97. The following specific measures ensured this compliance:

- Type 1 measuring equipment was used, which was calibrated at the start of the survey and at each site visit. No notable calibration drift occurred.
- Noise monitoring equipment was equipped with specially-designed, dual-layer windshields manufactured by Rion, which have been confirmed by the supplier as being suitable for use in elevated wind speeds.
- Measurements were performed at a height of 1.4 m AGL, in free-field conditions, i.e., a minimum of 3.5 m from any reflective surface other than the ground.
- Background noise levels were recorded at continuous 10-minute intervals, as $L_{A90,\ 10min}$. Other parameters recorded included the $L_{Aeq,10min}$.
- During the survey, wind speeds were measured using an 80 m meteorological mast at heights of 40 m, 60 m and 80 m. Hub height (91.5 m) height wind speeds were calculated as specified in Section 14.2 and subsequently used to derive standardised 10 m wind speeds.
- Rain gauges were deployed and data from periods potentially affected by rainfall were excluded from further analysis.
- Periods of elevated background noise levels which were not considered representative of the location were identified and excluded from analysis.
- The GPG recommends at least 200 valid data points in each quiet daytime and night time period for each monitoring location, after exclusions are taken into account. In practice, this minimum was comfortably exceeded.

14.5.6. Survey record sheets and calibration certificates for noise and wind monitoring equipment used during the survey are included in **Appendix 14.2** and **Appendix 14.3** respectively. Details of the monitoring locations are presented in Table 14.4 and shown on **Figure 14.1**.

Table 14.4: Baseline Noise Survey Details

Location	National Grid Reference	Description of Monitoring Location	Noise Sources Observed During Visit
Smittons	NX 63290 91679	Front garden to the south-west of Smittons Farm	Wind in trees, running water, birdsong, livestock and passing motor vehicles
1 Muirdrochwood	NX 61804 91123	Back garden to the west of 1 Muirdrochwood	Wind in trees, birdsong and livestock
Furmiston	NX 60301 92270	Front garden to the south of Furmiston	Wind in trees, livestock, birdsong and barking dogs

Location	National Grid Reference	Description of Monitoring Location	Noise Sources Observed During Visit
Nether Loskie	NX 60027 91707	Backgarden to the south of Nether Loskie house	Wind in trees, running water, birdsong, livestock and vehicles
Marbrack	NX 59649 93182	Front garden south of Marbrack House	Wind in trees and birdsong
Craigengillan Cottage	NX 63631 94943	Centre of the back garden to the north of the house	Distant running water and wind in trees
Moorbrock	NX 62914 96643	Elevated area to the south side of the garage	Planes overhead and wind in trees

Data Analysis

14.5.7. The measured background noise levels and standardised 10 m height wind speeds were correlated and sorted into quiet daytime and night-time periods. Rain gauges were located at Craigengillan Cottage, Furmiston, Moorbrock and Smittons to allow for the exclusion of noise data during periods affected by rainfall. At monitoring locations where a rain gauge was not located, data from the rain gauge closest to that monitoring location was used.

14.5.8. In order to ensure a conservative assessment, where any 10-minute period coincided with rainfall, noise data from thirty-minutes either side of the recorded intervals were removed from analysis.

14.5.9. Trendlines (lines of best fit) were then applied to scatter plots of the data to represent 'prevailing background noise level' curves. In all cases, the use of third order polynomial trendlines was considered most appropriate.

14.5.10. Table 14.5 details the prevailing background noise levels obtained for quiet daytime and night-time measurement periods.

Table 14.5: Prevailing Background Noise Levels

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Background Noise Level, dB, $L_{A90,10min}$								
Quiet Daytime									
Smittons	32.1	33.2	34.3	35.5	36.8	38.0	39.3	40.5	41.8
1 Muirdrochwood	26.3	28.5	30.8	33.1	35.3	37.3	39.0	40.2	41.0
Furmiston	31.3	33.6	35.9	38.1	40.3	42.4	44.3	46.1	47.7
Nether Loskie	34.3	35.1	35.8	36.6	37.4	38.4	39.5	40.9	42.6
Marbrack	36.9	38.6	40.4	42.3	44.2	46.2	48.2	50.3	52.6
Craigengillan Cottage	39.6	40.4	41.3	42.2	43.3	44.5	45.8	47.4	49.2
Moorbrock	31.1	33.0	34.8	36.7	38.5	40.0	41.4	42.5	43.1
Night-time									
Smittons	32.2	33.4	34.6	35.8	37.1	38.4	39.8	41.2	42.6
1 Muirdrochwood	25.2	27.3	29.7	32.2	34.7	37.1	39.3	41.2	42.6
Furmiston	29.3	31.3	33.6	36.1	38.6	41.2	43.6	45.8	47.6
Nether Loskie	33.7	34.6	35.6	36.6	37.6	38.7	39.8	40.8	42.0
Marbrack	35.6	37.4	39.5	41.7	44.0	46.3	48.4	50.3	51.8
Craigengillan Cottage	39.3	40.2	41.3	42.5	43.8	45.2	46.6	48.1	49.7
Moorbrock	31.4	32.8	34.4	36.1	37.8	39.4	40.9	42.1	43.0

14.5.11. These background noise levels are presented graphically in Plates 14.3 to 14.16, along with data points which have been excluded from analysis, as recommended in the GPG.

