Technical Appendix 10.2: Operational Noise Report

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Executive Summary

TNEI Services Ltd was commissioned by LUC on behalf of Appin Wind Farm Limited ('the Applicant') to undertake predictions of the wind turbine noise that would be emitted by the operation of the proposed Appin Wind Farm (hereinafter referred to as 'the Proposed Development'). The noise predictions were used to assess the potential impact of operational noise from the Proposed Development on the nearest noise sensitive receptors.

The Scottish Government's web based renewables advice on 'Onshore Wind Turbines' states: *'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. 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.'* The advice document then goes on to state: *'The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise [IOA GPG]. The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'* The guidance contained within ETSU-R-97 and current good practice has been used to assess the potential operational noise impact of the Proposed Development.

The operational noise assessment has been undertaken in three stages:

1) derive the Total ETSU-R-97 Noise Limits (which are applicable to noise from all wind turbines in the area operating concurrently) at noise sensitive receptors;
2) predict the likely effects (undertaking a cumulative noise assessment where required) to determine whether noise immission at the noise sensitive receptors will meet the Total ETSU-R-97 Noise Limits; and
3) derive Site Specific Noise Limits for the Proposed Development (taking account of the noise limit that has already been allocated to / could realistically be used by other schemes) and undertake predictions against those limits.

Background noise monitoring was undertaken at three noise sensitive receptors. The monitoring locations were considered to be representative of the noise sensitive receptors located closest to the Proposed Development.

A total of thirteen noise sensitive receptors were chosen as Noise Assessment Locations (NALs). The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Development. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations deemed representative of the expected background noise environment was used to assess the wind turbine noise impact at those receptors.

Wind speed data was measured using a LiDAR unit. The wind data measured directly at 120 m was standardised to a height of 10 m in accordance with current good practice. Analysis of the measured data was undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits at each of the NALs.

Based on the guidance in ETSU-R-97 and to reflect the presence of existing wind turbines in the area, the daytime Total ETSU-R-97 Noise Limit was set at 40 dB(A) or background plus 5 dB whichever is the

greater. The night-time Total ETSU-R-97 Noise Limit has been set at 43 dB(A) or background plus 5 dB whichever is the greater. The Site Specific daytime limit for noise associated with the Proposed Development has been set such that it never exceeds 35 dB(A) or background plus 5 dB, whichever is the greater. This represents the lower end of the daytime limits that can be applied under ETSU-R-97. The night-time Site Specific Noise Limits have been set at 43 dB(A) or background plus 5 dB whichever is the greater.

The exception to the setting of both the daytime and night-time fixed minimum noise limits occurs where a property occupier has a financial involvement in the wind farm development where the fixed minimum limit can be increased to 45 dB(A) or a higher permissible limit above background during the daytime and night-time periods. For the purposes of this assessment, no properties have been considered as financially involved.

Predictions of wind turbine noise for the Proposed Development were made, based upon the sound power level data for the Vestas V162, 7.2 MW with Serrated Blades and a hub height of 119 m. This wind turbine model has been chosen as it is considered to be representative of the type of turbine that could be installed at the site. Whatever the final turbine choice is, the Proposed Development would have to meet the noise limits determined and contained within any condition applied as part of consent.

Modelling was undertaken using the ISO 9613:2024 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors'* noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment. For the other schemes, predictions have been undertaken using sound power level data for the installed turbines or a suitable candidate. The model of turbine was either identified through an online search, or through the use of the Council's Planning Application Portal.

A cumulative assessment was undertaken at the NALs closest to the Proposed Development in each direction. The likely cumulative assessment shows that the Proposed Development can operate concurrently with other operational, consented and proposed (in planning) wind farms and wind turbine developments in the area at all NALs whilst still meeting the Total ETSU-R-97 Noise Limit. At NAL1, mitigation for the Proposed Development would be required for certain wind speeds and directions as summarised below.

Site Specific Noise Limits have also been derived that take account (where required) of the other wind farm/turbine developments. Where wind turbine immission from the other wind turbines at a given receptor were found to be at least 10 dB below the Total ETSU-R-97 Noise Limit, it is considered that they will be using a negligible proportion of the limit, as such it was considered appropriate to allocate the entire noise limit to the Proposed Development. For the receptors where turbine predictions were found to be within 10 dB of the Total ETSU-R-97 Noise Limit, apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with current good practice.

Predicted noise levels indicate that wind turbine noise immission were below the Site Specific Noise Limits at all NALs (except NAL1). At NAL1, an exceedance ranging from 0.7 dB to 3 dB was predicted between 6 ms^{-1} and 10 ms^{-1} during the daytime. Predicted noise levels have therefore been reduced to ensure that the Site Specific Noise Limits are met, this would be achieved by the adoption of low noise modes, but this would only be required for a limited range of wind speeds and wind directions. The use of Site Specific Noise Limits would ensure that the Proposed Development could operate concurrently with other wind farms/turbines in the area and would also ensure that the Proposed Development's individual contribution could be measured and enforced if required.

Should consent be granted for the Proposed Development it would be appropriate to include a set of noise related planning conditions, which detail the noise limits applicable to the Proposed Development.

There are a number of wind turbine makes and models that may be suitable for the Proposed Development. Should the Proposed Development receive consent the final choice of turbine would be subject to a competitive tendering process. As such, predictions of wind turbine noise are for information only. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

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1 Introduction

1.1 Brief

1.1.1 TNEI Services Ltd was commissioned by LUC on behalf of Appin Wind Farm Limited ('the Applicant') to undertake an operational noise assessment for the proposed Appin Wind Farm (hereinafter referred to as 'the Proposed Development'). The following steps summarise the noise assessment process:

- Measure existing background noise levels, assess and present the noise data with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* (1) and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (2) (IOA GPG) which represents current good practice;
- Determine the Total ETSU-R-97 Noise Limits applicable to all wind farms/ turbines in the area;
- Assess and undertake a cumulative noise assessment, where required, to take account of other proposed, consented or operational schemes near to the Proposed Development;
- Derive Site Specific Noise Limits for the Proposed Development, suitable for inclusion in the noise related planning condition should Scottish Ministers be minded to grant consent for the Proposed Development;
- Undertake predictions of the operational wind turbine noise immission from the Proposed Development that will be incident at neighbouring noise sensitive receptors;
- Compare predictions of the operational wind turbine noise immission from the Proposed Development against the Site Specific Noise Limits that will be incident at neighbouring noise sensitive receptors; and
- Assess the impact of noise from the Proposed Development with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines, which are contained within ETSU-R-97 and the IOA GPG (current good practice).

1.2 Background

1.2.1 The site is located approximately 6.2 km north of Moniaive and 14.8 km east of Carsphairn within Dumfries and Galloway. The approximate OS Grid Reference for the centre of the Site is 272887, 597709 and the proposed layout is shown on Figure A1.1a (Annex 1). The area surrounding the site is rural in nature, comprising of open moorland and forestry.

1.2.2 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine provided by the Applicant, the Vestas V162, 7.2 MW with serrated blades and a hub height of 119 m. This turbine has been selected as it is representative of the turbine type which could be installed at the Site.

1.2.3 The noise assessment has considered schemes which are operational, consented and proposed (planning application submitted), which are having a meaningful contribution to the predicted noise immission levels at noise sensitive receptors neighbouring the Proposed Development. The schemes considered in the assessment are summarised in Table 1.1 of this report.

Table 1.1 Cumulative Wind Farm/ Turbine Development

Wind Farm/ Wind Turbine	Number of Turbines	Status	Make and Model of Turbine considered in Modelling
Wether Hill	14	Operational	Siemens SWT-1.3-62, 1.3 MW, 60 m hub height
Afton	25	Operational	Gamesa G80, 2 MW, 78 m hub height
Sanquhar Community Wind Farm	9	Operational	Vestas V112, 3.6 MW, STE Blades and 74 m hub height
Whiteside Hill	10	Operational	GE 2.85-103, 2.85 MW, 69.5 m hub height
Windy Rig	12	Operational	Nordex N100/3300, 3.3 MW, 75 m hub height
Twentyshilling	9	Operational	Vestas V117, 4.2 MW, STE Blades, 81.5 m hub height
Troston Loch	14	Consented	Nordex N133, 4.8 MW, Standard Blades, 83 m hub height
Lorg	10	Consented, Tip Height Variation Submitted	Vestas V162, 5.6 MW, Standard Blades, 119 m hub height
Cornharrow	7	Consented	Siemens-Gamesa SG6.6-155, 6.6 MW, 122.5 m hub height
Sanquhar II	44	Consented	Vestas V162, 6.2 MW, STE Blades, 119 m hub height & Vestas V136, 4.5 MW, STE, 81 m hub height
Manquhill	8	Consented	Vestas V150, 6 MW, STE Blades, 125 m hub height
Margree	9	Consented	Nordex N163/5.X, 5.7 MW, Standard Blades, Mode 0
Glenshimmeroch	10	Consented	Vestas V150, 4.2 MW, STE Blades, 105 m & 125 m hub heights
Euchanhead	21	In Planning	Vestas V150, 5.6 MW, STE Blades, 155 m hub height
Cloud Hill	10	In Planning	Vestas V150, 5.6 MW, STE Blades, 105 m hub height

1.2.4 Figure A1.1b in Annex 1 shows the location of the above developments relative to the Proposed Development.

1.2.5 The Site Specific Noise Limits presented in this report for the Proposed Development have taken account of the noise limits that have already been allocated to, or could potentially be used by, the other schemes in the area.

1.2.6 For the purposes of assessing the above schemes in conjunction with the Proposed Development the following terms have been referred to throughout the assessment:

- 'Total ETSU-R-97 Noise Limits'; defined as being the limit that should not be exceeded from the cumulative operation of all wind farm developments, including the Proposed Development; and
- 'Site Specific Noise Limits'; defined as being the limit that is specific to the Proposed Development only, and derived through the apportionment (where required), of the 'Total ETSU-R-97 Noise Limits' in accordance with current good practice.

1.2.7 Note that in this report, the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the received noise) at any receptor location due to the operation of the wind turbines. All references to dB are dB(A) unless otherwise stated. A full glossary of terms is provided in Section 8.

2 Noise Planning Policy and Guidance

2.1 Overview of Noise Planning Policy and Guidance

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

- National Planning Policy [(3)];
- Local Policy;
- Web Based Renewables Advice: *'Onshore Wind Turbines'* [(4)];
- Planning Advice Note PAN 1/2011: *'Planning and Noise'* [(5)];
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*; and
- 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) May 2013.

2.2 National Legislation and Planning Policy

2.2.1 As the Proposed Development has capacity to generate over 50 MW, the Proposed Development requires consent from the Scottish Ministers under Section 36 of the Electricity Act 1989. In such cases the Planning Authority is a statutory consultee in the development management process and procedures.

2.2.2 In determining an application for Section 36 consent, the Scottish Ministers must first have regard to the extent to which the Applicant has met its duties in terms of Schedule 9 of the Electricity Act 1989. The Applicant must assess and, if required, mitigate the effects of the Proposed Development on environmental matters.

2.2.3 Furthermore, decision makers must also consider National Energy and Planning Policy, and, in the context of a Section 36 application, the statutory Development Plan. As of February 2023, National Planning Framework 4 ('NPF4') now forms part of the statutory Development Plan alongside the relevant Local Development Plan and any related Supplementary Guidance. Such plans will often contain policies tailored specifically to control certain kinds of development and such policies should carry more weight and be more dominant in the minds of decision makers.

