Chapter 9

Noise

SCOTTISHPOWER RENEWABLES

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Chapter 9

9 Noise

9.1 Introduction

1. This chapter considers the potential noise and vibration effects that could arise as a result of the Proposed Development detailed on **Figure 4.1 Site Layout** and **Chapter 4: Development Description**. The noise aspects of the Site selection and design are described in full in **Chapter 3: Site Selection and Design**. Potential effects during both the construction and operation phases have been assessed. This chapter should be viewed alongside associated figures (**Figures 9.1 – 9.4)** and appendices (**Appendix 9.1 – 9.11**) of the Environmental Impact Assessment Report (EIAR), including **Chapter 4: Development Description**.

2. The potential noise and vibration impacts that have been assessed are:

   - impacts as result of noise generated during construction on sensitive receptors;
   - impacts as result of vibration generated during construction on sensitive receptors;
   - impacts as a result of groundborne vibration and air overpressures[1] from possible onsite borrow pit blasting works on sensitive receptors; and
   - impacts as a result of wind turbine noise on sensitive receptors, accounting for possible cumulative effects with other local existing and proposed windfarm developments.

3. The assessment has been undertaken in accordance with national and local planning policy and following current best practice guidance, including the Department of Trade and Industry's ETSU-R-97 document: *The assessment and rating of noise from windfarms*, and the Institute of Acoustics: *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (IoA GPG), which have informed the assessment of operational noise that would be generated by the Proposed Development.

4. No construction works associated with wind turbine installation (including foundations etc.) are required within 1 kilometre (km) of sensitive receptors. The closest proposed temporary construction compound is also located more than 1km away from receptors. However, some construction works to upgrade existing forestry tracks would be required at distances starting from approximately 220 metres (m) from a sensitive receptor. Assessments of construction noise and vibration have therefore been undertaken for these works. These assessments have been undertaken in accordance with BS 5228-1:2009+A1:2014: *Code of practice for Noise and vibration control on construction and open sites. Noise* (BS5228-1) and BS 5228-2:2009+A1:2014: *Code of practice for Noise and vibration control on construction and open sites. Vibration* (BS5228-2).

5. Four borrow pit search areas are included as part of the Proposed Development. It is anticipated that blasting works may be required in the stone winning process at these borrow pits. An assessment of blast induced air overpressure and groundborne vibration has therefore been undertaken in accordance with Planning Advisory Note 50: *Controlling the Effects of Surface Mineral Workings* (Planning Advise Note (PAN 50)), BS5228-1 and BS5228-2.

6. The Site is to be accessed off the C46W, from up to two new upgraded access junctions along the eastern Site Boundary. Travel to these access points could be via the U52W, A714 and C46W to the south, or the B741, B7023, B7045 and C46W (Newton Stewart Road) to the north (which in turn link to the A75, A77 and B734). These routes pass small villages including Glentrool, Straiton, Cloyntie, Kirkmichael, Crosshill and Dailly, and a number of other isolated properties However, construction traffic movements are not anticipated to generate high road traffic noise levels. Assessment of construction traffic noise has therefore been scoped-out as no significant effects would arise.

7. The delivery of wind turbine components to the Site would be from the south utilising the C46W, A714, U52W and A75. Localised road and junction improvement works are anticipated to be necessary to facilitate abnormal deliveries (e.g. wind turbine blades). Such junction works are anticipated to comprise (for example) the laying of additional areas of load bearing surfaces, the cutting back of vegetation/tree canopies, minor earthwork reprofiling, localised widening and road sign removals etc. Such works would be, local, temporary and short-term only, and would be akin to temporary work associated with utilities servicing etc.

8. **Appendix 4.1 Offsite Access Appraisal** considers the potential noise effects of the proposed offsite access route to the Site, concluding that there would be no potential significant effects likely to occur as a result of the offsite access route upgrade works and as a result, this has not been assessed further within this chapter.

9. Once operational, development generated traffic would be extremely low. Assessment of operational traffic noise has therefore been scoped-out as no significant effects would arise.

10. Fixed plant items associated with the Proposed Development, i.e. the associated Substation Compound and Energy Storage Facility[2] would be sited more than 1.17km from the nearest sensitive receptors. Assessment of fixed plant noise has therefore been scoped-out as no significant effects would arise.

11. This chapter is necessarily technical in nature and contains terminology relating to noise and vibration. The terminology used in this chapter is defined and explained in **Appendix 9.1 Glossary of Acoustic Terminology**.

9.2 Legislation, Policy and Guidance

9.2.1 Policy

9.2.1.1 National Policy

Scottish Planning Policy (SPP)

12. Published in June 2014, the SPP states that its purpose is to set out national planning policies which reflect Scottish Ministers' priorities for the operation of the planning system, and for the development and use of land. The SPP sits alongside the *National Planning Framework* (NPF) and sets out the policy that would help to deliver the objectives of the NPF.

13. With regard to on-shore wind energy development, the SPP provides overarching advice to planning authorities, for example with regard to spatial frameworks in development plans, and the need to identify where there is strategic capacity for windfarms.

14. In the section entitled 'Onshore wind' it is stated that: "Development plans should also set out the criteria that will be considered in deciding all applications for wind farms of different scales – including extensions and re-powering, taking account of the considerations set out at paragraph 169." Paragraph 169 lists a number of different considerations including "cumulative impacts", and "noise".

National Planning Framework

15. The National Planning Framework 4 (NPF 4) states that it is a long term plan for Scotland that sets out where development and infrastructure is needed. Currently in draft form only, it was laid in parliament on the 10 November 2021 for consideration over a 120 day period. In parallel with parliamentary scrutiny, the draft NPF

[1] Which includes noise. Both the audible (noise) and the sub-audible elements (sensed as concussion) arising from a blast event, are together known as 'air overpressure'.

[2] Subject to landowner agreement

4 is also subject to consultation, which is open until the 31 March 2022. The results of those considerations are not yet known, but in draft form the NPF4 includes a number of policies that include reference to noise and which are pertinent to the Proposed Development:

"*Policy 6: Design, quality and place*

…[Several points including:]

e) Proposals that are detrimental to the character or appearance of the surrounding area taking into account effects on daylight, sunlight, noise, air quality and privacy should not be supported, in order to protect amenity"

"*Policy 14: Health and wellbeing*

…[Several points including:]

d) Development proposals that would result in unacceptable levels of noise will not be supported. A noise impact assessment will be required where significant exposure to noise is likely to arise from the proposed development."

"*Policy 19: Green Energy*

…[Several points including:]

k) Specific considerations will vary relative to the scale of the proposal and area characteristics but development proposals for renewable energy developments must take into account:

…[Several points including:]

• impacts on communities and individual dwellings, including visual impact, residential amenity, noise and shadow flicker;"

"*Policy 22: Minerals*

…[Several points including:]

d) Extraction criteria: Development proposals for the sustainable extraction of aggregates should be supported where they:

…[Several points including:]

• demonstrate acceptable levels (including cumulative impact) of noise, dust, vibration and potential pollution of land, air and water;"

16. Until the NPF4 is finalised and formally adopted, the latest version of the NPF is NPF3. Published in June 2014, the NPF3 is stated to be a long-term strategy, being a spatial expression of the Government's Economic Strategy and its plans for development and investment in infrastructure. Wind resource in Scotland is recognised within the NPF3, being referenced several times, but only at a high level, with no specific guidance or policies laid out with respect to noise or vibration.

Planning Advice Note 1/2011, Planning and Noise (PAN 1/2011)

17. Published in March 2011, PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit adverse effects of noise. Information and advice on noise assessment methods are provided in the accompanying Technical Advice Note (TAN): *Assessment of noise*. Included within PAN 1/2011 and the accompanying TAN are details of the legislation, technical standards and codes of practice for specific noise issues.

18. With regard to noise from wind turbines, paragraph 29 of PAN 1/2011 states the following:

"*There are two sources of noise from wind turbines – the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry (DTI) and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise.*"

19. The web-based planning advice referred to in PAN 1/2011 is contained in an online document entitled: *Onshore wind turbines*. This document is summarised below, and also refers to the use of ETSU-R-97.

20. The accompanying TAN to PAN 1/2011 also refers to ETSU-R-97, including a summary of the associated assessment approach. The ETSU-R-97 assessment guidance is summarised below.

21. The TAN points out that the ETSU-R-97 report presents a consensus view of a group of experts, who between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from windfarms.

22. The TAN also includes reference to Planning Advice Note 50: *Controlling the environmental effects of surface mineral workings* (PAN 50) which includes consideration to the blast-induced effects (groundborne vibration and air overpressure), as summarized below.

23. With regards to the assessment and control of noise and vibration from construction sites the use of BS 5228: 2009 (Parts 1 and 2) is discussed. This version of BS 5228 has been superseded by BS 5228-1:2009+A1:2014: *Code of practice for noise and vibration control on construction and open sites. Noise* (BS5228-1) and BS 5228-2:2009+A1:2014: *Code of practice for noise and vibration control on construction and open sites. Vibration* (BS5228-2). These standards are summarised in the corresponding section below.

Planning Advisory Note 50: Controlling the Effects of Surface Mineral Workings

24. **Paragraphs 33 to 38** of this document are concerned with blasting, including vibration and air overpressure. It is confirmed that the levels of vibration generated by surface mineral workings are well below those required to cause structural damage to properties, but that vibration and air overpressure may give rise to nuisance. It is also confirmed that the levels of air overpressure and noise can be significantly affected by meteorological conditions.

25. It is recommended that any planning conditions pertinent to blast-induced vibration should look to set acceptable vibration level limits, but that such an approach would be impractical for air overpressures due to affecting factors outside the control of the operator (e.g. meteorological effects). It is identified that the operator would always be concerned with maximising the effectiveness of the blast, and therefore minimising lost energy through air overpressure[1].

26. A summary of good practice on blasting works is also presented within this PAN.

9.2.1.2 Local Policy

South Ayrshire Local Development Plan

27. Adopted in September 2014, the South Ayrshire Local Development Plan (LDP) is the strategic land use plan that sets out the strategic spatial priorities and planning policies for the South Ayrshire area. The LDP confirms that noise can have a serious effect on health and well-being, so rather than trying to lessen these effects after a development has taken place, it is more effective to avoid development areas where these problems could occur.

28. In June 2019, South Ayrshire Council approved the Proposed Replacement South Ayrshire LDP (PLDP2) for publication and consultation, and a subsequent update was made in March 2020 which is referred to as The Modified Proposed LDP 2 (MPLD2). The MPLDP2 was submitted to the Scottish Government for inspection and in March 2021 Scottish Ministers appointed a reporter to carry out an examination of the MPLDP2. The examination process is yet to be completed, so the MPLDP2 is not currently adopted, with the LDP remaining

in force. The relevant LDP policies that are pertinent to noise or vibration and the Proposed Development are summarised below:

"*LDP policy: air, noise and light pollution*

We will not allow development which would expose significant numbers of people to unacceptable levels of air, noise or light pollution."

"*LDP policy: minerals and aggregates*

…Minerals other than coal

We will accept proposals for extracting and working minerals other than coal if they accord with the following criteria:

[Several points including]…

b. they ensure that the environmental impacts on local communities, including from noise, blasting and vibration, and potential pollution of land, air and water, are adequately controlled or mitigated;…"

"*LDP policy: wind energy*

We will support proposals if:

[Several points including]…

c. they do not have any other significant detrimental effect on the amenity of nearby residents, including from noise and shadow flicker; …"

South Ayrshire Local Development Plan Supplementary Guidance: Wind Energy

29. This Supplementary Guidance document, dated December 2015, was prepared following adoption of the LDP, and provides additional planning guidance on the LDP policy for wind energy.

30. In the subsection entitled 'Noise', it is confirmed that the noise generated from wind turbines comprises both gearbox/generator noise and aerodynamic noise, with the latter generally being dominant. It is stated that a noise impact assessment would be required for all windfarm proposals with the scale of information submitted being appropriate to the size and capacity of the development, e.g. a desktop assessment generally may only be appropriate for small wind turbines.

31. The need for a cumulative assessment is confirmed with a requirement for this to consider any proposed, consented or existing wind turbines within a search radius of 5km. Reference is made to ETSU-R-97 and the IoA GPG as being the appropriate guidance for noise assessment to follow. These documents are summarised in the corresponding section below.

32. It is also stated that further guidance on the information required to be submitted as part of any noise assessment is contained in Environmental Health document entitled: *Noise Impact Assessment Requirements for Wind Turbine Developments*', which is based on ETSU-R-97 and the IoA GPG, and also summarised below.

33. Finally, with reference to research by SLR and Scottish Planning Policy, the need to consider the duration and character by noise qualitative assessment is highlighted, including describing the potential for audibility of wind turbine noise. Noise from a windfarm is reported as not audible if predicted at levels below 25dB(A). It is suggested that at 38dB(A) noise from windfarms would be audible and create annoyance, although this is contrary to guidance in ETSU-R-97 and the IoA GPG, and is of course dependent upon the prevailing baseline conditions, indeed it is then confirmed that noise surveys would be required to assist in determining potential impacts.

9.2.2 Guidance

Scottish Government Online Planning Advice for Renewable Energy Technologies: Onshore Wind Turbines

34. This web based planning advice superseded the former PAN 45: *Renewable energy*. It is confirmed that operational wind turbine noise comprises two different components, the mechanical noise produced by the gearbox, generator and other parts of the drive train, and the aerodynamic noise produced by the passage of the blades through the air. It is stated that there has been significant reduction in the mechanical noise generated by wind turbines through improved wind turbine design.

35. With regards to the appropriate assessment method, it is stated that:

"*The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97) describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments*",

and that this:

"*gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions*".

36. Reference is made to further reports by Hayes McKenzie for the Department of Energy and Climate Change (DECC) suggesting that best practice guidance is required to add to the way in which ETSU-R-97 should be implemented in practice. It is confirmed that "*a previous report…by the same authors concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by the wind turbines that were tested. The Salford university report into Aerodynamic Modulation of Wind Turbine Noise…summarised the conclusions of the Hayes McKenzie report and investigated further complaints caused by amplitude modulation of aerodynamic noise (AM). Report findings were constrained by low incidence of AM and the low numbers of people adversely affected in the UK*".

37. It also recognised that the Institute of Acoustics has subsequently published the IoA GPG, which provides significant support on technical issues to all users ETSU-R-97, in applying its assessment method. It is confirmed that *"the Scottish Government accepts that the guidance represents current industry good practice*".

Energy Technology Support Units R-97 document: The Assessment and Rating of Noise from Windfarms

38. As referenced for use in PAN 1/2011 and the online planning advice for renewable technologies: *Onshore wind turbines*, this document was written by a 'Noise Working Group' (NWG) including developers, noise consultants and environmental health officers, set up in 1995 by the Department of Trade and Industry through ETSU (the Energy Technology Support Unit).

39. This document presents a consensus view of the working group and was prepared to present a common approach to the assessment of noise from wind turbines. This document states that noise from wind turbines or windfarms should be assessed against site specific noise limits.

40. These limits are derived based on a set of acceptable lower limits, and an allowable exceedance above the prevailing background noise levels, including consideration to a range of prevailing wind speed conditions, relevant to the Proposed Development. The noise limits should be derived for external areas used for relaxation, or areas where a quiet noise environment is highly desirable. Separate limits are required for night-time and daytime periods. Night-time limits are derived drawing upon measured night-time background noise levels, whilst daytime limits are derived drawing upon the background noise levels measured during 'quiet daytime' periods.

41. Night-time is defined as the period 23:00 to 07:00, whilst 'quiet daytime' periods are defined as 18:00 to 23:00 on all days, as well as 13:00 to 18:00 on Saturdays and Sundays, and 07:00 to 13:00 on Sundays.

42. For the daytime, the suggested limits are 5dB above the prevailing background noise level determined during quiet daytime periods, or 35 to 40dB(A), whichever is the higher. The absolute criterion within the 35 to

40dB(A) range is selected taking account of the Site environs (e.g. number of local receptors), the energy generation capacity of the windfarm (e.g. number of kilowatt Hours (kWh) that can be generated), and the associated duration and level of exposure.

43. During the night-time, the suggested limits are 5dB above the prevailing night-time background noise level or 43dB(A), whichever is the higher. The absolute criterion for the night-time is higher than that for the daytime, as the derivation of this limit is based on preventing sleep disturbance within a building whereas for the daytime, limits are based on occupation of external spaces used for relaxation.

44. It is required that the prevailing background noise levels are determined in terms of the $L_{A90,10min}$ noise index for both quiet daytime and night-time periods, for wind conditions ranging from 2 to 12m/s.

45. The noise limits are calculated by undertaking a regression analysis of the $L_{A90,10min}$ background noise levels and the prevailing average wind speed for the same 10-minute periods, when measured or determined at 10m above ground at the location of the proposed wind turbines. The allowable limit is then defined at +5dB above the average noise level at each wind speed (as defined by the regression analysis), or the absolute noise level lower limit (or '*fixed element*'), whichever is the higher (assuming no financial involvement with the scheme).

46. Where a property has a financial involvement in the scheme, the document allows a relaxation of the derived noise limits, stating that:

"It is widely accepted that the level of disturbance or annoyance caused by a noise source is not only dependent upon the level and character of noise but also the receiver's attitude towards the noise source in general. If the residents at the noise-sensitive properties were financially involved in the project, then higher noise limits will be appropriate."

and

"It is recommended that both the day and night-time lower fixed limits can be increased to 45dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the windfarm."

47. The ETSU guidance states that the derived limits should be applied to noise from the proposed windfarm or wind turbines in terms of the $L_{A90,T}$ index, and that the $L_{A90,T}$ of the windfarm noise is typically 1.5 to 2.5dB less than the $L_{Aeq,T}$ measured over the same period.

48. The derived noise limits are applicable to both the aerodynamic (e.g. 'blade swish') and mechanical (e.g. generator related) components of windfarm noise.

49. Where noise from the windfarm is tonal, a correction of between 2 and 5dB is to be applied to the windfarm noise. Guidance is provided on how to determine the level of correction required, but typically, the need for any applicable correction is confirmed by the wind turbine manufacturers.

50. It is stated within this document that:

"The NWG is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a windfarm was constructed in the vicinity in the past which resulted in increased noise levels at some properties, that residents of those properties are now able to tolerate still higher noise levels. The existing windfarm should not be considered as part of the prevailing background noise."

51. Accordingly, where an existing windfarm contributes to the prevailing background noise levels:

- it is necessary that significantly affected measurements are discarded in the determination of the underlying baseline conditions; and
- it is necessary to either include for the contribution of that windfarm when assessing windfarm noise levels against the allowable noise limits, or correct for that contribution when deriving a limit applicable to the proposed windfarm operating in isolation.

52. ETSU-R-97 also details a simplified assessment methodology, which is based on the principle that if the lowest fixed element for the daytime noise limits (35dB $L_{A90,T}$) can be met at high wind speeds, then the need to consider the limit element which is relative to the background noise levels can be discounted, because this would only be higher at such speeds.

The Institute of Acoustics: A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IoA GPG)

53. The IoA GPG presents the report of a 'NWG assembled in response to a request from the DECC. The guide is intended to represent current good practice in applying the ETSU-R-97 method to assessing the noise impact of wind turbine developments with a power rating of over 50 kilowatts (kW).

54. The document provides clarification and updated guidance on a range of matters relating to ETSU-R-97 noise assessments, including consultation with relevant stakeholders, background noise survey methodology, noise survey data analysis, derivation of noise limits, noise prediction model input data, algorithms and parameters, cumulative impact assessment procedures, assessment reporting, planning conditions and amplitude modulation. A set of supplementary guidance notes (SGNs) also form part of the publication and include further specific detail for different technical areas.

55. The detail of the IoA GPG has been considered in the preparation of this assessment. Some of the key considerations relevant to this assessment are summarised as follows:

- calculations of predicted wind turbine noise may be carried out using ISO 9613-2: *Acoustics – Attenuation of sound during propagation outdoors* (International Organization for Standardization, 1996) (ISO 9613-2); preferred receptor heights, meteorological and ground absorption input parameters for this calculation procedure are given;
- wind turbine sound power level source data should include appropriate uncertainty corrections. Guidance is given for determining when such uncertainty corrections have been inherently included in wind turbine source emission data;
- 'excess amplitude modulation' (i.e. where the wind turbine noise has higher variability with momentary time than the 2 – 3dB(A) considered within ETSU-R-97) is still the subject of research; current practice (at the time of publishing of the IoA GPG) in relation to determining applications for wind turbine developments is to not impose a planning condition specific to this phenomenon; and
- a method is detailed within the IoA GPG to allow the effect of wind direction to be taken into account during noise level predictions. This method details a number of corrections based on the angle of the wind in relation to the position of the source and receiver, and the nature of the local ground (flat or complex).

56. The IoA GPG also confirms that the ETSU-R-97 noise level limits should be applied cumulatively, and provides guidance on determining when a cumulative assessment is required as well as appropriate cumulative assessment methods for a variety of different scenarios. These scenarios include 'concurrent application', 'existing windfarm consented with less than total ETSU-R-97 limits', 'existing windfarms consented to the total ETSU-R-97 limits currently operating', 'permitted windfarm consented to total ETSU-R-97 limits but not yet constructed', and 'significant headroom present'.

57. In the section entitled 'Cumulative Impact Assessment necessary', it is stated that:

"During scoping of a new windfarm development consideration should be given to cumulative noise impacts from any other windfarms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing windfarms at the same receptor location, then a cumulative noise impact assessment is necessary."

"Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary."

58. This confirms that where noise levels from the new development are 10 dB(A) or more below the limits imposed on surrounding developments further consideration to cumulative impacts is not required.

59. In the case of the Proposed Development there are two existing cumulative windfarms (Hadyard Hill Windfarm and Dersalloch Windfarm) consented with planning conditions stipulating noise limits less than the total ETSU-R-97 limit (see **Section 9.5.1**). These developments are however at sufficient distances from the Proposed Development that, they can be either scoped-out of the cumulative assessment (on the basis of resulting levels being more than 10dB below applicable limits), or that at the noise sensitive receptors closest to the Proposed Development, there is headroom between the current operational wind turbine noise levels and the applicable limits (see **Sections 9.6.5.4 and 9.6.6.2**). There are also two concurrent developments which are in close proximity to the Proposed Development, Craiginmoddie Windfarm, see **Section 9.5.1.3,** and Knockcronal Windfarm, see **Section 9.5.1.4.**

60. The subsequent advice on appropriate assessment methods is then provided for a situation where the 10dB difference check is not demonstrable:

"Concurrent applications

Concurrent applications with no pre-existing wind farms permit the apportionment of the ETSU-R-97 limits on an energy basis to each wind farm from the outset. LPAs may wish to bring together concurrent wind farm applicants, such that apportionment can be discussed and agreed in conjunction with the applicants. Noise limits for all the wind farms operating cumulatively are derived at all noise sensitive receptors, just as they would be if one wind farm were being considered. Having derived noise limits for the cumulative effects of all the contributing wind farms, the wind farm developers can then work together to 'apportion' the noise limits for each wind farm operating in isolation such that the cumulative effects of all wind farms operating together cannot cause the cumulative noise limits derived in accordance with ETSU-R-97 to be exceeded. Thus the noise limits which meet with the requirements of ETSU-R-97 could only be exceeded if one or more of the wind farms were to operate above its own apportioned noise limits."

61. The text above positively promotes dialogue between the applicants of concurrent developments to seek to agree limit apportionment. Figure 7 of the document then presents an illustration of an apportioned limit between two proposed windfarms. That figure presents two different daytime noise limits, one for each development, the sum of which gives the total ETSU-R-97 limit. The figure also presents how the predicted levels from each of the two developments fall below their respective limits (and as such the combined levels when operating simultaneously would be below the total ETSU-R-97 daytime limit).

"Existing wind farm/s consented with less than total ETSU-R-97 limits

If an existing wind farm is consented to noise limits of less than the total ETSU-R-97 limits, a future wind farm applicant can then use these limits as a base within their predictions. Whether the existing wind farm is currently operating or not is immaterial to the assessment, as it will not be able to exceed its own conditions. It is becoming more common to apply noise limits which are less than total ETSU-R-97 limits because of cumulative considerations.

This should be undertaken in consultation with the LPA and relevant applicant(s). An example of this in practice is the apportionment of the ETSU-R-97 noise limit between concurrent applications. It may be the case that conditioning the scheme to the exact predicted noise levels (at all wind speeds) for the candidate turbine presented within the submitted noise impact assessment may constrain the applicant in future turbine procurement options. Therefore, a constant margin above the predicted noise levels (or below the total ETSU-R-97 limits) could be chosen which provides the applicant with procurement options but in combination with the neighbouring wind farm/s can still achieve the ETSU-R-97 limits."

and

"Significant presented headroom

In cases where there is significant headroom (e.g. 5 to 10 dB) between the predicted noise levels from the existing wind farm and the total ETSU-R-97 limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the total ETSU-R-97 limits, agreement could be sought with the LPA as to a suitable predicted noise level (including an appropriate margin to cover factors such as potential increases in noise) from the existing wind farm to be used to inform the available headroom for the cumulative assessment without the need for negotiation or cumulative conditioning. This may be the case particularly at low wind speeds."

62. In addition to the above, under the section entitled 'Existing wind farm/s consented to the total ETSU-R-97 limits, currently operating', the principle of a '*controlling property*' is described, i.e. in complying with the noise limits at one property (which for example may be in close proximity to a given windfarm), there would be limit headroom at another property (which for example may be at a greater distance from that windfarm). This principle can equally be applied where the limit in question is less than the total allowable ETSU-R-97 limit.

63. The document includes a table detailing the key points which good practice suggests should be included in assessment reporting, as duplicated in **Table 9.1** below**.**

Topic	Reporting Requirements
Consultations	• consultation with Local Planning Authority; and • EHO input into selection of background noise measurement equipment.
Background Measurements	• number of monitoring locations; • map showing monitoring locations; • description of monitoring locations; • description of noise environment; • photos of monitoring locations; • monitoring period; • description of noise measurement equipment wind shield; • certification/calibration of all equipment used and any calibration drift; • wind (speed and direction) and rainfall measurement data sources; • clear representation of excluded data in time histories or scatter plots; • chart showing distribution of wind speeds and direction; and • cumulative issues in background measurements.
Noise Predictions	• prediction methodology; • candidate wind turbine model; • wind turbine source noise data (including noise-reduced modes if used); • wind turbine source octave band noise levels; • description of noise propagation/attenuation factors; • atmospheric attenuation – assumed temperature and relative humidity; • ground effects – Assumed ground factor; • assumed receiver height; • barrier/screening attenuation; • wind direction filtering (if considered); and • noise contours.
Assessment	• wind shear assessment method; • derivation of prevailing background noise; • type, order and coefficients of regression line;

Topic	Reporting Requirements
	• scatter data shown on plots; • derivation of noise limits and numerical values; • amenity noise limit; • justification for amenity noise limit if chosen; • night-time noise limit; • financially involved noise limit; • capping of noise limits at highest wind speed measured; • comparison of predicted noise level with derived noise limits; and • correction from L_{Aeq} to L_{A90}. • potential tonal content; • properties covered by assessment; • incorporated mitigation (wind turbines running in low noise mode) (if relevant); and • cumulative issues.

Table 9.1 Suggested Key Points for Inclusion in a Wind Turbine Noise Assessment Report

South Ayrshire Council Environmental Health, Wind Turbines Development: Submission Guidance Note

64. This note has been published by the Environmental Health Department of South Ayrshire Council to provide guidance to applicants seeking consent for a wind turbine development. Guidance is provided for development of both large scale (e.g. wind arms), and small scale (defined as a wind turbine of 50kW or less with a rotor swept area of 200m^2 or less). For large scale development, as is the case here, the provided guidance is based on that contained within ETSU-R-97 and the IoA GPG, indeed it is stated that:

"All planning applications for wind turbine development must be accompanied by a site specific noise impact assessment. It is expected that the noise impact assessment will be undertaken in accordance with ETSU-R-97, the IoA Good Practice Guide to the Application of ETSU (May 2013) and the IoA SGNs that accompany these documents."