Plate 14.3: Quiet Daytime Smittons

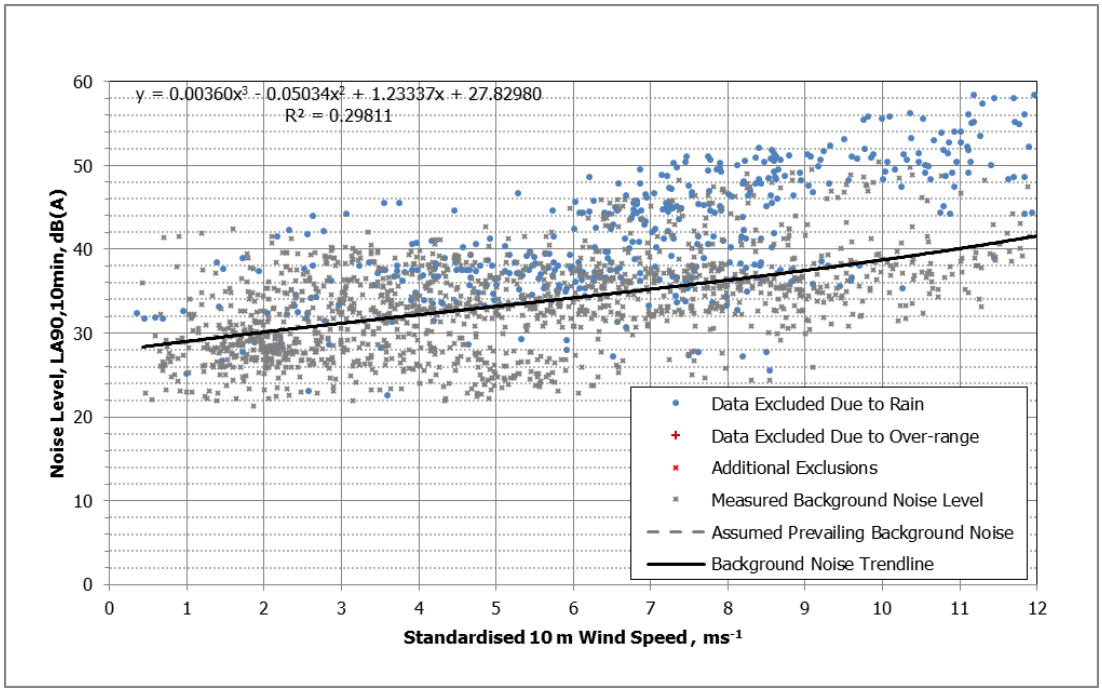


Plate 14.4: Night-time Smittons

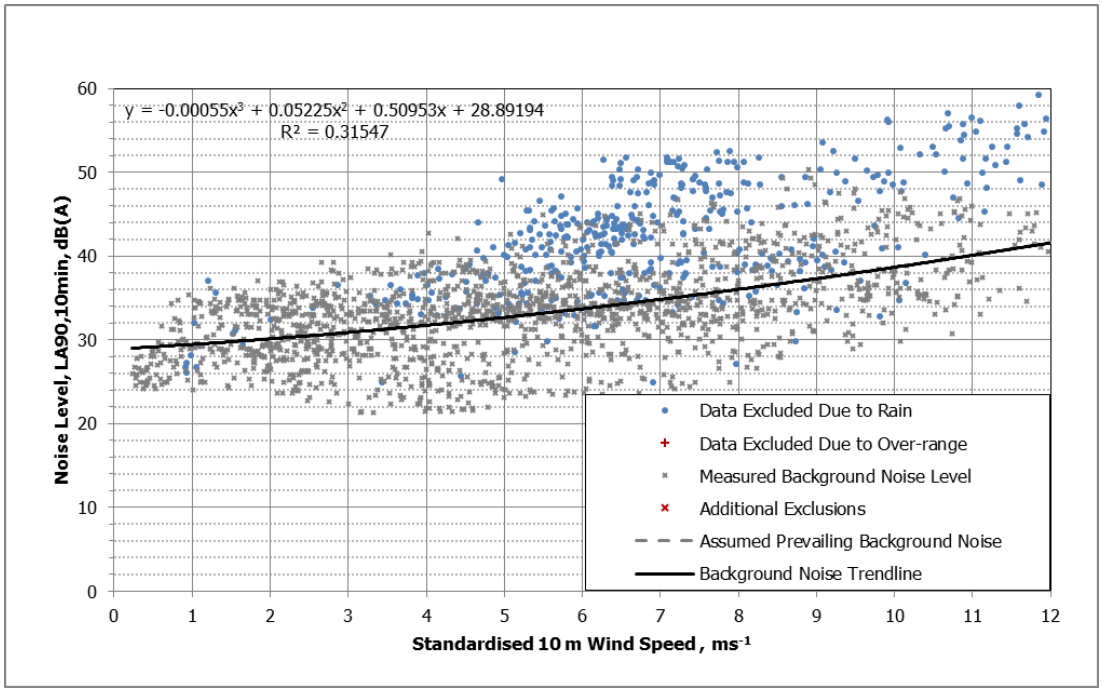


Plate 14.5: Quiet Daytime 1 Muirdrochwood

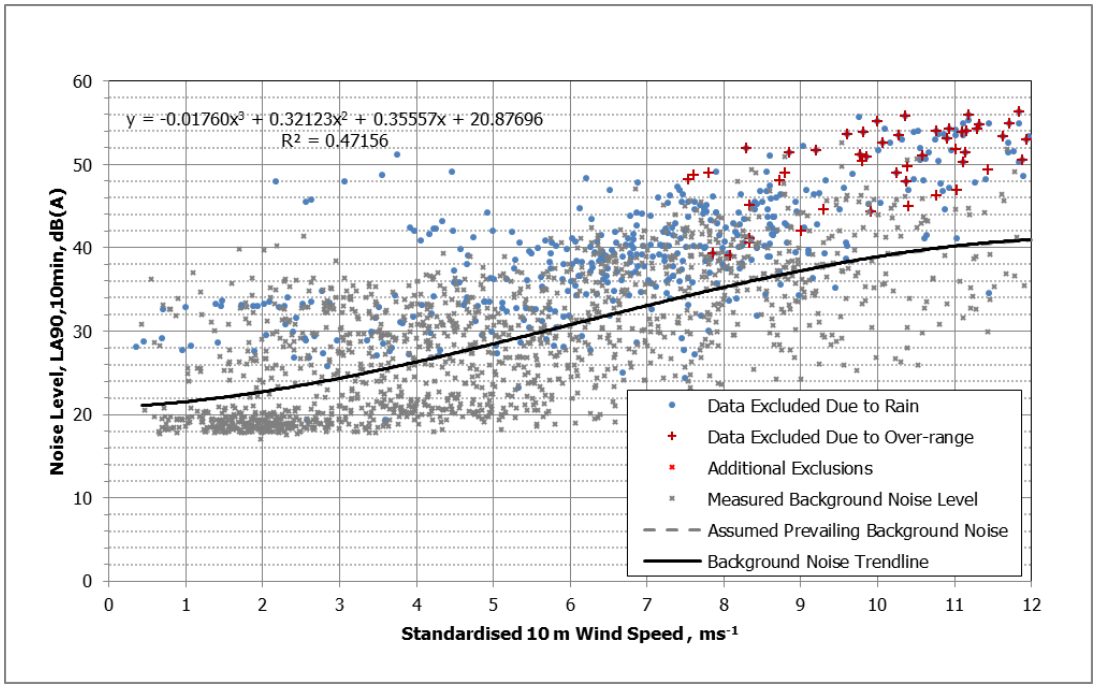


Plate 14.6: Night-time 1 Muirdrochwood

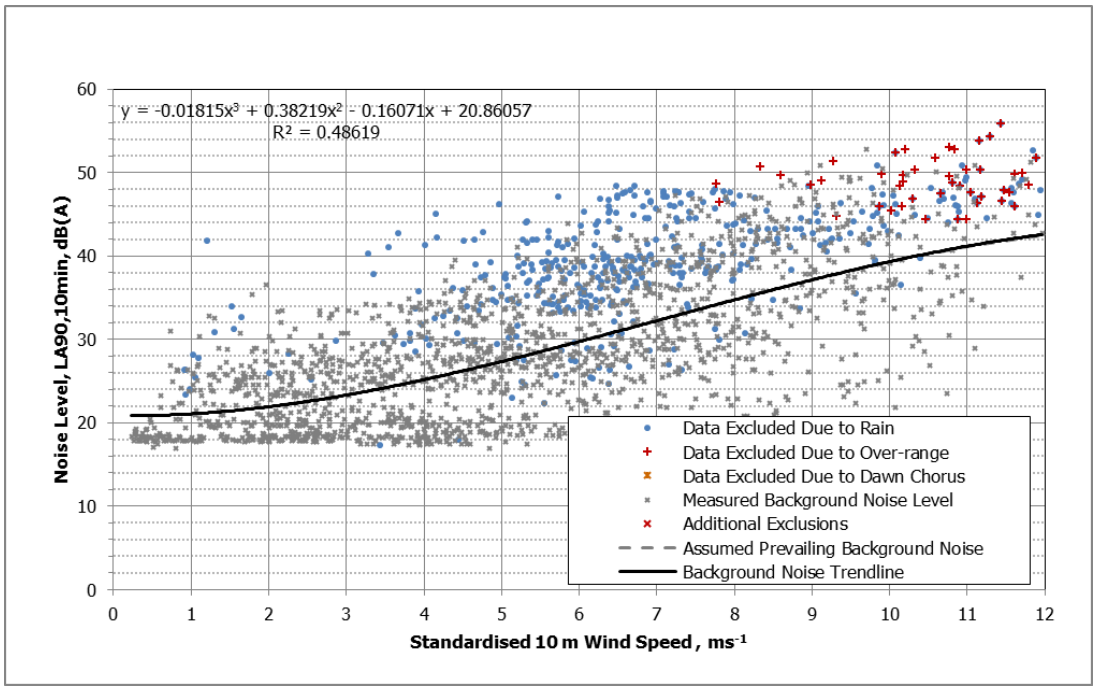


Plate 14.7: Quiet Daytime Furmiston

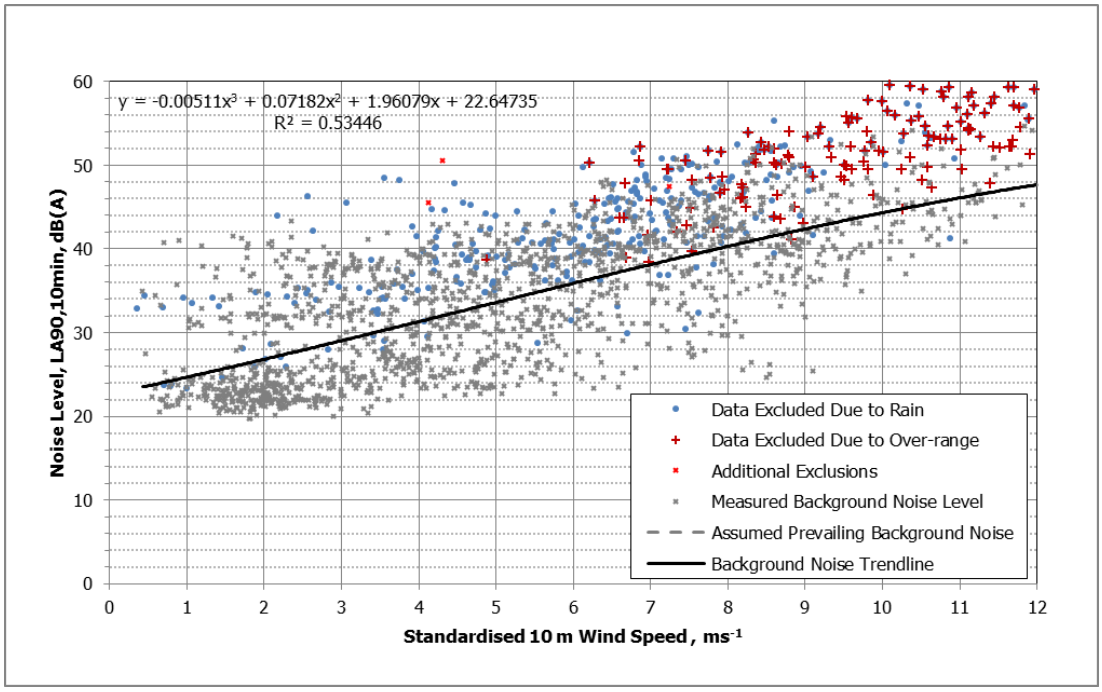


Plate 14.8: Night-time Furmiston

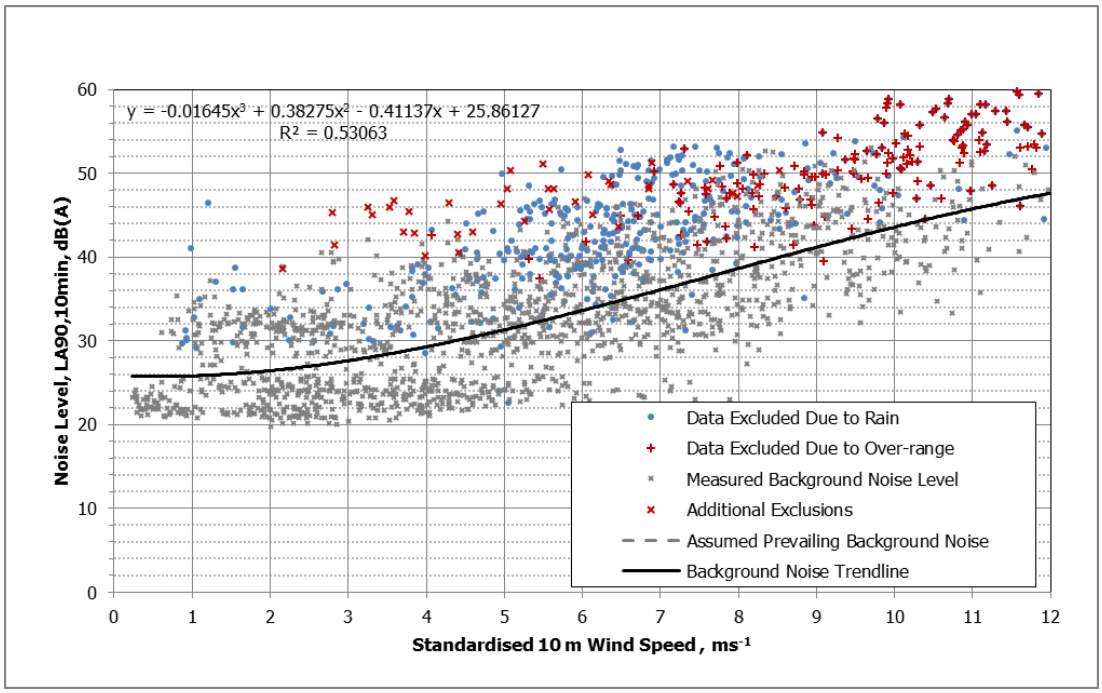


Plate 14.9: Daytime Nether Loskie

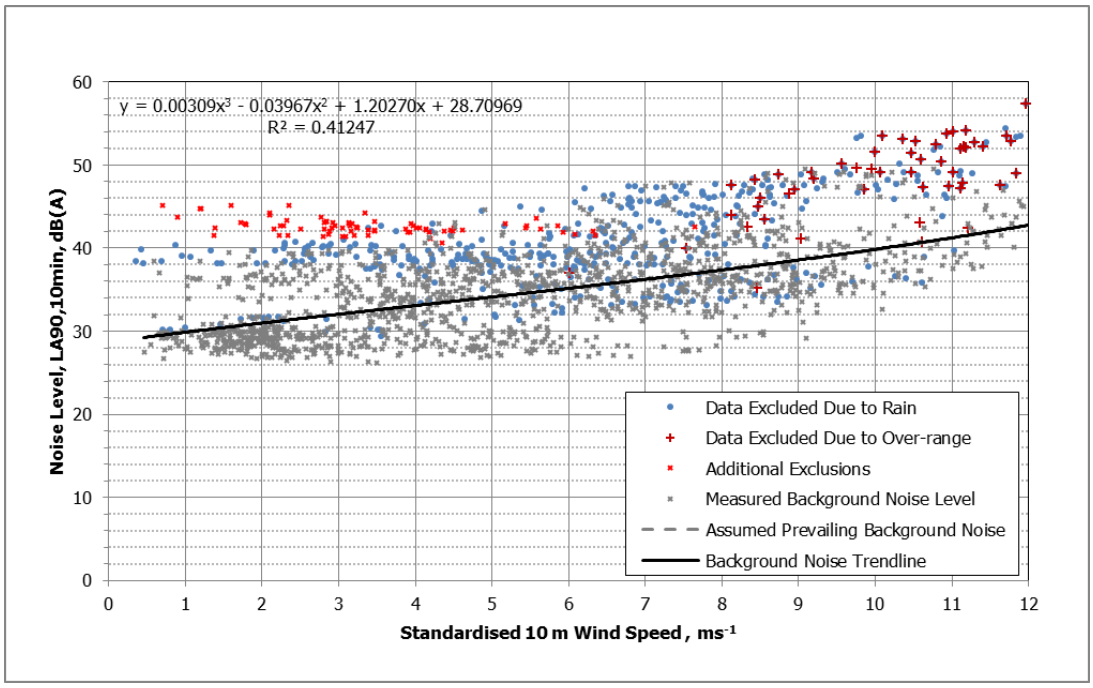


Plate 14.10: Night-time Nether Loskie

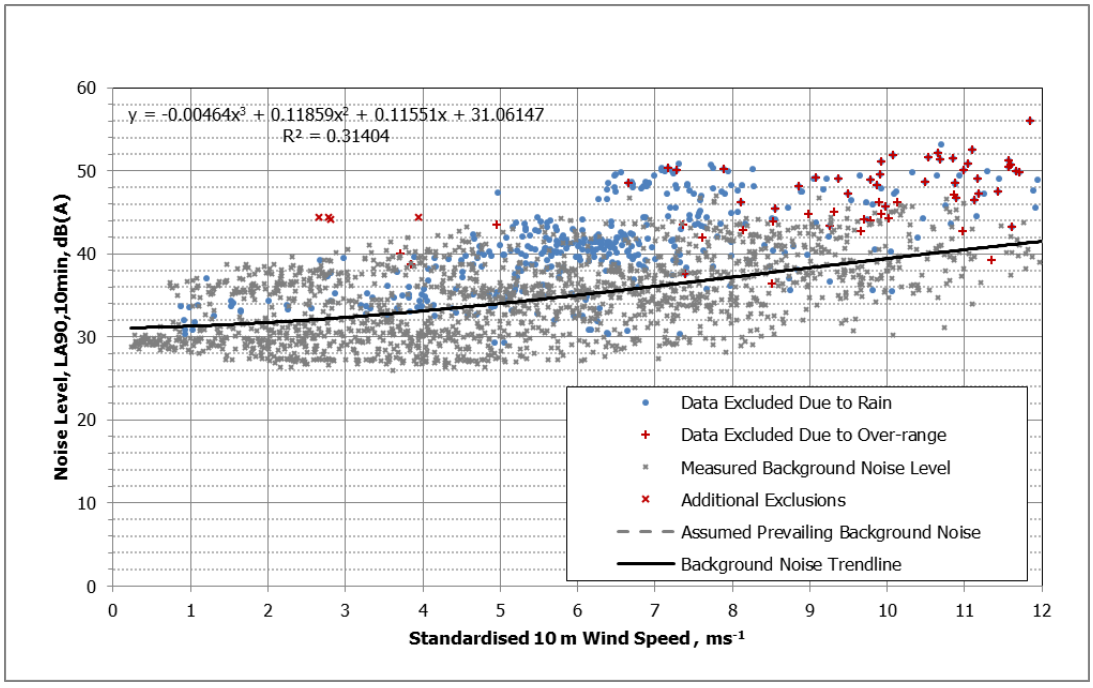


Plate 14.11: Daytime Marbrack

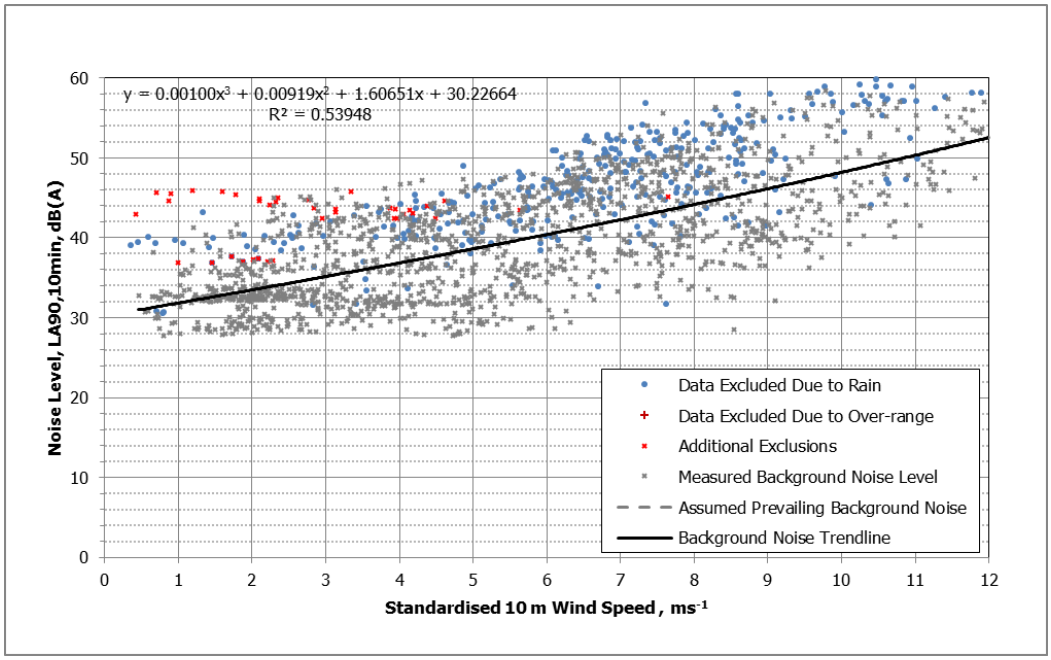


Plate 14.12: Night-time Marbrack

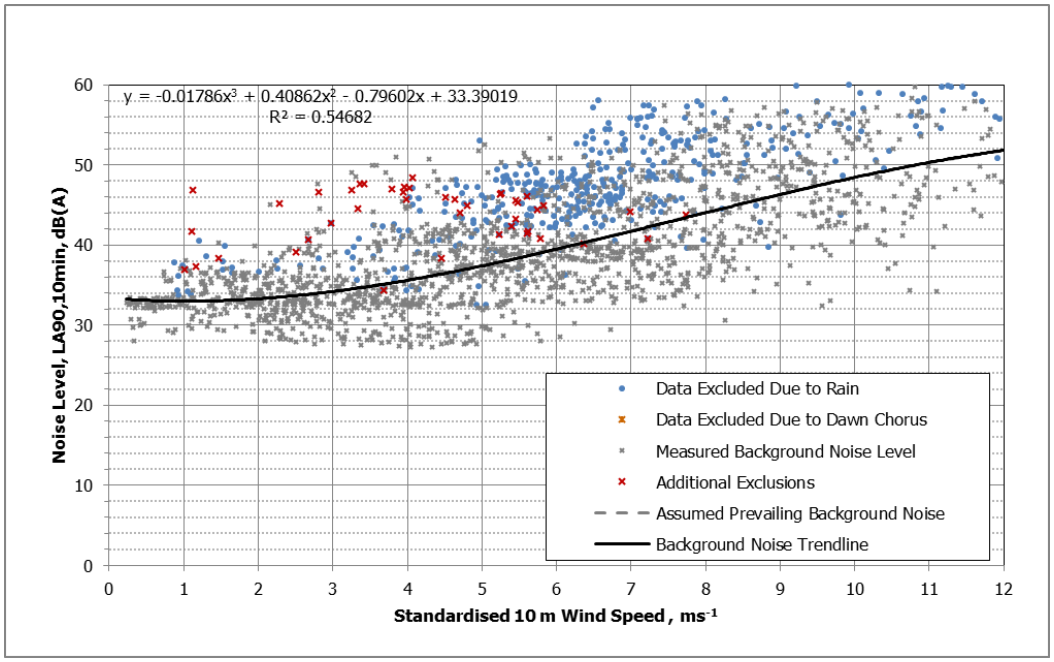


Plate 14.13: Daytime Craigengillan Cottage