2.2.4 NPF4 was adopted on 13 February 2023 and supersedes National Planning Framework 3 and Scottish Planning Policy. Policy 11 – Energy states that renewable energy projects must be able to demonstrate how any noise impacts on communities have been addressed through the project's design and any associated mitigation. Policy 23 – Health and Safety outline how '*development proposals that are likely to raise unacceptable noise issues will not be supported'* and states that *'a Noise Impact Assessment may be required where the nature of the proposal or its location suggests that significant effects are likely.'*

2.2.5 The Scottish Government's online Onshore Wind: Policy Statement 2022 (published on 21 December 2022) [(6)] states (in Section 3.7) that: *'The Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments.'*

2.3 Local Policy

Dumfries and Galloway Local Development Plan

Dumfries and Galloway Local Development Plan 2

2.3.1 The adopted Development Plan for the area comprises the Dumfries and Galloway Local Development Plan (LDP) 2 which was adopted in October 2019. The Local Plan sets out detailed policies and specific proposals for the development and use of land within Dumfries and Galloway.

2.3.2 Policy IN1: Renewable Energy, covers the principal policy guidance in relation to renewable energy. It states:

'The Council will support development proposals for all renewable energy generation and/or storage which are located, sited and designed appropriately.'

2.3.3 The acceptability of any proposed development will be assessed against several considerations, of which noise is one. It is further stated that to enable this assessment, sufficient detail should be submitted regarding a number of points, of which includes *'environmental and other impacts associated with the construction and operational phases of the development including details of any visual impact, noise and odour issues.'*

2.3.4 Policy IN2: Wind Energy, provides the principal policy guidance in relation to wind energy developments. It states:

'The Council will support wind energy proposals that are located, sited and designed appropriately'. Amongst the assessed considerations is 'The extent of any detrimental impact on communities, individual dwellings, residents and local amenity, including assessment of the impacts of noise, shadow flicker, visual dominance and the potential for associated mitigation.'

Dumfries and Galloway LDP 2 Supplementary Guidance –Wind Energy Development: Development Management Considerations

2.3.5 The policy detailed above is supported by more detailed guidance contained within Supplementary Guidance - Wind Energy Development: Development Management Considerations. The guidance was adopted in February 2020 and is a material consideration as it forms part of the development plan and is afforded the same weight as the LDP.

2.3.6 In relation to noise paragraph E11 states:

'for all large and medium turbines a full site-specific noise impact assessment, following ETSU-R-97 and Institute of Acoustics methodology (or subsequent accepted national guidelines), which includes cumulative impact would be required for all appropriate noise sensitive properties as agreed with Environmental Standards.'

2.4 Planning Advice Note PAN 1/2011: Planning and Noise

2.4.1 PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. Paragraph 29 contains some specific information on noise from wind farms and 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.'

2.5 Web Based Planning Advice – Onshore Wind Turbines

2.5.1 The 'Onshore Wind Turbines' web-based document also describes the types of noise (mechanical and aerodynamic) that wind turbines generate. Mechanical noise is generated by the gearbox and generator and other parts of the drive train, which can be radiated as noise through the nacelle, gear box, tower and supporting structures, together with the aerodynamic noise generated by the action of the blades rotating through the air. The document states '*there has been significant reduction in the mechanical noise generated by wind turbines through improved turbine* design' and goes on to note:

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

2.5.2 The web-based document then refers to the IOA GPG as a source, which provides:

'significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'

2.5.3 The document also refers to the role of PAN1/2011 'Planning and Noise' to:

'provide advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.'

2.5.4 Examination of the Technical Advice Note (7) confirms that it provides advice on wind farms by referring to ETSU-R-97 and relevant parameters for modelling identified in the Institute of Acoustics Bulletin March 2009, on page 37. This has been superseded by the introduction of the IOA GPG in May 2013.

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

2.6.1 As wind farms started to be developed in the UK in the early 1990's, it became apparent that existing noise standards did not fully address the issues associated with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. This methodology was developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.6.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers, wind farm operators, independent acoustic consultants and legal experts who:

'…between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.'

2.6.3 In this way it represented the views of all the stakeholders that are involved in the assessment of noise impacts of wind farm developments. The recommendations of the WGNWT are presented in the DTI Report – ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms (1996).'*

2.6.4 The basic aim of the WGNWT in arriving at the recommendations was the intention to provide:

'Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding to the costs and administrative burdens on wind farm developers or local authorities.'

2.6.5 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that would arise through the development of renewable energy sources:

'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'

2.6.6 Where noise at the nearest noise sensitive receptors is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 ms^{-1} at a height of 10 m, then it does not need to be considered in the noise assessment, as protection of the amenity of these properties can be controlled through a simplified noise limit. In this regard ETSU-R-97 states that:

'For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 m/s at 10 m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'

2.6.7 The ETSU-R-97 assessment procedure specifies that where wind turbine noise is expected to be above the simplified limit of 35 dB L_{A90} noise limits should be set relative to existing background noise levels at the nearest receptors. These limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for daytime and night-time, are applied where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2 to 3 ms^{-1}) and up to 12 ms^{-1}, where all wind speeds are referenced to a 10 m measurement height.

2.6.8 Separate noise limits apply for daytime and for night-time. Daytime limits are chosen to protect a property's external amenity, and night-time limits are chosen to prevent sleep disturbance indoors, with windows open.

2.6.9 The daytime noise limit is derived from background noise data measured during so-called 'quiet periods of the day', which comprise weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of 10 minute background noise levels using the $L_{A90,10min}$ measurement index are logged continuously over a range of wind speed conditions. These measured noise levels are then plotted against concurrent wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU–R-97 daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5 dB(A) above the best fit curve over the desired wind speed range; subject to an appropriate daytime fixed minimum limit:

'For wind speeds where the best fit curve to the background noise data lies below a level of 30 - 35 dB(A) the criterion curve is set at a fixed level in the range 35 - 40 dB(A). The precise choice of criterion curve level within the range 35 - 40 dB(A) depends on a number of factors: the number of noise affected properties, the likely duration, the level of exposure and the potential impact on the power output of the wind farm. The quiet daytime limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas.'

2.6.10 The night time noise limit is derived from background noise data measured during the night time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10 minute L_{A90} noise levels measured over the night time periods are plotted against concurrent wind speed data and a 'best fit' correlation is established. The night time noise limit is also based on a level 5 dB(A) above the best fit curve over the 0 - 12 ms^{-1} wind speed range, with a fixed minimum limit of 43 dB L_{A90}.

2.6.11 The exception to the setting of both the daytime and night-time fixed minimum limits occurs where a property occupier has a financial involvement in the wind farm development. Paragraph 24 of ETSU-R-97 states:

'The Noise Working Group recommends that both day and night time lower fixed limits can be increased to 45 dB(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 wind farm.'

2.6.12 ETSU-R-97 provides a robust basis for determining the noise limits for wind turbine(s) and since its introduction has become the accepted standard for such developments across the UK.

2.7 Current Good Practice

A Good Practice Guide on the Application of ETSU-R-97

2.7.1 In May 2013, the Institute of Acoustics issued *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG). The document provides guidance on background data collection, data analysis and limit derivation, noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.7.2 The Authors of the IOA GPG sets out the scope of the document in Section 1.2:

'This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government.'

2.7.3 The guidance document was endorsed, on behalf of Scottish Government by the Cabinet Secretary for Finance, Employment and Sustainable Growth, Mr John Swinney MSP (8) The recommendations included in the IOA GPG have been considered and applied throughout this noise assessment for the Proposed Development.

2.7.4 The IOA GPG refers to six Supplementary Guidance Notes and where applicable these have also been considered in this report.

2.7.5 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the Proposed Development.

2.8 WSP BEIS Report

2.8.1 In February 2023, WSP published *'A review of noise guidance for onshore wind turbines'* (9)('WSP BEIS report'). The report, which was subsequently re-issued as version 5 in September 2023, was commissioned by (the former) UK Government Department for Business, Energy & Industrial Strategy (BEIS). The primary aim of the review was to make a recommendation on whether, in view of government policies on noise and Net Zero, and available evidence, the existing guidance requires updating.

2.8.2 The WSP BEIS report concluded that:

'the guidance would benefit from further review and updating of the aspects identified. This could be supported by currently available evidence, which is summarised in this report. However, the study has also highlighted gaps in the state of knowledge, which should be addressed by further research, to support any updates to the guidance.'

2.8.3 A series of recommendations are made regarding further research whilst some additional suggestions are included regarding the development of new or updated guidance. The following recommendation is included on page 26 of the WSP BEIS report:

'the separation of the 'policy position' (addressing the balance between controlling noise impact and enabling renewable energy development), 'technical guidance' (application of

the assessment approach), and 'technical justification' (the supporting evidence) into discrete, linked documents'

2.8.4 The WSP BEIS report notes at the outset that *'Any views expressed within it do not necessarily represent the views of the UK government or the governments of any of the devolved administrations'.* The report does state on page 25 that:

'Consideration should be given to including a clear position statement in guidance confirming the intended policy balance between protection from noise impact, and enabling of renewable energy development (to achieve Net Zero), linked with the wider policies that underpin the government approach to noise management.'

2.8.5 In June 2024, the UK Government Department for Energy Security and Net Zero (DESNZ) awarded a contract to Noise Consultants Limited to update ETSU-R-97. At the present time there is no confirmed publication date.

2.8.6 In relation to the guidance that should be used to assess the Proposed Development, the Scottish Government Guidance is clear; the Onshore Wind Policy Statement 2022 states:

'3.7.1. 'The Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments.'

'3.7.4. Until such time as new guidance is produced, ETSU-R-97 should continue to be followed by applicants and used to assess and rate noise from wind energy developments.'

2.8.7 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the Proposed Development.

3 Potential Impacts

3.1 Operational Noise Sources

3.1.1 Wind turbines may emit two types of noise. Firstly, aerodynamic noise is a more natural sounding 'broad band' noise, albeit with a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. Potential sources of mechanical noise include gearboxes or generators.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low, although at very low wind speeds the blades do not rotate, or rotate very slowly, and so negligible aerodynamic noise is generated. In higher winds aerodynamic noise may be masked by the normal sound of wind blowing through the trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines (10).

3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound can be defined as the frequency range below 20 Hz, while low frequency noise (LFN) is typically in the frequency range 20 – 200 Hz (11). An average young healthy adult has an audible range from 20 Hz to 20,000 Hz, although the sensitivity of the ear varies with frequency and is most sensitive to sounds with frequencies between 500 Hz and 4,000 Hz. Wind turbines do produce low frequency sounds (12), but our threshold of hearing at such low frequencies is relatively high and they therefore go unnoticed. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.

3.2.2 In 2004, the former DTI commissioned The Hayes McKenzie Partnership to report on claims that infrasound or LFN emitted by wind turbine generators (WTGs) were causing health effects. Of the 126 wind farms operating in the UK, five had reported LFN problems, therefore, such complaints are an exception, rather than a general problem that exists for all wind farms. Hayes McKenzie investigated the effects of infrasound and LFN at three wind farms for which complaints had been received and the results were reported in May 2006 (13). The report concluded that:

- *'infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;*
- *low frequency noise was measurable on a few occasions but below the existing permitted Night Time Noise Criterion. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was always lower than that of local road traffic noise;*
- *that the common cause of complaint was not associated with LFN, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep.'*

3.2.3 The Applied and Environmental Geophysics Research Group at Keele University was commissioned by the Ministry of Defence (MOD), the DTI and the British Wind Energy Association (BWEA) to undertake microseismic and infrasound monitoring of LFN and vibrations from wind farms for the purposes of siting wind farms in the vicinity of Eskdalemuir in Scotland. Whilst the testing showed that vibration can be detected several kilometres away from wind turbines, the levels of vibration from wind turbines were so small that only the most sophisticated instrumentation can reveal their presence and they are almost impossible to detect. Nevertheless, the Renewable Energy Foundation alleged potential adverse health effects and when that story was picked up in the popular press, notably the Scotsman, the report's authors expressed concern over the way in which their work had been misinterpreted and issued a rebuttal statement [14] in August 2005:

'Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health.'