65. However, there are some deviations in the provided guidance compared to ETSU-R-97 and the IoA GPG, for example it is stated that:

"South Ayrshire Council has determined that noise from all large wind turbine developments shall be restricted to the following limits at all relevant noise sensitive receptors:-

…35dB $L_{A90,\ 10\ min}$ daytime hours and 38dB $L_{A90,\ 10\ min}$ night time hours or ETSU derived limits of background noise level plus 5dB (whichever is greater)

40dB $L_{A90,\ 10\ min}$ or ETSU derived limits of background noise level plus 5dB (whichever is greater), at properties with valid financial interest

45dB $L_{A90,\ 10\ min}$ or ETSU derived limits of background noise level plus 5dB (whichever is greater), at properties with valid financial interest where there are also cumulative noise impacts."

66. By contrast the fixed elements of the ETSU-R-97 allowable noise levels are 35-40 dB(A) during daytime hours, (not simply 35dB(A)) and 43dB(A) during night-time hours (not 38dB(A)), with subsequent upwards relaxations allowed where a property has a financial involvement, e.g. up to a fixed element of 45dB(A). In addition, ETSU-R-97 applies these limits to the total cumulative noise levels, it is not the case that the level of relaxation that can be applied for financial involvement is variable depending upon whether or not there is a cumulative impact.

67. In addition, this limit guidance does not account for a situation where an existing windfarm may already be subject to noise limits greater than those which the note describes (as is the case here, see **Section 9.5.1**). Separate guidance is however given for cumulative assessments, based on achieving operational noise levels 10 dB(A) lower than the levels of existing wind turbines, whilst also recognising that there may be some circumstances where an alternative approach is more appropriate.

68. A further deviation from ETSU-R-97 is that the guidance states that site specific noise limits would be set that are based on predicted wind turbine noise levels rather than the application of the derived ETSU-R-97 compliant limits at each noise sensitive property. By comparison the IoA GPG states:

"It may be the case that conditioning the scheme to the exact predicted noise levels (at all wind speeds) for the candidate turbine presented within the submitted noise impact assessment may constrain the applicant in future turbine procurement options. Therefore, a constant margin above the predicted noise levels (or below the total ETSU-R-97 limits) could be chosen which provides the applicant with procurement options but in combination with the neighbouring wind farm/s can still achieve the ETSU-R-97 limits"

69. The guidance duplicates the content of **Table 9.1** with regards to reporting requirements and goes on to state that in addition, South Ayrshire Council require that the following information is also provided:

- accurate 12-digit grid references for the wind turbine(s);
- accurate 12-digit grid references for the noise sensitive receptors;
- elevations of wind turbines and receptors;
- details of any financial involvement at noise sensitive receptors;
- sound power level details for the wind turbine(s). Broadband and A-weighted octave band data is required, together with uncertainty figures and any tonal penalty; and
- information regarding any valley effect. It will be necessary to demonstrate whether or not, a 3dB correction is required in respect of the valley/significantly sloping ground effect.

British Standard 5228-1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

70. This standard sets out techniques to predict the likely noise effects from construction works, based on detailed information on the type and number of plant being used, their location and the length of time they are in operation.

71. The noise prediction methods can be used to establish likely noise levels in terms of the $L_{Aeq,T}$ over the core working day. This standard also documents a database of information, including previously measured sound pressure level data for a variety of different construction plant undertaking various common activities.

72. Three example methods are presented for determining the significance of construction noise impacts. In summary, these methods adopt either a series of fixed noise level limits, are concerned with ambient noise level changes as a result of the construction operations or a combination of the two.

73. With respect to absolute fixed noise limits, those detailed within Advisory Leaflet 72: 1976: *Noise control on building sites* are presented. These limits are presented according to the nature of the surrounding environment, for a 12-hour working day. The presented limits are:

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

74. The above noise level limits are applicable at the façade of the receptor in question (not free-field).

75. The standard goes on to provide methods for determining the significance of construction noise levels by considering the change in the ambient noise level that would arise as a result of the construction operations. Two example assessment methods are presented, these are the 'ABC method' as summarised within **Table 9.2** and the '5 dB(A) change' method as described below **Table 9.2**.

Assessment Category and Threshold Value Period	Threshold Value, in Decibels (dB) ($L_{Aeq,T}$)		
	Category (A)[A)]	Category (B)[B)]	Category (C)[C)]
Night-time (23:00 – 07:00)	45	50	55
Evenings and weekends[D)]	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the Site exceeds the threshold level for the category appropriate to the ambient noise level. NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3dB due to site noise. NOTE 3: Applied to residential receptors only			
A) Category A: threshold values to use when ambient levels (when rounded to the nearest 5dB) are less than these values. B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as Category A values. C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than Category A values. D) 19.00-23.00 weekdays, 13.00-23.00 Saturdays and 07.00-23.00 Sundays			

Table 9.2 Example Threshold of Potential Significant Effect at Dwellings (Construction Noise) – ABC Method

76. With respect to the '5 dB(A) change' method, the guidance states:

"Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65dB, 55dB and 45dB L_{Aeq}, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact."

77. With regards to blast induced noise, the following is stated:

"Blasting can be an emotive issue for residents around an opencast site. Good liaison between operator and residents is essential to prevent unnecessary anxiety. Wherever possible, the operator should inform each resident of the proposed times of blasting and of any deviation from this programme in advance of the operations. On each day that blasting takes place it should be restricted as far as practicable to regular periods."

British Standard 5228-2:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

78. This standard provides recommendations for basic methods of vibration control relating to construction and open sites. The legislative background to vibration control is described and guidance is provided concerning methods of measuring vibration and assessing its effects on the environment.

79. Guidance criteria are suggested for the assessment of the significance of vibration effects; such criteria are provided in terms of Peak Particle Velocities (PPV) and are concerned with both human and structural responses to vibration. Those applicable to human perception and disturbance are presented within

Vibration Level (PPV)	Effect
0.14mms^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3mms^{-1}	Vibration might be just perceptible in residential environments.
1.0mms^{-1}	It is likely that vibration of this level in residential environments would cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10mms^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Table 9.3 Guidance Criteria for the Assessment of Significance of Vibration for Human Perception and Disturbance

80. The standard goes on to present guidance criteria applicable to the vibration response limits of buildings in terms of the component PPV. These are presented within **Table 9.4**. It should be noted that the values presented within **Table 9.4** are applicable to cosmetic damage only. It is stated that minor damage is possible at vibration magnitudes which are greater than twice those given in the table.

Type of building	Peak component particle velocity in frequency range of predominant pulse	
	4Hz to 15Hz	15Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4Hz and above	50mm/s at 4Hz and above
Unreinforced or light framed structures Residential or light commercial buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above
NOTE 1: Values referred to are at the base of the building. NOTE 2: For Unreinforced or light framed structures, residential or light commercial buildings, at frequencies below 4Hz, a maximum displacement of 0.6mm (zero to peak) is not to be exceeded		

Table 9.4 Guidance Criteria for the Assessment of Significance of Transient Vibration for Cosmetic Building Damage

81. With regards to blast operations, on page 73 of this British Standard, a calculation method to determine blast induced vibration levels at different distances is presented. The method presented is based on analysis of the results of vibration measurements undertaken at the site in question. This method therefore relies upon a degree of blasting works being undertaken at the Site, before accurate distance calculations can be completed. The calculation method allows the resultant PPV vibration level to be determined at different distances for known charge weights.

82. It is confirmed that the majority of energy generated within the atmosphere from surface blasting is of a sub-audible nature (i.e. at frequencies <20Hz), although there is a component that is audible to the human ear and as such would be heard as noise. Audible noise and the sub-audible element (sensed as concussion) are together known as air overpressure.

83. Air overpressure may be sensed or felt by humans and can excite secondary vibrations at audible frequencies in buildings (e.g. rattling of windows and ornaments on shelves) that have been found to give rise to adverse comments from occupants of buildings affected by the blasting. However, this standard states that there is no known evidence of structural damage to buildings/structures from excessive air overpressure levels from quarry blasting. It is stated that:

"*routine blasting can regularly generate air overpressure levels at adjacent premises of around 120 dB (lin). This level corresponds to an excess air pressure which is equivalent to that of a steady wind velocity of 5 m/s (Beaufort force 3, gentle breeze) and is likely to be above the threshold of perception.*"

84. Research is referenced that has identified that a poorly mounted window that is pre-stressed might crack at 150 dB (lin), with most windows cracking at around 170 dB (lin), whereas structural damage would not be expected at levels below 180 dB (lin).

85. It is stated that due to uncertainties with meteorological conditions, it is not possible to predict the location of maximum air overpressure, but a methodology for air overpressure measurement is presented, whilst it is stated that pressure variations in the atmosphere due to windy conditions can mask the blast generated air overpressure, and that for this reason, it is not accepted practice.

9.3 Consultation

86. Consultation has comprised the responses received to the submitted Scoping Report and separate correspondence with the Environmental Health Department of South Ayrshire Council (and their advisors for operational windfarm noise, ACCON UK).

9.3.1 The Energy Consents Unit (ECU)

87. In the Scoping Opinion (see **Appendix 2.1 Scoping Opinion**), the ECU stated the following:

"*Scottish Ministers request the Company takes account of the advice provided by South Ayrshire Council and please see the points raised in the response on Annex A1-A12. The noise assessment should be carried out in line with relevant legislation and standards as detailed in Chapter 10 of the scoping report. The noise assessment report should be formatted as per Table 6.1 of the IOA "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*".

88. The referenced '*Table 6.1*' is duplicated as **Table 9.1** above.

89. The noise and/or vibration related responses referenced as within 'Annex A1 to A12' are the consultation responses that were received by the ECU from South Ayrshire Council Environmental Health (also including their noise and vibration technical advisors ACCON UK). A summary of consultation undertaken with South Ayrshire Council is presented below.

9.3.2 South Ayrshire Council

90. Both before and after receipt of the Scoping Opinion, as well as during its preparation, telephone and written consultation was also undertaken with the South Ayrshire Council Environmental Health Department and ACCON UK. The purpose of this consultation was to seek to agree the scope and approach the proposed assessment as well as the supporting baseline noise survey.

91. **Table 9.5** below summarises the points that were agreed with South Ayrshire Council and ACCON UK.

Area of Agreement	Description
Construction noise Construction vibration	It was agreed that on the basis that there are no receptors within 1km of the wind turbine Developable Area, assessment of construction noise and vibration could be scoped-out because significant effects would not arise.
Construction traffic noise	It was agreed that an assessment of construction traffic noise could be scoped-out on the basis that construction traffic movements are not anticipated to generate road traffic noise levels that would be sufficiently high to give rise to significant effects.
Borrow pits - Blast induced noise, vibration and air overpressure	It was agreed that where blasting works may be required, an assessment of blast induced noise, vibration and air overpressures would be scoped-in. This assessment is to be undertaken with reference to BS5228-2, PAN 50 (including Annex D: *The control of blasting at surface mineral workings*), and it would consider the likelihood of impacts arising with reference to the locations for onsite borrow pits, and the mitigation measures that would be available for incorporation into the working methods.
Wind turbine noise assessment	It was agreed that an assessment of wind turbine noise would be scoped-in, and that this would be undertaken in accordance with the guidance contained within ETSU-R-97 and the IoA GPG but also cognisant of the guidance contained within the South Ayrshire Council LDP Supplementary Guidance: *Wind Energy*, and the South Ayrshire Council Environmental Health, *Wind Turbines Development: Submission Guidance Note*.
Wind turbine low frequency noise, infrasound and excess amplitude modulation	It was agreed that assessment of wind turbine low frequency noise and infrasound could be scoped-out of the assessment on the basis that guidance referenced by Scottish Planning Policy concludes that "*there is no evidence of health effects arising from infrasound or low frequency noise generated by the wind turbines*". It was also agreed that an assessment of excess amplitude modulation could be scoped-out on the basis that guidance referenced Scottish Planning Policy found low incidence of AM and the low numbers of people adversely affected in the UK.
Operational traffic noise assessment	It was agreed that an assessment of operational phase road traffic noise could be scoped-out on the basis that development generated road traffic travelling to and from the Site would be extremely low, and that significant effects would not arise.
Noise form energy storage/other fixed plant noise	It was agreed that an assessment of noise from any Energy Storage Facility or other associated fixed plant could be scoped-out on the basis that these could be cited at sufficient distance from receptors that significant effects would not arise.
Baseline noise survey	It was agreed that a detailed baseline noise survey would be undertaken. The general spread and extent of the proposed noise measurement locations as detailed in the Scoping Report was agreed, and that the results obtained from these measurement locations could generally be used as 'proxies' for other identified local sensitive receptors. It was suggested that for Measurement Location E (see Scoping Report), for which the receptors of either Black Row and White Row had been proposed as measurement options, an alternative property of White Row would likely be preferable as this was anticipated to be subject to less noise from a water course passing through the general area. It was also suggested that for proposed measurement Locations C (Genoch Cottage) and F (Doughty Farm) (see **Section 9.5.2**), in order to demonstrate that the obtained baseline measurement data had not been contaminated by noise from existing wind turbines (located to the north east and west respectively), it would be appropriate to undertake a directional filtering analysis of the obtained measurement data.
Cumulative assessment	It was agreed that an assessment of cumulative wind turbine noise should be scoped-in, as required by ETSU-R-97 and the IoA GPG. It was agreed that the assessment should include for the following developments[1]: • Dersalloch Windfarm (Operational); and • Hadyard Hill Windfarm (Operational). However, the following developments could be scoped-out of the assessment: • Knockskae Windfarm (Refused); • Linfairn Windfarm (Withdrawn); • Glenmount Windfarm (Withdrawn); • Clauchrie Windfarm (In Scoping but 6.8km from the wind turbine Developable Area; and • Hadyard Hill Windfarm Extension (Withdrawn). The cumulative noise assessment methodology was developed in full compliance with guidance contained within the IoA GPG and was fully agreed.
[1] Subsequent to completed consultation, Scoping Reports for two further windfarm developments, both in close proximity to the Proposed Development, were submitted to the ECU: • Craiginmoddie Windfarm – proposed to the immediate west of the Proposed Development; and	

Area of Agreement	Description
	• Knockcronal Windfarm – proposed to the immediate north of the Proposed Development (at the site of the formerly proposed Linfairn Windfarm). A formal application was then subsequently lodged with the ECU for the Craiginmoddie Windfarm late 2020. Knockcronal Windfarm Application was submitted late November 2021 after the cut-off date off date for Cumulative Developments as noted in Chapter 5: LVIA and is therefore referred to as a Scoping Application throughout. These two developments have therefore also been scoped-in to the cumulative assessment.

Table 9.5 Summary of Consultation with South Ayrshire Council and ACCON UK

92. **Table 9.5** confirms that it was agreed that assessments of both construction noise and construction vibration could be scoped-out, but this has been revisited. Whilst *the Design manual for roads and bridges* (DMRB) is specific to the assessment of impacts associated with new or updated road schemes, the construction noise and vibration guidance that it contains can be applied more generally. The DMRB Volume 11 Section 3 Part 7: LA111: *Noise and vibration* states that for construction noise, "a *study area of 300m from the closest construction activity is normally sufficient to encompass noise.*". In the case of the Proposed Development, site access track upgrade works would be required within 300m of a noise-sensitive receptor. Assessments of construction noise and vibration from access track upgrade works have therefore been scoped back into the assessment.

9.3.3 Historic Environment Scotland

93. In their written consultation response, the following is stated with respect to Scheduled Monument (SM) index no. 3357: '*Knockinculloch, enclosures on east slope of, 600m NW of Glenalla'*

"*We consider that there is a potential for impacts on the setting of his scheduled monument caused by the presence of turbines and other infrastructure in its vicinity. The proposals may affect views to and from the monument and, also, may give rise to impacts caused by shadow flicker and noise. We therefore recommend that an assessment should give detailed consideration to the potential for impacts on this scheduled monument and its setting. We would expect that mitigation is embedded into the design of the development to reduce and avoid adverse impacts where appropriate. Any such assessment should be informed by visualisations and we welcome further discussion on visualisation viewpoints.*"

9.3.4 Glasgow Prestwick Airport

94. In response to the Question 13 of the Scoping Report: "Do you agree with the Noise proposed approach for baseline collection, measurement locations, prediction of effects and significance assessment?", Glasgow and Prestwick Airport (GPA) responded as follows:

"*GPA consider the approach to noise assessment appropriate*".

9.3.5 Crosshill, Straiton and Kirkmichael Community Council

95. Annex A99 to A100 and A102 to A103 of the Scoping Opinion**,** see **Appendix 2.1 Scoping Opinion** includes the comments made by Crosshill, Straiton and Kirkmichael Community Council on the noise related content of the Scoping Report. These are presented in **Table 9.6**, as well as the detail of how each point has been addressed.

Comment	Response
Annex 99: Considering the proposed height of the wind turbines 5km would not be sufficient as a Study Area.	The search area of 5km for cumulative developments is in accordance with the South Ayrshire Council Environmental Health Guidance: *Wind turbine development: Submission Guidance note* as prepared by the noise and vibration technical advisors to South Ayrshire Council, and is in line with the consultation responses received from South Ayrshire Council.
Annex 99: Additional to Dersalloch and Hadyard Hill windfarms there are 2 other proposed sites, one already in application, that are proposing wind turbines of a similar height within 5km of this Site which should be included in the Study Area.	advisors ACCON UK, and is compliant with the South Ayrshire Council Environmental Health Guidance: *Wind turbine development: Submission Guidance note*. This guidance requires that account should be given to all wind turbines that are consented or within the planning process (i.e. for which there is a live application) and that are within the Study Area. Subsequent to completed consultation with South Ayrshire Council, a Scoping Report was submitted for the Craiginmoddie Windfarm, followed by an application. The site of the Craiginmoddie Windfarm is to the immediate west of the Proposed Development. A Scoping Report has also been lodged for the Knockcronal Windfarm to the immediate north of the Proposed Development. These Proposed Developments have therefore also been scoped-in to the cumulative assessment.
Annex 99: Do not agree with scoping out construction traffic noise. These are quiet, rural roads and any additional traffic is always significant. PAN 1/2011 insists noise from traffic sources should be assessed. Regarding 1km proximity to the proposal 2 homes (receptors) are within 1km of the proposal so noise and vibration issues should be revisited. Annex 102: We do not agree with the decision to scope out noise caused by vehicular access to the Site. Tallaminnoch is within 250m of the access road and would certainly be subjected to significant noise levels.	In scoping-out an assessment of construction traffic noise, consideration has been given to both the flows that would arise, those that currently prevail, and the routes that are proposed to be used by construction traffic as well as the proximity of any receptors to those routes. South Ayrshire Council and its noise and vibration technical advisors ACCON UK have agreed than an assessment of construction traffic noise can be scoped-out. An appraisal has been undertaken for the offsite access and can be found in **Appendix 4.1 Offsite Access Appraisal.** No potentially significant noise and vibration impacts have been identified as a result of offsite access upgrade works. An assessment of construction noise and vibration from the offsite access upgrade works has therefore been scoped-out of the assessment.
Annex 99: Energy Storage Facility – since this is an unknown in terms of potential noise generated it should not be scoped out.	The location of the Energy Storage Facility and any fixed plant associated with the Proposed Development would be more than 1.17km from the nearest receptors. This distance is sufficient that a significant effect would not arise. The scoping-out of an assessment of noise from the Energy Storage Facility and any fixed plant has been agreed with South Ayrshire Council and its noise and vibration technical advisors ACCON UK.
Annex 100: Low frequency noise and infra-sound. The document referred to was published in 2014. More recent documents point out the effects on health, both physical and mental, of low frequency noise and infra-sound. Court judgements in other countries have recognised these as injurious to health. Annex 103: We do not agree with scoping out low frequency noise and infrasound. The document referred to is from 2014	It has been agreed with South Ayrshire Council and its technical advisors ACCON UK for noise and vibration, that assessments of low frequency noise and infrasound are scoped-out.

Comment	Response
and more recent publications are of the opinion that they are potentially harmful, both physically and mentally.	
Annex 100: Blasting – when ScottishPower Renewables built Dersalloch some blasting occurred outwith agreed blasting schedules so control was inadequate.	An assessment of blast induced groundborne vibration and air overpressure has been scoped-in and has been undertaken in accordance with BS5228, PAN 50 and PAN 50 Annex D.
Annex 100: Knockskae has not been included, yet already is affected by noise from the Dersalloch Windfarm, therefore cumulative effect very likely.	Both the Dersalloch Windfarm and the receptor of Knockskae have been included within the assessment of wind turbine noise. The scope of the cumulative noise assessment has been agreed with South Ayrshire Council and its noise and vibration technical advisors ACCON UK (but also with the subsequent addition of both the Craiginmoddie Windfarm and Knockcronal Windfarm, for which there was a change of planning status following the completion of consultation (to 'Application Submitted' and 'Scoping Report submitted' respectively).

Table 9.6 Summary of Consultation comments from Crosshill, Straiton and Kirkmichael Community Council

9.3.6 Dailly Community Council

96. Annex A105, A108 to A109 and A111 of the Scoping Opinion, see **Appendix 2.1 Scoping Opinion** includes the comments made by Dailly Community Council on the noise related content of the Scoping Report. These are presented in **Table 9.7**, as well as the detail of how each point has been addressed.

Comment	Response
Annex 105: There are now a lot of windfarms in the area, cumulative information/data and noise generated by windfarms must be considered – Hadyard Hill, Craiginmoddie, Clauchrie, Dersalloch, Keirs Hill and others, even those further afield – for example Mark Hill, Killgallioch. Annex 108: Besides Dersalloch and Hadyard Hill Windfarms, there is the Consulting Clauchrie, and the Scoping Craiginmoddie, both have been mentioned before. There is also the possibility of another in the Stinchar Valley area at Knockodhar. Annex 108: Cumulative effect from all those windfarms in the potential area should be included, as indicated previously.	The scope of the cumulative noise assessment has been determined in accordance South Ayrshire Council Environmental Health Guidance: *Wind turbine development: Submission Guidance note* which requires that account should be given to all wind turbines that are consented or within the planning process (i.e. for which there is a live application), and that are within 5km of the Proposed Development. This has been agreed with South Ayrshire Council and its noise and vibration technical advisors ACCON UK (but also with the subsequent addition of both the Craiginmoddie Windfarm and Knockcronal Windfarm, for which there was a change in planning status following the completion of consultation (to 'Application Submitted' and 'Scoping Report submitted' respectively).
Annex 108: Considering the height of the wind turbines 5km is not enough. Through experience, noise travels, and depending on the wind direction the noise is substantial. '*This is considered sufficient to ensure that all potentially significant cumulative noise effects will be addressed – i.e. the combined effect of noise from the Proposed Development when operated simultaneously with any other identified windfarm developments.*' How would this be addressed?	The search area of 5km for cumulative developments is in accordance with the South Ayrshire Council Environmental Health Guidance: *Wind turbine development: Submission Guidance* note as prepared by the noise and vibration technical advisors to South Ayrshire Council, and is in line with the consultation responses received from South Ayrshire Council.
Annex 108: Noise experienced from windfarms is not only dependent on wind direction. Local experience shows that it can be heavily influenced by topography. Mitigation is already in place for one property due to noise levels generated by the operational Hadyard Hill Windfarm. This surely suggests that further mitigation would be required for this development. What impact would this have on overall output and how will cumulative impact be assessed?	The assessment of operational wind turbine noise has been undertaken in accordance with ETSU-R-97 and the IoA GPG. Account of wind direction and topography has been undertaken in accordance with the guidance contained within these documents. The need for mitigation has been identified as part of the completed noise assessment.
Annex 108: Construction traffic noise – this should not be scoped-out. Noise travels, and this is a rural quiet area. Additional traffic will make a significant difference.	In scoping-out an assessment of construction traffic noise, consideration has been given to both the flows that would arise, those that currently prevail, and the routes that are proposed to be used by construction traffic as well as the proximity of any receptors to those routes. South Ayrshire Council and its noise and vibration technical advisors ACCON UK have agreed than an assessment of construction traffic noise can be scoped-out.
Annex 108: Such works would be small scale, local, temporary and short-term only, and would be akin to temporary work associated with utilities servicing etc. An assessment of construction noise and vibration from off-site road and junction improvement works is therefore scoped-out of the assessment.' – is not necessarily the case and should not be scoped-out.	The scope of the noise and vibration assessment has been agreed with South Ayrshire Council and its noise and vibration technical advisors ACCON UK. Notwithstanding this, an appraisal has been undertaken for the offsite access upgrade works and can be found in **Appendix 4.1 Offsite Access Appraisal.** No potentially significant noise and vibration impacts have been identified. An assessment of construction noise and vibration from the offsite access upgrade works has therefore been scoped-out of the assessment.
Annex 108: Operational Phase – Energy Storage Facility – this is an unknown noise feature – this should not be scoped-out.	The location of the Energy Storage Facility and any fixed plant associated with the Proposed Development would be more than 1.17km from the nearest receptors. This distance is sufficient that a significant effect would not arise. The scoping-out of an assessment of noise form the Energy Storage Facility and any fixed plant has been agreed with South Ayrshire Council and its noise and vibration technical advisors ACCON UK.
Annex 108: Low frequency and infra-sound – there is new international evidence relating to the effects on health – physical and mental. This should not be scoped-out – this must be thoroughly assessed based on up-to-date information Annex 111: Low frequency noise and Infrasound should not be scoped-out – mentioned, opinion on this subject has changed dramatically.	It has been agreed with South Ayrshire Council and its technical advisors ACCON UK for noise and vibration, that assessments of low frequency noise and infrasound are scoped-out.

Comment	Response
Annex 108: Baseline noise survey – is 3 weeks long enough to take into account differing weather conditions during different seasons?	The baseline noise survey has been undertaken in accordance with the guidance contained within ETSU-R-97 and the IoA GPG. The obtained baseline data sets significantly exceed the guidance on minimum measurement durations as detailed within these documents.

Table 9.7 Summary of Consultation Comments from Dailly Community Council

9.4 Assessment Methodology and Significance Criteria

9.4.1 Study Area

97. For the assessments of construction noise and vibration, consideration has been given to the construction works that would be required within 300m of sensitive receptors. This comprises access track upgrade works only, which would be at distances of 220m+ from a single receptor. No other construction works would be required within a distance of 1km of sensitive receptors. This Study Area can therefore be considered to cover the works with the potential to generate the highest noise and vibration levels at receptors, and therefore a worst case.

98. For the assessment of blast-induced groundborne vibration and air overpressure, the Study Area extends from the onsite borrow pit search areas (see **Figure 4.1 Site Layout**) to the closest sensitive receptors, such that the locations with the greatest potential for adverse effects are assessed.

99. For the wind turbine noise assessment, potential cumulative developments within 5km of the Proposed Development have been identified. The Study Area has then been determined by selection of the noise-sensitive receptors with the greatest potential to be subject to an adverse impact either from the Proposed Development operating in isolation, or under the cumulative scenario (i.e. simultaneously with the identified cumulative developments).

100. This has therefore included selection of:

- the closest noise-sensitive receptors to the Proposed Development; and
- the closest noise-sensitive receptors to the identified cumulative developments, but that are also in the vicinity of the Proposed Development.

101. With regard to cumulative impacts, cognisance has been given to the fact that noise levels greater than 10dB below those permitted for identified cumulative development would be required in order to give rise to a cumulative impact, see **paragraphs 57 and 58**.

9.4.2 Desk Study

102. A desk study has been undertaken to assist in determining the baseline conditions. This has included:

- identification of cumulative windfarms and associated development details (e.g. scheme layouts, installed wind turbine types, the noise level limits imposed on consented cumulative developments through planning conditions, and other planning conditions that control the levels of noise that can be generated by the consented cumulative developments);
- identification of noise-sensitive receptors including those with the greatest potential to be subject to an impact from the Proposed Development operating in isolation, or under the cumulative scenario;
- identification of possible local noise sources in the vicinity of the identified receptors (including local water courses etc.); and
- identification of information to inform the operational noise level predictions (e.g. topographic ground contour detail).