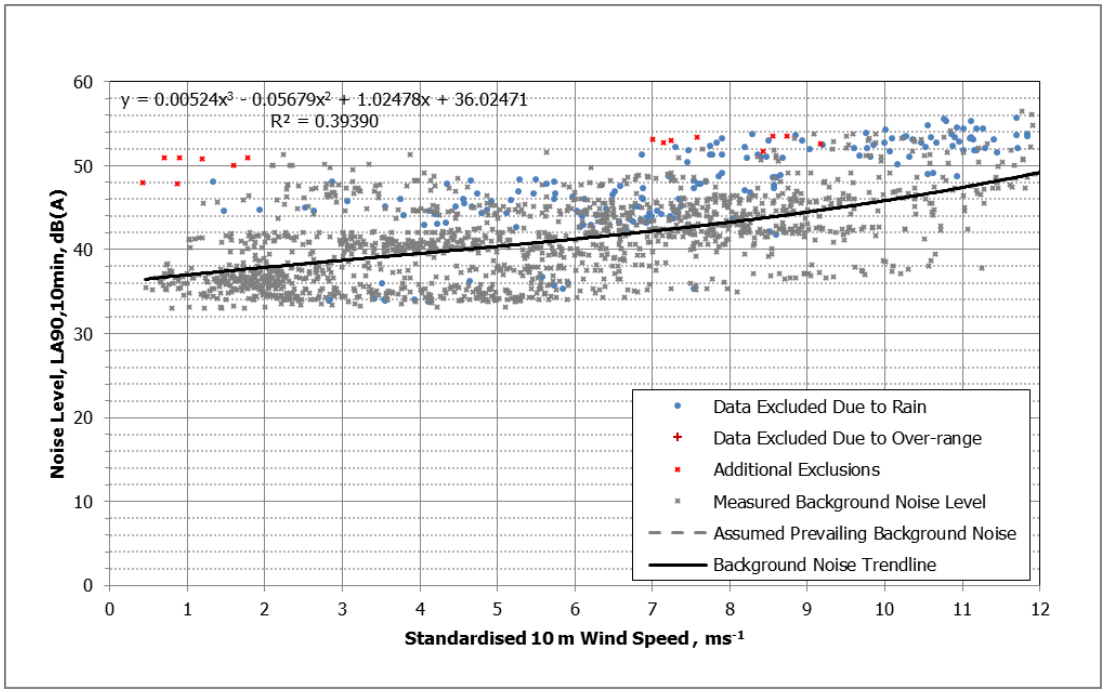


Plate 14.14: Night-time Craigengillan Cottage

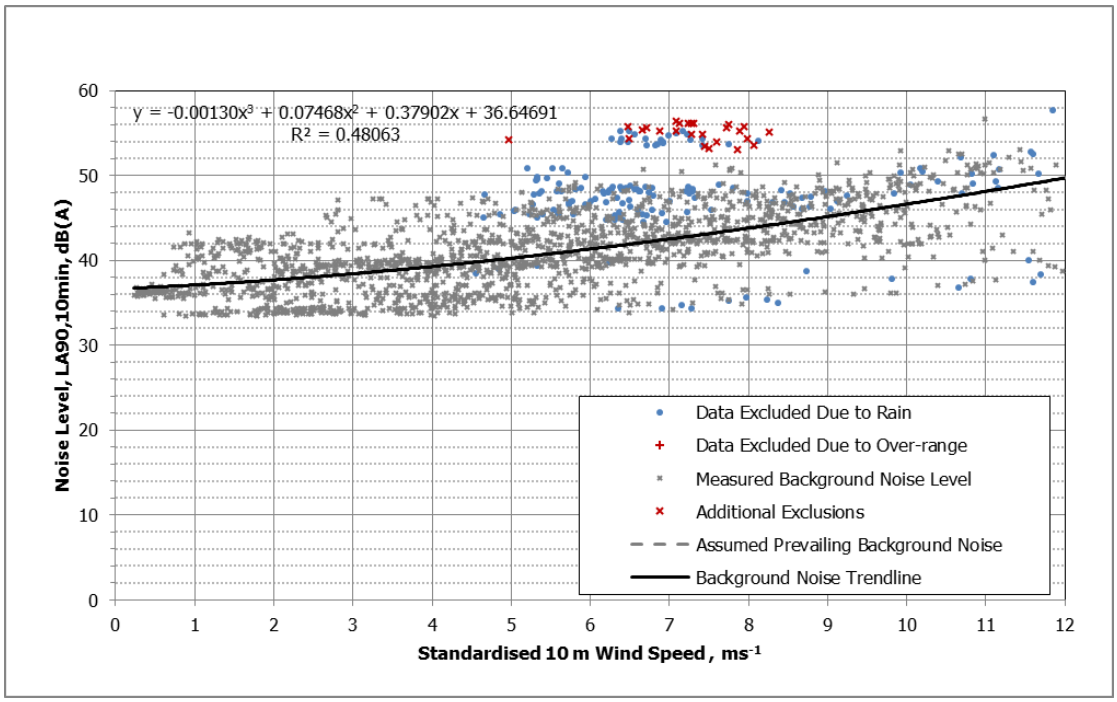


Plate 14.15: Daytime Moorbrock

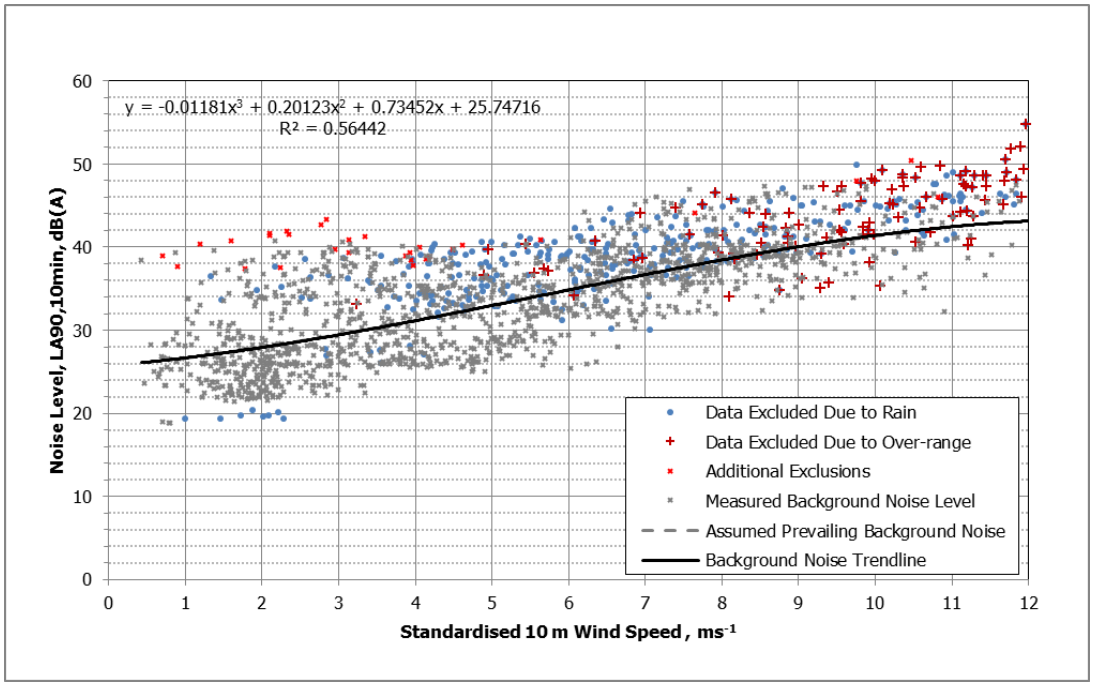
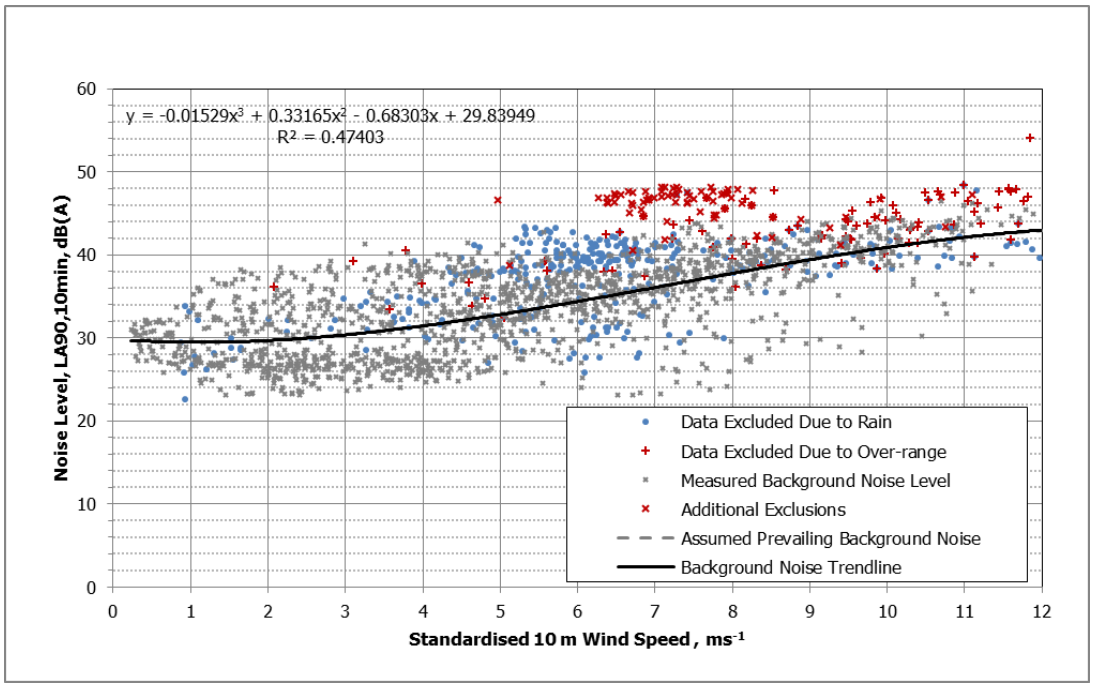


Plate 14.16: Night-time Moorbrock



Assessment Locations

14.5.12. The properties considered to be the most noise sensitive by virtue of their proximity to the Proposed Development have been assessed. Should the predicted operational noise levels comply with noise limits at the most noise sensitive assessment locations, noise levels at receptors further from the Proposed Development will also comply.

14.5.13. Table 14.6 details the locations of these receptors, along with the background noise data applied, as shown in **Figure 14.1**.