3.2.4 In response to concerns that wind turbines emit infrasound and cause associated health problems, Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Defra Report on Low Frequency Noise and its Effects, said in the article in the Scotsman ('Wind farm noise rules 'dated'- James Reynolds, 5 August 2005'):

'I can state quite categorically that there is no significant infrasound from current designs of wind turbines.'

3.2.5 An article [15] published in the IOA Bulletin (March/April 2009) concluded that there is no robust evidence that either low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, has an adverse effect on wind farm neighbours.

3.2.6 Work [16] by Dr Leventhall looked at infrasound levels within the ear compared to external sources and concluded:

'The conclusion is that the continuous inner ear infrasound levels due to internal sources, which are in the same frequency range as wind turbine rotational frequencies, are higher than the levels produced in the inner ear by wind turbines, making it unlikely that the wind turbine noise will affect the vestibular systems, contrary to suggestions made following the measurements at Shirley. The masking effect is similar to that in the abdomen (Leventhall 2009). The body, and vestibular systems, appear to be built to avoid disturbance from the high levels of infrasound which are produced internally from the heartbeat and other processes. In fact, the hearing mechanisms and the balance mechanisms, although in close proximity, have developed to minimise interaction (Carey and Amin 2006).'

3.2.7 More recently during a planning Appeal (PPA-310-2028, Clydeport Hunterston Terminal Facility, approximately 2.5 km south-west of Fairlie, 9 Jan 2018), the health impacts related to LFN associated with wind turbines were considered at length by the appointed Reporter (Mr M Croft). The Reporter considered evidence from Health Protection Scotland and the National Health Service. In addition, he also considered LFN surveys undertaken by the Appellant and the Local Authority, both of which demonstrated compliance with planning conditions and did not identify any problems attributable to the turbine operations; some periods with highest levels of low frequency noise were in fact recorded when the turbines were not operating.

3.2.8 The Reporter concluded that:

- The literature reviews by bodies with very significant responsibilities for the health of local people found insufficient evidence to confirm a causal relationship between wind turbine noise and the type of health complaints cited by some local residents;
- The NHS's assessment is that concerns about health impact are not supported by good quality research; and
- Although given the opportunity, the Community Council failed to provide evidence that can properly be set against the general tenor of the scientific evidence.

3.2.9 The WSP BEIS Report notes on page 113 that:

'Several studies have investigated the claimed links between adverse health symptoms and infrasound emissions from wind turbines. Although some experimental studies have linked infrasonic signals with activation of physiological sensory processing, these have tended to be based on signals that are not representative of wind turbine infrasound. There remains no compelling evidence of adverse health effects associated with wind turbine infrasound exposure at sound frequencies and' levels expected to be present at noise-sensitive receptor locations in the vicinity of wind farms'

3.2.10 The WSP BEIS Report goes on to note on page 114 that:

'Overall, the findings from the existing evidence base indicate that infrasound from wind turbines at typical exposure levels has no direct adverse effects on physical or mental health, and reported symptoms of ill-health are more likely to be psychogenic in origin.'

3.2.11 It is noted that research into infrasound is ongoing but the WSP BEIS report concluded that:

'It is expected that further evidence from ongoing studies into wind turbine infrasound effects will emerge soon, in particular from the NHMRC studies in Australia. However, based on the existing scientific evidence, it does appear probable that the above findings will not be contradicted by newer evidence.'

3.2.12 Since the publication of the WSP BEIS report, the study that was granted funding by NHMRC (the National Health and Medical Research Council of Australia) was published in the Environmental Health Perspectives (EHP) journal which is published by the United States National Institute of Environmental Health. The study [17] aimed to test the effect of exposure to 72 hours of infrasound (designed to simulate a wind turbine infrasound signature) exposure on human physiology, particularly sleep. The study concluded that:

'Our findings did not support the idea that infrasound causes WTS[1]. High level, but inaudible, infrasound did not appear to perturb any physiological or psychological measure tested in these study participants.'

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[1] WTS stands for Wind Turbine Syndrome which is a term for adverse human health effected related to the proximity of wind turbines.

3.2.13 It is therefore not considered necessary to carry out specific assessments of LFN and it has not been considered further in the noise assessment.

3.3 Amplitude Modulation of Aerodynamic Noise (AM)

3.3.1 In the context of wind turbine noise amplitude modulation describes a variation in noise level over time; for example, observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. Amplitude Modulation of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68:

'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.

This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dBA (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'

3.3.2 In recent times the Acoustics community has sought to make a distinction between the AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In some appeal decisions it may also be referred to as 'Excess Amplitude Modulation' (EAM). It should be noted that the noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

3.3.3 On 16 December 2013, RenewableUK (RUK) released six technical papers (18) on AM, which reflected the outcomes of research commissioned over the previous three years, together with a template planning condition. Whilst this research undoubtedly improved understanding of Other Amplitude Modulation (OAM) and its effects, it should be noted that at the time of writing it has not been endorsed by any relevant body such as the Institute of Acoustics (IOA).

3.3.4 On 22 January 2014, the IOA released a statement regarding the RUK research and the proposed planning condition to deal with the issue of amplitude modulation from a wind turbine and stated:

'This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it. The proposed planning

condition, though, needs a period of testing and validation before it can be considered to be good practice. The IOA understands that RenewableUK will shortly be making the analysis tool publicly available on their website so that all interested parties can test the proposed condition, and the IOA will review the results later in the year. Until that time, the IOA cautions the use of the proposed planning condition.'

3.3.5 Research regarding amplitude modulation continued. In April 2015, the IOA issued a discussion document entitled *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'*. The document presented three methods that can be used to quantify the level of AM at a given measurement location. After extensive consultation a preferred method of measuring OAM, which provides a framework for practitioners to measure and rate AM, was recommended by the IOA.

3.3.6 On 3 August 2015, the Department for Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS), commissioned independent consultants WSP Parsons Brinkerhoff to carry out a literature review on OAM (which they refer to simply as AM). The stated aims were as follows:

- *To review the available evidence on Amplitude Modulation (AM) in relation to wind turbines, including but not limited to the research commissioned and published by RenewableUK in December 2013;*
- *To work closely with the Institute of Acoustics' AM working group, who are expected to recommend a preferred metric and methodology for quantifying and assessing the level of AM in a sample of wind turbine noise data;*
- *To review the robustness of relevant dose response relationships, including the one developed by the University of Salford as part of the RenewableUK study, on which the correction (or penalty) for amplitude modulation proposed as part of its template planning condition is based;*
- *To consider how, in a policy context, the level(s) of AM in a sample of noise data should be interpreted, in particular determining at what point it causes a significant adverse impact;*
- *To recommend how excessive AM might be controlled through the use of an appropriate planning condition; and*
- *To consider the engineering/cost trade-offs of possible mitigation measures.*

3.3.7 Their report, which was released in October 2016, concluded that there is sufficient robust evidence that excessive AM leads to increased annoyance from wind turbine noise and recommended that excessive AM is controlled through a suitably worded planning condition, which will control it during periods of complaint. Those periods should be identified by measurement using the metric proposed by the work undertaken by the IOA, and enforcement action would rely upon professional judgement by Local Authority Environmental Health Officers based on the duration and frequency of occurrence.

3.3.8 It is not clear within the body of the report which evidence the authors relied upon to arrive at their conclusions, although the Executive Summary states (page 4):

"It is noted that none of the Category 1 or 2 papers have been designed to answer the main aim of the current review in its entirety. The Category 1 studies have limited representativeness due to sample constraints and the artificiality of laboratory

environments, whereas the Category 2 studies generally do not directly address the issue of AM WTN exposure-response. A meta - analysis of the identified studies was not possible due to the incompatibility of the various methodologies employed. Notwithstanding the limitations in the evidence, it was agreed with DECC that the factors to be included in a planning condition should be recommended based on the available evidence, and supplemented with professional experience".

3.3.9 The report(19) states that any planning condition must accord with existing planning guidance, and should be subject to legal advice on a case by case basis. Existing guidance would include compliance with the six tests of a planning condition embodied in Circular 4/98. The report's authors did not dictate a particular condition to be used but did suggest that any condition should include the following elements (p5):

- *"The AM condition should cover periods of complaints (due to unacceptable AM);*
- *The IoA-recommended metric should be used to quantify AM (being the most robust available objective metric);*
- *Analysis should be made using individual 10-minute periods, applying the appropriate decibel 'penalty' to each period, with subsequent analysis;*
- *The AM decibel penalty should be additional to any decibel penalty for tonality; and*
- *An additional decibel penalty is proposed during the night time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day."*

3.3.10 AM was considered in the WSP BEIS report. The report notes that the IOA Method provides a suitable approach to measure and quantify AM (whilst noting that work is ongoing to refine the approach) but also highlights that further work is required to develop a robust mechanism for controlling AM that could be incorporated into a planning condition. In relation to the potential adoption of a penalty scheme to control AM the WSP BEIS report notes on page 208 that:

'In practice, the details of applying such a penalty scheme are complicated by the complexities of wind turbine sound measurements. These often involve a considerable amount of data filtering and data aggregation to address the practical difficulties of measuring a highly variable source, which is often also at a level that is relatively low compared with other, fluctuating residual sounds present in the acoustic environment. Such details will need to be carefully considered in further study, and the example planning condition proposed by a group of IOA members in 2017 [505] should be considered as a starting point.'

3.3.11 Until such a 'further study' is completed, and additional guidance is published, the approach set out in the IOA GPG remains valid, the document states (paragraph 7.2.10):

'7.2.1 The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM.'

3.3.12 In February 2025, the Scottish Government published a set of standard consent conditions to be attached to proposals granted consent under Section 36 of the Electricity Act 1989 (20). The operational noise condition which forms Condition 32 does not include AM.

4 Methodology

4.1 Assessing Operational Noise Impact

4.1.1 To undertake an assessment of the operational noise impact in accordance with the requirements of ETSU-R-97 and the IOA GPG, the following steps are required:

- Specify the location of the wind turbines for the Proposed Development;
- Measure the background noise levels as a function of on-site wind speed at a selection of representative Noise Monitoring Locations (NML);
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise data;
- Establish for each NAL the Total ETSU-R-97 Noise Limits on analysis of the measured background noise levels;
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Development and all nearby cumulative wind turbines;
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total ETSU-R-97 Noise Limits;
- Determine the Site Specific Noise Limits which take account of the noise limit already allocated to/ could theoretically be used by other schemes in the area; and
- Calculate the likely noise immission levels due to the operation of the Proposed Development on its own and compare it to the Proposed Development's Site Specific Noise Limits.

4.1.2 In order to consider the steps outlined above the assessment has been split into three separate stages:

- Stage 1 – determine the Total ETSU-R-97 Noise Limits (which are applicable to noise from all wind turbines in the area operating concurrently) at the NALs;
- Stage 2 – undertake a cumulative assessment where noise predictions from the Proposed Development are within 10 dB of the total noise predictions from the other wind farms/turbines within the area; and
- Stage 3 – establish the Proposed Development's Site Specific Noise Limits (at levels below the Total ETSU-R-97 Noise Limits, where limit apportionment is required) and compare the noise predictions from the Proposed Development on its own against the proposed Site Specific Noise Limits.