103. The desk study included consideration of the following sources of information:

- the AddressBase Plus™ database, which marries the UK postal address database with OS six figure grid references;
- 1:50000 OS Land Ranger mapping for the Site and surrounding area;
- 1:25000 OS Explorer mapping for the Site and surrounding area;
- OS Terrain5™ topographic ground contour details regenerated at 2m contours for the Site and surrounding area;
- freely available on-line aerial and street scene photography for the Site and surrounding area;
- the South Ayrshire Council Planning Portal and the ECU's on-line portals, for the identification of cumulative windfarm development details, including layouts, for both proposed developments (i.e. at scoping stage, application submitted or consented but yet to be commenced), and existing developments (i.e. under construction or operational);
- the Scottish National Heritage[3] Windfarm Footprint Maps, depicting all windfarm developments which NatureScot[4] have been consulted upon including their latest known planning status; and
- Cumulative windfarm development details, including proposed layouts, provided through discussions with the respective development applicants.

9.4.3 Field Surveys

104. A detailed baseline noise survey has been undertaken to determine the prevailing background noise levels at a sample of six noise-sensitive receptors in the vicinity of the Proposed Development. Additional detail can be found in the Baseline Noise Survey, see **Section 9.5.3.**

105. Three of the six sample noise-sensitive receptors were also subject to measurements during a previous baseline noise survey undertaken on behalf of the applicant of the subsequently withdrawn Linfairn Windfarm. The results of that survey are reported in the Knockcronal Windfarm Scoping Report with pertinent detail replicated in **Section 9.5.4**. Relevant results from that baseline noise survey have also been presented in this noise assessment in the interest of consistency with the Knockcronal Windfarm noise assessment work (given that it is a concurrent application).

9.4.4 Assessment Methodology

9.4.4.1 Construction Noise

106. As the Proposed Development is currently at the planning stage, detailed information on construction techniques and the equipment that would be used is not available. The potential effects associated with the construction phase have therefore been assessed based on a number of assumptions with regards to the operations likely to be undertaken and the machinery considered likely to be used. These assumptions have been made drawing upon the content of **Chapter 4: Development Description.**

107. Noise sensitive receptors within 300m of anticipated construction works have been identified. For each receptor, a series of construction noise level predictions have been undertaken in accordance with the methodologies presented in BS5228-1. These predictions have been undertaken accounting for the distance of the receptors to the works, as well as the ground conditions etc.

108. The calculated construction noise levels have then been assessed in accordance with the BS5228-1 ABC method, as detailed in **Table 9.2,** with the applicable assessment criteria determined drawing upon the results of the baseline noise survey.

109. The resulting impact magnitude and effect significance have been determined following the criteria described in **Section 9.4.5** below.

[3] Now known as NatureScot.

[4] Formerly Scottish Natural Heritage (SNH).

9.4.4.2 Construction Vibration

110. The assessment of groundborne vibration associated with typical construction activities has been undertaken drawing upon the guidance in BS5228-2.

111. A series of groundborne vibration predictions have been conducted in order to determine the typical distances at which the threshold criteria detailed BS5228-2 for human perception and disturbance would arise (see

112. Vibration Level (PPV)	Effect
0.14mms-1	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3mms-1	Vibration might be just perceptible in residential environments.
1.0mms-1	It is likely that vibration of this level in residential environments would cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10mms-1	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

113. Table 9.3**).** Predictions have employed the empirical methods detailed in BS5228-2, in the Transport and Road Research Laboratory Research Report 246: *Traffic induced vibrations in buildings* (TRRL RR 246: 1990), and within the Transport Research Laboratory Report 429 (2000): *Groundborne vibration caused by mechanical construction works*.

114. Vibration-sensitive receptors within 300m of anticipated construction works have then been identified. The distance of each receptor from the works has been compared against the calculated distances associated with each of the threshold criteria.

115. The resulting the impact magnitude and effect significance have been determined following the criteria described in **Section 9.4.5** below.

9.4.4.3 Blast Induced Noise, Vibration and Air Overpressure

116. Given that BS5228 identifies that the best approach to address groundborne vibration is to base any assessment on site-specific operational measurements, at this stage a qualitative assessment has been undertaken.

117. This assessment has given general consideration to the potential for blast-induced groundborne vibration and air overpressure impacts to arise drawing on the guidance contained in PAN 50, BS5228-1 and BS5228-2.

118. The resulting impact magnitude and significance of effect have been identified following the method detailed in **Section 9.4.5** below.

9.4.4.4 Wind Turbine Noise

119. The assessment of operational noise has been undertaken following the methodology detailed within ETSU-R-97 and the IoA GPG, including the following steps:

- completion of the Desk Study described above to identify cumulative developments, the noise limits applicable to those developments, the closest sensitive receptors to the Proposed Development and those which have the greatest potential to be subject to a cumulative impact;
- a representative sample of identified receptors have been selected for assessment. These receptors have been selected to ensure a good geographic spread across the local area;
- a detailed baseline noise survey has been undertaken, including measurements at six different locations. That survey is hereafter referred to as the 'Carrick' baseline noise survey. The adopted measurement locations were selected at distances from existing wind turbines such that the obtained measurement data would not be influenced by noise from any existing wind turbines. Notwithstanding this, for the two measurement locations closest to operational windfarms, a directional analysis of the obtained data has been undertaken to confirm that the measurement results are not influenced by noise from existing wind turbines (see **Section 9.5.3.3** below);
- the baseline data obtained from each measurement location has been assessed in accordance with ETSU-R-97 and the IoA GPG. This has included separate consideration to 'quiet daytime' and night-time periods, with the relationships between background noise level and standardised wind speed determined;
- the baseline noise survey being used to inform the Knockcronal Windfarm noise assessment work has been reviewed. That survey is hereafter referred to as the 'Knockcronal' baseline noise survey.
- The baseline survey results from the Carrick and Knockcronal baseline noise surveys have been compared and contrasted. For receptors where measurements were undertaken during both surveys, the worst case (lowest measurement data) has been brought forward into the assessment.
- the total ETSU-R-97 daytime and night-time wind turbine noise level limits have been identified for each measurement location for both daytime and night-time periods. The fixed elements of these limits have been set cognisant of those that are set in the limits to which the operational Dersalloch and Hadyard Hill Windfarms must comply. The limit elements relative to background noise levels have been set at the determined background level +5dB(A) as required by ETSU-R-97;
- a detailed noise model has been prepared for the Site and surrounding area, including the selected noise-sensitive receptors, the Proposed Development and the identified cumulative developments. Additional details of the noise modelling process can be found in **Appendix 9.2 Noise Modelling and Prediction**;
- the noise model has been used to determine the resulting wind turbine noise levels at the selected receptor for the Proposed Development and each of the identified cumulative developments (proposed and operational) operating in isolation and together, and the three proposed developments (Carrick Windfarm, Craiginmoddie Windfarm, and Knockcronal Windfarm) operating together;
- noise level predictions have been undertaken for each receptor for 10m height integer wind speeds between 2 and 12m/s;
- noise level predictions for the Proposed Development have been undertaken for a candidate wind turbine for the Proposed Development;
- noise level predictions for Craiginmoddie Windfarm have been undertaken based on the same candidate wind turbine as the Proposed Development, which is also that used in the noise chapter of the submitted Craiginmoddie Environmental Impact Assessment Report (EIAR);
- noise level predictions for Knockcronal Windfarm have been undertaken based on a candidate wind turbine type advised by the respective applicant as being used in the Knockcronal noise assessment work;
- noise level predictions undertaken for the operational Dersalloch and Hadyard Hill Windfarms have been completed on a worst case basis, representing the highest noise levels that these developments can generate when operating within their existing consents. This has included account of both controlling properties (for Hadyard Hill Windfarm), and the maximum sound power levels permitted for use (for Dersalloch Windfarm, as defined under an associated planning condition);
- initially, consideration has been given to the receptors closest to the identified operational cumulative developments. For these receptors, the predicted noise levels for the Proposed Development operating in isolation have been compared against the noise level limits imposed on the operational developments. Where the levels from the Proposed Development are more than 10dB below the permitted limits, a significant effect would not arise from the Proposed Development operating either in isolation or under the cumulative scenario, and further consideration to impacts at these receptors is scoped-out. Where this is not the case, the receptors are brought forward into the next stage of assessment;
- consideration has then been given to the receptors closest to the Proposed Development, but in the direction of the operational cumulative developments. For these receptors, the worst case noise levels from the operational developments have been compared against the total ETSU-R-97 noise level limits. Where the worst case levels are more than 10dB below the total limits[5], a significant effect would not

[5] also with consideration to directional effects.

arise from operational developments and they are scoped-out of the cumulative assessment. Where this is not the case, the worst case noise levels have been subtracted from the total ETSU-R-97 limits to determine the 'residual' noise level limits that remain available for proposed developments. N.B. Provided that the proposed developments comply with the residual limits, there would be no exceedance of the total limits in the cumulative scenario;

- two operational scenarios have then been assessed:
  - The Proposed Development only (Carrick Windfarm); and
  - All three proposed developments (Carrick Windfarm, Craiginmoddie Windfarm and Knockcronal Windfarm) operating simultaneously.
- for each scenario, the predicted receptor noise levels have been assessed against the identified residual noise limits. As the residual noise limits have been determined including account of noise from the existing operational developments, limit compliance would ensure that there is no cumulative impact;
- where any exceedance of the residual limits is identified, the proposed development giving raise to that exceedance has been identified and consideration has been given to available noise mitigation measures; and
- consideration has then been given to an example limit apportionment in the case that all three of the proposed developments (Carrick Windfarm, Craiginmoddie Windfarm and Knockcronal Windfarm) where to be granted consent (**Appendix 9.11 Example Limit Apportionment**))

120. Ultimately, the limits against which the Proposed Development have been assessed, have been set such that the Proposed Development would not give rise to a cumulative exceedance of the total ETSU-R-97 noise levels, accounting for the levels generated by the existing operational developments.

121. The resulting impact magnitude and significance of effect have been identified following the method detailed in **Section 9.4.5** below.

9.4.5 Significance Criteria

122. The significance of effect has been determined taking into consideration the receptor sensitivity and the impact magnitude applying the criteria described below. Different impact magnitude criteria have been determined for each assessed impact, to reflect the applicable guidance in each case.

9.4.5.1 Receptor Sensitivity

123. The guidance contained within the TAN to PAN 1/2011 has been drawn upon in the generation of an appropriate set of receptor sensitivity criteria. These criteria are presented in **Table 9.8**.

Receptor Sensitivity	Description	Examples
High	Receptors where people or operations are particularly susceptible to noise and/or vibration.	Residential, quiet outdoor recreational areas, schools and hospitals.
Medium	Receptors moderately sensitive to noise and/or vibration, where it may cause some distraction or disturbance.	Offices and restaurants.
Low	Receptors where distraction or disturbance from noise and/or vibration is minimal.	Unoccupied buildings or factories and working environments with existing levels of noise.

Table 9.8 Noise and Vibration Receptor Sensitivity Criteria

9.4.5.2 Construction Phase

9.4.5.2.1 Impact Magnitude - Construction Noise

124. Construction noise has been assessed based on noise level criteria determined following a worst case interpretation of the guidance contained within BS 5228-1. This Standard details three example methods for determining the significance of potential construction noise impacts, as summarised in **paragraphs 72 to 76**.

125. With regards to the method based on absolute noise level criteria, following a worst case approach, the lowest criterion for the daytime period (07:00 to 19:00) is 70.0dB(A) $L_{Aeq,T}$ façade, which is equivalent to 67dB(A) free-field. This is stated to apply in rural areas.

126. Following the ABC assessment method, the most stringent assessment criterion (taken from Category A, see **Table 9.2**), which applies during the daytime (07:00 to 19:00 weekdays and 07:00 to 13:00 Saturdays), is applicable where the prevailing ambient noise levels are up to 62.4dB $L_{Aeq,T}$. Where this criterion is applicable, the threshold value for construction site is 65dB $L_{Aeq,T}$, if noise levels exceed this threshold value, a potential significant effect is indicated.

127. With regards to the 5dB(A) change method, the allowable construction noise level during the daytime is 65dB $L_{Aeq,T}$, or higher where the resulting ambient noise level change would be less than +5dB(A).

128. With regards to the above, it can be seen that applying the ABC or 5dB(A) change method gives rise to the most stringent daytime construction noise level criteria of 65dB $L_{Aeq,T}$. This limit has therefore been adopted as the level above which moderate impacts could arise and applies to the free-field noise levels.

129. When using the ABC method, it can be seen that a 5dB step is present between the absolute noise level criteria associated with each category. Therefore, to determine the impact magnitude associated with construction noise, this 5dB step has been applied to the adopted criterion of 65dB(A) $L_{Aeq,T}$. The resulting impact magnitude scale is detailed in **Table 9.9**.

Receptor Construction Noise Level, $L_{Aeq,T}$ (dB)	Impact Magnitude
≥ 70.0dB(A)	High
65.0dB(A) to 69.9dB(A)	Medium
60.0dB(A) to 64.9dB(A)	Low
≤ 59.9dB(A)	Slight

Table 9.9 Impact Magnitude Scale – Construction Noise

9.4.5.2.2 Impact Magnitude - Construction Vibration

130. The impact magnitude for construction vibration has been determined according to the assessment criteria for human perception and disturbance as detailed in BS5228-1 (see **Table 9.3**). The resulting impact magnitude scales is presented in **Table 9.10**.

Vibration Level (PPV)	Impact Magnitude
>10mms^{-1}	High
1.0mms^{-1} to 10mms^{-1}	Medium
0.3mms^{-1}1 to 1.0mms^{-1}	Low
<0.3mms^{-1}	Slight

Table 9.10 Impact Magnitude Scale – Construction Vibration

9.4.5.2.3 Impact Magnitude - Blast Induced Noise Vibration and Air Overpressure

131. Where it is identified that structural damage would not arise as a result of blast-induced groundborne vibration or air overpressures, and that embedded mitigation measures are sufficient to offset concerns about such effects from local residents, the magnitude of impact has been categorised as Slight or Low. Where there is a risk of structural damage, or there are insufficient embedded measures to offset concerns from local residents, the magnitude of impacts has been categorised as Medium or High.

9.4.5.2.4 Significance of Effect

132. The significance of effects for construction phase impacts has been determined by consideration to both the receptor sensitivity and the impact magnitude, by application of the matrix presented in **Table 9.11**.

Impact Magnitude	Receptor Sensitivity		
	High	**Medium**	**Low**
High	Major	Moderate	Minor
Medium	Moderate	Minor	Negligible/Minor
Low	Minor	Negligible/Minor	Negligible
Slight	Negligible/Minor	Negligible	Negligible

Table 9.11 Significance Matrix

9.4.5.1 Operational Phase

9.4.5.1.1 Significance of Effect – Wind Turbine Noise

133. For operational wind turbine noise, account has also been given to the receptor sensitivity detailed in **Table 9.8**, with the significance of effect determined based on whether or not the applicable noise level limits (as described in **Section 9.4.4.4**) would be met. For high sensitivity receptors, as present in this case, a significant effect (in terms of the Electricity Works (Environmental Impact Assessment (EIA)) (Scotland) Regulations 2017 (EIA Regulations)) is determined where noise from the Proposed Development gives rise to an exceedance of the applicable noise limits. Where no exceedance of the applicable limits arises as a result of the Proposed Development, a 'not significant' effect is determined.

9.4.5.2 Effect Categorisation

134. Identified effects have been categorised as:

- either 'adverse' (e.g. noise level increases) or 'beneficial' (e.g. noise level decreases);
- either 'temporary' or 'permanent;
- either 'local', 'regional' or 'national'; and
- either 'direct' or 'indirect'.

135. Effects identified to be either Negligible and Minor are considered to be 'Not Significant', whilst those identified to be Moderate and Major are considered to be 'Significant' in terms of the EIA Regulations.

9.4.6 Limitations to Assessment

136. The wind turbine type to be installed at the Proposed Development is not yet known and would depend on the results of a tender process that would not be progressed until after the application for the Proposed Development has been determined.

137. The assessment of wind turbine noise has therefore necessarily been based on manufacturer's noise emission data for a candidate wind turbine type. The candidate wind turbine selected for the assessment is the Siemens Gamesa SG 6.0-155. This wind turbine type fits within the physical parameters for the Proposed Development (maximum heights/dimensions of 200m to blade tip), being available with 122.5m hub, and so can be considered a technically feasible selection.

138. It is standard practice for windfarm development to be subject to a noise related planning condition stipulating appropriate noise level limits with which the development should comply once operational. Example limits have been derived as part of this assessment, see **Section 9.7.3.2** below.

139. At this point, the proposed Knockcronal Windfarm is at Scoping stage, whilst the Craiginmoddie Windfarm is at 'Application submitted' stage. It is not known whether either of these developments will ultimately get consent. It is also not known what the final detail of any such consent would be if forthcoming. The completed assessment has therefore considered the following two scenarios:

1. the Proposed Development is granted consent but neither Craiginmoddie Windfarm nor Knockcronal Windfarm are; and
2. all three of the proposed developments (Carrick Windfarm, Craiginmoddie Windfarm and Knockcronal Windfarm) are granted consent.

140. Under scenario 1), the full available noise limits could be conditioned as the limits for the Proposed Development to comply with. Under scenario 2), an apportionment of the available noise limits will be required between the three developments. The completed assessment has included for such an apportionment to demonstrate how the total cumulative noise level limits could be complied with in the case where all three development were to be granted consent and then operate simultaneously (**Appendix 9.11 Example Limit Apportionment**).

141. Whilst there are other intermediate scenarios (e.g. just two of the three developments gaining consent), which might allow different limit apportionments to be considered, scenario 2) represents the most limiting case for the purpose of demonstrating compliance with the total cumulative noise level limits.

142. The construction contract for the Proposed Development would be subject to a tender process and the final construction working methods and plant to be employed would therefore not be known until that tender process is complete. It has therefore been necessary to base the construction noise and vibration assessments on assumed construction plant/operations. Those plant and operations have been selected as appropriate for the nature of the works to be undertaken.

9.5 Baseline Conditions

9.5.1 Cumulative Developments

143. The following cumulative developments have been identified as having the potential to give rise to a cumulative noise impact with the Proposed Development:

- Dersalloch Windfarm (4.5km to the north east[6]) – operational;
- Hadyard Hill Windfarm (4.2km to the west[6]) – operational;
- Craiginmoddie Windfarm (adjacent to the west) – proposed (Application submitted); and
- Knockcronal Windfarm (adjacent to the north) – proposed (Scoping Report submitted).

144. Of the above, both the Dersalloch Windfarm and Hadyard Hill Windfarm are 'operational' and were identified within the Scoping Report for the Proposed Development. The Craiginmoddie and Knockcronal Windfarms are both 'proposed' and the Scoping Reports for both of these developments were submitted to the ECU after the Scoping Report for the Proposed Development was prepared. The application for Craiginmoddie Windfarm was received by the ECU in January 2021and the application for Knockcronal Windfarm was submitted late November 2021, after this assessment was completed, but prior to submission of the Proposed Development Application.

145. The location of the above windfarm developments can be seen in **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

146. The following other windfarm developments have also been identified within 5km of the Site Boundary, but, as agreed with South Ayrshire Council and its technical advisors for noise and vibration (ACCON UK), these have been scoped-out of the assessment for the reasons stated:

- Knockskae Windfarm (adjacent to the north) – refused;
- Linfairn Windfarm (adjacent to the north, with largely common land to the Knockcronal Windfarm) – application withdrawn;
- Glenmount Windfarm (1.5km to the east) – application withdrawn;

[6] Shortest distance between the Site Boundary for the Proposed Development and installed cumulative development wind turbines.

- Clauchrie Windfarm (8km south of the wind turbine Developable Area) – Refused, progressing to Public Inquiry, but scoped-out based on distance; and
- Hadyard Hill Windfarm Extension (adjacent to the west, with largely common land to the Craiginmoddie Windfarm) – application withdrawn.

9.5.1.1 Dersalloch Windfarm (Operational)

147. This development comprises 23 wind turbines, seven with a tip height of up to 115m and 16 with a tip height of up to 125m.

148. The closest receptors to Dersalloch Windfarm, with the potential to be subject to a cumulative impact with the Proposed Development are:

- Baing Farm (OS grid reference: 240245, 601582); and
- Culdoch Cottage (OS grid reference: 238820, 603027).

149. These receptors can be seen on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations.**

150. Planning condition 15 of the Dersalloch Windfarm consent requires that "there shall be no commencement of development unless and until the details of the proposed turbines (including… sound power levels)…have been submitted to, and approved by the Planning Authority" and that the development shall "not be brought into use unless it has been implemented in complete accordance with the details as approved".

151. Two submissions were made for the discharge of Planning Condition 15, the first confirming that whilst the wind turbine types to be installed were yet to be finalised, that the noise emission levels of the finally selected wind turbine for installation would not exceed 107dB(A) at all wind speeds. The submitted data is presented in **Table 9.12**, also including for a +2dB uncertainty correction.

	Wind Speed at 10m Height, m/s					
	7	8	9	10	11	12
Sound Power Level. L_{WA} Unconstrained Mode	109	109	109	109	109	109
Data includes +2dB additional uncertainty correction						

Table 9.12 Maximum Sound Power Level Data (L_{WA}) for Wind Turbines to be Installed at Dersalloch Windfarm, dB(A)

152. The second submission stated that the wind turbine type to be installed had been confirmed as the Siemen SWT 3.0-101 with hub heights of 74.5m (for 125m tip) and 64m (for 115m tip). The noise emission data for this wind turbine, installed at each hub height, was included, as duplicated in **Table 9.13** below, with the addition of a +2dB uncertainty correction.

Hub Height	Wind Speed Referenced to 10m (Standardised U_{10}), m/s									
	3	4	5	6	7	8	9	10	11	12+
74.5m Hub	92.9	97.1	101.6	106.3	108.5	109	109	109	109	109
64m Hub	92.6	96.7	101.1	105.9	108.3	108.9	109	109	109	109
Data includes +2dB additional uncertainty correction										

Table 9.13 Sound Power Level Data (L_{WA}) for the Siemens SWT 3.0-101 as installed at Dersalloch Windfarm, dB(A)

153. Octave band sound power level data was also submitted for the Siemens SWT 3.0-101 installed at each hub height. That data is duplicated in **Table 9.14** below.

Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s	Octave Band Centre Frequency (Hz)								
	32	63	125	250	500	1k	2k	4k	8k
74.5m Hub Height									
6m/s	75.1	85.9	90.0	94.7	97.0	100	97.5	92.0	78.0
8m/s	79.1	87.4	93.8	97.7	99.5	102.5	100.6	94.5	80.9
64m Hub Height									
6m/s	74.7	85.5	89.6	94.3	96.6	99.6	97.1	91.6	77.6
8m/s	78.8	87.5	93.6	97.6	99.5	102.5	100.4	94.5	80.8

Table 9.14 Octave Band Sound Power Level Spectra (L_{WA}) for the Siemens 3.0-101 as Installed at Dersalloch Windfarm, 74.5 and 64m hub heights, dB(A)

154. Planning Condition 33 of the development consent states the noise level limits to which the development is required to comply. This condition is duplicated as follows:

"*At wind speeds not exceeding 12 metres per second as measured and calculated at a height of 10 metres above ground level using the methods described in "Prediction and Assessment of Wind Turbine Noise" (published in IOA Bulletin March/April 2009), the noise emission levels of the wind farm measured at any dwellings existing at the date of this permission shall comply with the following:*

(a) During night-time hours, as defined in ETSU-R-97 as 23:00 to 07:0 on all days, the Windfarm noise emission level shall not exceed 43dB LA90, 10 min or ETSU-R-97 derived "night-time" noise limit based on the measured LA90, 10 min Background Noise Level plus 5dB(A), whichever is the greater.

(b) At all other times, the Windfarm noise emission level shall not exceed 37.5dB LA90, 10 min or the ETSU-R-97 derived "quiet waking hours" noise limit based on the measured LA90, 10 min Background Noise Level plus 5dB(A), whichever is the greater.

(c) The above noise emission limits may be increased to 45dB LA90, 10 min or the relevant ETSU-R-97 derived "quiet waking hours" or "night-time hours" noise limit based on the measured LA90, 10 min noise level plus 5dB(A), whichever is the greater, when measured at any dwelling owed by persons with a financial involvement in the windfarm.

(d) Background Noise Levels referenced to in this condition shall be those recorded by the regression lines in Appendix D3 forming part of the Dersalloch Windfarm 2012 Addendum produced by Scottish Power Renewables in February 2012."

155. The background noise regression lines for Baing Farm, as detailed within Appendix D3 of the 2012 ES Addendum, are presented in tabular form in Table 9.5 of the same document. It is confirmed that the noise environment at Baing Farm was dominated by a local water course and the lowest background noise levels were measured at the receptor of Grimmet (OS grid reference: 240245, 601582), for which the regression lines are presented in Tabular form in Table 9.7 of the 2012 ES Addendum.

156. These measurement data are duplicated in **Table 9.15** below.

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s								
	4	5	6	7	8	9	10	11	12
Measurement Location: Baing Farm									
Amenity Hours	49.9	49.9	49.9	50.0	50.2	50.5	50.8	51.3	51.8
Night-time Hours	49.9	49.9	49.9	49.9	50.2	50.5	51.0	51.6	52.3
Measurement Location: Grimmet									
Amenity Hours	37.3	37.7	38.6	39.7	41.1	42.3	43.4	44.0	44.1

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s								
	4	5	6	7	8	9	10	11	12
Night-time Hours	35.7	36.0	36.6	37.4	38.4	39.5	40.6	41.7	42.7

Table 9.15 Background Noise Levels, Dersalloch Windfarm Consent, Receptors: Baing Farm and Grimmet – $L_{A90,T}$, dB(A)

157. In accordance with Condition 33, the applicable noise level limits at Baing Farm and Grimmet, assuming no financial involvement (FI) in the development, are as detailed in **Table 9.16**.

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s								
	4	5	6	7	8	9	10	11	12
Receptor: Baing Farm									
Amenity Hours	54.9	54.9	54.9	55.0	55.2	55.5	55.8	56.3	56.8
Night-time Hours	54.9	54.9	54.9	54.9	55.2	55.5	56.0	56.6	57.3
Receptor: Grimmet									
Amenity Hours	42.3	42.7	43.6	44.7	46.1	47.3	48.4	49.0	49.1
Night-time Hours	43.0	43.0	43.0	43.0	43.4	44.5	45.6	46.7	47.7

Table 9.16 Wind Turbine Noise Level Limits, Dersalloch Windfarm Consent, Receptors: Baing Farm and Grimmet – $L_{A90,T}$, dB(A) – Non FI

9.5.1.2 Hadyard Hill Windfarm (Operational)

158. This development comprises 52 wind turbines, nine with a hub height of 68.5m and 43 with a hub height of 58.5m[7].

159. The closest receptors to the Hadyard Hill Windfarm, with the potential to be subject to a cumulative impact with the Proposed Development are:

- Corphin Cottage (OS grid reference: 228709, 596655);
- Delamford Cottage[8] (OS Grid Reference 229056.00, 599166.00); and
- Dobbingstone Farm (OS Grid Reference: 230170, 600502).