14.5.14. Blackmark and Stroanpatrick are located to the east of the site, adjacent to the proposed Longburn Wind Farm development. Background noise monitoring was undertaken at Stroanpatrick as part of the Longburn application, as detailed in Tables 11.11 in the Longburn noise assessment chapter[21].

Table 14.6: Noise Assessment Locations

Location	Easting	Northing	Background Data Applied
Smittons	263295	591702	Smittons
1 Muirdrochwood	261850	591137	1 Muirdrochwood
2 Muirdrochwood	261826	591121	1 Muirdrochwood
Furmiston	260307	592302	Furmiston
Nether Loskie	260023	591717	Nether Loskie
Marbrack	259697	593259	Marbrack
Craigengillan	263690	594831	Craigengillan
Craigengillan Cottage	263628	594937	Craigengillan
Marscalloch Cottage	260374	591371	Nether Loskie
Moorbrock	262939	596644	Moorbrock
Blackmark	265286	591687	Stroanpatrick
Strahanna Farm	264550	595867	Moorbrock
Stroanpatrick	264309	591961	Stroanpatrick

Noise Limits

14.5.15. The method of establishing these limits is described in Section 14.3. Table 14.7 details the ETSU-R-97 noise limits derived from the measured background noise levels for all the assessment locations. It is from these limits that apportioned noise limits applicable to the Proposed Development are derived.

[21] Noise and Vibration, Longburn Wind Farm,

14.5.16. As Moorbrock is financially involved with Windy Rig, it is subject to the higher limits of 45 dB(A) or 5 dB(A) above prevailing background noise levels for both daytime and night-time. Similarly, Stroanpatrick is financially involved with Longburn, and is therefore subject to the increased fixed lower limits for financial involvement when considering cumulative noise effects.