4.1.3 There are a range of turbine makes and models that may be appropriate for the Proposed Development. In the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Vestas V162, 7.2 MW with a hub height of 119 m. The final selection of turbine will follow a competitive tendering process and thus the final model of turbine may differ from those on which this assessment has been based. However, the final choice of turbine will be required to comply with the noise limits which have been established for the site.

4.2 Consultation

Scoping Opinion (dated March 2022)

4.2.1 The scoping opinion issued by the Scottish Government's Energy Consents Unit stated that the noise assessment should be carried out in accordance with the relevant legislation and standards detailed within Chapter 9 of the submitted EIA Scoping Report, and that the subsequent operational noise assessment should be formatted as per Table 6.1 of the IOA GPG.

4.2.2 Dumfries and Galloway Council (DGC) did not respond to the noise section within the Scoping Report so it is assumed that they had no comment to make in relation to the proposed noise assessment. Additional consultation was undertaken directly with DGCs Environmental Health Officer (EHO) as summarised in the sections below.

Consultation with Dumfries and Galloway Council's EHO (June 2022)

4.2.3 Prior to the commencement of the noise impact assessment for the Proposed Development, direct consultation was undertaken with the Environmental Health Department at DGC in order to agree the approach to the noise assessment and the noise monitoring locations. In addition, a representative from the Environmental Health Department was also invited to attend the installation of the noise monitoring equipment, however at the time of the installation no response had been received from DGC. A copy of the installation report providing details of the installed noise monitoring locations was sent to DGC on 1st September 2022. No response was received regarding the installation report either.

4.2.4 A copy of the original consultation letter and email correspondence is included in Annex 2.

4.3 Setting the Total ETSU-R-97 Noise Limits (Stage 1)

Identifying Existing Noise Limits

4.3.1 Noise limits have already been set at some properties located closest to the Proposed Development due to other wind farm schemes in area.

4.3.2 The noise and meteorological data collected as part of the noise assessment work undertaken for the Proposed Development has been used to derive a set of Total ETSU-R-97 Noise Limits at the nearest noise sensitive receptors.

Background Noise Levels and Wind Shear

4.3.3 Wind shear can be defined as *'the change in the relationship between wind speed at different heights'*. Due to wind shear, wind speeds recorded on one meteorological mast at different heights are usually different, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4 ms^{-1} is recorded at 80 m height, 3.5 ms^{-1} may be recorded at 40 m and 2.5 ms^{-1} may be recorded at 10 m.

4.3.4 Hub height wind speed is the key wind speed for a wind farm noise assessment, as it is the wind speed at hub height which will determine the noise emitted by the wind turbines and informs the turbine control system. Ideally, both wind turbine noise predictions and background noise level measurements should refer to hub height wind speed (or a representation thereof), ensuring that there is no discrepancy between the wind speed at which the noise is emitted and the wind speed at which the corresponding background noise is measured.

4.3.5 The IOA GPG states that one of three methods (A, B or C) to account for wind shear may be adopted. For this assessment the 'Method A' of Section 2.6.3 of the IOA GPG was used to fully take account of wind shear. The details are described in Section 5 'Baseline'.

Noise Impact Criteria in ETSU-R-97

4.3.6 Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish, for each NAL, the daytime and night-time Total ETSU-R-97 Noise Limits, which would apply for the cumulative operation of all wind turbines in the area. The Total ETSU-R-97 Noise Limits for the daytime has been set at 40 dB(A) or background plus 5 dB whichever is the greater, and the Total ETSU-R-97 Noise Limits at night-time has been set at 43 dB(A) or background plus 5 dB whichever is the greater. This 'Total' limit relates to noise from all wind farm developments in the area. The limit was chosen with due regard to the guidance in ETSU-R-97 and following a review of the existing noise limits at receptors set by nearby wind farms.

4.3.7 As detailed in Section 2.6.9 above, ETSU-R-97 suggests that the daytime fixed minimum limit should be set somewhere in the range between 35 and 40 dB. The precise choice of criterion level within the range 35 - 40 dB(A) depends on a number of factors, including the number of dwellings in the neighbourhood of the wind farm, the effect of noise limits on the number of kWh generated and the duration and level of exposure to any noise. Site Specific Noise Limits have been derived such that they are always at or below the limit established using the lower fixed minimum limit.

4.3.8 The acceptable limits for wind turbine operational noise are clearly defined for all time periods by the application of the ETSU-R-97 methodology. Consequently, the test applied to operational noise is whether or not the predicted wind turbine noise immission levels at nearby noise sensitive properties lie below the ETSU-R-97 noise limits. Depending on the levels of background noise, the satisfaction of the ETSU-R-97 derived limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind turbine noise would be audible.

4.4 Assessment of likely effects and the requirement for a cumulative assessment (Stage 2)

4.4.1 The IOA GPG (2013) includes a detailed section on cumulative noise and provides guidance on where a cumulative assessment is required. Section 5.1.4 and 5.1.5 of the GPG state:

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

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.'

4.4.2 An assessment was undertaken at each of the NALs located proximate to the Proposed Development to determine whether the wind turbine noise immission from the Proposed Development were within 10 dB of the wind turbine noise immission from the other schemes. Where predictions were found to be within 10 dB of each other, then a cumulative noise assessment was undertaken to determine the likely impacts of the Proposed Development, however, if wind turbine immissions were greater than 10 dB apart then a cumulative noise assessment was not required.

Noise Prediction / Propagation Model

4.4.3 Modelling was undertaken using the ISO 9613:2024 '*Acoustics – Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors*' noise prediction model, which supersedes the 1996 edition of the standard. The difference between the two editions of the standard regarding wind turbine noise predictions is negligible. The use of this prediction model accords with current good practice and is considered to provide a realistic impact assessment.

4.4.4 A European Commission (EC) research project into wind farm noise propagation over large distances, published as 'Development of a Wind Farm Noise Prediction Model,' JOULE project JOR3-CT95-0051 in 1998, identified a simplified version of ISO 9613-2 as the most suitable at that time.

4.4.5 The use of ISO 9613-2 is discussed in the IOA GPG which states, in Section 4.1.4:

'ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'

4.4.6 There is currently no standard approach to specifying error bands on noise predictions. Table 4 of ISO 9613-2 suggests, at best, an estimated of accuracy of ± 3 dB(A). The work undertaken as part of the EC research study concluded that the ISO 9613-2 algorithm reliably predicted noise levels that would generally occur under downwind propagation conditions. The error bands referenced in the ISO standard itself relate to the general application of the standard. Additional, wind farm specific studies, have also been undertaken to validate the use of the standard to predict wind farm noise and these are referenced in Section 4 of the IOA GPG which goes on to conclude that: *'The outcome of this research has demonstrated that the ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'* TNEIs experience of undertaking compliance monitoring for operational wind farms indicates that the predictions undertaken using the guidance in the IOA GPG show a good correlation with measured levels.

4.4.7 The ISO 9613-2 model can take account of the following factors that influence sound propagation outdoors:

- Geometric divergence;
- Atmospheric absorption;

- Reflecting obstacles;
- Screening;
- Vegetation; and
- Ground attenuation.

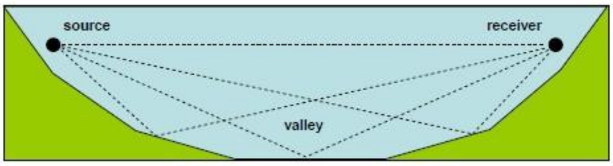
4.4.8 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.4.9 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10 km on an elevated ridge. It also should be noted that no correction for background contribution was undertaken, and the monitoring locations were located as far as 1.7 km from the nearest turbine, where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For the study's modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally, but not with the requirements of the IOA GPG.

4.4.10 The model used in this assessment does not model barrier attenuation using the method in ISO 9613-2 but instead uses the guidance in the IOA GPG to consider whether any topographical corrections are required as set out below in Sections 4.4.10 to 4.4.13. Any differences in ground height (AOD) between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

4.4.11 The IOA GPG states that a *'further correction of +3 dB should be added to the calculated overall A-weighted level for propagation 'across a valley', i.e. a concave ground profile or where the ground falls away significantly between a turbine and the receiver location.'* The potential reflection paths are illustrated in Schematic 4.1 below.

Schematic 4.1: Multiple reflection paths for sound propagation across concave ground



Source: IOA GPG, page 21, Figure 5

4.4.12 A formula from the JOULE Project JOR3-CT95-0051 dated 1998 is suggested for determining whether a correction is required.

$$h_m \geq 1.5 \times (abs\,(h_s - h_r) / 2)$$

where h_m is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver respectively).

4.4.13 The calculation of h_m requires consideration of the digital terrain model and needs to be performed for each path between every turbine and every receiver. Interpretation of the results of the calculation above and the subsequent inclusion of a concave ground profile correction requires careful consideration with any topographical variation considered in the context of a site.

4.4.14 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. The IOA GPG states that where there is no line of sight between the highest point on the rotor and the receiver location a reduction of no more than 2 dB may be applied.

4.4.15 The modelling parameters used in this assessment are detailed in Section 6.2 below.

4.5 Setting the Site Specific Noise Limits (Stage 3)

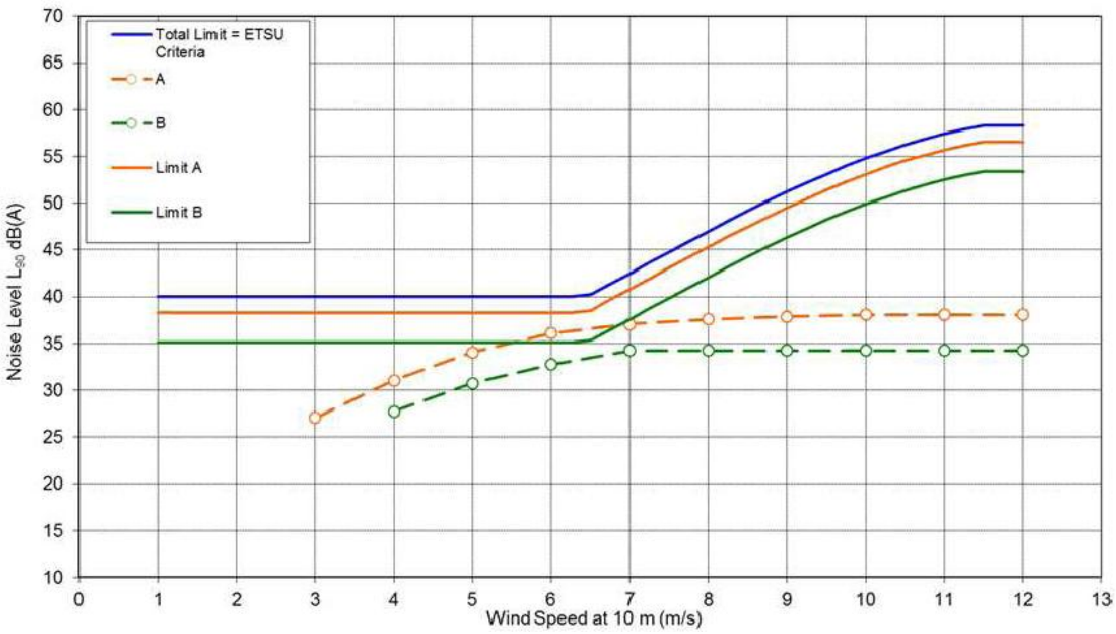
4.5.1 Summary Box 21 of the IOA GPG states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

4.5.2 In order to determine Site Specific Noise Limits at receptors in proximity to the Proposed Development (where required) limit apportionment has been undertaken. The limit apportionment has considered the noise limit already allocated to other wind farms in the area.