160. These receptors can be seen on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

161. Corphin Cottage would also be a 'controlling property' (as described in the IoA GPG) with respect to the resulting operational noise levels at Doughty Farm (OS grid reference: 232475, 597681 - see **Table 9.25**

Ref.	Name	Description	Easting (OSGB)	Northing (OSGB)	Closest Wind Turbine	Distance to Closest Wind Turbine
1	Blair Farm	Residential	232434	602474	Craiginmoddie wind turbine 5 Carrick wind turbine1	2695m 3915m
2	Glenmartin	Residential	232851	602543	Craiginmoddie wind turbine 5 Carrick wind turbine 01	2865m 3795m
3	The Shieling	Residential	233338	602685	Craiginmoddie wind turbines 6 and 7 Carrick wind turbine 1	3125m (both) 3780m
4	Knockinculloch Enclosure	Scheduled Monument	234264	600518	Carrick wind turbine 1	1485m
5	Glenalla	Residential	234695	600209	Carrick wind turbine 2	1110m
6	Knockskae	Residential	237281	601390	Knockcronal wind turbine 2 Carrick wind turbine 7	1530m 2580m
7	Linfairn	Residential	238164	601210	Knockcronal wind turbine 4 Carrick wind turbine 8	1325m 2820m
8	Genoch Cottage	Residential	239054	600791	Knockcronal wind turbine 4 Carrick wind turbine 10	1495m 2155m
9	Culdoch Cottage	Residential	238820	603027	Dersalloch wind turbine 3 Knockcronal wind turbine 4 Carrick wind turbine 10	1570m 3255m 4355m
10	Baing Farm	Residential	240245	601582	Dersalloch wind turbine 5 Knockcronal wind turbine 4Carrick wind turbine 10	1825m 2920m 3320m
11	Tairlaw Toll Cottage	Residential	239791	599523	Carrick wind turbine 10	1425m
12	Tairlaw Toll House	Residential	239815	599518	Carrick wind turbine 10	1445m
13	Tallaminnoch Cottage	Residential	240023	598251	Carrick wind turbine 10	1445m
14	Black Row	Residential	236068	595459	Carrick wind turbine 13	2715m
15	Aldinna	Residential	235100	595315	Carrick wind turbine 4	3105m
16	White Row	Residential	234592	595792	Carrick wind turbine 4	2535m
17	Doughty Farm	Residential	232475	597681	Craiginmoddie wind turbine 11 Carrick wind turbine 4	1150m 1900m
18	Corphin Cottage	Residential	228709	596655	Hadyard Hill wind turbine 50 Craiginmoddie wind turbine 13 Carrick wind turbine 4	1175m 2350m 5810m
19	Delamford Cottage	Residential	229056	599166	Hadyard Hill wind turbine 57 Craiginmoddie wind turbine 1 Carrick wind turbine 1	590m, 1640m 5245m
20	Dobbingstone Farm	Residential	230170	600502	Craiginmoddie wind turbine 4 Hadyard Hill wind turbine 60 Carrick wind turbine 1	1615m 1960m 4380m

162. Table 9.25), which is the closest property to the Proposed Development that is in the direction of Hadyard Hill Windfarm. i.e. compliance with the applicable noise level limits at Corphin Cottage, would result in there being limit 'headroom' at Doughty Farm.

163. Technical Appendix 6.2 of the ES of the formerly proposed Hadyard Hill Extension[9] confirms that the Hadyard Hill Windfarm has been installed with the Bonus-2.3MW wind turbine. Annex 6: *Wind Turbine Data* of that ES confirms the noise emission data for the Bonus 2.3MW wind turbine, as well as the associated octave band spectra[10]. That data is duplicated in **Table 9.17** and **Table 9.18**Table 9.18 below. It can be seen that the

[7] As detailed within the Environmental Statement of the formerly proposed Hadyard Hill Extension, Volume 2: *Main Report*, Technical Appendix 6.2: *Operational Noise Assessment*, Annex 7: *Wind Turbines Considered and Topographic Corrections*
[8] Also representative of Delamford Farm (OS Grid reference: 229144, 599343).
[9] As prepared for the operator of the Hadyard Hill Windfarm.
[10] Delta Aalborg Oest turbine test report AV297-03. Lw is 105.4dBA at 8m/s and slope of 1.12dB per m/s (regression analysis)

data is for a wind turbine installed with 80m hub height. Applying this data to lower hub heights (as installed) represents a worst case.

	Wind Speed Referenced to 10m (Standardised U_{10}), m/s									
	3	4	5	6	7	8	9	10	11	12+
80m Hub Height										
Sound Power Level. L_{WA}	*104.2*	*104.2*	*104.2*	104.2	105.3	106.4	107.5	*107.5*	*107.5*	*107.5*
Test reports details data for 6-9m/s and that 1dB uncertainty was observed during the test. Data flatlined at 107.5dB above 9m/s and at 104.2dB below 5m/s to extend the wind speed range (Italic text).										

Table 9.17 Sound Power Level Data for Bonus 2.3MW as Installed at Hadyard Hill Windfarm, dB(A)

164. It can be seen that below 6m/s and above 9m/s, the sound power level data has been flat-lined (italic text), to extend the data-set over a wider wind speed range. Flat lining above 9m/s reflects that the wind turbine would be operating at capacity above this speed, and as such noise emission levels would remain constant. Flatlining below 6m/s represents a worst case because in practice, as wind speeds reduce from 6m/s down to wind turbine cut-in speed, the noise emission levels would also reduce.

Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s	Octave Band Centre Frequency (Hz)								
	32	63	125	250	500	1k	2k	4k	8k
8m/s	-	91.0	97.7	98.7	98.5	97.3	97.3	95.6	81.4

Table 9.18 Octave Band Sound Power Level Spectra (L_{WA}) for the Bonus 2.3MW as Installed at Hadyard Hill Windfarm,80m Hub Height, dB(A)

165. Planning conditions 7.11 and 7.12 of the consent for this development state the noise level limits to which it is required to comply. These conditions are duplicated as follows:

"7.11 At properties occupied by persons with a financial interest in the development, day and night time noise levels must not exceed an LA90 (10 minutes) of 45 decibels. At wind speeds above 5.5 metres per second the LA90 should not exceed Leq (10 minutes) by more than 5 decibels.

7.12 At residential properties with no such financial interest, for wind speeds of up to 5.5 metres per second the LA90, (10 minutes) should not exceed 38dB (day time) and 43dB (night time) when measured at the external façade of the nearest residential properties."

166. The above conditions are open to interpretation and do not accurately reflect the ETSU-R-97 guidance. For example, the element of condition 7.11 that relates to wind speeds above 5.5m/s should reference the prevailing conditions in terms of the L_{A90} noise index, not the L_{eq} noise index, whilst condition 7.12 has omitted to detail what limit applies at non-financially involved properties at wind speeds above 5.5m/s. There is also no reference to any specific documentation of the baseline noise conditions as to be used in the application of the stated limits.

167. The assessment of noise from the Proposed Development has therefore been undertaken based on noise level limits determined in full compliance with ETSU-R-97 and the IoA GPG guidance, but cognisant of the stated fixed limit element levels (38dB (daytime non FI), 43dB (night-time non FI), as detailed in these conditions and therefore applicable to the Hadyard Hill Windfarm.

9.5.1.3 Craiginmoddie Windfarm (Proposed – Application Submitted)

168. The application for this development was received by the ECU in January 2021. The application included the *Craiginmoddie Wind Farm* EIAR, dated December 2020, which confirms the following details for this proposed development:

- number of wind turbines: 14;
- maximum tip height: 200m; and
- candidate wind turbine type: Siemens Gamesa SG 6.0-155 installed with 122.5m hub.

169. The above details were also confirmed in discussions with the applicant of the proposed Craiginmoddie Windfarm in 2021.

170. Sound power level data for the Craiginmoddie Windfarm candidate wind turbine (Siemens Gamesa SG 6.0-155), has been provided by the manufacturer[11]. Data has been provided for the wind turbine operating in unrestricted mode (AM-0 (6.6MW)) and noise reduced modes N1 to N6. The data provided was referenced to hub height wind speed, and the data for Mode AM-0 is also that adopted in Chapter 10*: Noise* of the Craiginmoddie EIAR.

171. The sound power level data has been standardised to a reference height of 10m assuming the proposed hub height of 122.5m, by applying the hub height to 10m height correction detailed within **Appendix 9.3 Wind Shear Correction**. The resulting wind turbine noise emission data is detailed in **Table 9.19.** A +2dB uncertainty correction has been included, in accordance with IoA GPG recommendations.

Mode	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s				
	2	3	4	5	6+
Unrestricted (AM0)	94.0	95.1	100.3	105.1	107.0
Noise Reduced Mode N1	94.0	95.1	100.3	104.8	106.0
Noise Reduced Mode N2	94.0	95.1	100.3	104.6	105.5
Noise Reduced Mode N3	94.0	95.1	100.3	104.0	104.0
Noise Reduced Mode N4	94.0	95.1	100.3	103.0	103.0
Noise Reduced Mode N5	94.0	95.1	100.3	102.0	102.0
Noise Reduced Mode N6	94.0	95.1	100.3	101.0	101.0
Data includes +2dB additional uncertainty correction					

Table 9.19 Sound Power Level Data (L_{WA}) for the Siemens Gamesa SG6.0-155, 122.5m hub height, dB(A)

172. The same technical document[11] also provides octave band (63Hz to 8kHz) and third octave band (10Hz to 160Hz) spectral data for hub height wind speeds of 6 and 8m/s. The spectra data was provided for the wind turbine operating in unrestricted mode (AM-0 (6.6MW)) and each of the noise reduced modes N1 to N6. The same octave band data for Mode AM-0 is presented in Chapter 10: *Noise* of the Craiginmoddie Windfarm EIAR.

173. The third octave band data have been converted into octaves to allow determination of full octave band spectra between 32Hz and 8kHz. Those data have then been standardised to a reference height of 10m assuming the proposed hub height of 122.5m (following the method in **Appendix 9.3 Wind Shear Correction**). The standardised data have then applied to the broadband levels detailed in **Table 9.24** in accordance with the IoA GPG. The resulting octave band spectral data are presented in **Table 9.25**, including for a +2dB uncertainty correction.

[11] Siemens Gamesa technical document entitled: SG 6.0-155 Standard Acoustic Emissions, Rev.0,AM 0 – AM-8, N1 – N6, IEC Ed.3, document code: D2359800/002, dated 24/02/2020.

Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s	Octave Band Centre Frequency (Hz) 32	63	125	250	500	1k	2k	4k	8k
Unrestricted Mode (AM0)									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	75.9	84.8	92.2	96.8	99.1	98.9	99.2	92.6	77.6
6+	77.7	86.6	94.0	98.6	100.9	100.7	101.0	94.4	79.4
Noise Reduced Mode N1									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	76.3	84.8	91.9	96.4	98.7	98.5	98.8	92.2	77.2
6+	77.5	86.0	93.1	97.6	99.9	99.7	100.0	93.4	78.4
Noise Reduced Mode N2									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	76.5	84.9	91.8	96.2	98.5	98.3	98.6	92.0	77.0
6+	77.4	85.8	92.7	97.1	99.4	99.2	99.5	92.9	77.9
Noise Reduced Mode N3									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	77.0	85.0	91.3	95.6	97.9	97.7	98.0	91.4	76.4
6+	77.0	85.0	91.3	95.6	97.9	97.7	98.0	91.4	76.4
Noise Reduced Mode N4									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	76.8	84.5	90.3	94.6	96.9	96.7	97.0	90.4	75.4
6+	76.8	84.5	90.3	94.6	96.9	96.7	97.0	90.4	75.4
Noise Reduced Mode N5									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	76.6	84.0	89.4	93.6	95.9	95.7	96.0	89.4	74.4
6+	76.6	84.0	89.4	93.6	95.9	95.7	96.0	89.4	74.4
Noise Reduced Mode N6									
2	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4
3	65.9	74.8	82.2	86.8	89.1	88.9	89.2	82.6	67.6
4	71.1	80.0	87.4	92.0	94.3	94.1	94.4	87.8	72.8
5	76.4	83.5	88.4	92.6	94.9	94.7	95.0	88.4	73.4
6+	76.4	83.5	88.4	92.6	94.9	94.7	95.0	88.4	73.4
Data includes +2dB additional uncertainty correction									

Table 9.20 Octave Band Sound Power Level Spectra (L_{WA}) for Siemens Gamesa SG 6.0-155, Various Modes, 122.5m hub height, dB(A)

174. Table 3.1 and Figure 3.1 of the Craiginmoddie EIAR also confirm the proposed layout. That layout is presented in **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

175. The closest receptors to the proposed Craiginmoddie Windfarm site, with the potential to be subject to a cumulative impact with the Proposed Development are:

- Doughty Farm (OS grid reference: 232475, 597681);
- Knockinculloch enclosure (OS grid reference: 234264, 600518); and
- Glenalla (OS grid reference: 234695, 600209).

176. These receptors are presented on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

9.5.1.4 Knockcronal Windfarm (Proposed – Scoping Report Submitted)

177. The Scoping Report for this development was submitted to the ECU in December 2020. Entitled: *Knockcronal Wind Farm, EIA Scoping Report,* and dated 30 October 2020, that report confirmed that the development would comprise "*approximately 12 wind turbines*", with a maximum tip height of 200m.

178. However, subsequent discussions have been held with the Knockcronal Windfarm applicant who have advised a reduction in the proposals being applied for. The following has been confirmed as the latest detail for this proposed development:

- number of wind turbines: 9;
- maximum tip height: 180m (3 wind turbines) & 200m (6 wind turbines) – See **Table 9.21** below; and
- candidate wind turbine type: Vestas V150-6.0MW operating in Mode PO6000 (6.0MW variant).

179. Through discussions with the Knockcronal Windfarm applicant, the proposed turbine locations and maximum tip heights detailed in **Table 9.21** were confirmed for this proposed development. This layout is presented on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

Turbine ID	Easting (OSGB)	Northing (OSGB)	Tip Height (m)	Max hub height for Vestas V150-6.0 candidate turbine option
1	236759	599643	200	125
2	237131	599863	200	125
3	237491	599614	200	125
4	237838	599922	180	105
5	237972	599514	180	105
6	238202	599132	180	105
7	237720	599172	200	125
8	237249	599234	200	125
9	236820	599164	200	125

Table 9.21 Knockcronal Windfarm Proposed Turbine Locations and Heights

180. The Knockcronal Windfarm applicant also confirmed noise emission data for the candidate wind turbine (Vestas V150-6.0MW operating in Mode PO6000 (6.0MW variant)). The provided broad-band sound power level data and octave band spectra (normalised to 100dB(A)) are detailed in **Table 9.22** and **Table 9.23**. The data in **Table 9.22** was confirmed to include a +2dB uncertainty correction and be for this wind turbine installed with 125m hub. Applying the same data to the wind turbines proposed with lower (105m) hub heights represents a worst case.

Mode	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s					
	3	4	5	6	7	8+
PO6000 (6.0MW)	95.0	98.6	103.0	106.3	106.8	106.9
Data includes +2dB additional uncertainty correction						

Table 9.22 Sound Power Level Data (L_{WA}) for the Vestas V150-6.0MW in mode PO06000, 125m hub height, dB(A)

Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s	Octave Band Centre Frequency (Hz)								
	32	63	125	250	500	1k	2k	4k	8k
Mode PO6000 (6.0MW)									
N/A - Data normalised to 100dB(A)	64.7	73.6	81.0	85.6	87.9	87.7	88.0	81.4	66.4

Table 9.23 Octave Band Sound Power Level Spectra (L_{WA}) for Vestas V150-6.0 in mode PO6000, dB(A)

181. The closest receptors to the proposed Knockcronal Windfarm site, with the potential to be subject to a cumulative impact with the Proposed Development are:

- Glenalla (OS grid reference: 234695, 600209);
- Knockskae (OS grid reference: 237281, 601390);
- Linfairn (OS grid reference: 238164, 601210);
- Genoch Cottage (OS grid reference: 239054, 600791);
- Tairlaw Toll Cottage (OS grid reference: 239791, 599523); and
- Tallaminnoch Cottage (OS grid reference: 240023, 598251).

182. These receptors are presented on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

183. The Scoping Report for this proposed development also includes extensive detail of a previously completed baseline noise survey, which the Knockcronal Windfarm applicant has confirmed is being used to inform the noise assessment work for this development, see **Section 9.5.4**.

9.5.2 Noise Sensitive Receptors

184. Noise-sensitive receptors in the vicinity of the Proposed Development and the identified cumulative developments have been identified from a review the AddressBase Plus® database, freely available aerial and street view photography, OS mapping and the results of Site visits.

185. The AddressBase Plus® database allies the Royal Mail address database with OS six figure grid references. These data also include a categorisation scheme with primary, secondary, tertiary and quaternary codes, detailing the nature of each data entry. Examples are presented in **Table 9.24** below:

Code	Class description	Primary code	Secondary code	Tertiary code	Quaternary code
CE03PS	Primary School	C (Commercial)	E (Education)	03 (Preparatory / First / Primary / Infant / Junior / Middle School)	PS (First School)
RD04	Terraced	R (Residential)	D (Dwelling)	04 (Terraced)	-
RG	Garage	R (Residential)	G (Garage)	-	-
RI02NC	Non-commercial lodgings	R (Residential)	I (Residential Institute)	02 (Communal Residence)	NC (Non-Commercial lodgings)

Table 9.24 Example Classification Codes for AddressBase Plus® Database

186. The categorisation scheme is extensive with more than 550 different individual codes. The full dataset for the local area has been reviewed with all entries allocated into the following categories:

- residential;
- temporary residential;
- medical;
- educational;
- religious/place of worship;
- community facilities – sensitive;
- community facilities – other;
- not noise-sensitive; and
- other.

187. The results of the above categorisation were then complemented by the addition of the findings of the wider desk review. For example, where any receptors were found not to be represented with the AddressBase data, these were added manually. This has included the addition of the Knockinculloch Enclosure Scheduled Monument as referenced with respect to possible noise impact in the Historic Environment Scotland (HES) consultation response.

188. Ruins have been identified at the locations of Garleffin (OS grid reference: 234766, 599974) and High Genoch (OS Grid reference: 238802, 600589), but these are not identified as residential within the AddressBase Plus® database, do not have postal addresses and are not habitable being derelict in nature. These are therefore not considered noise-sensitive receptors.

189. The final identified sensitive receptor set is presented in **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

190. **Table 9.25** details the noise-sensitive receptors that have been selected for assessment. This includes those closest to the Proposed Development and those with the greatest potential to be subject to a cumulative noise impact. They also have a good geographic spread across the local area. Also presented are the approximate grid coordinates for each receptor, the distance to the closest existing and/or proposed wind turbine. These receptors are presented in **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

191. None of these receptors have a financial involvement in the Proposed Development. It is anticipated that the receptors of Doughty Farm may have a financial involvement in Craiginmoddie Windfarm and the Hadyard Hill Windfarm, but, to represent a worst case, it has been assumed that this is not the case.

Ref.	Name	Description	Easting (OSGB)	Northing (OSGB)	Closest Wind Turbine	Distance to Closest Wind Turbine
1	Blair Farm	Residential	232434	602474	Craiginmoddie wind turbine 5 Carrick wind turbine1	2695m 3915m
2	Glenmartin	Residential	232851	602543	Craiginmoddie wind turbine 5 Carrick wind turbine 01	2865m 3795m
3	The Shieling	Residential	233338	602685	Craiginmoddie wind turbines 6 and 7 Carrick wind turbine 1	3125m (both) 3780m
4	Knockinculloch Enclosure	Scheduled Monument	234264	600518	Carrick wind turbine 1	1485m
5	Glenalla	Residential	234695	600209	Carrick wind turbine 2	1110m
6	Knockskae	Residential	237281	601390	Knockcronal wind turbine 2 Carrick wind turbine 7	1530m 2580m
7	Linfairn	Residential	238164	601210	Knockcronal wind turbine 4 Carrick wind turbine 8	1325m 2820m
8	Genoch Cottage	Residential	239054	600791	Knockcronal wind turbine 4 Carrick wind turbine 10	1495m 2155m
9	Culdoch Cottage	Residential	238820	603027	Dersalloch wind turbine 3 Knockcronal wind turbine 4 Carrick wind turbine 10	1570m 3255m 4355m
10	Baing Farm	Residential	240245	601582	Dersalloch wind turbine 5 Knockcronal wind turbine 4Carrick wind turbine 10	1825m 2920m 3320m
11	Tairlaw Toll Cottage	Residential	239791	599523	Carrick wind turbine 10	1425m
12	Tairlaw Toll House	Residential	239815	599518	Carrick wind turbine 10	1445m
13	Tallaminnoch Cottage	Residential	240023	598251	Carrick wind turbine 10	1445m
14	Black Row	Residential	236068	595459	Carrick wind turbine 13	2715m
15	Aldinna	Residential	235100	595315	Carrick wind turbine 4	3105m
16	White Row	Residential	234592	595792	Carrick wind turbine 4	2535m
17	Doughty Farm	Residential	232475	597681	Craiginmoddie wind turbine 11 Carrick wind turbine 4	1150m 1900m
18	Corphin Cottage	Residential	228709	596655	Hadyard Hill wind turbine 50 Craiginmoddie wind turbine 13 Carrick wind turbine 4	1175m 2350m 5810m
19	Delamford Cottage	Residential	229056	599166	Hadyard Hill wind turbine 57 Craiginmoddie wind turbine 1 Carrick wind turbine 1	590m, 1640m 5245m
20	Dobbingstone Farm	Residential	230170	600502	Craiginmoddie wind turbine 4 Hadyard Hill wind turbine 60 Carrick wind turbine 1	1615m 1960m 4380m

Table 9.25 Noise-Sensitive Receptors Selected for Assessment

9.5.3 Carrick Baseline Noise Survey

192. A detailed baseline noise survey has been undertaken in the vicinity of the Proposed Development. Continuous long-term monitoring was undertaken at the following receptor locations, which were selected as representative of the receptors detailed in **Table 9.25** that are closest to the Proposed Development:

- Measurement Location A: Blair Farm (Receptor Ref.1);
- Measurement Location B: Glenalla (Receptor Ref.5);
- Measurement Location C: Genoch Cottage (Receptor Ref.8);
- Measurement Location D: Tairlaw Toll (adjacent to Receptor Ref.12);
- Measurement Location E: White Row (Receptor Ref.16); and
- Measurement Location F: Doughty Farm (Receptor Ref.17).

193. These measurement locations are presented on **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.

194. The survey commenced on 19 August 2020 and concluded on the 24 September 2020. The obtained measurement durations at each location are detailed in **Table 9.26**.

Measurement Location	Measurement Duration	Total Number of Days Monitored
A – Blair Farm	09:30 19 August 2020 to 10:00 17 September 2020	29
B – Glenalla	16:50 19 August 2020 to 10:00 11 September 2020	23
C – Genoch Cottage	11:30 19 August 2020 to 14:50 17 September 2020	29
D – Tairlaw Toll	12:30 19 August 2020 to 14:30 17 September 2020	29
E – White Row	14:20 19 August 2020 to 13:00 17 September 2020	29
F – Doughty Farm	15:30 19 August 2020 to 11:50 17 September 2020 and 12:20 17 September 2020 to 06:40 24 September 2020	36

Table 9.26 Noise Measurement Durations

195. The IoA GPG advises that a survey duration of less than two weeks is unlikely to be sufficient to obtain a dataset covering the required range of wind speeds and directions (the latter if relevant). It can be seen from **Table 9.26** that all measurement locations were subject to significantly longer measurement durations than the minimum 14-day period, to ensure that a representatively wide range of wind conditions have been captured.

196. The noise survey was undertaken using BS EN 61672-1:2013 Class 1 specification sound pressure level measurement equipment detailed in **Table 9.27** below.

WSP Equipment Reference	Equipment Item	Make and Model	Serial Number
Cube 3	Sound Pressure Level Meter	01 dB CUBE	10630
	Pre-amplifier	Acoem PRE 22	10184
	Microphone	GRAS 40CD	288065
	Hand Held Calibrator	01 dB-Metravib CAL 21	34344461
Rion 3	Sound Pressure Level Meter	Rion NL52	242744
	Preamplifier	NH-25	32772
	Microphone	UC-59	6229
	Hand Held Calibrator	NC74	34246512
Duo 6	Sound Pressure Level Meter	01 dB-Metravib DUO	10328
	Preamplifier	01 dB Metravib PRE 22	10233

WSP Equipment Reference	Equipment Item	Make and Model	Serial Number
	Microphone	GRAS 40CD	154531
	Hand Held Calibrator	01 dB-Stell CAL 21	34134166
Cube 1	Sound Pressure Level Meter	01 dB CUBE	10621
	Preamplifier	Acoem PRE 22	10635
	Microphone	GRAS 40CD	207269
	Hand Held Calibrator	01 dB-Metravib CAL 21	34344463
Rion 2	Sound Pressure Level Meter	Rion NL52	510145
	Preamplifier	NH-25	10138
	Microphone	UC-59	02850
	Hand Held Calibrator	NC74	34615220
Duo 8	Sound Pressure Level Meter	01 dB-Metravib DUO	10330
	Preamplifier	01 dB Metravib PRE 22	10219
	Microphone	GRAS 40CD	330600
	Hand Held Calibrator	01 dB-Stell CAL 21	50441999

Table 9.27 Baseline Noise Survey Measurement Equipment

197. All sound level meters had been calibrated to traceable standards within the preceding two years and the calibrators within the preceding 12 months. Each measurement system was field-calibration-checked at the point of installation and at collection. No significant measurement drifts occurred.

198. Each of the 01dB measurement systems were fitted with a standard factory fit windshield, as well as a secondary windshield system which comprised a cylinder of 20mm thick 45ppi reticulated foam. This secondary cylinder had a diameter of approximately 220mm, a height of approximately 300mm and was mounted on a wire mesh frame. The secondary windshields were designed in line with the conclusions of the ISVR '*Noise measurements in windy conditions*' document dated 1996, as referenced by ETSU-R-97. These secondary windshields were designed to comply with the following report conclusion:

"*Overall the preferred windscreen configuration of those tested is a two layer windscreen, with an outer cover of 45 ppi foam, a diameter of 200 to 300mm, and the standard UA0237 or UA 0570/0393 as the inner screen."*

199. Samples of the secondary windshields have been tested by an independent acoustic laboratory which found that the effect of adding the secondary windshield gave rise to an insertion loss of less than +/-1dB in all octave bands between 63Hz and 8kHz. In accordance with the above referenced ISVR document this insertion loss is considered to be "*satisfactory"* with insertion losses of between 1 and 3 dB being classified as "*marginal"*, and insertion losses of greater than 3dB considered to be "*unsatisfactory*".

200. Each of the Rion measurement systems were installed with their standard outdoor WS-15 windshields, which are of substantial dimensions (reticulated foam with approx. 200mm diameter).

201. Each measurement system was installed with the microphone mounted under free-field conditions, approximately 1.2m above ground level. The measurement location at each property was selected to be representative of the primary external living spaces, but also to minimise the influence of any local sources such as road traffic, water courses and wind through local trees/foliage etc. The installation location selected at each property is detailed in **Appendix 9.4 Baseline Noise Survey**. This appendix also includes additional survey details including photographic records of each measurement location and the installed equipment as well as the field-calibration records etc.

202. As the noise survey was undertaken entirely within the British Summer Time (BST) period. The time clocks on the Rion measurement systems were set to UK BST, whilst the time clocks on the Cube and Duo measurement systems were noted relative to UK BST with the obtained measurement data subsequently time adjusted to UK BST. This approach allows the obtained data to be accurately time aligned with the meteorological survey results (See **Section 9.5.3.1** below). The system time clocks where then checked at the end of the survey, to ensure that none had exhibited a significant drift in accordance with the IoA GPG which states:

"*A synchronisation drift of more than 1 minute over the duration of the survey should be reported and best avoided.*"

203. None of the measurement systems drifted to this degree, see **Appendix 9.4 Baseline Noise Survey**.

204. Each measurement system was used to obtain noise level data in the $L_{A90,T}$ noise index (as well as other environmental monitoring indices), in continuous 10-minute intervals over the full measurement durations. Measurement data was obtained for the periods commencing on the hour, 10 minutes past, 20 minutes past, half past, 20 minutes to and 10 minutes to each hour.

9.5.3.1 Meteorological Data

205. For the duration of this baseline noise survey, simultaneous 10-minute meteorological measurements were undertaken on the Site of the Proposed Development. The meteorological mast was installed at OS grid reference: 235158, 598511. The obtained measurement data included rainfall, average wind speed and wind direction.

206. Anemometers were installed on the mast at heights of 30m, 50.4m, 70m and 81m above ground, with a rain gauge installed at 3m. Wind direction vanes were installed at heights of 28m and 78m.

207. The installed anemometers and vanes were accurate to within the IoA GPG requirements of +/- 0.2m/s and +/- 6° respectively whilst the tipping rain bucket had a resolution of 0.2mm/tip, which is also complaint with IoA GPG requirements.