Table 14.7: Cumulative Noise Limits

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Cumulative Noise Limits, dB, $L_{A90,10min}$								
Quiet Daytime									
Smittons	37.2	38.2	39.2	40.2	41.3	42.5	43.7	45.1	46.6
1 Muirdrochwood	35.0	35.0	35.8	38.1	40.3	42.3	44.0	45.2	46.0
2 Muirdrochwood	35.0	35.0	35.8	38.1	40.3	42.3	44.0	45.2	46.0
Furmiston	36.3	38.6	40.9	43.1	45.3	47.4	49.3	51.1	52.7
Nether Loskie	38.1	39.1	40.2	41.2	42.4	43.6	44.9	46.3	47.8
Marbrack	41.9	43.6	45.4	47.3	49.2	51.2	53.2	55.3	57.6
Craigengillan	44.6	45.4	46.3	47.2	48.3	49.5	50.8	52.4	54.2
Craigengillan Cottage	44.6	45.4	46.3	47.2	48.3	49.5	50.8	52.4	54.2
Marscalloch Cottage	38.1	39.1	40.2	41.2	42.4	43.6	44.9	46.3	47.8
Moorbrock	45.0	45.0	45.0	45.0	45.0	45.0	46.4	47.5	48.1
Blackmark	35.7	37.6	39.9	42.5	45.4	48.7	52.3	52.3	52.3
Strahanna Farm	36.1	38.0	39.8	41.7	43.5	45.0	46.4	47.5	48.1
Stroanpatrick	45.0	45.0	45.0	45.0	45.4	48.7	52.3	52.3	52.3
Night-time									
Smittons	43.0	43.0	43.0	43.0	43.0	43.0	43.7	45.1	46.6
1 Muirdrochwood	43.0	43.0	43.0	43.0	43.0	43.0	44.3	46.2	47.6
2 Muirdrochwood	43.0	43.0	43.0	43.0	43.0	43.0	44.3	46.2	47.6
Furmiston	43.0	43.0	43.0	43.0	43.6	46.2	48.6	50.8	52.6
Nether Loskie	43.0	43.0	43.0	43.0	43.0	43.3	44.4	45.5	46.5
Marbrack	43.0	43.0	44.5	46.7	49.0	51.3	53.4	55.3	56.8
Craigengillan	44.3	45.2	46.3	47.5	48.8	50.2	51.6	53.1	54.7
Craigengillan Cottage	44.3	45.2	46.3	47.5	48.8	50.2	51.6	53.1	54.7
Marscalloch Cottage	43.0	43.0	43.0	43.0	43.0	43.3	44.4	45.5	46.5
Moorbrock	45.0	45.0	45.0	45.0	45.0	45.0	45.9	47.1	48.0
Blackmark	43.0	43.0	43.0	43.4	46.6	49.9	53.6	53.6	53.6
Strahanna Farm	43.0	43.0	43.0	43.0	43.0	44.4	45.9	47.1	48.0
Stroanpatrick	45.0	45.0	45.0	45.0	46.6	49.9	53.6	53.6	53.6

Calculation of Apportioned Limits

14.5.17. **Figure 8.3** shows all windfarms either operational, consented, in planning or in scoping within 15 km of the Proposed Development. For the purpose of this assessment, developments in scoping have been omitted, as ETSU-R-97 recommends that only sites with a valid planning application onwards should be considered.

14.5.18. The proposed Longburn Wind Farm lies to the east of the Proposed Development. The scheme consists of ten, 134 m to tip turbines and is under appeal, at time of writing. It has been dealt with under the written representation procedures and a decision is due imminently at the time of writing (November 2018). The cumulative effects of the Longburn wind turbines, in conjunction with the Proposed Development have therefore been assessed.

14.5.19. The next closest proposed wind energy development is Windy Rig Wind Farm, which consists of 12, 125 m to tip turbines on a site approximately 3 km to the north of the Shepherds' Rig site. The decision notice for this scheme was received in November 2018.

14.5.20. Cumulative screening was undertaken to determine whether the nearest developments have the potential to produce noise levels within 10 dB of the Proposed Development. This screening is presented in **Figure 14.2**.

14.5.21. As can be seen, there are 9 properties where the cumulative sites have the potential to produce noise levels within 10 dB of the Proposed Development, as detailed in Table 14.8 below;

Table 14.8: Cumulative Receptors

Location	Easting	Northing
Smittons	263295	591702
1 Muirdrochwood	261850	591137
2 Muirdrochwood	261826	591121
Craigengillan	263690	594831
Craigengillan Cottage	263628	594937
Moorbrock	262939	596644
Blackmark	265286	591687
Strahanna Farm	264550	595867
Stroanpatrick	264309	591961

14.5.22. The next nearest developments, Windy Standard and Wether Hill, are located approximately 6 km to the north and east of the Proposed Development

respectively. At this distance, there is no reasonable prospect of noise from these developments producing noise levels within 10 dB of the Proposed Development. They have therefore been excluded from further analysis.

14.5.23. Worst Case noise levels due to Longburn and Windy Rig have been calculated for each receptor identified in Table 14.8, following GPG advice.

14.5.24. Where there is no reasonable prospect of the current cumulative scenario producing noise levels up to the consented limits, the GPG recommends that predicted noise levels should be used along with an additional safety margin. This approach prevents the sterilisation of an area in which existing wind turbine noise levels are substantially lower than their consented limits, enabling further appropriate development to be considered. In such instances, an additional safety margin of 5 dB has been applied, providing a realistic worst-case noise emission level. Where this additional 5 dB safety margin results in predicted noise levels greater than the noise limit applicable to the relevant development, noise levels are assumed to be equal to the limit as a worst-case approach.

Windy Rig

14.5.25. The decision notice for the Windy Rig development specifies that:

'At wind speeds not exceeding 12 m/s as measured or calculated at a height of 10 m above ground level at the wind farm, the wind farm noise immission at any dwelling existing at the time of this permission shall comply with the following:

a) During night time hours, as defined in ETSU-R-97 as 23.00 to 07.00 on all days, the wind farm noise immission level shall not exceed 43 dB LA90,10min

b) At all other times, the wind farm noise immission level shall not exceed 35 dB LA90,10min

c) The above noise immission limits may be increased to 45 dB LA90,10min at any dwelling owned by persons with financial involvement with the wind farm.

14.5.26. The nearest noise sensitive property to Windy Rig is Moorbrock, located approximately 2.8 km to its south. This property is financially involved, and is therefore subject to the increased fixed lower limit of 45 dB $L_{A90,10min}$.

14.5.27. As can be seen in Table 14.9, at all wind speeds sufficient headroom is present between the noise predictions and noise limits such that there is no reasonable prospect of the Windy Rig development producing noise levels up to the existing limits. Sound power levels have therefore been increased by a further 5 dB as discussed above.

Table 14.9: Windy Rig Sound Power Level Adjustment

	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Nordex N100 Sound Power Level, dB LWA, Including 2 dB Uncertainty[22]	98.5	100.5	104.8	106.4	107.0	107.5	107.5	107.5	107.5
Prediction at controlling property, dB, $L_{A90,10min}$	16.8	17.8	19.8	24.1	25.7	26.3	26.8	26.8	26.8
Noise Limit	45	45	45	45	45	45	45	45	45
Headroom between prediction and limit, dB	-28.2	-27.2	-25.2	-20.9	-19.3	-18.7	-18.2	-18.2	-18.2
Additional safety margin, dB	5	5	5	5	5	5	5	5	5
Adjusted Sound Power Levels, dB, LWA	103.5	105.5	109.8	111.4	112.0	112.5	112.5	112.5	112.5

Longburn

14.5.28. At the time of writing, the Longburn development is at appeal, and as such noise limits specified by conditions are not available. The limit for the proposed Longburn development is therefore based on background noise levels within the Longburn Noise Assessment, assuming that any limits will be derived from these.

14.5.29. The property where headroom between the predicted level and noise limit is smallest is Blackmark, located approximately 980 m to the south of Longburn, which has therefore been selected as the controlling property.

14.5.30. As can be seen in Table 14.10, the sound power levels at all wind speeds have been increased such that they meet the noise limit at Blackmark (limited to 5 dB).