4.5.3 This approach is demonstrated in Graph 4.1 below. In this example the total limit (shown in blue) is shared between wind farm A and wind farm B. The two noise limits for a given receptor (the solid orange and green lines) when added together equate to the Total ETSU-R-97 Noise Limit, and the predicted levels for each wind farm (the dashed lines) meet the specific limits established for the individual wind farms.

Graph 4.1: Limit Apportionment Example



4.5.4 The limit derivation can also be undertaken with consideration to the amount of headroom between another schemes(s) predictions and the Total Noise Limit. With regard to this Section 5.4.11 of the IOA GPG states:

'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 Noise Limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the Total Noise 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.'

4.5.5 With this in mind, where appropriate, an additional 2 dB buffer has been added to the other schemes' turbine noise predictions. This is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60 % increase in emitted noise levels from the other schemes.

4.5.6 Where predicted wind turbine noise levels from the individual wind farm/ turbine schemes are found to be >10 dB below the Total ETSU-R-97 Noise Limits then it has been deemed appropriate to allocate the entire noise limit to the Proposed Development. Further information on the approach to apportionment is provided in Section 6.6 below.

5 Baseline

5.1 Identification of Potential Noise Receptors

5.1.1 At the start of the noise assessment, preliminary desktop noise modelling was undertaken using the Resoft 'WindFarm' [21] software in order to locate noise sensitive receptors which may be affected and to identify suitable locations at which to monitor background noise levels. An initial wind turbine layout was input into the 'WindFarm' software and using noise data for a candidate turbine representative of the type that could be installed on the site a noise contour plot was produced. The noise contour plot was included in the consultation letter sent to the Environmental Health Department at DGC. A copy of that letter is included in Annex 2.

5.1.2 The noise contour plot predicted wind turbine noise levels at the noise sensitive receptors surrounding the Proposed Development with predicted turbine noise (measured in $dB_{(A), L90}$) decreasing with distance from the Proposed Development. All properties or clusters of properties within the 35 dB(A) contour were identified and assessed to determine which properties would provide representative background noise data for others in the area.

5.1.3 In accordance with ETSU-R-97, the noise contour plot was based on a noise level at a wind speed of 10 ms^{-1} (as standardised to 10 m height) as the manufacturer determined that this is the wind speed with the highest predicted noise level between 0 and 10 ms^{-1} for the candidate turbine.

5.1.4 The IOA GPG notes *that 'noise-sensitive receptors*, [are] *principally houses (existing or for which planning consent is being sought / has been given) and any building used for long-term residential purposes (such as a nursing home)'.* Following a review of noise sensitive receptors surrounding the Proposed Development, the closest receptors were found to be residential properties.

5.1.5 The properties identified for noise monitoring were selected following a detailed review of the area using aerial photography to identify receptors which would be representative of other nearby properties. Where possible, locations were selected which were subject to minimal influence from other noise sources such as local watercourses, operational wind turbines and vegetation.

5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken for the purposes of setting the Total ETSU-R-97 Noise Limits. Data was recorded over the period 12 August - 20 October 2022 at two noise sensitive receptors and from 23 August – 20 October 2022 at a third location.

5.2.2 Details of the exact monitoring periods, the rationale behind the exact kit location and the dominant noise sources observed at each of the Noise Monitoring Location (NML) are detailed in the Field Data Sheets (FDS) and installation report included in Annex 3.

5.2.3 The NML is the position that the sound level meter was sited at each property, as shown on Figure A1.1a-b (Annex 1) and summarised in Table 5.1.

Table 5.1 Noise Monitoring Locations

NML/ Receptor Name	Easting	Northing
NML1 – Shinnelhead	272958	599160
NML2 – High Appin	274653	697262
NML3 – Blairoch	270732	596568

5.3 Noise Monitoring Equipment

5.3.1 Section 2.4 of the IOA GPG includes information on the type and specification of noise monitoring equipment which should be used for background noise surveys and states:

'Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances.'

5.3.2 The noise monitoring equipment used for the background noise survey meets with the requirements of the IOA GPG. Details of the noise monitoring equipment used, the calibration drift recorded and photographs at each NML are detailed in the FDS included in Annex 3. The IOA GPG states that for calibration drift greater than 1 dB the measurements should be discarded. The maximum calibration drift recorded during the noise survey was -0.4 dB as detailed in the FDS (included in Annex 3).

5.3.3 Copies of the calibration/conformance certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 4. All sound level meters conform to Class 1/ Type 1.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *'in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), where appropriate, away from obvious local sources of noise such as boiler flues, fans and running water. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 All measurement systems were set to log the L_{A90} and L_{Aeq} noise levels over the required ten-minute intervals continuously over the deployment period.

5.4 Meteorological Data

5.4.1 ETSU-R-97 states on Page 84 that:

'background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that the actual operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.'

5.4.2 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.3.3.

5.4.3 For the Proposed Development, concurrent wind speed/direction were recorded using a LiDAR unit which was located within the Site (grid reference 271523, 598774). The meteorological data was collected, processed, and provided by the Applicant. The installation report and calibration information for the LiDAR can be provided upon request.

5.4.4 Tipping bucket rain gauges were installed at NML2 and NML3 for the duration of the noise survey to record periods of rainfall, time synchronised to the sound measurements. Rain data were collected by TNEI. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were analysed by TNEI and the 10-minute periods which contain the registered rainfall events and the preceding 10-minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-c (Annex 1) as blue squares.

5.4.5 Wind speed and direction data were collected over the same timescale and averaged over the same ten-minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

5.4.6 In accordance with the IOA GPG, methodology A, has been adopted for this assessment which involved using data collected directly at 120 m on the LiDAR (hub height used to derive the noise limits) which were then standardised to a height of 10 m above the ground.

Rain Data Exclusions

5.4.7 The overall soundscape at NML1 is affected by the nearby watercourse (Shinnel Water). At NML1 the noise monitoring equipment was installed to the north of the property, within the amenity area, to maximise distance to Shinnel Water located to the south of the property. There was also a small hydroelectric generator located along Shinnel Water, both of which was audible at the time of installation. Therefore, it was deemed that whilst the background noise measurements undertaken at NML1 were representative for this receptor, they would not be used for any other receptors.

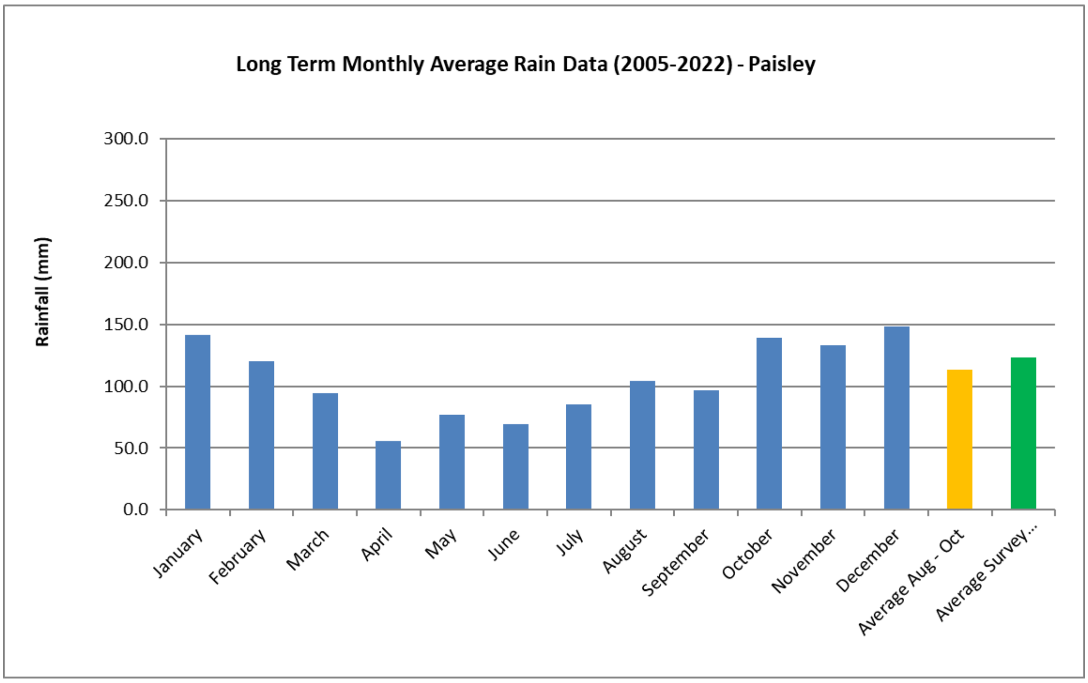
5.4.8 At NML3, there was also a watercourse located to the south of the property. It was noted as faintly audible during some of the visits to this location.

5.4.9 The impacts of rainfall are discussed in SGN2 of the IOA GPG (Section 2.4). Section 2.4.1 of SGN2 states that:

‘if the rainfall and resulting watercourse flows are atypical then it may be appropriate to remove the data.’ However, Section 2.4.2 states that ‘at some locations, the background noise environment will be dominated by noise from watercourses and the data may therefore show little correlation with wind speed. In such circumstances data filtering may not be necessary, this can sometimes be supported by using long term rain data for the area to show that rain fall during the survey period.’

5.4.10 During the survey there were some periods of rainfall, with some apparent lagging in the data following a rainfall event. Although this is part of the natural variation at the receptors after a period of rainfall throughout the year, manual exclusions or filtering of the data was undertaken to remove periods, using data measured from the rain gauge, where short term increases in noise were apparent. To ensure that the level of rain measured during the monitoring period was representative of the long term rainfall, TNEI also reviewed the rain data collected at the closest weather stations to the site. As per Figure 5 of SGN 2 the long term rain data from these weather station was compared with the data collected during the background noise survey and, as can be seen on the graph below, the rainfall data collected during the survey months appears to slightly above the average for August – October collected from 2005 to 2022.

Graph 5.1: Long Term Monthly Average Rain Data (2005-2022)



5.4.11 The exclusions are shown as manual exclusions for NML1 on Figure A1.2a and as filtered data for NML3 on Figure 1.2c. The filtering applied at NML3 is discussed in further detail below. These exclusions are in addition to those made in accordance with recommendations within the IOA GPG which are discussed in Section 5.4.4 above.

Influence of Existing Turbines on Background Measurements

5.4.12 ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise. The IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise, the following approaches can be adopted:

1. The existing wind turbines can be switched off (assuming the applicant has control of those turbines and noting that there would be associated cost implications);
2. The contribution of the wind turbines can be accounted for by filtering the measured data by direction (only including background data when a receptor is upwind of the wind turbines) or by subtracting predicted turbine noise from the measured levels;
3. Limits can be set using 'proxy' datasets measured at location(s) outside of the influence of the wind turbines; or
4. Limits can be set using data collected as part of previous background noise assessments undertaken before the wind turbines were operational, providing the equipment and both noise and meteorological data obtained are appropriate.

5.4.13 Choosing NMLs in this area was complex because there was the potential for the measured levels to be influenced by wind turbine noise from a number of operational wind farms in proximity to the Proposed Development. The operational wind farms, and their respective distances from the Proposed development, are noted as follows: Wether Hill (3.54 km southwest), Whiteside Hill (5.75 km north), Afton (7.72 km northwest), Windy Rig (7.82 km east), Sanquhar Community Wind Farm (8.2 km north), and Twentyshilling Hill (8.34 km northeast).