208. **Plots 9.4.1 to 9.4.3** of **Appendix 9.4 Baseline Noise Survey** present the wind direction information for the duration of the noise survey. Three wind roses are presented, the first covering the full 36 day survey duration (the survey duration for Location F), the second covers the 29 day survey duration (the survey duration for Locations A, C, D and E), the third covers the 23 day survey duration (the survey duration for Location B). It can be seen that the over the course of the survey wind directions were primarily from the south west (the generally prevailing conditions for the UK) and also the north, but with more easterly wind conditions during the last week of the survey (as included in the 36 day plot).

9.5.3.2 Carrick Baseline Noise Survey Results

209. In order to determine how the measured background noise levels, change with windspeed at each measurement location, it is necessary to correlate the noise measurement data with the wind speed data measured on the Site.

210. The measured average wind speeds obtained at heights of 50.4m and 81m have been used to determine hub height wind speed (125m has been used as a reasonable worst case). This has then been adjusted to 10m (standardised) height using the standard wind shear profile corresponding with standard ground roughness. The method used is detailed in **Appendix 9.3 Wind Shear Correction** and is in full accordance with the IoA GPG. This standardisation process is necessary to allow a fair comparison of results against predicted wind turbine noise levels (which are undertaken based on wind turbine noise emission also referenced to the same 10m standardised height).

211. The standardised 10m height average wind speed data and the measured $L_{A90,10min}$ noise level data for each measurement location have then been time-synchronised to BST (accounting for measurement start/end times). Adopting BST within the analysis ensured that it was based on the time clock to which the UK population were operating at the time of the baseline noise survey.

212. The synchronised datasets have then been filtered to remove any periods of significant rain (which has been defined as 1mm or more within the preceding 1-hour period), as well as any identified anomalous noise events not considered representative of the underlying background noise levels. Examples of anomalous noise events might include the operation of a fixed or mobile plant item, or lawn mowing operation which falsely increased the measured background levels for a limited period. Such events were identified from a manual inspection of the noise measurement data traces.

213. After filtering, the data has been split into the following sets as defined in ETSU-R-97:

- quiet daytime hours - 18:00 to 23:00 on all days, as well as 13:00 to 18:00 on Saturdays and Sundays, and 07:00 to 13:00 on Sundays; and
- night-time hours - 23:00 and 07:00 on all days.

214. The datasets for each location are presented in **Graphs 9.5.1 to 9.5.12** of **Appendix 9.5 Baseline Noise Conditions.** Separate graphs are presented for quiet daytime and night-time periods for each Measurement Location. Each graph depicts the data that has been retained in the analysis and that which has been removed either due to rain or manually for anomalous events.

215. To define the relationship between wind speed and background noise level, each graph includes a 3rd-order polynomial line of best fit for the retained dataset.

216. The identified background noise levels (based on the polynomial lines of best fit) are presented in tabular form in **Table 9.28**.

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Measurement Location A: Blair Farm											
Quiet daytime hours	23.3	24.0	25.3	27.0	29.1	31.5	34.1	36.9	39.8	42.7	45.6
Night-time hours	23.1	23.3	24.2	25.8	27.8	30.2	32.8	35.6	38.3	41.0	43.3
Measurement Location B: Glenalla											
Quiet daytime hours	26.6	27.4	28.2	29.0	29.9	31.0	32.2	33.7	35.4	37.3	39.6
Night-time hours	27.4	27.5	28.0	28.9	30.1	31.5	33.1	34.8	36.5	38.2	39.8
Measurement Location C: Genoch Cottage											
Quiet daytime hours	28.4	28.8	29.4	30.2	31.1	32.2	33.4	34.8	36.2	37.8	39.5
Night-time hours	25.7	26.1	26.8	28.0	29.4	31.0	32.7	34.4	36.1	37.6	38.9
Measurement Location D: Tairlaw Toll											
Quiet daytime hours	33.7	33.9	34.2	34.7	35.3	36.2	37.2	38.3	39.6	41.0	42.5
Night-time hours	33.4	34.0	34.5	35.0	35.5	36.0	36.6	37.3	38.2	39.3	40.6
Measurement Location E: White Row											
Quiet daytime hours	29.2	29.4	29.7	30.2	31.0	32.0	33.3	34.7	36.5	38.5	40.7
Night-time hours	28.8	29.0	29.4	30.1	31.0	32.1	33.3	34.6	35.9	37.4	38.8
Measurement Location F: Doughty Farm											
Quiet daytime hours	23.8	24.5	25.5	26.7	28.2	29.8	31.6	33.6	35.6	37.7	39.9
Night-time hours	23.4	23.5	24.1	25.3	26.8	28.8	30.9	33.3	35.6	38.0	40.3

Table 9.28 Carrick Baseline Noise Survey - Measurement Location Background Noise Levels, $L_{A90,T}$, dB(A)

9.5.3.3 Directional Filtering

217. The adopted measurement locations were sufficiently removed from existing windfarms that the measurement results were not influenced by operational wind turbine noise. To confirm this, a directional analysis of the data obtained at Measurement Location C (that closest to the operational Dersalloch Windfarm), and Measurement Location F (that closest to the operational Hadyard Hill Windfarm) has been undertaken.

218. The directional analysis is presented in full in **Appendix 9.6 Baseline Noise Survey Directional Analysis.** The principle of the directional analysis is that, if present, noise from an existing windfarm would be lower at a given measurement location when the wind direction is from the receptor to that windfarm (i.e. receptor 'upwind'), and therefore higher when the wind direction is from the windfarm to the receptor (i.e. receptor 'downwind), or when considering the full data set (all wind directions).

219. The directional analysis has identified that the measured noise levels under receptor 'upwind' conditions are either within 1dB of those that prevailing for the full data set (all wind directions), or actually slightly higher. This confirms that noise from existing windfarms has not made a significant contribution to the measured noise levels and therefore that the measurement results presented in **Table 9.28** can be relied upon as representative of conditions without the presence of wind turbine noise.

9.5.4 Knockcronal Baseline Noise Survey

220. The Knockcronal Windfarm applicant has confirmed that their noise assessment work is drawing upon the results of a baseline noise survey previously undertaken for the now withdrawn Linfairn Windfarm. This is also confirmed within the Knockcronal Windfarm Scoping Report. Appendix 8.1 of that Scoping Report contains a report entitled *Knockcronal Wind Farm Baseline Noise Assessment*, dated 20 October 2020, prepared by Hoare Lea Acoustics. That report provides full and comprehensive details of the completed baseline noise survey, which is more briefly summarised as follows:

- the survey was undertaken to inform an assessment of windfarm noise undertaken in accordance with ETSU-R-97 and the IoA GPG.
- six measurement locations were employed: Glenalla Farm, Knockskae, Linfairn Farm, Genoch Cottage, Tairlaw Toll Cottage and Tairlaw Toll House.
- of those six measurement locations, three (Glenalla Farm, Genoch Cottage and Tairlaw Toll House), are receptors where measurements were also undertaken during the Carrick baseline noise survey (see **Section 9.5.3**).
- the measurements undertaken at Glenalla Farm and Tairlaw Toll House are reported to have been at positions very close to the measurement positions adopted in the Carrick baseline noise survey (within 3m).
- The measurements undertaken at Genoch Cottage are reported to have been undertaken on the north-west side of the property and were subject to some water course noise. By comparison the Carrick baseline noise survey adopted a measurement position on the south side of that property and were not subject to water course noise.
- the survey was undertaken between mid-November 2017 and late January 2018, with all locations subject to appropriate measurement durations in excess of the 14 day period referenced in the IoA GPG. At the location subject to the shortest survey duration, measurement data was obtained for 45 days;
- all measurements are reported to have been undertaken with appropriately specified and installed equipment, including the use of appropriate windshields;
- all of the measurement systems are reported to have been calibrated to traceable standards within the previous 24 months and the field calibrator used within the previous 12 months;
- the measurement systems are reported to have been subject to a scheme of onsite calibration including at the start and end of the survey and at interim points when equipment battery changes were undertaken, with no significant measurement drifts arising;
- it is reported that each measurement system was time synchronised to Greenwich Mean Time (GMT);
- at each noise measurement location, $L_{A90,10min}$ noise level data was obtained for the duration of the survey periods; and
- photographic evidence of each measurement location is provided.

9.5.4.1 Meteorological Data

221. The baseline noise assessment report confirms that for the duration of survey, meteorological data was obtained on the Knockcronal application site at OS Grid Reference: 238149, 600032. This was initially

obtained from an installed LiDAR system, which was changed to SoDAR system part way through the survey. Both systems are reported to have been time synchronised to GMT.

222. Based on OS Terrain 5™ topographic data, the reported meteorological measurement location is appropriately representative of the proposed Knockcronal Windfarm, but is on lower ground than the proposed Carrick Windfarm. In comparison, the Carrick baseline noise survey data has been analysed with reference to meteorological data obtained from a mast installed on the Carrick site, at a position representative of the upper most Carrick turbines, and therefore on higher ground. Analysis of the Knockcronal and Carrick baseline noise survey results can therefore be expected to yield different results due to each being referenced to different meteorological data sources, see **Section 9.6.5.1.1**.

223. Rainfall data are reported to have been obtained at two of the baseline survey noise monitoring locations for the duration of the survey.

9.5.4.2 Knockcronal Baseline Noise Survey Results

224. The reported analysis of the obtained baseline data confirms the following:

- The obtained data were appropriately filtered for quiet daytime and night-time periods as defined in ETSU-R-97 and the IoA GPG.
- the analysis included the removal of rain affected periods and other periods affected by anomalous noise sources, as appropriate.
- After data removals, the remaining number of data points in each of the quiet daytime and night-time datasets were greater than the minimums recommended within ETSU-R-97 and IoA GPG.
- Average wind speed data obtained from the LiDAR / SoDAR systems at heights of 100 and 120m above ground were used to calculate wind speeds at a worst case hub height of 132m. Those data where then standardised to 10m height. Calculations are reported to have been undertaken in accordance with the method duplicated in **Appendix 9.3 Wind Shear Correction**, which is in compliant with IoA GPG guidance. Adopting a 132m hub height in these calculations represents a worst case for the now proposed 125m hub height associated with the assessed candidate turbine ((Vestas V150-6.0MW operating in Mode PO6000 (6.0MW variant)).
- For each measurement location and each period (quiet daytime and night-time), the filtered noise data were plotted on scatter graphs against the standardised 10m windspeed data, with a line of best fit added to represent the relationship between wind speed and background noise level.
- The applied lines of best fit were 4th order polynomials, which is in accordance with the IoA GPG.
- The analysis graphs demonstrate solid relationships between background noise levels and wind speed, in part due to the extensive datasets that were collected.

225. The key outputs of the baseline noise survey analysis are the quiet daytime and night-time scatter graphs including polynomial lines of best fit. Copies of those graphs for the receptors common to the Carrick baseline noise survey are presented as **Graphs 9.5.13 to 9.5.18** in **Appendix 9.5: Baseline Noise Conditions.**

226. The Knockcronal baseline noise survey results, for receptors common to Carrick baseline noise survey, are presented in tabular form in **Table 9.29** below.

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Measurement Location B: Glenalla											
Quiet daytime hours	28.7	28.6	28.9	29.6	30.7	32.1	33.7	35.6	37.5	39.2	40.7
Night-time hours	28.4	29.4	29.9	30.4	30.9	31.7	32.9	34.5	36.3	38.2	40.0
Measurement Location C: Genoch Cottage											
Quiet daytime hours	34.3	34.4	34.7	35.2	35.8	36.5	37.2	38.1	39.2	40.6	42.5
Night-time hours	33.7	34.6	35.4	36.0	36.3	36.5	36.6	36.9	37.5	38.8	40.9

Period	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Measurement Location D: Tairlaw Toll											
Quiet daytime hours	35.0	35.0	35.2	35.6	36.4	37.6	39.0	40.8	42.7	44.6	46.2
Night-time hours	34.7	35.5	35.7	35.8	36.0	36.7	37.8	39.4	41.4	43.7	46.0

Table 9.29 Knockcronal Baseline Noise Survey - Measurement Location Background Noise Levels – Locations Common to Carrick Baseline Noise Survey, $L_{A90,T}$, dB(A)

9.5.4.3 Directional Filtering

227. The baseline noise assessment report confirms that, as for the Carrick baseline noise survey, a directional analysis of the survey data was undertaken to check for any significant contribution to the noise environment from Dersalloch Windfarm. It was found that noise from Dersalloch Windfarm was not prevalent at any of the adopted baseline noise measurement locations. This is consistent with findings of the Carrick baseline noise survey directional analysis, see **Section 9.5.3.3**.

9.6 Potential Effects

9.6.1 Mitigation by Design and Embedded Mitigation

9.6.1.1 Construction Noise and Vibration

228. There are a number of safeguards that exist to minimise the effects of construction noise and vibration. These include:

- the various EC Directives and UK Statutory Instruments that limit noise emissions of a variety of construction plant; and
- the powers that exist for local authorities under Sections 60 and 61 of the Control of Pollution Act 1974 to control environmental noise on construction sites.

229. In addition, the adoption of Best Practicable Means (BPM) as defined in the Control of Pollution Act 1974 is usually the most effective means of controlling noise and vibration from construction sites. BPM would be employed including the following measures:

- staff would receive appropriate environmental training at the beginning of the contract and throughout the construction;
- silenced or sound reduced compressors, would be used where necessary;
- silencers or mufflers would be fitted to pneumatic tools where required;
- deliveries would be programmed to arrive during daytime hours only, with care being taken to minimise noise when unloading vehicles;
- delivery vehicles would be prohibited from waiting within the Site temporary construction compound with their engines running;
- plant items would be properly maintained and operated according to manufacturers' recommendations, in such a manner as to avoid causing excessive noise;
- access to the Site would be along agrees access routes only;
- there would be compliance with agreed working hours, e.g. construction activities audible beyond the Site Boundary would only be undertaken during the daytime between 07:00 to 19:00 hours Monday to Friday and 07:00 to 13:00 hours on weekends, or as agreed with the South Ayrshire Council Environmental Health Officer;
- effective liaison with the local community would be established and maintained throughout the construction period. This would include provision of information on the on-going activities (including blasting where required) and provision of contact telephone numbers for the Site to obtain information during operational hours, a representative being identified with appropriate authority to resolve any problems and a log of complaints and actions taken to remedy these being maintained; and
- the good practice advice detailed in both BS5228-1 and BS5228-2 would be complied with.

230. Compliance with the above measures would be ensured through inclusion within a Construction Environmental Management Plan (CEMP) which the appointed contractor would be required to comply with (**Appendix 4.2 Outline Construction Environmental Management Plan** presents an Outline CEMP). The final CEMP would be subject to agreement with South Ayrshire Council and the Scottish Environment Protection Agency (SEPA) and a planning condition could be used to ensure that it was followed in practice.

9.6.1.2 Blast Induced Vibration and Air Overpressure

231. Embedded mitigation measures that serve to reduce potential vibration and air overpressure from blasting works (should this be necessary) include the following:

- four different borrow pit search areas have been identified, geographically spread across the Site, increasing the potential for stone extraction without the need for blasting, see **Figure 4.1 Site Layout**;
- if blasting is identified to be needed, it may be possible for this to be spread across the four borrow pit areas, limiting the duration and extent of works in the vicinity of any individual receptor; and
- each borrow pit search area is located at substantial distance from the closest noise and vibration-sensitive receptors (approx. 1.2km at the closest point), such that attenuation of resulting vibration and air overpressure levels as a result of geometric spreading (distance) would be substantial.

232. In addition, the following good practice measures would be employed and can be ensured through inclusion within the final CEMP as to be agreed with South Ayrshire Council and the Scottish Environment Protection Agency (SEPA):

- care would be taken with the development of faces, and with trial blasts, as anomalous vibration levels might be produced when there is no free face to relieve the energy produced;
- appropriate burden would be ensured to avoid over- or under-confinement of the charge;
- accurate drilling and setting out would be undertaken;
- charge levels would be appropriate;
- exposed detonating cords would not be used;
- stemming with appropriate material such as sized gravel or stone chippings would be undertaken;
- decking charges/in hole delays/delay detonation would be used to ensure smaller maximum instantaneous charges (MICs);
- a series of groundborne vibration measurements and air overpressure measurements would be undertaken to check compliance with appropriate criteria (adopted from BS5228-2);
- each charge would be individually designed to maximise efficiency and reduce energy loss through vibration and air overpressure;
- the use of surface detonating cords and secondary blasting would be avoided wherever possible;
- the areas of heave and the total charges would be minimised;
- blasting in adverse weather conditions would be avoided (i.e. wind in the direction of sensitive receptors);
- blasting would be undertaken only within the (less-sensitive) hours of 10:00 and 12:00 and 14:00 and 16:00 on Mondays to Fridays, and 10:00 and 12:00 on Saturdays; and
- local residents would be informed in advance of the proposed times of blasting works, along with details of the good practice mitigation measures that are in place, to ensure good relations and appropriate reassurance.

9.6.1.1 Wind Turbine Noise

233. Embedded mitigation measures that serve to reduce the potential impact of wind turbine noise include the following:

- the proposed wind turbines have been sited at significant distances from the closest noise-sensitive receptors (1.1km at the closest point, see **Table 9.25**), such that the attention of noise as a result of geometric spreading (distance) is maximised; and
- wind turbines have been located such that attenuation from landform (acoustic screening) is maximised where possible.

9.6.2 Potential Effects – Construction Noise

234. The only onsite construction works required within 300m of noise-sensitive receptors would be site access track upgrade works. Such works would be undertaken within approximately 220m of Tallaminnoch Cottage (receptor ref. 13, see **Figure 9.1 Noise and Vibration Sensitive Receptors, Cumulative Developments and Baseline Noise Measurement Locations**.). The next closest onsite works to noise-sensitive receptors would be at distances of approximately 1km and greater.

235. The construction contract for the Proposed Development would be subject to a tender process. The precise details of the construction methodologies to be employed during the access track upgrade works are therefore yet to be finalised as these would depend upon the successful tenderer. However, the appointed contractor would be required to develop a CEMP, which would detail the construction methods to be employed and the measures to be adopted to control noise emissions.

236. For the purpose of this assessment, it has therefore been necessary to assume appropriate construction plant / operations considered likely to be deployed during the access track upgrade works. These are detailed in **Table 9.30**

Plant / Operation	Sound Pressure Level ($LAeq_{,T}$ / LAFmax at 10m) from BS5228-1 – LAFmax level denoted by*
Chain Saw - Felling	86
Tracked Excavator - Trenching	71 - 77
Tracked Excavator - Earthworks	68 - 80
Tracked Excavator - Dumping/Spreading Load/Compacting	78 - 86
Dumper Truck - Distribution	56* - 92*
Dumper Truck - Tipping/Load	74 - 86
Lorry - Pass-by/Movement of Materials	76* - 88*

237. Table 9.30 below, along with the range of associated sound pressure levels at 10m, as obtained from BS5228-1.

Plant / Operation	Sound Pressure Level ($L_{Aeq,T}$ / L_{AFmax} at 10m) from BS5228-1 – L_{AFmax} level denoted by*
Chain Saw - Felling	86
Tracked Excavator - Trenching	71 - 77
Tracked Excavator - Earthworks	68 - 80
Tracked Excavator - Dumping/Spreading Load/Compacting	78 - 86
Dumper Truck - Distribution	56* - 92*
Dumper Truck - Tipping/Load	74 - 86
Lorry - Pass-by/Movement of Materials	76* - 88*

Table 9.30 Sample of Access Track Upgrade Construction Activities and Associated Typical Sound Pressure Level Data at 10m (BS 5228-1:2009+A1:2014), Free-field dB(A)

238. Drawing on the data presented in **Table 9.30, Table 9.31** presents the resulting calculated noise level (or range of noise levels) for each plant/operation at the closest receptor distance of 220m. Given the nature of the local area, these calculations have assumed propagation across acoustically absorptive ground, but include the following worst case assumptions:

- that each plant item is operated continuously for 100% of the working day;
- that there is no attenuation due to screening; and
- that there is no attenuation due to atmospheric absorption.

239. In addition, it should also be noted that for distribution activities such as moving dumper trucks and lorries, the noise level data presented within BS5228-1 are based on the L_{AFmax} noise index. Noise levels adopting this noise index would typically be significantly higher than the corresponding $L_{Aeq,T}$ noise levels, and strictly should therefore not be compared against assessment criteria adopting the $L_{Aeq,T}$ noise index (as being applied in this assessment, see **Table 9.9**). Including L_{AFmax} noise levels in this assessment therefore also represents a worst case.

240. Whilst it is considered unlikely that all of the identified plant / operations would occur simultaneously (and continuously), the combined noise levels are also presented in **Table 9.31.**

Plant/Operation	Sound Pressure Level ($L_{Aeq,T}$ / L_{AFmax}) at closest receptor distance of 220m – L_{AFmax} level denoted by*
Chain Saw - Felling	54.4
Tracked Excavator - Trenching	39.4 – 45.4
Tracked Excavator - Earthworks	36.4 – 48.4
Tracked Excavator - Dumping/Spreading Load/Compacting	46.4 – 54.4
Dumper Truck - Distribution	24.4* - 60.4*
Dumper Truck - Tipping/Load	42.4 – 54.4
Lorry - Pass-by/Movement of Materials	44.4* - 56.4*
Combined – All Plant/Operations	**55.8 – 64.0**

Table 9.31 Sample of Access Track Upgrade Construction Activities and Associated Worst Case Sound Pressure Levels at 220m, Free-field dB(A)

241. It can be seen from **Table 9.31** that even when assuming all plant/operations operating simultaneously, the resulting noise levels at the closest receptor range from 55.8 to 64.0dB(A). In accordance **Table 9.9**, these levels correspond to an impact magnitude of Slight to Low at worst.

242. Therefore, the receptor sensitivity is High and the impact magnitude is Slight to Low at worst giving rise to a **Negligible to Minor** adverse effect at worst (**Not Significant**). The resulting effect would be direct, temporary and local.

9.6.3 Potential Effects – Construction Vibration

243. As detailed in the construction noise assessment above (**Section 9.6.2**), the precise construction methods to be employed would not be known until after the construction contractor is confirmed, with that appointment being the subject of a tender process. However, it is assumed that the access track upgrade works (the closest works to vibration sensitive receptors), is likely to utilise vibratory rollers (for ground compaction) and also HGV arrival and departures which could be over uneven ground. Both of these activities have the potential to generate groundborne vibration.

244. It is anticipated that piling work would be required in the formation of the wind turbine foundations, but such works would be undertaken at distances of greater than 1km (see **Table 9.25**) and at such distances, a significant effect would not arise.

245. **Table 9.32** below presents the possible distances at which the adopted impact magnitude criteria may be registered (see **Table 9.10**) based on a specified confidence limit (where applicable), and the empirical prediction procedures presented within BS5228-2, TRL RR 246 (applicable to HGV induced vibration), and TRL Report 429 (applicable to vibratory rollers).

Operation	Confidence Limit	Distance	PPV (mm/s)
	95	60	0.3
Vibratory Rollers (start and end)	95	23	1.0
Vibratory Rollers – Steady State[1]	95	3.3	10
HGV's[2]	N/A	50	0.3[3]
	N/A	17	1.0[3]
	N/A	2.5	10[3]
1 Assumes 2 rollers, 0.4mm amplitude, drum width of 1.3m, e.g. heavy duty ride on roller 2 Assumes max height / depth of surface defect of 50mm, max speed of 30km/h, and that surface defect occurs at both wheels. 3 Where alluvium soils are present, higher vibration levels can be expected.			

Table 9.32 Predicted Groundborne Vibration Levels Applicable to Typical Access Track Upgrade Construction Works

246. Comparing the worst case receptor distance of 220m with the content of **Table 9.32**

Operation	Confidence Limit	Distance	PPV (mm/s)
Vibratory Rollers (start and end)	95	60	0.3
	95	23	1.0
Vibratory Rollers – Steady State1	95	3.3	10
HGV's2	N/A	50	0.33
	N/A	17	1.03
	N/A	2.5	103
1 Assumes 2 rollers, 0.4mm amplitude, drum width of 1.3m, e.g. heavy duty ride on roller 2 Assumes max height / depth of surface defect of 50mm, max speed of 30km/h, and that surface defect occurs at both wheels. 3 Where alluvium soils are present, higher vibration levels can be expected.			

247. Table 9.32**,** it can be seen that resulting groundborne vibration levels would be below a PPV of 0.3mm/s. In accordance **Table 9.10**, these levels correspond to an impact magnitude of Slight at worst.

248. Therefore, the receptor sensitivity is High and the impact magnitude is Slight giving rise to a **Negligible** adverse effect at worst (**Not Significant**). The resulting effect would be direct, temporary and local.

9.6.4 Potential Effects - Blast Induced Vibration and Air Overpressure Vibration

249. PAN 50 confirms that the levels of groundborne vibration as a result of blasting during surface mineral workings "*are well below those required to give rise to structural damage*". With regard to human perception of vibration due to blasting, BS5228-2 states that "*ground borne vibration can lead to concern being expressed by residents around open cast sites*", but that any concerns raised are "*usually over the likelihood of property damage*" rather than annoyance / nuisance (which is unsurprising given the infrequent, occasional nature of the source). The standard goes on to state that "*Good public relations have been shown to reassure the public of the fact that normal production blasting has not been found to damage property, and that even the most cosmetic of plaster cracking is extremely unlikely*".

250. Accordingly, given that the embedded mitigation measures include for local residents to be kept informed of the times of blasting works as well as the details of the good practice mitigation measures that are to be in place, it is considered that appropriate measures are in place to allay possible concerns from residents.

251. Notwithstanding this, the closest residential receptor to any of the borrow pit search area is Glenalla, which is at a distance of circa 1.2km from the most western of the borrow pit search areas, see **Figure 4.1: Site**

Layout). This substantial distance is sufficient that concerns over possible impacts (either building damage or nuisance) as a result of groundborne vibration are not expected.

252. Therefore, the receptor sensitivity is High[12] and the impact magnitude is Slight, giving rise to a **Negligible** adverse effect (**Not Significant**). The resulting effect would be direct, temporary and local.

Air Overpressure

253. Provided that an exposed detonating cord is not used (which is the usual situation – see embedded mitigation section above), the characteristic noise from a blast is no longer a sharp crack but rather a 'dull thump'[13] . Peak noise levels from blasting are comparable to the sort of levels typically generated at properties by passing cars[13], but in the case of blasting would only exist for around a second and also occur relatively infrequently.

254. Because of its very brief duration, infrequent occurrence and low frequency content (much of which is below 20Hz and hence inaudible to the human ear) blast noise is usually considered not to be a significant problem with respect to disturbance to humans.

255. Air overpressure may be sensed or felt by humans and can excite secondary vibrations at audible frequencies in buildings (e.g. rattling of windows and ornaments on shelves) that has been found to give rise to adverse comments from occupants of buildings affected by the blasting. However, there is no known evidence of structural damage to buildings/structures from excessive air overpressure levels from quarry blasting[14] .

256. Noise attenuation due to topography (whether natural or man-made), ground effects and air absorption between the blast site and receiver would be much greater for the audible component of the pressure wave (i.e. above 20Hz), but relatively slight on the lower frequency (or concussive) component. As a consequence, the air overpressure from blasting can carry over large distances.

257. BS5228-2 notes that "meteorological conditions, over which the operator has no control, such as temperature, cloud cover, humidity, wind speed, turbulence and direction would all affect the intensity of air overpressure at any location". These meteorological effects cannot be reliably predicted, although under still conditions, once outside the immediate vicinity of the blast, air overpressure intensity would reduce at 6dB per doubling of distance.

258. For the reasons stated above regarding blast design and the prevailing meteorological conditions, both of which would influence source levels, it is not possible to predict air overpressure from blasting with any certainty – this is confirmed in BS5228-2. Furthermore, it is not generally accepted practice to set specific limits for air overpressure. In order to control air overpressure, the best practical approach is to take measures to minimise its generation at source, as outlined in the embedded mitigation section above.

259. These embedded mitigation measures are sufficient to alley possible concerns from residents. Notwithstanding this, the substantial separation distance of at circa 1.1km and greater from the borrow pit search areas is sufficient that possible impacts as a result of air overpressures are not expected.