[22] Taken from Windy Rig Noise report, Atmos Consulting, Windy Rig Wind Farm, Feb 2017, Table 10-4 Octave Sound Power Level Data for the Nordex N100 3.3 MW turbine

Table 14.10: Longburn Sound Power Level Adjustment

	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Vestas V100 Sound Power Level, dB LWA, Including 2 dB Uncertainty	98.2	102.1	105.9	107.0	107.0	107.0	107.0	107.0	107.0
Prediction at controlling property, dB, $L_{A90,10min}$	29.1	34.0	36.8	37.9	37.9	37.9	37.9	37.9	37.9
Noise Limit[23]	35.7	37.6	39.9	42.5	45.4	48.7	52.3	52.3	52.3
Headroom between prediction and limit, dB	-6.6	-3.6	-3.1	-4.6	-7.5	-10.8	-14.4	-14.4	-14.4
Additional safety margin, dB	5.0	3.6	3.1	4.6	5.0	5.0	5.0	5.0	5.0
Adjusted Sound Power Levels, dB, LWA	101.3	105.2	109.0	110.1	110.1	110.1	110.1	110.1	110.1

Cumulative Noise Levels due to Other Wind Farm Developments

14.5.31. Table 14.11 details the predicted cumulative noise level (excluding noise due to the Proposed Development) for each of the cumulative assessment locations identified in Table 14.7 and using the adjusted sound power levels detailed in Tables 14.8 and 14.9. It should be borne in mind that as the noise assessment follows GPG advice with regard to cumulative noise effects, the noise levels presented in Table 14.11 are a theoretical worst case; a number of conservative assumptions have been made, as detailed in the previous sections of this chapter.

Table 14.11: Cumulative Noise Levels Due to Other Developments.

Receptor	**Standardised Wind Speed at 10 m AGL, ms^{-1}**								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Predicted Cumulative Noise, dB, $L_{A90,10min}$								
Smittons	28.4	31.9	34.2	36.8	37.2	37.2	37.2	37.2	37.2
1 Muirdrochwood	24.0	27.5	29.8	32.4	32.8	32.8	32.8	32.8	32.8
2 Muirdrochwood	24.0	27.5	29.8	32.4	32.8	32.8	32.8	32.8	32.8
Craigengillan	30.8	34.3	36.6	39.2	39.6	39.6	39.7	39.7	39.7
Craigengillan Cottage	30.0	33.5	35.8	38.4	38.8	38.8	38.8	38.8	38.8

[23] At all windspeeds the daytime limit is lower than the night-time limit, and as such only the worst case daytime limit has been presented.

Moorbrock	26.1	28.9	31.1	34.2	35.0	35.2	35.4	35.4	35.4
Blackmark	34.1	37.6	39.9	42.5	42.9	42.9	42.9	42.9	42.9
Strahanna Farm	26.4	29.8	32.0	34.7	35.2	35.3	35.3	35.3	35.3
Stroanpatrick	33.0	36.5	38.8	41.4	41.8	41.8	41.8	41.8	41.8

Apportioned Noise Limits

14.5.32. The apportioned limits have been calculated by logarithmically subtracting the worst case existing cumulative turbine noise levels (Table 14.11), from the cumulative noise limits (Table 14.6). The result is the remaining noise budget available to the Proposed Development.

14.5.33. As discussed in Section 14.3, apportioned limits have been based upon a daytime fixed lower limit of 35 dB, $L_{A90,10min}$.

14.5.34. It should be noted that whilst Moorbrock and Stroanpatrick have a financial interest in Windy Rig and Longburn respectively, these properties have no such interest in the Proposed Development. Therefore, the apportioned noise limits at these properties have been reduced so that they are no greater than the limits that would be applied to the development in isolation, assuming a daytime fixed lower limit of 35 dB, $L_{A90,10min}$.

14.5.35. The resulting apportioned limits may be presented in the planning conditions of any consent of the Proposed Development and will ensure the Proposed Development's compliance with ETSU-R-97 when considered both individually and cumulatively.

14.5.36. As the limit at Blackmark at 5, 6 and 7 ms^{-1} is already fully utilised by Longburn, the apportioned limit is 10 dB below the Cumulative limit as specified in Table 14.6 (highlighted in Table 14.12).

Table 14.12: Apportioned Limits

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Apportioned Noise Limits, dB, $L_{A90,10min}$								
Quiet Daytime									
Smittons	36.6	37.0	37.6	37.5	39.2	41.0	42.6	44.3	46.1
1 Muirdrochwood	34.6	34.2	34.6	36.7	39.5	41.8	43.7	44.9	45.8
2 Muirdrochwood	34.6	34.2	34.6	36.7	39.5	41.8	43.7	44.9	45.8
Furmiston	36.3	38.5	40.8	43.0	45.3	47.4	49.3	51.1	52.7
Nether Loskie	38.1	39.1	40.2	41.1	42.4	43.6	44.9	46.3	47.8
Marbrack	43.6	44.8	46.2	47.7	49.4	51.2	53.2	55.4	57.6
Craigengillan	44.4	45.0	45.8	46.4	47.7	49.0	50.5	52.2	54.0
Craigengillan Cottage	44.4	45.1	45.9	46.6	47.8	49.1	50.5	52.2	54.1
Marscalloch Cottage	38.1	39.1	40.1	41.1	42.3	43.6	44.9	46.3	47.8
Moorbrock	35.6	37.4	39.2	40.9	42.8	44.5	46.0	47.2	47.9
Blackmark	30.6	**27.6**	**29.9**	**32.5**	41.8	47.4	51.8	51.8	51.8
Strahanna Farm	35.6	37.3	39.0	40.7	42.8	44.5	46.0	47.2	47.9
Stroanpatrick	32.4	31.2	33.5	36.1	42.9	47.7	51.9	51.9	51.9
Night-time									
Smittons	42.8	42.6	42.4	41.8	41.7	41.7	42.6	44.3	46.1
1 Muirdrochwood	42.9	42.9	42.8	42.6	42.6	42.6	44.0	46.0	47.5
2 Muirdrochwood	42.9	42.9	42.8	42.6	42.6	42.6	44.0	46.0	47.5
Furmiston	43.0	43.0	43.0	42.9	43.5	46.2	48.6	50.8	52.6
Nether Loskie	43.0	43.0	43.0	43.0	43.0	43.3	44.4	45.5	46.5
Marbrack	43.0	43.0	44.5	46.6	48.9	51.3	53.5	55.4	57.0
Craigengillan	44.1	44.8	45.8	46.8	48.2	49.8	51.3	52.9	54.6
Craigengillan Cottage	44.1	44.9	45.9	46.9	48.3	49.9	51.4	52.9	54.6
Marscalloch Cottage	43.0	43.0	43.0	43.0	42.9	43.2	44.4	45.5	46.5
Moorbrock	42.9	42.8	42.7	42.4	42.3	43.8	45.5	46.8	47.8
Blackmark	42.4	41.5	40.1	36.2	44.2	48.9	53.2	53.2	53.2
Strahanna Farm	42.9	42.8	42.6	42.3	42.2	43.8	45.5	46.8	47.8
Stroanpatrick	42.5	41.9	40.9	39.1	44.9	49.2	53.3	53.3	53.3

14.6. Assessment of Potential Effects

Construction and Decommissioning Noise

14.6.1. Due to the separation distance between the Proposed Development and the nearest noise sensitive property, construction noise has not been assessed in terms of a noise level. Following the adoption of the good practice and embedded measures outlined in Section 14.8, no significant construction noise effects are anticipated.

14.6.2. Noise produced during decommissioning of the Proposed Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with. Therefore, no significant decommissioning noise effects are anticipated.

Operational Noise

14.6.3. Table 14.13 details the predicted noise immission levels due to the operation of the Development, following the methodology described in Section 14.3.

Table 14.13: Predicted Operational Noise Levels due to the Development

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Predicted Noise Level, dB, $L_{A90,10min}$								
Smittons	25.1	28.0	31.6	35.0	36.9	36.9	36.9	36.9	36.9
1 Muirdrochwood	23.7	26.6	30.3	33.6	35.5	35.5	35.5	35.5	35.5
2 Muirdrochwood	23.7	26.6	30.3	33.6	35.5	35.5	35.5	35.5	35.5
Furmiston	24.5	27.4	31.1	34.5	36.4	36.4	36.4	36.4	36.4
Nether Loskie	21.5	24.3	27.9	31.3	33.2	33.2	33.2	33.2	33.2
Marbrack	22.8	25.7	29.3	32.7	34.6	34.6	34.6	34.6	34.6
Craigengillan	28.9	31.9	35.6	39.0	40.9	40.9	40.9	40.9	40.9
Craigengillan Cottage	29.3	32.3	36.0	39.4	41.3	41.3	41.3	41.3	41.3
Marscalloch Cottage	21.3	24.1	27.7	31.0	32.9	32.9	32.9	32.9	32.9
Moorbrock	24.5	27.4	31.1	34.4	36.3	36.3	36.3	36.3	36.3
Blackmark	21.2	24.0	27.6	30.9	32.8	32.8	32.8	32.8	32.8
Strahanna Farm	22.9	25.8	29.4	32.8	34.7	34.7	34.7	34.7	34.7
Stroanpatrick	21.9	24.8	28.4	31.8	33.7	33.7	33.7	33.7	33.7

14.6.4. Table 14.14 details the difference (margin) between predicted noise immission levels (Table 14.13) and the apportioned noise limits (Table 14.12) for the assessed receptors. A negative margin indicates that the predicted noise level is below the derived noise limit.