5.4.14 To ensure that the influence of any operational wind turbine noise was appropriately considered, the Total Noise measurements at all three NMLs were adjusted by subtracting the predicted wind turbine noise levels (for each ten-minute period) from the noise level measured at each NML (as referenced in Section 5.2.3 of the IOA GPG) to obtain the Calculated Background Noise Levels. This procedure was only applied to datapoints which had not been excluded due to directional filtering, rainfall, manual exclusions, or otherwise. Where predicted operational turbine noise levels were equal to, or greater than, the measured Total Noise levels, it was not possible to undertake this correction and, in this case, it has been assumed that the Calculated Background Noise levels were 10 dB below the measured value. In practice this is considered a cautious approach which results in the calculation of cautious prevailing background noise levels.

5.4.15 The resultant directivity attenuation of the predicted operational turbine noise immission levels at NML1 and NML2 were such that it was not appropriate to undertake directional filtering. However, at NML3, the predominant contributor to predicted operational turbine noise immission levels was Wether Hill. Therefore, directional filtering, in combination with the subtraction method, was used to derive the prevailing background noise levels. The filter angle was selected as a 180° arc such that any Total Noise measurements obtained when the wind direction was between 120° - 300° were excluded from the regression analysis.

5.4.16 The results of this analysis are available on Figures A1.2a-c.

5.5 Directional Filtering of Background Noise

5.5.1 In Section 3.1.22 of the IOA GPG the need to directionally filter background noise data is discussed. Where a receiver is located upwind of a dominant local noise source whilst also being systematically downwind of the turbines then it may be necessary to filter background noise data particularly when this corresponds to the prevailing wind direction.

5.5.2 Directional filtering of background noise was undertaken at NML3 to filter out potential noise from Wether Hill as discussed in 5.4.15 above. No other directional filtering for other extraneous noise sources was required.

5.6 Analysis of Measured Data

5.6.1 Analysis of the measured data has been undertaken in accordance with the recommendations in ETSU-R-97 and the IOA GPG.

5.6.2 Meteorological data was screened upon receipt by TNEI and where rainfall occurred, the noise and wind speed data has been excluded from the assessment as detailed in Section 5.4 above.

5.6.3 Time series graphs are provided in Annex 5, which show the variation in measured wind speed/direction and noise level over the monitoring period. These graphs also show where data was excluded, either due to rainfall, birdsong or manual exclusions due to atypical data.

5.7 Prevailing Background Noise Level

5.7.1 Table 5.2 and Table 5.3 summarise the prevailing background noise levels measured during the noise monitoring period, after filtering of the individual datasets as discussed above.

Table 5.2 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods ($L_{A90,10\ min}$ dB(A))

NML	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 – Shinnelhead	26.8*	26.8*	26.8	27.3	28.4	29.9	31.7	33.6	35.5	37.3	39.0	40.3
NML2 – High Appin	23.4	23.7	24.2	25.1	26.2	27.4	28.8	30.2	31.6	33.0	34.4	35.5
NML3 – Blairoch	26.1	27.0	28.0	29.0	30.1	31.1	32.3	33.4	34.6	35.8	37.0	38.3

* Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Sections 5.7.4 and 5.7.6.

Table 5.3 Summary of Prevailing Background Noise Levels during Night-time Periods ($L_{A90,10\ min}$ dB(A))

NML	Wind Speed (ms-1) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 – Shinnelhead	25.5*	25.5*	25.5*	25.5	26.0	26.8	28.0	29.6	31.5	33.7	36.1	38.8
NML2 – High Appin	23.0*	23.0*	23.0	23.4	24.4	25.7	27.3	29.1	30.9	32.7	34.3	35.6
NML3 – Blairoch	26.9*	26.9	27.1	27.5	28.2	29.0	30.0	31.2	32.5	33.8	35.2	36.7

* Flatlined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Sections 5.7.4 and 5.7.6

5.7.2 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a-c (Annex 1). There is a set of graphs for each of the NMLs, which show the range of wind speeds and directions recorded during the survey by the LIDAR and the 10-minute average wind speeds plotted against the recorded $L_{A90,\ 10min}$ noise levels at the NML along with a calculated 'best fit' polynomial regression line for the quiet daytime and night-time periods. Each Figure also includes a table with the number of recorded data points per integer wind speed bin and the prevailing measured background noise levels.

5.7.3 The prevailing measured background noise levels have been calculated using a best fit polynomial regression line of no more than a fourth order through the measured $L_{A90,\ 10min}$ noise data, as required by ETSU-R-97 and the IOA GPG.

5.7.4 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low-speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. This is presented on the figures; the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit through the data is shown as a dashed black line.

5.7.5 Section 2.9.5 of the IOA GPG recommends that no fewer than 200 valid data points should be recorded in each of the quiet daytime and night-time periods, with no fewer than 5 valid data points in any 1 ms^{-1} wind speed bin. Where the background noise data has been filtered by wind direction the IOA GPG (Section 2.9.6) recommends that 100 data points and 3 per wind speed bin may be appropriate. Where the minimum number of data points in a wind speed bin was not achieved, data in that bin has been manually excluded from the assessment.

5.7.6 ETSU-R-97 states (Page 101) that data may not be extrapolated beyond the measured range of wind speeds. It is however reasonable to assume that background noise levels will not decrease at higher wind speeds. As such, in the interest of protecting residential amenity, the noise levels for higher wind speeds where data has not been collected have been set equal to those derived for lower wind speeds as set out below (as per Section 3.1.20 of the IOA GPG).

5.7.7 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.4 below.

Table 5.4 Analysis of Measured Datasets

NML	Quiet Daytime	Night Time
NML1 – Shinnelhead	Flatlined below 3 ms^{-1} (minimum level recorded).	Flatlined below 4 ms^{-1} (minimum level recorded).
NML2 – High Appin	Not flatlined at any wind speed due to sufficient datapoints in each wind speed bin.	Flatlined below 3 ms^{-1} (minimum level recorded).
NML3 – Blairoch	Not flatlined at any wind speed due to sufficient datapoints in each wind speed bin.	Flatlined below 2 ms^{-1} (minimum level recorded).

5.7.8 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a-c (Annex 1). The Figures also show the final prevailing background noise levels which have been determined following the analysis detailed above.

6 Noise Assessment Results

6.1 Noise Assessment Locations

6.1.1 Noise Assessment Locations (NAL) refer to the position on the curtilage denoted by the blue house symbol on Figure A1.1a-b (Annex 1). A total of thirteen noise sensitive receptors were chosen as representative NALs. The NALs chosen were the closest receptors to the Proposed Development. Predictions of wind turbine noise have been made at each of the NAL as detailed in Table 6.1. All NALs listed below, except NAL13, are inhabited.

6.1.2 This approach ensures that the report models the worst case (highest) noise immission level expected at each group of noise sensitive receptors, as, generally speaking, sound levels decrease due to the attenuating factors described in Section 6.2.2 and thus the closer to a noise source, the higher the noise level. Table 6.1 details which NML has been used to determine noise limits for each NAL.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting	Northing	Elevation (m AOD)	Approximate Distance to Nearest Appin Turbine* (m)	Background Noise Data Used
NAL1 - Shinnelhead	272939	599143	280	1,663 (T1)	NML1
NAL2 - High Appin	274653	597276	258	2,091 (T9)	NML2
NAL3 - Appin Lodge	275249	597409	219	2,690 (T9)	NML2
NAL4 - High Auchenbrack	275704	597132	208	3,035 (T9)	NML2
NAL5 - Kilnmark	276068	596512	205	3,307 (T9)	NML2
NAL6 - Auchenbrack	276625	596515	193	3,863 (T9)	NML2
NAL7 - Kirkconnel	276321	594505	223	4,021 (T9)	NML2
NAL8 - Dalwhat Farm Cottage	273814	593359	179	3,198 (T9)	NML3
NAL9 - Corriedow	272118	593813	200	2,647 (T9)	NML3
NAL10 - Glenjaan	271669	594245	205	2,399 (T9)	NML3
NAL11 - Benbuie	271065	596125	227	1,370 (T7)	NML3
NAL12 - Blairoch Cairnhead	270713	596545	237	1,250 (T5)	NML3
NAL13 – Cairnhead (Bothy)	270144	597209	299	1130 (T4)	NML3

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden).*

6.1.3 TNEI understand that the building known as Cairnhead to the north west of Blairoch Cairnhead is inhabitable and has therefore not been considered as a noise sensitive receptor.

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the Proposed Development. This assessment considers the Vestas V162, 7.2 MW with serrated blades and a hub height of 119 m.

6.2.2 The turbines considered in the cumulative assessment are summarised in Annex 6. Details of the sound power level, octave data and measurement uncertainty used for the turbines considered in this assessment are included in Annex 7. The data for the candidate turbine used in this assessment and for modelling some of the other nearby schemes has not been included due to data confidentiality. The detailed noise data would be available upon request subject to the signing of the appropriate Non-Disclosure Agreement. Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG.

6.2.3 Manufacturer data is usually supplied based on a specific hub height whilst values are presented as standardised to 10 m height. The noise model used in this assessment alters turbine noise data to account for different hub heights, where applicable. The hub height modelled for the Proposed Development is 119 m. The hub heights considered for the other wind farm/turbine developments are summarised in Annex 6.

6.2.4 The location of the wind turbines are shown on Figure A1.1a-b and grid references are included in Annex 6.

6.3 Noise Propagation Parameters

6.3.1 As detailed in Section 4.4 above, the full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors.

6.3.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4.0 m above local ground level, mixed ground (G=0.5) and air absorption co-efficients based on a temperature of 10 °C and 70 % relative humidity to provide a realistic impact assessment. The modelling parameters reflect current good practice as detailed within the IOA GPG.

6.3.3 The wind turbine noise immission levels are based on the $L_{A90,10\ minute}$ noise indicator in accordance with the recommendations in ETSU-R-97, which were obtained by subtracting 2 dB(A) from the turbine sound power level data (L_{Aeq} indicator).

6.3.4 A topographical assessment has been undertaken between each noise sensitive receptor and wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA [(22)] and an Excel model found that if the formula in the IOA GPG is applied directly a +3 dB correction is required for some turbines at a number of receptors as summarised in Annex 6.

6.3.5 In addition, an assessment has been undertaken to determine whether any topographical screening effects of the terrain occur where there is no direct line of sight between the highest point on the turbine rotor and the receiver location. Upon analysis of each noise sensitive receptor it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors as detailed in Annex 6. In reality, there is significant screening at some of the locations so more attenuation may occur in practice, the use of a 2 dB value is therefore considered to be conservative as it results in the highest predicted levels. All corrections have been applied, where necessary, in all of the Tables and Graphs in this report.

6.3.6 The need to include a concave ground/screening correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits detailed in planning conditions regardless of any difference in noise propagation caused by topography. Should consent be granted, the need to apply a concave slope correction will need to be considered by the Applicant prior to the final selection of a turbine model for the Proposed Development.

6.3.7 The cumulative assessment has taken into account directivity effects in line with good practice. The directivity of wind turbines has been recognised for some time. Building on earlier work by NASA, in 1988 Wyle Laboratories studied sound propagation using an omnidirectional loudspeaker source elevated 80 ft above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

6.3.8 Hubbard (1990) (IOA GPG Section 4.4.3) described a number of factors believed to influence propagation and directivity, notably refraction caused by vertical wind and temperature gradients. In the downwind direction the wind gradient causes the sound rays to bend toward the ground, whereas in the upwind direction the rays curve upward away from the ground. Upwind of the turbine this results in a region of increased attenuation termed the ‘shadow zone’. The excess attenuation is frequency dependent, with lowest frequencies least attenuated. Relating this to the earlier NASA studies, Hubbard noted that the distance from the source to the edge of the shadow zone is related to the wind speed gradient and the elevation of the source, which for a typical turbine source was calculated to be approximately 5 times the source height.