260. Therefore, the receptor sensitivity is High[12] and the impact magnitude is Slight, giving rise to a **Negligible** adverse effect (**Not Significant**). The resulting effect would be direct, temporary and local.

[12] This has been selected as a worst case for Knockinculloch Enclosure, such that the assessment also encompasses the closest residential property. However, given that this is a Scheduled Monument not subject to permanent residential occupancy it would be reasonable to apply a lower sensitivity grade if considered in isolation.

9.6.5 Potential Effects – Wind Turbine Noise

9.6.5.1 Determination of Applicable Cumulative Noise Level Limits

9.6.5.1.1 Adopted Baseline Noise Survey Data

261. Baseline noise measurements were undertaken at Glenalla, Genoch Cottage and Tairlaw Toll House during both the Carrick and Knockcronal baseline noise surveys. **Graphs 9.19 to 9.24** in **Appendix 9.5: Baseline Noise Conditions** compare the polynomial lines of best fit determined from each survey.

262. In each graph, the results from the Carrick baseline noise survey are generally lower than those determined from the Knockcronal baseline noise survey. This is as expected for the reasons outline in **paragraph 222**. The Carrick baseline data analysis therefore represents a worst case, reflective of the Carrick site being subject to higher windspeeds than the Knockcronal site due to it being on higher ground.

263. The cumulative noise level limits have therefore been determined drawing upon the results of the Carrick baseline noise survey as detailed in **Table 9.28** and **Graphs 9.5.1 to 9.5.12** of **Appendix 9.5 Baseline Noise Conditions**.

9.6.5.1.2 Applicable Cumulative Noise Level Limits

264. ETSU-R-97 states that during the daytime, the fixed element of the limit should be selected between 35 and 40dB(A), with further relaxation up to 45dB(A) allowable where the receptor has a financial involvement in the development. This document states that the selection of the lower limit should be made with due consideration to "*the number of dwellings in the neighbourhood of the windfarm"*, "*the effect of noise limits on the number of kWh generated"* and the "*duration and level of exposure"*. With respect to the latter, it is stated that the proportion of time during which the background noise levels are low, and how low the background noise level gets are both recognised factors which could affect the setting of an appropriate lower limit.

265. In addition, the IoA GPG recognises that in a complex cumulative scenario (as is the case here) consideration needs to be given to the noise level limits that are imposed on consented developments.

266. In the case of this development, the Dersalloch Windfarm is consented with the fixed limit elements set at 37.5dB(A) for the daytime and 43dB(A) for the night-time. Similarly, the Hadyard Hill Windfarm is consented with the fixed limit elements set at 38dB(A) during the daytime and 43dB(A) during the night-time.

267. It is also of note that South Ayrshire Councils scoping response to the previously proposed Hadyard Windfarm Extension, the following was stated:

"*ACCON* [South Ayrshire Council's noise and vibration technical advisors] *have also advised that the following operational noise limits should be applied. To accord with the current noise conditions for Hadyard Hill their advice is that a daytime limit should be based on 38dB L_{A90} and for the night-time limit of 43dB L_{A90}."*

268. This recognises the point that it would be incongruous to set the fixed element of a cumulative noise level limit lower than the fixed element already permitted for a consented development.

269. Accordingly, the fixed elements of the cumulative daytime and night-time noise level limits have been set at 38dB(A) and 43dB(A) respectively.

270. The resulting cumulative noise level limits, for properties without a financial involvement in the Proposed Development have been determined as follows:

- daytime (07:00 to 23:00): The quiet daytime hours background noise level (L_{A90}) +5dB or 38dB(A), whichever is the higher; and

[13] PAN 50 Annex D.
[14] BS 5228-2 Annex 3 Section G1 paragraph 3.

- night-time (23:00 to 07:00): The night-time hours background noise level (L_{A90}) +5dB or 43dB(A), whichever is the higher.

271. Application of the above limits is therefore in accordance with ETSU-R-97 and consistent with the limits already imposed on the consented cumulative developments.

272. The resulting noise level limits can be seen in **Graphs 9.7.1 to 9.7.12** of **Appendix 9.7 Cumulative Noise Level Limits**, and are presented in tabular form in **Table 9.33**. These limits apply to the total cumulative wind turbine noise levels.

Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s											
	2	3	4	5	6	7	8	9	10	11	12
Measurement Location A: Blair Farm											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	46.0	48.3
Measurement Location B: Glenalla											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
Measurement Location C: Genoch Cottage											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
Measurement Location D: Tairlaw Toll											
Daytime Limit (Non FI)	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
Measurement Location E: White Row											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
Measurement Location F: Doughty Farm											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.3

Table 9.33 Total Cumulative Noise Level Limits, $L_{A90,T}$, dB(A)

9.6.5.2 Noise Level Predictions

273. In order to facilitate an assessment of the Proposed Development (including for possible cumulative effects), a detailed noise model has been prepared for the Site and surrounding area.

274. The model has been prepared in the CadnaA® noise modelling suite. The noise model was set to use the ISO 9613-2 prediction method, which includes prescribed formulae for accounting for the effects of geometric divergence, ground absorption and atmospheric absorption. The ISO 9613-2 prediction method is for the calculation of sound pressure levels at a 'downwind' location and the research findings presented in *Development of a windfarm noise prediction model* (Bass et al 1998), identified that this model tends to over-predict windfarm noise levels, whilst also being the best available. This noise prediction model is referenced as appropriate for use within the IoA GPG, but with the following recommendations, which have been applied:

- topographic screening effects of the terrain should be limited to a reduction of no more than 2dB (unless a higher value can be fully justified), and only applied where there is no line of sight between the highest point on the wind turbine rotor and the receiver location; and
- a correction of +3dB (or + 1.5dB if using G=0.0) should be added where the propagation of noise from the wind turbine to a receiver is across a valley (as defined in the IoA GPG).

275. Whilst the IoA GPG presents methodologies for the determination of additional corrections to account for propagation directivity, which could be used for example to account for effects of wind direction where a receptor is located between two developments, such corrections have not been included within the modelled results. The predicted operational noise levels can therefore be considered worst case in this regard, assuming downwind propagation conditions from all wind turbines.

276. Additional information on the completed noise modelling and predictions can be found in **Appendix 9.2 Noise Modelling and Prediction**.

277. The noise model has been used to determine receptor noise levels for the following scenarios:

- the Proposed Development operating in isolation;
- each of the four cumulative windfarm developments (Dersalloch, Hadyard Hill, Craiginmoddie and Knockcronal) operating in isolation; and
- the three currently proposed developments (Carrick, Craiginmoddie and Knockcronal) operating simultaneously.

278. Noise level predictions for Dersalloch Windfarm and Hadyard Hill Windfarm, have been undertaken on a worst case basis, i.e. the highest levels expected when operating within their existing consents. These level data have been used to inform the Cumulative Scoping exercise**, see Section 9.6.5.4** and **Appendix 9.9: Cumulative Scoping**, and in the determination of the remaining available ('residual'[15]) noise level limits for the proposed developments, see **Section 9.6.6.2**.

9.6.5.2.1 Wind Turbine Sound Power Level Data

Proposed Development

279. To inform this noise assessment, the candidate wind turbine for the Proposed Development is the Siemens Gamesa SG 6.6-155 installed with a hub height of 122.5m. The noise emission data for this turbine is detailed in **Table 9.20** and has been determined based on manufacturers noise emission data with addition of a +2dB uncertainty correction.

Dersalloch Windfarm

280. **Table 9.12** details the wind turbine sound power levels that have been permitted for this development under condition 15 of its consent. These data extend over the wind speed range 7 to 12m/s. **Table 9.13** details the sound power levels for the wind turbine as installed (for both 64 and 74.5m hub heights), extending over a wider wind speed range of 3 to 12m/s.

281. Within the range 8 to 12m/s the data are the same (for a hub height of 74.5m), being 109dB(A). At a wind speed of 7m/s, the permitted level (109dB(A) from **Table 9.12**) is 0.5dB higher than that of the installed wind turbine (108.5dB(A) from **Table 9.13** for 74.5m hub height).

282. The wind turbine sound power level data that has been applied for this development is therefore a combination of that contained within **Table 9.12** and **Table 9.13**. The applied data is presented in **Table 9.34**. This comprises:

- the data from **Table 9.13** (for 74.5m hub) for wind speeds at 3 to 7m/s, but with an uplift of 0.5dB; and
- the data contained within **Table 9.12** for wind speeds of 8 to 12m/s.

283. Applying the 74.5m hub data to wind turbines installed with the lower 64m hub represents a worst case.

[15] Also sometimes referred to as the available 'noise budget'.

Hub Height	Wind Speed Referenced to 10m (Standardised U_{10}), m/s									
	3	4	5	6	7	8	9	10	11	12+
the Siemens 3.0-101 (worst case)	93.4	97.6	102.1	106.8	109	109	109	109	109	109
Data includes +2dB additional uncertainty correction										

Table 9.34 Worst Case Sound Power Level Data for the Siemens 3.0-101 as Installed at Dersalloch Windfarm, dB(A)

284. Given that **Table 9.34** includes for the maximum allowed sound power levels as permitted under conditions 15 of the extant consent, applying these data in the modelling process gives rise to worst case noise levels from this windfarm when operating within its current consent and represent an overestimation of the levels that currently arise.

285. The octave band spectra presented within **Table 9.14** for 74.5m hub height have been applied, but level adjusted to correspond to the single figure sound power levels in **Table 9.34**. The spectra for 6m/s has been applied for wind speed up to 6m/s. The spectra for 8m/s has been applied at wind speeds of 7m/s and higher.

Hadyard Hill Windfarm

286. For Hadyard Hill Windfarm, the wind turbine sound power level data and octave band spectrum detailed in **Table 9.17** and **Table 9.18** have been applied. For each windspeed, the adopted spectrum has been level-adjusted to correspond to the single figure sound power levels presented in **Table 9.17**.

287. Application of this data includes for a number of worst case assumptions including:

- a +2dB uncertainty correction;
- the data for 6m/s has been applied down to 3m/s (i.e. assumes no reduction in noise with reducing wind speed below 6m/s); and
- the adopted data is for the wind turbine installed at an 80m high hub (application to lower hub heights, as is the case here, represents a worst case).

288. Notwithstanding the above, as detailed within **paragraphs 323 to 327**, it has been identified that Corphin Cottage is a 'controlling property' for this development. Application of these wind turbine data have been identified to result in a limit exceedance at this controlling property. Therefore, the modelled receptor results for this development can be considered to represent a worst case, because in practice, lower noise levels would result from this development when operating in compliance with its existing consent.

289. Furthermore, the Dailly Community Council consultation response confirms that noise mitigation is implemented at the Hadyard Hill Windfarm i.e. a noise management scheme with reduced modes of operation applied to certain wind turbines etc. Given that the modelled receptor noise levels assume all wind turbines operating in unconstrained mode, this is further confirmation that the results can be considered to represent a worst case for this development when operating within its consent.

9.6.5.3 Predicted Receptor Levels

290. The full suite of modelled results can be found in **Appendix 9.8 Modelled Receptor Noise Levels**. In addition, a series of noise contour plots have been generated for a wind speed of 10m/s. These noise contour plots assume all wind turbines operating in unconstrained modes (i.e. worst case for consented developments and without mitigation for the proposed developments). The contour plots are illustrated in the following figures:

- **Figure 9.2 Noise Contour - 10m/s – Proposed Development (Carrick) in Isolation**;
- **Figure 9.3 Noise Contour - 10m/s – All Cumulative Developments (Operational and Proposed)**; and
- **Figure 9.4 Noise Contour – 10m/s – Proposed Developments (Carrick, Craiginmoddie & Knockcronal)**.

291. All of the predictions, including the noise contours assume downwind propagation from all turbines. Significantly lower noise levels can be expected during upwind propagation conditions (i.e. when the wind direction is from the receptor towards the turbines)

292. **Table 9.35** presents the modelled results for Dersalloch Windfarm at the closest receptors to the Proposed Development that are in the direction of Dersalloch Windfarm.

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Glenalla	-	6.6	10.8	15.3	20.0	22.2	22.2	22.2	22.2	22.2	22.2
Knockskae	-	14.2	18.4	22.9	27.6	29.8	29.8	29.8	29.8	29.8	29.8
Linfairn	-	13.7	17.9	22.4	27.1	29.3	29.3	29.3	29.3	29.3	29.3
Genoch Cottage	-	13.4	17.6	22.1	26.8	29.0	29.0	29.0	29.0	29.0	29.0
Tairlaw Toll Cottage	-	14.1	18.3	22.8	27.5	29.7	29.7	29.7	29.7	29.7	29.7

Table 9.35 Receptor Noise Levels – Dersalloch Windfarm in Isolation – Worst Case Operation Within Consent, $L_{A90,T}$, dB

293. **Table 9.36**

Receptor	Wind Speed Referenced to 10m Height (Standardised U10), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Doughty Farm	-	28.8	28.8	28.8	28.8	29.9	31.0	32.1	32.1	32.1	32.1

294. Table 9.36 presents the modelled results for Hadyard Hill Windfarm at closest receptors to the Proposed Development that are in the Direction of Hadyard Hill Windfarm.

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Doughty Farm	-	28.8	28.8	28.8	28.8	29.9	31.0	32.1	32.1	32.1	32.1

Table 9.36 Receptor Noise Levels – Hadyard Hill Windfarm in Isolation – Worst Case Operation Within Consent, $L_{A90,T}$, dB

295. **Table 9.37** presents the model results for the Proposed Development operating in isolation, without mitigation (i.e. all proposed wind turbines operating in unconstrained mode).

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Blair Farm	7.4	8.6	13.8	18.6	20.4	20.4	20.4	20.4	20.4	20.4	20.4
Glenmartin	8.0	9.2	14.4	19.2	21.0	21.0	21.0	21.0	21.0	21.0	21.0
The Shieling	9.5	10.7	15.9	20.7	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Knockinculloch Enclosure	20.9	22.1	27.3	32.1	33.9	33.9	33.9	33.9	33.9	33.9	33.9
Glenalla	22.9	24.1	29.3	34.1	35.9	35.9	35.9	35.9	35.9	35.9	35.9
Knockskae	15.4	16.6	21.8	26.6	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Linfairn	13.9	15.1	20.3	25.1	26.9	26.9	26.9	26.9	26.9	26.9	26.9
Genoch Cottage	13.7	14.9	20.1	24.9	26.7	26.7	26.7	26.7	26.7	26.7	26.7
Culdoch Cottage	10.4	11.6	16.8	21.6	23.4	23.4	23.4	23.4	23.4	23.4	23.4
Baing Farm	11.3	12.5	17.7	22.5	24.3	24.3	24.3	24.3	24.3	24.3	24.3
Tairlaw Toll Cottage	18.3	19.5	24.7	29.5	31.3	31.3	31.3	31.3	31.3	31.3	31.3
Tairlaw Toll House	18.3	19.5	24.7	29.5	31.3	31.3	31.3	31.3	31.3	31.3	31.3

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Tallaminnoch Cottage	19.1	20.3	25.5	30.3	32.1	32.1	32.1	32.1	32.1	32.1	32.1
Black Row	13.4	14.6	19.8	24.6	26.4	26.4	26.4	26.4	26.4	26.4	26.4
Aldinna	11.7	12.9	18.1	22.9	24.7	24.7	24.7	24.7	24.7	24.7	24.7
White Row	12.9	14.1	19.3	24.1	25.9	25.9	25.9	25.9	25.9	25.9	25.9
Doughty Farm	15.6	16.8	22.0	26.8	28.6	28.6	28.6	28.6	28.6	28.6	28.6
Corphin Cottage	5.0	6.2	11.4	16.2	18.0	18.0	18.0	18.0	18.0	18.0	18.0
Delamford Cottage	3.8	5.0	10.2	15.0	16.8	16.8	16.8	16.8	16.8	16.8	16.8
Dobbingstone Farm	5.7	6.9	12.1	16.9	18.7	18.7	18.7	18.7	18.7	18.7	18.7

Table 9.37 Receptor Noise Levels – Proposed Development in Isolation – No Mitigation / Unconstrained Mode, $L_{A90,T}$, dB

296. **Table 9.38** presents the model results for the three proposed developments (Carrick, Craiginmoddie and Knockcronal) operating simultaneously, without mitigation (i.e. all proposed wind turbines operating in unconstrained mode).

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Blair Farm	14.2	16.0	21.0	25.7	27.7	27.8	27.8	27.8	27.8	27.8	27.8
Glenmartin	14.0	15.8	20.8	25.6	27.6	27.6	27.7	27.7	27.7	27.7	27.7
The Shieling	14.0	15.9	20.9	25.6	27.7	27.7	27.8	27.8	27.8	27.8	27.8
Knockinculloch Enclosure	23.1	25.2	30.1	34.9	36.9	37.0	37.0	37.0	37.0	37.0	37.0
Glenalla	24.0	26.1	31.0	35.8	37.8	37.9	37.9	37.9	37.9	37.9	37.9
Knockskae	16.0	24.0	28.0	32.5	35.4	35.8	35.9	35.9	35.9	35.9	35.9
Linfairn	14.6	23.5	27.4	31.9	34.9	35.3	35.4	35.4	35.4	35.4	35.4
Genoch Cottage	14.3	22.1	26.1	30.6	33.5	33.9	34.0	34.0	34.0	34.0	34.0
Culdoch Cottage	11.3	17.1	21.3	25.9	28.6	28.9	29.0	29.0	29.0	29.0	29.0
Baing Farm	12.0	18.3	22.5	27.0	29.8	30.1	30.2	30.2	30.2	30.2	30.2
Tairlaw Toll Cottage	18.5	23.5	27.8	32.4	35.0	35.3	35.4	35.4	35.4	35.4	35.4
Tairlaw Toll House	18.5	23.5	27.8	32.4	35.0	35.3	35.3	35.3	35.3	35.3	35.3
Tallaminnoch Cottage	19.3	22.7	27.3	32.0	34.3	34.5	34.5	34.5	34.5	34.5	34.5
Black Row	14.7	17.0	21.9	26.6	28.7	28.8	28.8	28.8	28.8	28.8	28.8
Aldinna	14.5	16.5	21.4	26.1	28.2	28.3	28.3	28.3	28.3	28.3	28.3
White Row	16.0	17.9	22.8	27.6	29.6	29.7	29.7	29.7	29.7	29.7	29.7
Doughty Farm	25.3	26.5	31.7	36.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3
Corphin Cottage	17.8	19.0	24.2	29.0	30.8	30.8	30.8	30.8	30.8	30.8	30.8
Delamford Cottage	19.6	20.8	26.0	30.8	32.6	32.6	32.6	32.6	32.6	32.6	32.6
Dobbingstone Farm	20.8	22.0	27.2	32.0	33.8	33.8	33.8	33.8	33.8	33.8	33.8

Table 9.38 Receptor Noise Levels – Proposed Developments (Carrick, Craiginmoddie, Knockcronal) – No Mitigation / Unconstrained Mode, $L_{A90,T}$, dB

9.6.5.4 Cumulative Scoping

297. The proposed developments (Craiginmoddie Windfarm and Knockcronal Windfarm) are adjacent to the Proposed Development and have therefore been scoped-in to the cumulative assessment.

298. Additional consideration has been given to the two operational developments (Dersalloch Windfarm and Hadyard Hill Windfarm) below.

Closest Receptors to Operational Cumulative Developments

299. Consideration has been given to whether there is the potential for the Proposed Development to give rise to a cumulative impact at the sensitive receptors closest to the operational cumulative developments. These receptors are listed below with the closest operational development to each receptor detailed in brackets:

- Culdoch Cottage (Dersalloch Windfarm);
- Baing Farm (Dersalloch Windfarm);
- Corphin Cottage (Hadyard Hill Windfarm);
- Delamford Cottage (Hadyard Hill Windfarm); and
- Dobbingstone Farm (Hadyard Hill Windfarm).

300. **Table 9.39** details the cumulative noise level limits that have been applied at each of these receptors.

Receptor	Applied Daytime Noise Limits
Culdoch Cottage	Limit as detail in **Table 9.16 (**Measurement Location: Grimmet)
Baing Farm	Limit as detailed in **Table 9.16 (**Measurement Location: Baing Farm)
Corphin Cottage	Limit as detailed in **Table 9.33 (**Measurement Location F: Doughty Farm)
Delamford Cottage	
Dobbingstone Farm	

Table 9.39 Applied Noise Level Limits (Closest Receptors to Identified Cumulative Developments)

301. **Appendix 9.9 Cumulative Scoping (Graphs 9.9.1 to 9.9.3)**, presents the daytime noise level limits applied at each of these receptors. As a worst case it is assumed that none of these receptors have a financial involvement in any of the developments. Also presented are these noise level limits reduced by 10dB. For each of the above receptors, the predicted noise levels from the Proposed Development operating in isolation have also been plotted on the applicable graph. The daytime noise level limits have been selected as a worst case, being more stringent than the corresponding night-time limits.

302. This assessment is present in tabular form in **Table 9.40.**

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
Measurement Location: Grimmet (Dersalloch Consent)												
Culdoch Cottage	Proposed Development only level [A]	10.4	11.6	16.8	21.6	23.4	23.4	23.4	23.4	23.4	23.4	23.4
	Daytime limit (Non FI) [B]	43.7	42.6	42.3	42.7	43.6	44.7	46.1	47.3	48.4	49.0	49.1
	Daytime limit (Non FI) -10dB [C]	33.7	32.6	32.3	32.7	33.6	34.7	36.1	37.3	38.4	39.0	39.1
	-10dB compliance check [A-C] = [D]	**-23.3**	**-21.0**	**-15.5**	**-11.1**	**-10.2**	**-11.3**	**-12.7**	**-13.9**	**-15.0**	**-15.6**	**-15.7**
Measurement Location: Baing Farm (Dersalloch Consent)												
Baing Farm	Proposed Development only level [A]	11.3	12.5	17.7	22.5	24.3	24.3	24.3	24.3	24.3	24.3	24.3
	Daytime limit (Non FI) [B]	55.5	55.2	54.9	54.9	54.9	55.0	55.2	55.5	55.8	56.3	56.8
	Daytime limit (Non FI) -10dB [C]	45.5	45.2	44.9	44.9	44.9	45.0	45.2	45.5	45.8	46.3	46.8
	-10dB compliance check [A-C] = [D]	**-34.2**	**-32.8**	**-27.2**	**-22.4**	**-20.6**	**-20.7**	**-20.9**	**-21.2**	**-21.5**	**-22.0**	**-22.5**
Measurement Location F: Doughty Farm												
Corphin Cottage	Proposed Development only level [A]	10.4	11.6	16.8	21.6	23.4	23.4	23.4	23.4	23.4	23.4	23.4
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.6	30.6	32.7	34.9
	-10dB compliance check [A-C] = [D]	**-17.6**	**-16.4**	**-11.2**	**-6.4**	**-4.6**	**-4.6**	**-4.6**	**-5.2**	**-7.2**	**-9.3**	**-11.5**
Delamford Cottage	Proposed Development only level [A]	3.8	5.0	10.2	15.0	16.8	16.8	16.8	16.8	16.8	16.8	16.8
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.6	30.6	32.7	34.9
	-10dB compliance check [A-C] = [D]	**-24.2**	**-23.0**	**-17.8**	**-13.0**	**-11.2**	**-11.2**	**-11.2**	**-11.7**	**-13.8**	**-15.9**	**-18.0**
Dobbingstone Farm	Proposed Development only level [A]	5.7	6.9	12.1	16.9	18.7	18.7	18.7	18.7	18.7	18.7	18.7
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.6	30.6	32.7	34.9
	-10dB compliance check [A-C] = [D]	**-22.3**	**-21.1**	**-15.9**	**-11.1**	**-9.3**	**-9.3**	**-9.3**	**-9.9**	**-11.9**	**-14.0**	**-16.2**

Table 9.40 Comparison of Proposed Development Noise Levels with Consented Limits -10dB, dB(A)

303. It can be seen from this assessment that at each receptor, the predicted operational noise levels from the Proposed Development are more than 10dB below the applicable limits. This is denoted within **Table 9.40** by all [D] values (bold text) being negative and depicted in **Appendix 9.9 Cumulative Scoping** (**Graphs 9.9.1 to 9.9.3)** by the individual receptor levels remaining below the -10dB limits.

304. As such, it can be concluded that, at the receptors of Culdoch Cottage, Baing Farm, Corphin Cottage, Delamford Cottage, and Dobbingstone Farm, noise from the Proposed Development would not give rise to a significant effect when operating either in isolation, or under the cumulative scenario.

305. As a result, these receptors are scoped-out of operational noise assessment and require no further consideration.

306. For these receptors, the receptor sensitivity is High and the residual effect is **Not Significant**. The resulting effect would be direct, permanent and local.

Closest Receptors to Proposed Development

307. Consideration has also been given to whether there is the potential for noise levels arising from the operational Hadyard Hill and Dersalloch Windfarms to give rise to a cumulative impact at the sensitive receptors closest to the Proposed Development. The noise levels arising from these developments have been determined at the closest receptors to the Proposed Development that are in the direction of each of these developments. These receptors are as follows, with the closest operational development to each receptor detailed in brackets:

- Glenalla (Dersalloch Windfarm);
- Knockskae (Dersalloch Windfarm);
- Linfairn (Dersalloch Windfarm);
- Genoch Cottage (Dersalloch Windfarm);
- Tairlaw Toll Cottage (Dersalloch Windfarm); and
- Doughty Farm (Hadyard Hill Windfarm).

308. **Table 9.41Error! Reference source not found.** details the cumulative noise level limits that have been applied at each of these receptors.

Receptor	Applied Daytime Noise Limits
Glenalla	Limit as detailed in **Table 9.33** (Measurement Location B: Glenalla)
Knockskae	Limit as detailed in **Table 9.33** (Measurement Location C: Genoch Cottage)
Linfairn	
Genoch Cottage	
Tairlaw Toll Cottage	Limit as detailed in **Table 9.33** (Measurement Location D: Tairlaw Toll)
Doughty Farm	Limit as detailed in **Table 9.33** (Measurement Location F: Doughty Farm)

Table 9.41 Applied Noise Level Limits (Closest Receptors to Proposed Development)

309. **Appendix 9.9 Cumulative Scoping (Graphs 9.9.4 to 9.9.6)**, present the daytime noise level limits applied at each of these receptors. As a worst case it is assumed that none of these receptors have a financial involvement in any of the developments. Also presented are these noise level limits reduced by 10dB. For each of the above receptors, the predicted noise levels from Dersalloch Windfarm/Hadyard Hill Windfarm have also been plotted on the applicable graph. The daytime noise level limits have been selected as a worst case, being more stringent than the corresponding night-time limits

310. This assessment is presented in tabular form in **Table 9.42.**

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s									
		3	4	5	6	7	8	9	10	11	12
Measurement Location B: Glenalla											
Glenalla	Dersalloch Windfarm only level [A]	6.6	10.8	15.3	20.0	22.2	22.2	22.2	22.2	22.2	22.2
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
	Daytime level limit -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.0	28.7	30.4	32.3	34.6
	-10dB compliance check [A-C] = [D]	**-21.4**	**-17.2**	**-12.7**	**-8.0**	**-5.8**	**-5.8**	**-6.5**	**-8.2**	**-10.2**	**-12.4**
Measurement Location C: Genoch Cottage											
Knockskae	Dersalloch Windfarm only level [A]	14.2	18.4	22.9	27.6	29.8	29.8	29.8	29.8	29.8	29.8
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.4	29.8	31.2	32.8	34.5
	-10dB compliance check [A-C] = [D]	**-13.8**	**-9.6**	**-5.1**	**-0.4**	**1.8**	**1.4**	**0.0**	**-1.4**	**-3.0**	**-4.7**
Linfairn	Dersalloch Windfarm only level [A]	13.7	17.9	22.4	27.1	29.3	29.3	29.3	29.3	29.3	29.3
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.4	29.8	31.2	32.8	34.5
	-10dB compliance check [A-C] = [D]	**-14.3**	**-10.1**	**-5.6**	**-0.9**	**1.3**	**0.9**	**-0.5**	**-1.9**	**-3.5**	**-5.2**
Genoch Cottage	Dersalloch Windfarm only level [A]	13.4	17.6	22.1	26.8	29.0	29.0	29.0	29.0	29.0	29.0
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.4	29.8	31.2	32.8	34.5
	-10dB compliance check [A-C] = [D]	**-14.6**	**-10.4**	**-5.9**	**-1.2**	**1.0**	**0.6**	**-0.8**	**-2.2**	**-3.8**	**-5.5**
Measurement Location D: Tairlaw Toll											
Tairlaw Toll Cottage	Dersalloch Windfarm only level [A]	14.1	18.3	22.8	27.5	29.7	29.7	29.7	29.7	29.7	29.7
	Daytime limit (Non FI) [B]	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Daytime limit (Non FI) -10dB [C]	28.9	29.2	29.7	30.3	31.2	32.2	33.3	34.6	36.0	37.5
	-10dB compliance check [A-C] = [D]	**-14.8**	**-10.9**	**-6.9**	**-2.8**	**-1.5**	**-2.5**	**-3.6**	**-4.9**	**-6.3**	**-7.8**
Measurement Location F: Doughty Farm											
Doughty Farm	Hadyard Hill Windfarm only level [A]	28.8	28.8	28.8	28.8	29.9	31.0	32.1	32.1	32.1	32.1
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9
	Daytime limit (Non FI) -10dB [C]	28.0	28.0	28.0	28.0	28.0	28.0	28.6	30.6	32.7	34.9

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s									
		3	4	5	6	7	8	9	10	11	12
	-10dB compliance check [A-C] = [D]	**0.8**	**0.8**	**0.8**	**0.8**	**1.9**	**3.0**	**3.5**	**1.5**	**-0.6**	**-2.8**

Table 9.42 Comparison of Dersalloch/Hadyard Hill Windfarm Noise Levels with Noise Limits -10dB, dB(A)

311. It can be seen from this assessment that at the receptors of Glenalla and Tairlaw Toll Cottage, worst case noise levels from Dersalloch Windfarm are more than 10dB below the applicable limits at all wind speeds. This is denoted within **Table 9.42** by all [D] values (bold text) being negative and in **Graphs 9.9.4 and 9.9.6** of **Appendix 9.9 Cumulative Scoping** by the individual receptor levels remaining below the -10dB limits for these receptors.