Table 14.14: Margin between Predicted Turbine Noise and Noise Limits

Receptor	Standardised Wind Speed at 10 m AGL, ms^{-1}								
	4	5	6	7	8	9	10	11	12
	Margin, dB, $L_{A90,10min}$								
Quiet Daytime									
Smittons	-11.5	-9.1	-5.9	-2.5	-2.2	-4.1	-5.7	-7.4	-9.2
1 Muirdrochwood	-10.9	-7.5	-4.3	-3.1	-3.9	-6.3	-8.1	-9.4	-10.3
2 Muirdrochwood	-10.9	-7.5	-4.3	-3.1	-3.9	-6.3	-8.1	-9.4	-10.3
Furmiston	-11.7	-11.1	-9.8	-8.6	-8.9	-11.0	-12.9	-14.7	-16.3
Nether Loskie	-16.6	-14.7	-12.2	-9.9	-9.2	-10.4	-11.7	-13.1	-14.6
Marbrack	-19.1	-17.9	-16.1	-14.6	-14.6	-16.6	-18.6	-20.7	-23.0
Craigengillan	-15.5	-13.2	-10.2	-7.5	-6.8	-8.2	-9.6	-11.3	-13.2
Craigengillan Cottage	-15.1	-12.8	-9.9	-7.2	-6.5	-7.8	-9.2	-10.9	-12.8
Marscalloch Cottage	-16.8	-15.0	-12.5	-10.1	-9.4	-10.6	-11.9	-13.4	-14.9
Moorbrock	-11.1	-10.0	-8.1	-6.4	-6.5	-8.2	-9.7	-10.9	-11.5
Blackmark	-9.4	-3.6	-2.3	-1.6	-9.0	-14.6	-18.9	-18.9	-18.9
Strahanna Farm	-12.7	-11.5	-9.6	-7.9	-8.1	-9.8	-11.3	-12.5	-13.2
Stroanpatrick	-10.4	-6.4	-5.1	-4.3	-9.3	-14.1	-18.2	-18.2	-18.2
Night-time									
Smittons	-17.8	-14.7	-10.7	-6.8	-4.8	-4.8	-5.7	-7.4	-9.2
1 Muirdrochwood	-19.2	-16.3	-12.5	-9.0	-7.0	-7.0	-8.5	-10.5	-11.9
2 Muirdrochwood	-19.2	-16.3	-12.5	-9.0	-7.0	-7.0	-8.5	-10.5	-11.9
Furmiston	-18.5	-15.5	-11.9	-8.5	-7.2	-9.8	-12.2	-14.4	-16.2
Nether Loskie	-21.5	-18.7	-15.0	-11.7	-9.8	-10.1	-11.2	-12.3	-13.3
Marbrack	-25.2	-22.3	-18.7	-15.7	-17.0	-20.3	-24.0	-24.0	-24.0
Craigengillan	-15.2	-12.9	-10.2	-7.8	-7.4	-8.9	-10.4	-12.0	-13.7
Craigengillan Cottage	-14.8	-12.6	-9.9	-7.6	-7.1	-8.6	-10.1	-11.7	-13.3
Marscalloch Cottage	-21.7	-18.9	-15.3	-11.9	-10.0	-10.3	-11.4	-12.6	-13.6
Moorbrock	-18.4	-15.4	-11.7	-8.0	-5.9	-7.5	-9.2	-10.5	-11.4
Blackmark	-21.2	-17.5	-12.5	-5.2	-11.4	-16.1	-20.4	-20.4	-20.4
Strahanna Farm	-20.0	-17.0	-13.2	-9.5	-7.5	-9.1	-10.8	-12.1	-13.1
Stroanpatrick	-20.6	-17.1	-12.5	-7.3	-11.2	-15.5	-19.7	-19.7	-19.7

14.6.5. As Table 14.14 shows, worst case noise levels due to the Proposed Development are below the apportioned limits applicable to the Proposed Development. Therefore, noise due to the Proposed Development has been

shown to be compliant with the requirements of ETSU-R-97, and consequently is considered to be not significant as per the EIA Regulations.

14.7. Mitigation and Residual Effects

Construction and Decommissioning Phases

14.7.1. The Proposed Development infrastructure has been located as far as practicable from residential dwellings in order to minimise the effect of noise during construction. The good practice measures detailed below will be implemented to manage the effects of noise during construction operations, and will be required of all contractors:

- Operations shall be limited to times agreed with Dumfries and Galloway Council.
- Deliveries of turbine components, plant and materials by HGV to site shall only take place by designated routes and within times agreed with Dumfries and Galloway Council.
- The site contractors shall be required to employ the best practicable means of reducing noise emissions from plant, machinery and construction activities, as advocated in BS 5228.
- Where practicable, the work programme will be phased, which would help to reduce the combined effects arising from several noisy operations.
- Where necessary and practicable, noise from fixed plant and equipment will be contained within suitable acoustic enclosures or behind acoustic screens.
- All sub-contractors appointed by the main contractor will be formally and legally obliged, and required through contract, to comply with all environmental noise conditions.
- If any blasting is required, the following mitigation measures will be considered;
  - Blasting will be limited to times agreed with Dumfries and Galloway Council.
  - Trial blasting, using progressively larger charge loads, to establish maximum acceptable charge.
  - Provision of information on blasting to neighbouring residents.
- Where practicable, night-time working will not be carried out. Local residents shall be notified in advance of any night-time construction activities likely to generate significant noise levels, *e.g.* turbine erection.
- Any plant and equipment normally required for operation at night (23:00 - 07:00), *e.g.*, generators or dewatering pumps, shall be silenced or suitably shielded to ensure that the night-time lower threshold of 45 dB, $L_{Aeq,night}$ shall not be exceeded at the nearest noise-sensitive receptors.

14.7.2. Application of the above measures to manage construction noise will ensure that effects are minimised as far as is reasonably practicable and that the construction process is operated in compliance with the relevant legislation.

14.7.3. Noise produced during decommissioning of the Proposed Development is likely to be of a similar nature to that during construction, although the duration of decommissioning will be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with.

Operational Phase

14.7.4. During the design of the layout of the wind turbines, the distance between the turbines and neighbouring properties was maximised where possible, in order to minimise the effects of noise.

14.7.5. The Proposed Development was designed with reference to a range of alternative turbine models. Noise immissions at surrounding receptors were considered at each of the main layout iterations and contributed to the design of the final layout.

14.8. Summary

Summary of Effects

14.8.1. An assessment of potential noise effects has been carried out for the construction, operational and decommissioning phases of the Proposed Development.

14.8.2. Construction noise will be limited in duration and confined to working hours as specified by Dumfries and Galloway Council and can be adequately controlled through use of embedded good practice measures and secured by planning condition. This will ensure that any noise from the Proposed Development site during construction will be adequately controlled.

14.8.3. Operational noise has been assessed in accordance with ETSU-R-97 and in line with current best practice. It has been shown that the Proposed Development would comply with the requirements of ETSU-R-97 at all receptor locations.

14.8.4. The cumulative effects of the Proposed Development in conjunction with any nearby wind energy developments either operational, consented or the subject of a current planning application were taken into consideration in the above assessment, in accordance with ETSU-R-97 and the Good Practice Guide.

14.8.5. Noise during decommissioning will be of a similar nature to that of construction and will be managed through best practice or other guidance or legislation relevant at the time.

Statement of Significance

14.8.6. No significant effects during construction or decommissioning are predicted to occur as a result of the Proposed Development.

14.8.7. The effect of operational noise has been assessed using the methodology described in ETSU-R-97. Apportioned noise limits have been calculated at the nearest noise sensitive properties and predictions made based on the candidate turbine. The predicted noise levels are calculated to be below the apportioned limits and therefore the effect of noise is considered to be **not significant**.