6.3.9 This observation was adopted in the IOA GPG, which states (Section 4.4.2) ‘Such reductions (due to “shadow zone” refraction effects) will in practice only progressively come into play at distances of between 5 and 10 turbine tip heights’, while Section 4.4.3 provides graphical examples of increasing broadband directivity with increasing tip height scaling in both flat and hilly terrain, without qualifying either of those designations.

6.3.10 The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The TNEI noise model can consider the effect of directivity, and in line with current good practice the attenuation values used are detailed in Table 6.2. These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required, to adopt a single attenuation value for receptors located more than 5 tip heights from a receiver.

Table 6.2 Wind Directivity Attenuation Factors used in Modelling

Direction (º)	0	15	30	45	60	75	90	105	120	135	150	165
Attenuation dB(A))	-10	-9.9	-9.3	-8.3	-6.7	-4.6	-2	0	0	0	0	0
Direction (º)	180	195	210	225	240	255	270	285	300	315	330	345
Attenuation (dB(A))	0	0	0	0	0	0	-2	-4.6	-6.7	-8.3	-9.3	-9.9

6.4 Total ETSU-R-97 Noise Limits (Stage 1)

6.4.1 The ETSU-R-97 noise limits are derived by establishing the 'best fit' correlation between background noise level and wind speed. These limits, sometimes referred to as the 'criterion curve', are based on a level 5 dB(A) above this best fit correlation curve, over a wind speed range from 0 to 12 ms^{-1}. Where the derived criterion curve for the daytime period lies below a fixed level in the range 35 – 40 dB(A) then ETSU-R-97 states that the criterion curve may be set at an absolute level somewhere within that range.

6.4.2 When considering the cumulative impacts of the Proposed Development operating in conjunction with other operational, consented and proposed schemes a Fixed Minimum Limit of 40 dB was adopted to establish the daytime Total ETSU-R-97 Noise Limit. This limit was chosen following a review of the noise limits allocated or proposed for nearby wind farms and with due regard to the guidance in ETSU-R-97.

6.4.3 Whilst a cumulative daytime Total ETSU-R-97 Noise Limit of 40 dB (or background noise plus 5 dB) is proposed, the Proposed Developments Site Specific Noise Limit has been set such that it never exceeds 35 dB (or background noise plus 5 dB whichever is the greater); this represents the lower end of the daytime limit that can be applied under in ETSU-R-97.

6.4.4 The Total ETSU-R-97 Noise Limits have been established for each of the NALs as detailed in Table 6.3 and Table 6.4 below, based on a fixed minimum of 40dB(A) (daytime) or 43 dB(A) (Night time) or background plus 5 dB(A).

Table 6.3 Total ETSU-R-97 Noise Limits Daytime

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5	42.3	44.0	45.3
NAL2 - High Appin	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL3 - Appin Lodge	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL4 - High Auchenbrack	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL5 - Kilnmark	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL6 - Auchenbrack	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL7 - Kirkconnel	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
NAL8 - Dalwhat Farm Cottage	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
NAL9 - Corriedow	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
NAL10 - Glenjaan	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
NAL11 - Benbuie	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
NAL12 - Blairoch Cairnhead	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
NAL13 – Cairnhead (Bothy)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3

Table 6.4 Total ETSU-R-97 Noise Limits Night-time

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
NAL2 - High Appin	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL3 - Appin Lodge	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL4 - High Auchenbrack	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL5 - Kilnmark	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL6 - Auchenbrack	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL7 - Kirkconnel	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL8 - Dalwhat Farm Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL9 - Corriedow	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL10 - Glenjaan	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL11 - Benbuie	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL12 - Blairoch Cairnhead	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL13 – Cairnhead (Bothy)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

6.5 Predicting the requirement for a cumulative assessment and the likely effects (Stage 2)

6.5.1 A comparison has been undertaken of the predicted wind turbine noise immission levels from the Proposed Development alongside all other schemes at each of the identified noise sensitive receptors in order to demonstrate whether predictions are within 10 dB of each other. All turbines have been assumed to be operating in full unconstrained mode. Table 6.5 below summarises the results and whether a cumulative noise assessment is required. As is detailed in Section 4.4 above, if the predictions are greater than 10 dB apart then a cumulative noise assessment is not required. Where predictions are found to be within 10 dB of each other a cumulative assessment is required.

Table 6.5 Cumulative Assessment Requirement

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Is a cumulative assessment required?
NAL1 - Shinnelhead	YES	YES
NAL2 - High Appin	YES	YES
NAL3 - Appin Lodge	YES	YES
NAL4 - High Auchenbrack	YES	YES
NAL5 - Kilnmark	YES	YES
NAL6 - Auchenbrack	YES	YES
NAL7 - Kirkconnel	YES	YES
NAL8 - Dalwhat Farm Cottage	YES	YES
NAL9 - Corriedow	YES	YES
NAL10 - Glenjaan	YES	YES
NAL11 - Benbuie	YES	YES
NAL12 - Blairoch Cairnhead	YES	YES
NAL13 – Cairnhead (Bothy)	YES	YES

6.5.2 As summarised in Table 6.5, predicted turbine noise was within 10 dB of existing turbine noise at all NALs. A cumulative assessment was undertaken at all NALs. A detailed list of all of the wind farms/ wind turbine developments considered in the noise predictions are included in Table A6.1 of Annex 6. In addition, a summary of the noise prediction comparisons are included as Table A6.3 of Annex 6.

6.5.3 The results of the cumulative assessment are summarised in tabular form in Table 6.6 and Table 6.7. The results show that the predicted cumulative wind turbine noise immission levels meet the Total ETSU-R-97 Noise limits under all conditions at all NALs. The predicted 'likely' cumulative levels are the actual levels expected at an NAL and include the addition of an appropriate level of uncertainty to the turbine data as per Section 4.2 of the IOA GPG. The uncertainty level added is generally +2 dB but this can vary depending on the turbine manufacturer data available for each turbine.

6.5.4 Figures A1.3a-m (Annex 1) show predictions from the Proposed Development and 'cumulative (including Proposed Development)' against the 'Total ETSU-R-97 Noise Limits'. The individual contribution of the cumulative schemes are also shown.

Table 6.6 ETSU-R-97 Compliance Table – Likely Cumulative Noise - Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5	42.3	44.0	45.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	34.9	38.3	39.3	39.3*	39.3*	39.3*	39.3*	39.3*
	Exceedance Level	-	-	-	-9.2	-5.1	-1.7	-0.7	-0.7	-1.2	-3.0	-4.7	-6.0
NAL2 - High Appin	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.9	34.3	35.6	35.6	35.7	35.7	35.7	35.7
	Exceedance Level	-	-	-	-12.6	-9.1	-5.7	-4.4	-4.4	-4.3	-4.3	-4.3	-4.8
NAL3 – Appin Lodge	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.5	33.7	33.8	33.8	33.9	33.9	33.9
	Exceedance Level	-	-	-	-14.4	-10.8	-7.5	-6.3	-6.2	-6.2	-6.1	-6.1	-6.6
NAL4 – High Auchenbrack	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.4	32.6	32.7	32.7	32.8	32.8	32.8
	Exceedance Level	-	-	-	-15.5	-11.9	-8.6	-7.4	-7.3	-7.3	-7.2	-7.2	-7.7
NAL5 - Kilnmark	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.0	26.5	29.7	30.9	30.9	31.0	31.1	31.1	31.1
	Exceedance Level	-	-	-	-17.0	-13.5	-10.3	-9.1	-9.1	-9.0	-8.9	-8.9	-9.4
NAL6 - Auchenbrack	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	22.4	25.8	29.1	30.3	30.3	30.4	30.5	30.5	30.5
	Exceedance Level	-	-	-	-17.6	-14.2	-10.9	-9.7	-9.7	-9.6	-9.5	-9.5	-10.0
NAL7 - Kirkconnel	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.0	25.2	27.6	28.6	28.8	29.2	29.6	29.6	29.6
	Exceedance Level	-	-	-	-17.0	-14.8	-12.4	-11.4	-11.2	-10.8	-10.4	-10.4	-10.9

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8 – Dalwhat Farm Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.6	27.6	29.7	30.6	30.8	31.2	31.8	31.8	31.8
	Exceedance Level	-	-	-	-14.4	-12.4	-10.3	-9.4	-9.2	-8.8	-9.0	-10.2	-11.5
NAL9 - Corriedow	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.2	30.3	32.4	33.2	33.4	33.8	34.4	34.4	34.4
	Exceedance Level	-	-	-	-11.8	-9.7	-7.6	-6.8	-6.6	-6.2	-6.4	-7.6	-8.9
NAL10 - Glenjaan	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	31.8	33.7	34.5	34.7	35.2	35.8	35.8	35.8
	Exceedance Level	-	-	-	-10.1	-8.2	-6.3	-5.5	-5.3	-4.8	-5.0	-6.2	-7.5
NAL11 – Benbuie	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	32.6	35.8	37.2	37.2	37.2	37.3	37.3	37.3
	Exceedance Level	-	-	-	-10.9	-7.4	-4.2	-2.8	-2.8	-2.8	-3.5	-4.7	-6.0
NAL12 – Blairoch Cairnhead	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.7	33.3	36.6	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-10.3	-6.7	-3.4	-2.0	-2.0	-2.0	-2.8	-4.0	-5.3
NAL13 – Cairnhead (Bothy)	Total Noise Limit: ETSU-R-97 L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.8	42.0	43.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.2	33.8	37.0	38.3	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-9.8	-6.2	-3.0	-1.7	-1.6	-1.6	-2.4	-3.6	-4.9

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 4 ms^{-1} therefore no cumulative predictions are included for wind speeds less than 4 ms^{-1}.

**Mitigation applied to the Proposed Development (see Section 6.6.7 below for further information)*

Table 6.7 ETSU-R-97 Compliance Table – Likely Cumulative Noise – Night-time

Location		Wind Speed (ms-1) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	34.9	38.3	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.2	-8.1	-4.7	-3.7	-3.6	-3.6	-3.6	-3.6	-4.4
NAL2 - High Appin	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.9	34.3	35.6	35.6	35.7	35.7	35.7	35.7
	Exceedance Level	-	-	-	-15.6	-12.1	-8.7	-7.4	-7.4	-7.3	-7.3	-7.3	-7.3
NAL3 – Appin Lodge	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.5	33.7	33.8	33.8	33.9	33.9	33.9
	Exceedance Level	-	-	-	-17.4	-13.8	-10.5	-9.3	-9.2	-9.2	-9.1	-9.1	-9.1
NAL4 – High Auchenbrack	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.4	32.6	32.7	32.7	32.8	32.8	32.8
	Exceedance Level	-	-	-	-18.5	-14.9	-11.6	-10.4	-10.3	-10.3	-10.2	-10.2	-10.2
NAL5 - Kilnmark	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.0	26.5	29.7	30.9	30.9	31.0	31.1	31.1	31.1
	Exceedance Level	-	-	-	-20.0	-16.5	-13.3	-12.1	-12.1	-12.0	-11.9	-11.9	-11.9
NAL6 - Auchenbrack	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	22.4	25.8	29.1	30.3	30.3	30.4	30.5	30.5	30.5
	Exceedance Level	-	-	-	-20.6	-17.2	-13.9	-12.7	-12.7	-12.6	-12.5	-12.5	-12.5
NAL7 - Kirkconnel	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.0	25.2	27.6	28.6	28.8	29.2	29.6	29.6	29.6
	Exceedance Level	-	-	-	-20.0	-17.8	-15.4	-14.4	-14.2	-13.8	-13.4	-13.4	-13.4

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8 – Dalwhat Farm Cottage	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.6	27.6	29.7	30.6	30.8	31.2	31.8	31.8	31.8
	Exceedance Level	-	-	-	-17.4	-15.4	-13.3	-12.4	-12.2	-11.8	-11.2	-11.2	-11.2
NAL9 - Corriedow	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.2	30.3	32.4	33.2	33.4	33.8	34.4	34.4	34.4
	Exceedance Level	-	-	-	-14.8	-12.7	-10.6	-9.8	-9.6	-9.2	-8.6	-8.6	-8.6
NAL10 - Glenjaan	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	31.8	33.7	34.5	34.7	35.2	35.8	35.8	35.8
	Exceedance Level	-	-	-	-13.1	-11.2	-9.3	-8.5	-8.3	-7.8	-7.2	-7.2	-7.2
NAL11 – Benbuie	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	32.6	35.8	37.2	37.2	37.2	37.3	37.3	37.3
	Exceedance Level	-	-	-	-13.9	-10.4	-7.2	-5.8	-5.8	-5.8	-5.7	-5.7	-5.7
NAL12 – Blairoch Cairnhead	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.7	33.3	36.6	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-13.3	-9.7	-6.4	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
NAL13 – Cairnhead (Bothy)	Total Noise Limit: ETSU-R-97 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.2	33.8	37.0	38.3	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-12.8	-9.2	-6.0	-4.7	-4.6	-4.6	-4.6	-4.6	-4.6

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 4 ms^{-1} therefore no cumulative predictions are included for wind speeds less than 4 ms^{-1}.