312. For the receptors of Knockskae, Linfairn and Genoch Cottage, worst case noise levels from Dersalloch Windfarm are approaching being 10dB below the applicable limit, being up to just 1.8dB above the -10dB limits between wind speeds of 7 and 8m/s only. This is denoted within **Table 9.42** where the [D] values (bold text) are positive and in **Graph 9.9.5** of **Appendix 9.9 Cumulative Scoping** by the individual receptor levels being just above the -10dB limit within this limited wind speed range.

313. However, it should be noted that this assessment assumes downwind propagation from all windfarms. In practice, noise form Dersalloch Windfarm would not give rise to a significant cumulative effect at these receptors when taking wind direction effects into account. This is because the highest cumulative noise levels would arise at these properties when they are directly downwind from the Proposed Development. Under such upwind propagation conditions, the resulting noise levels from Dersalloch Windfarm would be significantly reduced, falling below the -10dB limits.

314. As such, it can be concluded that, at the receptors of Glenalla, Knockskae, Linfairn, Genoch Cottage and Tairlaw Toll Cottage, noise from the Dersalloch Windfarm is not sufficient to give rise to significant effect when operating in isolation, or under the cumulative scenario.

315. As a result, no further consideration is required to be given to noise from Dersalloch Windfarm and it is scoped-out of the cumulative noise assessment.

316. It can also be seen that at the receptor of Doughty Farm, worst case noise levels from Hadyard Hill Windfarm are well below the cumulative noise level limits, but not by more than 10dB at wind speeds up to 10m/s. This is denoted within **Table 9.42** where the [D] values (bold text) are positive and in **Graph 9.9.7** of **Appendix 9.9 Cumulative Scoping** by the individual receptor levels being above the -10dB limit. The predicted Hadyard Hill Windfarm noise levels are up to 3.6dB above the -10dB limits at 9m/s.

317. As such it can be concluded that at the receptor of Doughty Farm, noise from the Hadyard Hill Windfarm is not sufficiently low that it can be scoped-out of the cumulative noise assessment.

318. In line with the above conclusions, the cumulative noise assessment presented in **Section 9.6.6** below accounts for the contribution of noise from the Hadyard Hill Windfarm at the receptor to Doughty Farm.

9.6.6 Cumulative Noise Assessment

9.6.6.1 Application of Background Data

319. **Table 9.43** details receptors that have not been scoped-out of the assessment and which background noise data has been applied at each in determining the applicable noise level limits.

Receptor	Applied Limits/Background Noise Data
Blair Farm	Blair Farm
Glenmartin	
The Shieling	
Knockinculloch Enclosure	Glenalla
Glenalla	
Knockskae	Genoch Cottage
Linfairn	
Genoch Cottage	
Tairlaw Old Cottage	Tairlaw Toll
Tairlaw Toll House	
Tallaminnoch Cottage	
Black Row	White Row
Aldinna	
White Row	
Doughty Farm	Doughty Farm

Table 9.43 Applied Background Noise Monitoring Locations

9.6.6.2 Determination of Residual Noise Level Limits

320. The total noise level limits presented in **Table 9.33** apply to the combined contribution of noise from all windfarms (existing and proposed), not the proposed development/s in isolation. It is therefore necessary to determine the remaining (residual) noise level limits that are available for use by the proposed development/s. Ensuring that the proposed development/s comply with the residual limits would then ensure no exceedance of the total limits under the cumulative scenario.

321. The following sub-sections describe how account has been taken of potential noise from each of the operational cumulative developments (Dersalloch Windfarm and Hadyard Hill Windfarm) in the determination of the residual level limits.

Dersalloch Windfarm

322. This development has been scoped-out of the cumulative assessment, see **Section 9.6.5.4**, No adjustments for noise from that windfarm are therefore required in determining the residual limits.

Hadyard Hill Windfarm

323. The Cumulative Scoping Assessment in **Section 9.6.5.4** has identified that for the receptor of Doughty Farm, noise from the Hadyard Hill Windfarm is required to be accounted for, for the daytime period.

324. Corphin Cottage is in closer proximity to Hadyard Hill Windfarm than Doughty Farm, and is in the same direction from the Proposed Development. Corphin Cottage is therefore a ‘controlling property’ with respect the noise levels that can be generated at Doughty Farm by the Hadyard Hill Windfarm.

325. **Table 9.44** below presents an assessment of the modelled Hadyard Hill Windfarm noise levels at Corphin Cottage. Assessment is against the applicable daytime noise level limit determined based on the measurement data obtained at Doughty Farm.

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s									
		3	4	5	6	7	8	9	10	11	12
Measurement Location F: Doughty Farm											
Corphin Cottage	Hadyard Hill Windfarm only level [A]	37.3	37.3	37.3	37.3	38.4	39.5	40.6	40.6	40.6	40.6
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.6	40.6	42.7	44.9
	Limit compliance check [A-B] = [C]	**-0.7**	**-0.7**	**-0.7**	**-0.7**	**0.4**	**1.5**	**2.0**	**0.0**	**-2.1**	**-0.7**

Table 9.44 Comparison of Worst Case Hadyard Hill Windfarm Noise Levels with Consented Limits at Corphin Cottage, dB(A)

326. It can be seen from **Table 9.44** that the modelled noise levels for Hadyard Hill Windfarm are equal to or in excess of the applicable noise limit in the windspeed range 7 to 10 m/s. The modelled Hadyard Hill noise levels at Doughty Farm, can therefore be taken to represent a worst case. This is because in practice, lower noise levels to those modelled will arise at this property in order for the Hadyard Hill Windfarm to operate within its extant consent (also see **paragraphs 288 and 289**).

327. For Doughty Farm, the predicted Hadyard Hill noise levels, have therefore been subtracted from the total daytime noise level limits. The final calculated residual limits, available for use by the proposed development/s, are presented in **Table 9.45** below.

Residual Noise Level Limits

	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Measurement Location A: Blair Farm											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	46.0	48.3
Measurement Location B: Glenalla											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
Measurement Location C: Genoch Cottage											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
Measurement Location D: Tairlaw Toll											
Daytime Limit (Non FI)	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
Measurement Location E: White Row											
Daytime Limit (Non FI)	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
Measurement Location F: Doughty Farm											
Daytime Limit (Non FI)	38.0	37.4	37.4	37.4	37.4	37.3	37.0	37.5	39.9	42.3	44.6
Night-time Limit (Non FI)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.3

Table 9.45: Residual Noise Level Limits, $L_{A90,T}$, dB(A)

9.6.6.3 Assessment Scenario 1: Proposed Development Only

328. This section considers the scenario where the Proposed Development is to be consented, but Knockcronal Windfarm and Craiginmoddie Windfarm are not.

329. For each receptor, the predicted noise levels for the Proposed Development operating in isolation (see **Table 9.37**) have been assessed by comparison against the applicable residual limits taken from **Table 9.45**. This assessment is presented in **Graphs 9.11.1 to 9.11.6** of **Appendix 9.11 Example Limit Apportionment.** This assessment is also presented in tabular form in **Table 9.46**.

330. As noted in paragraph **291**, all of the assessed operational noise levels assume downwind propagation from all turbines, representing a significant worst case. Significantly lower noise levels can be expected during upwind propagation conditions (i.e. when the wind direction is from the receptor towards the turbines).

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
Limit Measurement Location A: Blair Farm												
Blair Farm	Proposed Development only level [A]	7.4	8.6	13.8	18.6	20.4	20.4	20.4	20.4	20.4	20.4	20.4
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-30.6**	**-29.4**	**-24.2**	**-19.4**	**-17.6**	**-17.6**	**-18.6**	**-21.4**	**-24.3**	**-27.2**	**-30.1**
	Night-time compliance check [A-C]=[E]	**-35.6**	**-34.4**	**-29.2**	**-24.4**	**-22.6**	**-22.6**	**-22.6**	**-22.6**	**-22.9**	**-25.5**	**-27.9**
Glenmartin	Proposed Development only level [A]	8.0	9.2	14.4	19.2	21.0	21.0	21.0	21.0	21.0	21.0	21.0
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-30.0**	**-28.8**	**-23.6**	**-18.8**	**-17.0**	**-17.0**	**-18.0**	**-20.8**	**-23.7**	**-26.6**	**-29.5**
	Night-time compliance check [A-C]=[E]	**-35.0**	**-33.8**	**-28.6**	**-23.8**	**-22.0**	**-22.0**	**-22.0**	**-22.0**	**-22.3**	**-24.9**	**-27.3**
The Shieling	Proposed Development only level [A]	9.5	10.7	15.9	20.7	22.5	22.5	22.5	22.5	22.5	22.5	22.5
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-28.5**	**-27.3**	**-22.1**	**-17.3**	**-15.5**	**-15.5**	**-16.6**	**-19.4**	**-22.3**	**-25.2**	**-28.1**
	Night-time compliance check [A-C]=[E]	**-33.5**	**-32.3**	**-27.1**	**-22.3**	**-20.5**	**-20.5**	**-20.5**	**-20.5**	**-20.9**	**-23.5**	**-25.8**
Limit Measurement Location B: Glenalla												
Knockinculloch Enclosure[1]	Proposed Development only level [A]	20.9	22.1	27.3	32.1	33.9	33.9	33.9	33.9	33.9	33.9	33.9
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
	Daytime compliance check [A-B]=[D]	**-17.1**	**-15.9**	**-10.7**	**-5.9**	**-4.1**	**-4.1**	**-4.1**	**-4.8**	**-6.5**	**-8.4**	**-10.7**
	Night-time compliance check [A-C]=[E]	**-22.1**	**-20.9**	**-15.7**	**-10.9**	**-9.1**	**-9.1**	**-9.1**	**-9.1**	**-9.1**	**-9.3**	**-10.9**
Glenalla[1]	Proposed Development only level [A]	22.9	24.1	29.3	34.1	35.9	35.9	35.9	35.9	35.9	35.9	35.9
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
	Daytime compliance check [A-B]=[D]	**-15.1**	**-13.9**	**-8.7**	**-3.9**	**-2.1**	**-2.1**	**-2.1**	**-2.7**	**-4.4**	**-6.4**	**-8.6**
	Night-time compliance check [A-C]=[E]	**-20.1**	**-18.9**	**-13.7**	**-8.9**	**-7.1**	**-7.1**	**-7.1**	**-7.1**	**-7.1**	**-7.3**	**-8.9**
Limit Measurement Location C: Genoch Cottage												

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
Knockskae	Proposed Development only level [A]	15.4	16.6	21.8	26.6	28.4	28.4	28.4	28.4	28.4	28.4	28.4
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-22.6**	**-21.4**	**-16.2**	**-11.4**	**-9.6**	**-9.6**	**-10.0**	**-11.3**	**-12.8**	**-14.4**	**-16.1**
	Night-time compliance check [A-C]=[E]	**-27.6**	**-26.4**	**-21.2**	**-16.4**	**-14.6**	**-14.6**	**-14.6**	**-14.6**	**-14.6**	**-14.6**	**-15.4**
Linfairn	Proposed Development only level [A]	13.9	15.1	20.3	25.1	26.9	26.9	26.9	26.9	26.9	26.9	26.9
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-24.1**	**-22.9**	**-17.7**	**-12.9**	**-11.1**	**-11.1**	**-11.5**	**-12.8**	**-14.3**	**-15.9**	**-17.6**
	Night-time compliance check [A-C]=[E]	**-29.1**	**-27.9**	**-22.7**	**-17.9**	**-16.1**	**-16.1**	**-16.1**	**-16.1**	**-16.1**	**-16.1**	**-16.9**
Genoch Cottage	Proposed Development only level [A]	13.7	14.9	20.1	24.9	26.7	26.7	26.7	26.7	26.7	26.7	26.7
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-24.3**	**-23.1**	**-17.9**	**-13.1**	**-11.3**	**-11.3**	**-11.7**	**-13.0**	**-14.5**	**-16.1**	**-17.8**
	Night-time compliance check [A-C]=[E]	**-29.3**	**-28.1**	**-22.9**	**-18.1**	**-16.3**	**-16.3**	**-16.3**	**-16.3**	**-16.3**	**-16.3**	**-17.2**
Limit Measurement Location D: Tairlaw Toll												
Tairlaw Toll Cottage	Proposed Development only level [A]	18.3	19.5	24.7	29.5	31.3	31.3	31.3	31.3	31.3	31.3	31.3
	Daytime limit (Non FI) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
	Daytime compliance check [A-B]=[D]	**-20.4**	**-19.3**	**-14.4**	**-10.1**	**-9.0**	**-9.8**	**-10.8**	**-12.0**	**-13.2**	**-14.6**	**-16.2**
	Night-time compliance check [A-C]=[E]	**-24.7**	**-23.5**	**-18.3**	**-13.5**	**-11.7**	**-11.7**	**-11.7**	**-11.7**	**-11.9**	**-13.0**	**-14.2**
Tairlaw Toll House	Proposed Development only level [A]	18.3	19.5	24.7	29.5	31.3	31.3	31.3	31.3	31.3	31.3	31.3
	Daytime limit (Non FI) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
	Daytime compliance check [A-B]=[D]	**-20.4**	**-19.4**	**-14.5**	**-10.2**	**-9.0**	**-9.9**	**-10.9**	**-12.0**	**-13.3**	**-14.7**	**-16.2**
	Night-time compliance check [A-C]=[E]	**-24.7**	**-23.5**	**-18.3**	**-13.5**	**-11.7**	**-11.7**	**-11.7**	**-11.7**	**-11.9**	**-13.0**	**-14.3**
Tallaminnoch Cottage	Proposed Development only level [A]	19.1	20.3	25.5	30.3	32.1	32.1	32.1	32.1	32.1	32.1	32.1
	Daytime limit (Non FI) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3
	Daytime compliance check [A-B]=[D]	**-19.6**	**-18.5**	**-13.6**	**-9.3**	**-8.2**	**-9.0**	**-10.0**	**-11.1**	**-12.4**	**-13.8**	**-15.4**
	Night-time compliance check [A-C]=[E]	**-23.9**	**-22.7**	**-17.5**	**-12.7**	**-10.9**	**-10.9**	**-10.9**	**-10.9**	**-11.1**	**-12.1**	**-13.4**
Limit Measurement Location E: White Row												
Black Row	Proposed Development only level [A]	13.4	14.6	19.8	24.6	26.4	26.4	26.4	26.4	26.4	26.4	26.4
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-24.6**	**-23.4**	**-18.2**	**-13.4**	**-11.6**	**-11.6**	**-11.9**	**-13.4**	**-15.1**	**-17.1**	**-19.4**
	Night-time compliance check [A-C]=[E]	**-29.6**	**-28.4**	**-23.2**	**-18.4**	**-16.6**	**-16.6**	**-16.6**	**-16.6**	**-16.6**	**-16.6**	**-17.4**
Aldinna	Proposed Development only level [A]	11.7	12.9	18.1	22.9	24.7	24.7	24.7	24.7	24.7	24.7	24.7
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-26.3**	**-25.1**	**-19.9**	**-15.1**	**-13.3**	**-13.3**	**-13.5**	**-15.0**	**-16.8**	**-18.7**	**-21.0**
	Night-time compliance check [A-C]=[E]	**-31.3**	**-30.1**	**-24.9**	**-20.1**	**-18.3**	**-18.3**	**-18.3**	**-18.3**	**-18.3**	**-18.3**	**-19.1**
White Row	Proposed Development only level [A]	12.9	14.1	19.3	24.1	25.9	25.9	25.9	25.9	25.9	25.9	25.9
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-25.1**	**-23.9**	**-18.7**	**-13.9**	**-12.1**	**-12.1**	**-12.4**	**-13.9**	**-15.6**	**-17.6**	**-19.9**
	Night-time compliance check [A-C]=[E]	**-30.1**	**-28.9**	**-23.7**	**-18.9**	**-17.1**	**-17.1**	**-17.1**	**-17.1**	**-17.1**	**-17.1**	**-17.9**
Limit Measurement Location F: Doughty Farm												
Doughty Farm[1, 2]	Proposed Development only level [A]	15.6	16.8	22.0	26.8	28.6	28.6	28.6	28.6	28.6	28.6	28.6
	Daytime residual limit (Non FI) [B]	38.0	37.4	37.4	37.4	37.4	37.3	37.0	37.5	39.9	42.3	44.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.3
	Daytime compliance check [A-B]=[D]	**-22.4**	**-20.7**	**-15.5**	**-10.7**	**-8.9**	**-8.7**	**-8.4**	**-8.9**	**-11.4**	**-13.7**	**-16.0**
	Night-time compliance check [A-C]=[E]	**-27.4**	**-26.2**	**-21.0**	**-16.2**	**-14.4**	**-14.4**	**-14.4**	**-14.4**	**-14.4**	**-14.4**	**-16.7**

[1] Apportioned Limits
[2] Daytime limits corrected to account for worst case Hadyard Hill Windfarm Noise Levels

Table 9.46 Comparison of Proposed Development Only Levels with Residual Limits, $L_{A90,T}$, dB(A)

331. It can be seen from the completed assessment that for all receptors, predicted noise levels from the Proposed Development remain below the residual noise level limits. This is denoted within **Table 9.46** by the [D] and

[E] values (bold text) being negative and in **Graphs 9.10.1 to 9.10.6** of **Appendix 9.10 Operational Assessment** by the receptor noise levels remaining below the daytime and night-time noise level limits.

332. Therefore, for all receptors, without mitigation, the receptor sensitivity is High and resulting effect is **Not Significant**. The resulting effect would be direct, permanent and local.

9.6.6.4 Assessment Scenario 2: Three Proposed Developments (Carrick + Craiginmoddie + Knockcronal)

333. This section considers the scenario where all three of the proposed developments are consented (Carrick, Craiginmoddie and Knockcronal).

334. For each receptor, the predicted noise levels for the three proposed developments operating simultaneously (see **Table 9.38**) have been assessed by comparison against the residual limits taken from **Table 9.45**. This assessment is presented in **Graphs 9.11.7 to 9.11.12** of **Appendix 9.11 Example Limit Apportionment.** This assessment is also presented in tabular form in **Table 9.47**.

335. As noted in paragraph **291**, all of the assessed operational noise levels assume downwind propagation from all turbines, representing a significant worst case. Significantly lower noise levels can be expected during upwind propagation conditions (i.e. when the wind direction is from the receptor towards the turbines).

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
Limit Measurement Location A: Blair Farm												
Blair Farm	Proposed Developments [A]	14.2	16.0	21.0	25.7	27.7	27.8	27.8	27.8	27.8	27.8	27.8
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-23.8**	**-22.0**	**-17.0**	**-12.3**	**-10.3**	**-10.2**	**-11.3**	**-14.1**	**-17.0**	**-19.9**	**-22.8**
	Night-time compliance check [A-C]=[E]	**-28.8**	**-27.0**	**-22.0**	**-17.3**	**-15.3**	**-15.2**	**-15.2**	**-15.2**	**-15.5**	**-18.1**	**-20.5**
Glenmartin	Proposed Developments [A]	14.0	15.8	20.8	25.6	27.6	27.6	27.7	27.7	27.7	27.7	27.7
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-24.0**	**-22.2**	**-17.2**	**-12.4**	**-10.4**	**-10.4**	**-11.4**	**-14.2**	**-17.1**	**-20.0**	**-22.9**
	Night-time compliance check [A-C]=[E]	**-29.0**	**-27.2**	**-22.2**	**-17.4**	**-15.4**	**-15.4**	**-15.3**	**-15.3**	**-15.6**	**-18.2**	**-20.6**
The Shieling	Proposed Developments [A]	14.0	15.9	20.9	25.6	27.7	27.7	27.8	27.8	27.8	27.8	27.8
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	39.1	41.9	44.8	47.7	50.6
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.9	48.3
	Daytime compliance check [A-B]=[D]	**-24.0**	**-22.1**	**-17.1**	**-12.4**	**-10.3**	**-10.3**	**-11.3**	**-14.1**	**-17.0**	**-19.9**	**-22.8**
	Night-time compliance check [A-C]=[E]	**-29.0**	**-27.1**	**-22.1**	**-17.4**	**-15.3**	**-15.3**	**-15.2**	**-15.2**	**-15.5**	**-18.1**	**-20.5**
Limit Measurement Location B: Glenalla												
Knocknculloch Enclos	Proposed Developments [A]	23.1	25.2	30.1	34.9	36.9	37.0	37.0	37.0	37.0	37.0	37.0
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
	Daytime compliance check [A-B]=[D]	**-14.9**	**-12.8**	**-7.9**	**-3.1**	**-1.1**	**-1.0**	**-1.0**	**-1.7**	**-3.4**	**-5.3**	**-7.6**
	Night-time compliance check [A-C]=[E]	**-19.9**	**-17.8**	**-12.9**	**-8.1**	**-6.1**	**-6.0**	**-6.0**	**-6.0**	**-6.0**	**-6.2**	**-7.8**
Glenalla[1]	Proposed Developments [A]	24.0	26.1	31.0	35.8	37.8	37.9	37.9	37.9	37.9	37.9	37.9
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.7	40.4	42.3	44.6
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.8
	Daytime compliance check [A-B]=[D]	**-14.0**	**-11.9**	**-7.0**	**-2.2**	**-0.2**	**-0.1**	**-0.1**	**-0.8**	**-2.5**	**-4.4**	**-6.7**
	Night-time compliance check [A-C]=[E]	**-19.0**	**-16.9**	**-12.0**	**-7.2**	**-5.2**	**-5.1**	**-5.1**	**-5.1**	**-5.1**	**-5.3**	**-6.9**
Limit Measurement Location C: Genoch Cottage												
Knockskae	Proposed Developments [A]	16.0	24.0	28.0	32.5	35.4	35.8	35.9	35.9	35.9	35.9	35.9
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-22.0**	**-14.0**	**-10.0**	**-5.5**	**-2.6**	**-2.2**	**-2.5**	**-3.9**	**-5.3**	**-6.9**	**-8.6**
	Night-time compliance check [A-C]=[E]	**-27.0**	**-19.0**	**-15.0**	**-10.5**	**-7.6**	**-7.2**	**-7.1**	**-7.1**	**-7.1**	**-7.1**	**-8.0**
Linfairn	Proposed Developments [A]	14.6	23.5	27.4	31.9	34.9	35.3	35.4	35.4	35.4	35.4	35.4
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-23.4**	**-14.5**	**-10.6**	**-6.1**	**-3.1**	**-2.7**	**-3.0**	**-4.4**	**-5.8**	**-7.4**	**-9.1**
	Night-time compliance check [A-C]=[E]	**-28.4**	**-19.5**	**-15.6**	**-11.1**	**-8.1**	**-7.7**	**-7.6**	**-7.6**	**-7.6**	**-7.6**	**-8.5**
Genoch Cottage	Proposed Developments [A]	14.3	22.1	26.1	30.6	33.5	33.9	34.0	34.0	34.0	34.0	34.0
	Daytime limit (Non Fl) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.8	41.2	42.8	44.5
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9
	Daytime compliance check [A-B]=[D]	**-23.7**	**-15.9**	**-11.9**	**-7.4**	**-4.5**	**-4.1**	**-4.4**	**-5.8**	**-7.2**	**-8.8**	**-10.5**
	Night-time compliance check [A-C]=[E]	**-28.7**	**-20.9**	**-16.9**	**-12.4**	**-9.5**	**-9.1**	**-9.0**	**-9.0**	**-9.0**	**-9.0**	**-9.9**
Limit Measurement Location D: Tairlaw Toll												
Tairlaw Toll Cottage	Proposed Developments [A]	18.5	23.5	27.8	32.4	35.0	35.3	35.4	35.4	35.4	35.4	35.4
	Daytime limit (Non Fl) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non Fl) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
	Daytime compliance check [A-B]=[D]	**-20.2**	**-15.4**	**-11.4**	**-7.3**	**-5.3**	**-5.9**	**-6.8**	**-7.9**	**-9.2**	**-10.6**	**-12.1**
	Night-time compliance check [A-C]=[E]	**-24.5**	**-19.5**	**-15.2**	**-10.6**	**-8.0**	**-7.7**	**-7.6**	**-7.6**	**-7.8**	**-8.9**	**-10.2**
Tair	Proposed Developments [A]	18.5	23.5	27.8	32.4	35	35.3	35.3	35.3	35.3	35.3	35.3

Receptor		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
	Daytime limit (Non FI) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
	Daytime compliance check [A-B]=[D]	**-20.2**	**-15.4**	**-11.4**	**-7.3**	**-5.3**	**-5.9**	**-6.9**	**-8.0**	**-9.3**	**-10.7**	**-12.2**
	Night-time compliance check [A-C]=[E]	**-24.5**	**-19.5**	**-15.2**	**-10.6**	**-8.0**	**-7.7**	**-7.7**	**-7.7**	**-7.9**	**-9.0**	**-10.3**
Tallaminnoch Cottage	Proposed Developments [A]	19.3	22.7	27.3	32.0	34.3	34.5	34.5	34.5	34.5	34.5	34.5
	Daytime limit (Non FI) [B]	38.7	38.9	39.2	39.7	40.3	41.2	42.2	43.3	44.6	46.0	47.5
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.3	45.6
	Daytime compliance check [A-B]=[D]	**-19.4**	**-16.2**	**-11.9**	**-7.7**	**-6.0**	**-6.7**	**-7.7**	**-8.8**	**-10.1**	**-11.5**	**-13.0**
	Night-time compliance check [A-C]=[E]	**-23.7**	**-20.3**	**-15.7**	**-11.0**	**-8.7**	**-8.5**	**-8.5**	**-8.5**	**-8.7**	**-9.8**	**-11.1**
Limit Measurement Location E: White Row												
Black Row	Proposed Developments [A]	14.7	17.0	21.9	26.6	28.7	28.8	28.8	28.8	28.8	28.8	28.8
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-23.3**	**-21.0**	**-16.1**	**-11.4**	**-9.3**	**-9.2**	**-9.5**	**-10.9**	**-12.7**	**-14.7**	**-16.9**
	Night-time compliance check [A-C]=[E]	**-28.3**	**-26.0**	**-21.1**	**-16.4**	**-14.3**	**-14.2**	**-14.2**	**-14.2**	**-14.2**	**-14.2**	**-15.0**
Aldinna	Proposed Developments [A]	14.5	16.5	21.4	26.1	28.2	28.3	28.3	28.3	28.3	28.3	28.3
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-23.5**	**-21.5**	**-16.6**	**-11.9**	**-9.8**	**-9.7**	**-10.0**	**-11.4**	**-13.2**	**-15.2**	**-17.4**
	Night-time compliance check [A-C]=[E]	**-28.5**	**-26.5**	**-21.6**	**-16.9**	**-14.8**	**-14.7**	**-14.7**	**-14.7**	**-14.7**	**-14.7**	**-15.5**
White Row	Proposed Developments [A]	16.0	17.9	22.8	27.6	29.6	29.7	29.7	29.7	29.7	29.7	29.7
	Daytime limit (Non FI) [B]	38.0	38.0	38.0	38.0	38.0	38.0	38.3	39.7	41.5	43.5	45.7
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Daytime compliance check [A-B]=[D]	**-22.0**	**-20.1**	**-15.2**	**-10.4**	**-8.4**	**-8.3**	**-8.6**	**-10.0**	**-11.8**	**-13.8**	**-16.0**
	Night-time compliance check [A-C]=[E]	**-27.0**	**-25.1**	**-20.2**	**-15.4**	**-13.4**	**-13.3**	**-13.3**	**-13.3**	**-13.3**	**-13.3**	**-14.1**
Limit Measurement Location F: Doughty Farm												
Doughty Farm[1, 2]	Proposed Developments [A]	25.3	26.5	31.7	36.5	38.3	38.3	38.3	38.3	38.3	38.3	38.3
	Daytime residual limit (Non FI) [B]	38.0	37.4	37.4	37.4	37.4	37.3	37.0	37.5	39.9	42.3	44.6
	Night-time limit (Non FI) [C]	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.3
	Daytime compliance check [A-B]=[D]	**-12.7**	**-10.9**	**-5.7**	**-0.9**	**0.9**	**1.0**	**1.3**	**0.8**	**-1.6**	**-4.0**	**-6.3**
	Night-time compliance check [A-C]=[E]	**-17.7**	**-16.5**	**-11.3**	**-6.5**	**-4.7**	**-4.7**	**-4.7**	**-4.7**	**-4.7**	**-4.7**	**-7.0**

Receptor	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12

[1] Apportioned Limits
[2] Daytime limits corrected to account for worst case Hadyard Hill Windfarm Noise Levels

Table 9.47 Comparison of The Three Proposed Developments Operating Simultaneously with Derived Limits, $L_{A90,T}$, dB(A)

336. It can be seen from the completed assessment that for all receptors with the exception of Doughty Farm, predicted noise levels from the three Proposed Developments remain below the determined noise level limits. This is denoted within **Table 9.47** by the [D] and [E] values (bold text) being negative and in **Graphs 9.10.7 to 9.10.11** of **Appendix 9.10 Operational Noise Assessment** by the receptor noise levels remaining below the daytime and night-time noise level limits.

337. The results for Doughty Farm are presented in **Graph 9.10.12** of **Appendix 9.10 Operational Noise Assessment**. It can be seen that the night-time limits are achieved, but there is a very small exceedance of the daytime limit (up to +1.3dB at most) across a limited windspeed range of 6 to 9 m/s.

338. Also presented on that graph are the individual contributions from Carrick Windfarm, Craiginmoddie Windfarm and Knockcronal Windfarm. These show that the combined noise level at Doughty Farm is strongly dominated by the Craiginmoddie Windfarm, with contributions from both Carrick Windfarm and Knockcronal Windfarm being substantially below the limits. The contribution from Knockcronal Windfarm is more than 10dB below the daytime limit and contribution from Carrick Windfarm is approaching 10dB below the daytime limit (-8.4dB at 8m/s) as confirmed in **Table 9.46** and **Graph 9.10.6** of **Appendix 9.10 Operational Noise Assessment.** It is therefore the contribution from the Craiginmoddie Windfarm, not the Proposed Development, that gives rise to the minor exceedance of the daytime limit under this cumulative scenario.

339. Also, as noted in **paragraph 291** and **paragraph 335**, the completed assessment assumes downwind propagation from all turbines. Under this cumulative scenario this would rarely, if ever, be the case, because turbines are located in different directions from each receptor, meaning that it is never possible for all turbines to be subject to downwind propagation at the same time. A more realistic worst-case condition for Doughty Farm would north-westerly winds, when the wind is blowing from the Craiginmoddie Windfarm (the identified dominant source) towards that receptor. Under those conditions, even lower noise levels would arise from the Proposed Development due the propagation directivity, as allowed to be accounted for under Section 4.4 of the IoA GPG. Furthermore, under the most commonly occurring (i.e. 'prevailing') conditions, which are south-westerly winds, the Proposed Development will be upwind of Doughty Farm. Under those conditions, directivity attenuations of circa 8dB are applicable to the Proposed Development, which reduce its levels to significantly more than 10dB below the applicable limit (i.e. the contribution from the Proposed Development would be inconsequential to any assessment). This further confirms that any arising cumulative effect would not be as a result of the Proposed Development.

340. Therefore, for all receptors with the exception of Doughty Farm, without mitigation, the receptor sensitivity is High and the resulting effect is **Not Significant**. The resulting effect would be direct, permanent and local.

341. For the receptor of Doughty Farm, without mitigation, the receptor sensitivity is High and the resulting effect is **Significant**. The resulting effect would be direct, permanent and local.

342. However, as detailed in **paragraph 338** and **paragraph 339** , that effect is not caused by the Proposed Development. Notwithstanding this, consideration has been given to the available mitigation measures in the corresponding section below.

9.7 Mitigation

9.7.1 Mitigation – Construction Noise and Vibration

343. The assessments of construction noise and construction vibration have identified that with the embedded mitigation measures in place, significant effects would not arise. An appropriate planning condition can be used to ensure that the content of the CEMP, including the listed mitigation measures, are agreed with South Ayrshire Council as well as the Scottish Environmental Protection Agency (SEPA), and that the appointed contractor is required to comply with the CEMP.

9.7.2 Mitigation – Blast-Induced Vibration and Air Overpressure

344. The assessment has identified that, with the embedded mitigation measures in place, a significant effect would not arise. An appropriate planning condition can be used to ensure that the content of the CEMP, including the listed mitigation measures, are agreed with South Ayrshire Council as well as SEPA, and that the appointed contractor is required to comply with the CEMP.

9.7.3 Mitigation – Wind Turbine Noise

9.7.3.1 Mitigation

345. The assessment has identified that, under downwind propagation conditions, without mitigation, noise from the Proposed Development would be below the applicable daytime and night-time noise levels at all receptors.

346. A small exceedance of the daytime noise level limit has been identified at a single receptor, Doughty Farm, for the scenario where all three of the proposed developments (Carrick, Craiginmoddie and Knockcronal Windfarms) operate simultaneously. However it is contribution from Craiginmoddie Windfarm that has been identified as dominant and which gives rise to that minor exceedance. not contribution from the Proposed Development which is identified to be minimal. P**aragraph 338** and **paragraph 339** confirm that:

1. when assuming downwind propagation form all turbines (worst case), the contribution from the Proposed Development is approaching 10dB below the daytime limit (-8.4dB at 8m/s) at Doughty Farm. As such contribution form the Proposed Development is minimal;
2. even lower noise levels are expected from the Proposed Development under a more realistic worst-case condition of north-westerly winds (downwind from Craiginmoddie Windfarm); and
3. under the prevailing (south-westerly) conditions, noise levels from the Proposed Development would be further reduced to be substantially more than 10dB below the daytime limit.

347. This confirms that any arising cumulative effect is attributable to the Craiginmoddie Windfarm, not the Proposed Development. No additional mitigation measures are therefore required to the Proposed Development.

348. Consideration has however been given the noise mitigation measures that are available to the Craiginmoddie Windfarm, to ensure the daytime noise level limits are achieved at Doughty Farm. These include:

1. Selection of an alternative daytime fixed limit element that remains in compliance with ESTU-R-97;
2. FI of the dwelling occupants;
3. careful selection of the wind turbine that is ultimately selected for installation; and
4. use of wind turbine management scheme.

349. In respect of bullet point 1 above, the assessment has been completed on the basis of a fixed daytime limit element set at 38dB(A). ETSU-R-97 allows the daytime fixed limit element to be set between 35 and 40 dB, i.e. up to 2dB higher than that which has been adopted. The additional available 2dB flexibility is greater than the maximum identified exceedance of up to +1.3dB (see **paragraph 337**), so if applied, this would be sufficient that the applicable limit would then be achieved. Application of a higher 40dB(A) fixed limit element would be arguable in this case on the basis that it is only required at 1 property and only to facilitate compliance over a limited wind speed range. It would also be the case that if applied, the contribution from the Proposed Development would then be more than 10dB below the applicable limit at Doughty Farm, essentially scoping-out the need for further consideration of impact from the Proposed Development.

350. In respect of bullet point two, the Craiginmoddie Windfarm applicant has stated that they are in negotiations with Doughty Farm in respect of FI, but the outcome of those negotiations are not currently known. If successful, this would allow an increase of the fixed element of the total daytime limit at this receptor from to 45dB(A). This would be sufficient that the applicable limit would then be achieved. It would also be the case that the contribution from the Proposed Development would then be more than 10dB below the applicable limit essentially scoping-out the need for further consideration of impact from the Proposed Development.

351. In respect of bullet point three above, the completed assessment has been based on the use of a candidate wind turbine. It is possible that there are quieter wind turbines on the market that could ultimately be selected for installation that would allow the applicable daytime noise level limit to be achieved without need for any further mitigation. Notwithstanding this, there would be the opportunity to implement a wind turbine management scheme (bullet point four above) which could be used to reduce noise emissions from that development such that the daytime limit would be complied with.

352. A wind turbine noise management scheme is where selected wind turbines are operated in reduced noise modes (with an associated loss of energy yield) under specific wind speed and wind direction conditions. In this case, such a scheme could be limited to just the daytime period as no exceedance of the night-time limits has been identified. It would also only be required to operate between the wind speeds of 6 and 9m/s. It should be noted that the assessment presented within this chapter is based on worst-case downwind propagation only. Under upwind conditions, lower noise levels will result at receptors, giving rise to the need for less, and possibly no mitigation being required. Notwithstanding this, to demonstrate principle, consideration has been given to a noise management scheme for the Craiginmoddie Windfarm for worst-case downwind propagation conditions.

353. **Table 9.20** details the noise emission levels for the candidate wind turbine operating in unconstrained mode (as initially assessed) and in each available noise reduced mode. It can be seen that the higher the selected noise reduced mode is, the greater the noise reduction is compared to the unconstrained mode.

354. **Table 9.48** presents an example daytime noise management scheme for Craiginmoddie Windfarm (assuming worst-case downwind propagation form all turbines). Also presented are the resulting operational noise levels at Doughty Farm with that scheme in place, demonstrating that the mitigated levels can be controlled such that the adopted noise level limits are met with all three developments operating simultaneously.

Wind Turbine Reference	Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
	2	3	4	5	6	7	8	9	10	11	12
Example Daytime Management Scheme - Craiginmoddie											
Wind Turbine 11	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 10	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 9	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 12	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 8	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 14	AM0	AM0	AM0	AM0	AM0	**N3**	**N3**	**N3**	AM0	AM0	AM0
Wind Turbine 4	AM0	AM0	AM0	AM0	AM0	AM0	**N3**	AM0	AM0	AM0	AM0
Wind Turbine 2	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
Wind Turbine 13	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
Wind Turbine 3	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
Wind Turbine 1	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
Wind Turbine 7	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0

Wind Turbine Reference		Wind Speed Referenced to 10m Height (Standardised U_{10}), m/s										
		2	3	4	5	6	7	8	9	10	11	12
Wind Turbine 6		AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
Wind Turbine 5		AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0	AM0
AM0 = Unconstrained Mode N3 = Noise Reduced Mode 3												
Craiginmoddie Windfarm WITH MITIGATION		24.7	25.9	31.1	35.9	36.1	35.8	35.6	36.1	37.7	37.7	37.7
Carrick Windfarm		15.6	16.8	22.0	26.8	28.6	28.6	28.6	28.6	28.6	28.6	28.6
Knockcronal Windfarm		0.0	8.3	11.9	16.3	19.6	20.1	20.2	20.2	20.2	20.2	20.2
TOTAL [A]		**25.2**	**26.5**	**31.6**	**36.4**	**36.9**	**36.7**	**36.5**	**36.9**	**38.3**	**38.3**	**38.3**
Limit Compliance Check with Management Scheme												
Doughty	Daytime residual limit (Non FI) [B]	38.0	37.4	37.4	37.4	37.4	37.3	37.0	37.5	39.9	42.3	44.6
	Daytime compliance check [A-B]=[D]	**-12.8**	**-10.9**	**-5.8**	**-1.0**	**-0.5**	**-0.6**	**-0.5**	**-0.6**	**-1.6**	**-4.0**	**-6.3**

Table 9.48: Example Craiginmoddie Daytime Noise Management Scheme – Three Proposed Developments – Compliance Check, Doughty Farm $L_{A90,T}$, dB(A)

355. It should be noted that the above noise management scheme is an example only, and there are many alterative options that could be employed. For example, using a higher noise reduced mode than N3 would allow more wind turbines to remain in unconstrained mode. The final management scheme could be determined with consideration to the effect on energy yield, whilst ensuring that the applicable noise level limits are complied with. The above example is presented to demonstrate that the use of a noise management scheme at the Craiginmoddie Windfarm is a practicable option for that development to ensure that it does not give rise to a limit exceedance at Doughty Farm should that development benefit from a consent.

356. The assessment presented in **Table 9.48** above is also presented on Graphs 9.10.13 of **Appendix 9.10 Operational Noise Assessmen**t.

357. In brief, even when assuming downwind propagating from all turbines, noise from the Proposed Development is minimal at the Receptor of Doughty Farm. The identified small limit exceedance at Doughty Farm arises due to contribution from the Craiginmoddie Windfarm. However the above assessment of mitigation has identified that there are a number of measures that could be employed to reduce levels such that limit compliance is achieved. In order to ensure that this is the case in practice, it would be appropriate to use noise related conditions stipulating the limits to which each Proposed Developments must comply. This is considered further in the following section.

9.7.3.2 Limit Apportionment

358. Consideration has been given to an example limit apportionment scheme based on the limiting scenario where all three of the proposed developments were to benefit from a consent.

359. The residual noise level limits presented in **Table 9.45** have been split between the three proposed developments in such a way that each of the developments can operate within their individual apportioned limits and a cumulative exceedance of the total limits would not arise.

360. **Appendix 9.11 Example Limit Apportionment** provides additional details including an assessment against the apportioned limits. It is demonstrated how, with the mitigation for Craiginmoddie Windfarm as detailed in **Section 9.7.3.1**, each apportioned limit would be met and hence how there would be no cumulative exceedance of the total available noise level limits.

361. Other alternative limit apportionment schemes could be derived, for example in the case that not all three of the proposed developments were to be progressed or consented.

362. With an appropriate limit apportionment in place, at all receptors, the sensitivity is High[12] and the resulting effect is **Not Significant**. The resulting effect would be direct, permanent and local.

9.8 Residual Effects

363. A summary of the identified impacts and effects is presented in **Table 9.49**.

Description of Effect	Pre-mitigation Effect		Mitigation Measure	Residual Effect	
	Magnitude	Significance		Magnitude	Significance
During Construction					
Construction Noise	Slight	Negligible (Not Significant)	Adherence to best practice measures ensure through the CEMP	Slight	Negligible (Not Significant)
Construction Vibration	Slight	Negligible (Not Significant)		Slight	Negligible (Not Significant)
Blast induced vibration and air overpressure	Slight	Negligible (Not Significant)		Slight	Negligible (Not Significant)
During Operation					
Operational wind turbine noise	N/A	Not Significant (Development in isolation) Significant (cumulatively)	Adherence to appropriate noise level limits Application of an appropriate limit apportionment scheme.	N/A	Not Significant

Table 9.49 Residual Effects

9.9 Cumulative Assessment

9.9.1 Construction

364. The closest construction works to a sensitive receptor is limited to access track upgrades only, at a distance of 220m. It is considered unlikely that other construction works, not associated with the Proposed Development would occur simultaneously with the 300m construction noise Study Area, and even if this was the case, it is considered unlikely that the levels generated by the access track upgrade works would give rise to a significant cumulative effect. Regardless, the duration of the access track upgrade works within 300m of the receptors would be of limited duration, and as such any resulting cumulative effect would not be significant.

365. With regards to construction vibration, this has been assessed based on the 'peak particle velocity' i.e. the instantaneous highest velocity generated at any frequency for the assessed construction working operation. Even in the unlikely event that these works were to be undertaken concurrently with other construction works not associated with the Proposed Development, this metric would not be affected. Therefore, no significant cumulative effect would arise as a result of the Proposed Development.

366. The nature of blast-induced groundborne vibration and air overpressure is that it is instantaneous and therefore would not occur at the same time as that caused by blast works at any other local quarries or borrow pits should these be present. A significant cumulative effect would therefore not arise as a result of the Proposed Development.

9.9.2 Operation

367. The assessment of wind turbine noise has been undertaken in accordance with the ETSU-R-97 assessment methodology and the IoA GPG. This method sets out the noise level limits applicable to cumulative windfarm noise levels. The potential for a cumulative noise impact has therefore been duly considered and accounted for within the completed assessment. The noise limits against which the Proposed Development has been assessed, have been determined accounting for worst case noise levels generated by existing local windfarms operating within their extant consents. It has also been demonstrated how the three proposed windfarm developments (Carrick, Craiginmoddie and Knockcronal) could operate simultaneously within the remaining available (residual) limits (i.e. after accounting for noise from local operational windfarms). It has also been demonstrated how those residual noise level limits could be apportioned between the three proposed developments, and how each development could operate within its induvial apportionment. When operating within its apportioned limits (as demonstrated), the Proposed Development would not give rise to a significant cumulative noise effect.

9.10 Summary

368. The completed assessment has considered the potential noise and vibration impacts that could arise as a result of the Proposed Development during both the construction and operational phases of development.

369. Construction traffic movements are not anticipated to generate road traffic noise levels that would be sufficiently high to give rise to significant effects. As such, an assessment of construction traffic noise was scoped out of the completed assessment, as agreed with the noise and vibration technical advisors to South Ayrshire Council.

370. The vast majority of required construction works, including wind turbine installation works, would be undertaken at substantial distances from the closest noise and vibration sensitive receptors (beyond 1km). However, at their closest, some access track upgrade works would be required at an approximate distance of 220m+ from a single receptor. An assessment of construction noise and vibration has therefore been undertaken for these works when undertaken at the closest point to receptors (220m). It has been identified that the resulting noise and vibration levels from such works would be below applicable assessment criteria as determined in accordance with BS 5228-1:2009+A1:2014: C*ode of practice for noise and vibration control on construction and open sites. Noise* and *BS 5228-2:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites. Vibration.* Resulting effects have been identified to be not significant.

371. An assessment of blast-induced groundborne vibration and air overpressures has been undertaken to assess potential impacts that could arise should such blasting works be found to be necessary. It has been identified that resulting effects would not be significant, due to both the substantial distances between the borrow pit search areas and the nearest noise-sensitive receptors and the good practice control measures that would be employed. These measures would minimise the levels of groundborne vibration and air overpressure and also provide further reassurance to the nearest residents.

372. An assessment of wind turbine noise has been undertaken in accordance with current best practice, and national and local planning policy. The assessment has been undertaken in accordance with the requirements of the Energy Technical Support Unit's 1996 ETSU-R-97 document: *The assessment and rating of noise from wind farms*, and the Institute of Acoustics': *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (IoA GPG).

373. The assessment has been informed by the results of a desk-based review, Site visits, a detailed baseline noise survey, and a detailed noise modelling and prediction exercise. The completed assessment has accounted for possible cumulative effects from the Proposed Development operating simultaneously with existing local operational windfarms (Dersalloch Windfarm and Hadyard Hill Windfarm) as well as the proposed Craiginmoddie and Knockcronal Windfarms (should these gain consent).

374. It has been demonstrated how the Proposed Development, both in isolation, and with the proposed Craiginmoddie and Knockcronal Windfarms, could operate within the remaining available (residual) limits (i.e. after accounting for noise from local operational windfarms). The assessment found that for the candidate wind turbine type used for this assessment, no noise mitigation measures are required to be applied to the Proposed Development to facilitate limit compliance.

375. The assessment identified that, should the Craiginmoddie Windfarm be consented, that development would require a limited degree of turbine noise management to reduce noise levels to below the daytime limits at the receptor of Doughty Farm, or alternative measure such as careful turbine selection or Financial Involvement of the residents of that receptor. However the levels from the Proposed Development at that receptor would be substantially below the applicable limits.

376. The assessment has also demonstrated how the available noise level limits could be apportioned between the three proposed windfarm developments (Carrick, Craiginmoddie and Knockcronal), and how such apportioned limits could be used as part of consent conditions to ensure that a significant cumulative noise effect would not arise.

377. With the identified measures in place, it has been identified that a significant effect would not arise a result of the Proposed Development operating either in isolation or cumulatively with other local windfarms.

378. Fixed plant items associated with the Proposed Development, i.e. the associated Substation Compound and Energy Storage Facility would be sited at sufficient distance from noise sensitive receptors that a significant effect would not arise. As such, an assessment of fixed plant noise was scoped out of the completed assessment, as agreed with the noise and vibration technical advisors to South Ayrshire Council.

379. Traffic generation during the operational phase would be extremely low and as such would also not give rise to a significant effect. As such, an assessment of operational traffic noise was scoped out of the completed assessment, as agreed with the noise and vibration technical advisors to South Ayrshire Council.

9.11 References

Department of Trade and Industry (1996). ETSU-R-97, The Assessment and rating of noise from wind farms. ETSU/DTI https://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file20433.pdf

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. https://www.ioa.org.uk/publications/wind-turbine-noise

Subcommittee B/564/1 (2009). BS 5228-1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. London: BSi

Subcommittee B/564/1 (2009). BS 5228-2:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. London: BSi

The Scottish Government (1996). Planning advice note 50: Controlling the environmental effects of surface mineral workings. Scottish Government. https://www.gov.scot/publications/planning-advice-note-pan-50-controlling-environmental-effects-surface-mineral/

The Scottish Government (2000). Planning advice note 50: Controlling the environmental effects of surface mineral workings, Annex D: The control of blasting at surface mineral workings. Scottish Government. https://www2.gov.scot/Publications/2000/02/pan50-annex-d

The Scottish Government (2014). Scottish planning policy. Scottish Government. https://www.gov.scot/publications/scottish-planning-policy/pages/2/

The Scottish Government (2014). National planning policy framework 3. Scottish Government. https://www.gov.scot/publications/national-planning-framework-3/

The Scottish Government (2011). Planning advice note 1/2011: Planning and noise. Scottish Government. http://www.scotland.gov.uk/Publications/2011/02/28153945/0

The Scottish Government (2011). Technical advice note - assessment of noise. Scottish Government. http://www.scotland.gov.uk/Publications/2011/03/02104659/0

The Scottish Government (2014). Onshore wind turbines: planning advice. Scottish government. https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/

Subcommittee B/564/1 (2009). BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. London: BSi

Subcommittee B/564/1 (2009). BS 5228-2:2009. Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. London: BSi

South Ayrshire Council (2014). South Ayrshire Local Development Plan. https://www.south-ayrshire.gov.uk/documents/localdevplan_final.pdf

South Ayrshire Council (2019). Proposed Replacement South Ayrshire Local Development Plan (LDP2).

South Ayrshire Council (2020). South Ayrshire Modified Proposed Local Development Plan 2 (MPLDP2).

South Ayrshire Council (2015). South Ayrshire Local Development Plan Supplementary Guidance: Wind Energy. https://www.south-ayrshire.gov.uk/documents/adopted%20wind%20energy-supplementary%20guidance.pdf

Scottish Government. Scottish Executive Development Department (2002). Planning Advice Note 45: Renewable Energy Technologies

Hayes McKenzie Partnership Ltd (2011). Report on "Analysis of how noise impacts are considered in the determination of wind farm planning applications" Ref HM: 2293/R1.

Department of Energy and Climate Change (2011). Report on DECC research contract 01.08.09.01/492A (Analysis), Analysis of how noise impacts are considered in the determination of wind farm planning applications. www.gov.uk/government/publications/analysis-of-how-noise-impacts-are-considered-in-the-determination-of-wind-farm-planning-applications

The Department of the Environmental (1976). Advisory Leaflet 72: 1976: Noise control on building sites

Scottish Power Renewables (2020). Carrick Windfarm Scoping Report.

Scottish Government Energy Consents Unit (October 2020). Scoping Opinion on behalf of Scottish Ministers under the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 – Carrick Wind Farm.

Highways England (2020). The Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7: LA111 *Noise and Vibration*. Revision 2. https://www.standardsforhighways.co.uk/dmrb/search/cc8cfcf7-c235-4052-8d32-d5398796b364.

Transport and Road Research Laboratory, G R Watts (1990). Research report 246: *Traffic Induced Vibrations in Buildings*.

Transport and Research Laboratory, DM Hiller and G I Crabb (2000). Report 429: *Groundborne vibration caused by mechanical construction works*.

International Organization for Standardization (1996). ISO 9613-2: 1996 Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation. http://www.iso.org/iso/catalogue_detail.htm?csnumber=20649

Energiekontor (2021). Craiginmoddie Windfarm Environmental Impact Assessment Report.

Scottish Government (2017a). The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017

Energiekontor (2020). Craiginmoddie Wind Farm Environmental Impact Assessment Scoping Report.

ITP Energised (2020). Knockcronal Wind Farm EIA Scoping Report.

Scottish Government. Energy Division (2014). Consent under s36 of the electricity act 1989 and deemed planning permission under s57(2) of the town and country planning (Scotland) act 1997 by Scottish ministers for the construction and operation of Dersalloch Wind Farm, located about 4km east of Straiton, in the council area of South Ayrshire.

Scottish Power Renewables (2012). Dersalloch Windfarm Environmental Statement 2012 Addendum

Scottish Government, Energy Division, Consent and deemed planning permission by the Scottish ministers for the construction and operation of a wind powered electricity generating station at Hadyard Hill, near Barr, South Ayrshire. Consent and deemed planning permission

SSE (2015). Hadyard Hill Extension Wind Farm Environmental Statement: Volume 2: *Main Report*, and Technical Appendix 6.2: Operational Noise Assessment.

South Ayrshire Council (2017). Report by executive director of economy, neighbourhood and environment, Regulatory Panel: 31 August 2017. Subject: Application to construct and operate under Section 36 of the Electricity Act 1989 and the Electricity Works (Environmental Impact Assessment) (Scotland) regulations an extension to the existing Hadyard Hill wind farm, south east of Dailly and North East of Barr, South Ayrshire: 15/00453/DEEM, ECU Ref: EC00003118.

Delta Aalborg Oest.(2003). Turbine test report AV297-03.

Siemens Gamesa (2020). Technical document entitled: SG 6.0-155 Standard Acoustic Emissions, Rev.0,AM 0 – AM-8, N1 – N6, IEC Ed.3, document code: D2359800/002, dated 24/02/2020.

International Electrotechnical Commission (2002). IEC 61672-1:2002, Sound level meters - Part 1: Specifications.

Davis R A, Lower M C (1996). ETSU W/13/00386/REP, Noise measurements in windy conditions, ETSU/DTI

Hoare Lea (2020). Knockcronal Wind Farm. Baseline Noise Assessment. Revision 5 (Appendix 8.1 to the Knockcronal EIA Scoping Report)

HM Government (1974) *Control of Pollution Act 1974* (as amended). London: HMSO

Bass et al (1998). Development of a windfarm noise prediction model.

Scottish Government (1998). Planning Circular 4/1998: The use of conditions in planning permissions.

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