6.6 Derivation of Site Specific Noise Limits (Stage 3)

6.6.1 In order to protect residential amenity, the IOA GPG (2013) recommendations are that cumulatively, all schemes operate within the Total ETSU-R-97 Noise Limits. This can be found in summary box SB21 of the IOA GPG (2013) which states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

6.6.2 As detailed in Section 4.3.6 above, the daytime Site Specific Noise Limits (SSNLs) have been derived based on the lower Fixed Minimum Noise Limits as detailed within ETSU-R-97. This assumes that all consented/ in planning turbines are built and that the operational turbines continue to operate for the lifetime of their consent.

6.6.3 The apportionment options provided in the IOA GPG were considered to determine the most appropriate option for each NAL. Site Specific Noise Limits have been derived for each of the noise sensitive receptors considered within Table 6.1 above. Table 6.8 below summarises the approach adopted at each NAL in order to derive the Site Specific Noise Limits for the Proposed Development.

Table 6.8 Limit Derivation Strategy

NAL	Limit Derivation Strategy

NAL1	The likely predictions level from other schemes were found to be within 5 dB of the Total ETSU-R-97 Noise Limits at certain wind speeds during both day and night-time periods. As such, the Site Specific Noise Limit at these wind speeds was derived to be 10 dB below the Total ETSU-R-97 Noise Limit.
	
	At wind speeds where the predicted cumulative noise (excluding the Proposed Development) was >5 dB below the Total ETSU-R-97 Noise Limit, significant headroom was available. In accordance with Section 4.5 above, a 2 dB buffer was therefore added to the turbine noise predictions for each of the other developments; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60 % increase in emitted noise levels from the other schemes.
	
	The resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual noise limit'.
	
	The Site Specific Noise Limits were derived as follows:
	• When significant headroom is not available, the Site Specific Noise Limit were derived to be 10 dB below the Total ETSU-R-97 Noise Limit.
	• When significant headroom is available, the Site Specific Noise Limits were then determined by taking the lowest of either:
	    o The residual noise limit; or
	    o Background noise plus 5 dB or the daytime FML of 35 dB (whichever is greater).

<table>
<tr><th>NAL</th><th>Limit Derivation Strategy</th></tr>
<tr><td>NALs 2 – 4, 8 - 13</td><td>The likely predictions from other schemes were found to be within 10 dB of the Total ETSU-R-97 Noise Limits. As such, the limit has been apportioned based on a cautious prediction of cumulative turbine noise.

The noise predictions for the other cumulative schemes show that there is, in theory, significant headroom between the likely predicted levels and the Total ETSU-R-97 Noise Limit (>5 dB). In accordance with Section 4.5 above, a 2 dB buffer was therefore added to the turbine noise predictions for each of the other developments; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60 % increase in emitted noise levels from the other schemes.

The resulting ‘cautious’ predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the ‘residual noise limit’.

The Site Specific Noise Limits were then determined as follows:
• The night-time limit is set to the residual noise limit.
• The daytime noise limit is determined by taking the lowest of either:
    o The residual noise limit; or
    o Background noise plus 5 dB or the daytime fixed minimum limit of 35 dB (whichever is greater).</td></tr>
<tr><td>NALs 5 – 7</td><td>The likely predictions level from other schemes were found to be greater than 10 dB below the Total ETSU-R-97 Noise Limits. As such, the whole limit has been allocated to the Proposed Development.</td></tr>
</table>

6.6.4 Please note the buffers detailed above are in addition to the appropriate level of uncertainty already added to the turbine data as per Section 4.2 of the IOA GPG.

6.6.5 As summarised in Table 6.8 above, it is proposed that the full ETSU-R-97 noise limits be allocated to the Proposed Development at three of the NALs (NAL5 - 7), as the other schemes do not need a portion of the limit. For the remaining NALs, apportionment was required in order to allow the Proposed Development and the other wind farm developments to co-exist within the Total ETSU-R-97 Noise Limits.

6.6.6 Table 6.9 and Table 6.10 show the daytime and night-time Site Specific Noise Limits, noise predictions for the Proposed Development and the exceedance level. A negative exceedance demonstrates compliance with the Site Specific Noise Limits.

6.6.7 The Tables show that the predicted wind turbine noise immission levels assuming all turbines operate in full unconstrained mode meet the limits at all receptors except at NAL1, where an exceedance ranging from 0.7 dB to 3 dB was predicted between 6 ms^{-1} and 10 ms^{-1} during the daytime. Predicted noise levels have therefore been reduced to ensure that the limits are met, this would be achieved by the adoption of low noise modes, but this would only be required for a limited range of wind speeds and wind directions. To demonstrate that this level of reduction is practicable, predicted turbine noise at NAL1 during the daytime has been obtained assuming the following operational modes: T1 Mode SO5, T2 – T4 and T7 – T8 Mode SO1, T5 Mode SO2, T6 Mode SO3, and T9 Mode PO7200 (full mode).

6.6.8 The Tables show that, subject to the adoption of mitigation to ensure compliance, the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods.

6.6.9 A series of graphs to show the predicted wind turbine noise from the Proposed Development compared to the Site Specific Noise Limits are included as Figures A1.4a-m (Annex 1). There is a set of graphs for each of the NAL, which show the Total ETSU-R-97 Noise Limit (solid red line), the prevailing background noise level (black line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the Proposed Development (solid blue line). For NAL1 the reduced predicted turbine noise is demonstrated by the dashed blue line. It should be noted that at a number of locations the Total ETSU-R-97 Noise Limits are equal to the Site Specific Noise Limits so it can sometimes be difficult to distinguish between the two.

Table 6.9 Site Specific Noise Limits Compliance Table – Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	30.0	30.0	30.0	30.5	32.3	41.0	43.3
	Predicted Wind Turbine Noise L_{A90}	-	-	23.7*	25.5*	28.2*	29.7*	29.9*	29.9*	29.9*	29.9*	29.9*	29.9*
	Exceedance Level	-	-	-11.3	-9.5	-6.8	-0.3	-0.1	-0.1	-0.6	-2.4	-11.1	-13.4
NAL2 - High Appin	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	38.8	39.5
	Predicted Wind Turbine Noise L_{A90}	-	-	23.2	24.9	28.3	31.8	33.5	33.5	33.5	33.5	33.5	33.5
	Exceedance Level	-	-	-11.8	-10.1	-6.7	-3.2	-1.5	-1.7	-3.1	-4.5	-5.3	-6.0
NAL3 – Appin Lodge	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	38.9	39.6
	Predicted Wind Turbine Noise L_{A90}	-	-	20.0	21.7	25.1	28.6	30.3	30.3	30.3	30.3	30.3	30.3
	Exceedance Level	-	-	-15.0	-13.3	-9.9	-6.4	-4.7	-4.9	-6.3	-7.7	-8.6	-9.3
NAL4 – High Auchenbrack	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	39.2	40.5
	Predicted Wind Turbine Noise L_{A90}	-	-	19.2	20.9	24.3	27.8	29.5	29.5	29.5	29.5	29.5	29.5
	Exceedance Level	-	-	-15.8	-14.1	-10.7	-7.2	-5.5	-5.7	-7.1	-8.5	-9.7	-11.0
NAL5 - Kilnmark	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	39.4	40.5
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	18.5	21.9	25.4	27.0	27.0	27.0	27.0	27.0	27.0
	Exceedance Level	-	-	-18.3	-16.5	-13.1	-9.6	-8.0	-8.2	-9.6	-11.0	-12.4	-13.5
NAL6 - Auchenbrack	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	39.4	40.5
	Predicted Wind Turbine Noise L_{A90}	-	-	16.8	18.5	21.9	25.4	27.1	27.1	27.1	27.1	27.1	27.1
	Exceedance Level	-	-	-18.2	-16.5	-13.1	-9.6	-7.9	-8.1	-9.5	-10.9	-12.3	-13.4
NAL7 - Kirkconnel	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.6	38.0	39.4	40.5
	Predicted Wind Turbine Noise L_{A90}	-	-	13.7	15.5	18.9	22.4	24.0	24.0	24.0	24.0	24.0	24.0
	Exceedance Level	-	-	-21.3	-19.5	-16.1	-12.6	-11.0	-11.2	-12.6	-14.0	-15.4	-16.5

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8 – Dalwhat Farm Cottage	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	38.4	39.2	40.1	42.0	43.3
	Predicted Wind Turbine Noise L_{A90}	-	-	14.5	16.2	19.6	23.1	24.8	24.8	24.8	24.8	24.8	24.8
	Exceedance Level	-	-	-20.5	-18.8	-15.5	-13.0	-12.5	-13.6	-14.4	-15.3	-17.2	-18.5
NAL9 - Corriedow	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	38.4	38.5	39.4	41.0	42.6
	Predicted Wind Turbine Noise L_{A90}	-	-	17.4	19.2	22.6	26.1	27.7	27.7	27.7	27.7	27.7	27.7
	Exceedance Level	-	-	-17.6	-15.8	-12.5	-10.0	-9.6	-10.7	-10.8	-11.7	-13.3	-14.9
NAL10 - Glenjaan	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	38.2	37.7	38.6	40.4	42.2
	Predicted Wind Turbine Noise L_{A90}	-	-	19.0	20.8	24.2	27.7	29.3	29.3	29.3	29.3	29.3	29.3
	Exceedance Level	-	-	-16.0	-14.2	-10.9	-8.4	-8.0	-8.9	-8.4	-9.3	-11.1	-12.9
NAL11 – Benbuie	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	37.7	37.3	38.3	40.3	42.1
	Predicted Wind Turbine Noise L_{A90}	-	-	25.7	27.4	30.8	34.3	36.0	36.0	36.0	36.0	36.0	36.0
	Exceedance Level	-	-	-9.3	-7.6	-4.3	-1.8	-1.3	-1.7	-1.3	-2.3	-4.3	-6.1
NAL12 – Blairoch Cairnhead	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	38.0	37.7	38.8	40.6	42.3
	Predicted Wind Turbine Noise L_{A90}	-	-	26.6	28.4	31.8	35.3	36.9	36.9	36.9	36.9	36.9	36.9
	Exceedance Level	-	-	-8.4	-6.6	-3.3	-0.8	-0.4	-1.1	-0.8	-1.9	-3.7	-5.4
NAL13 – Cairnhead (Bothy)	Site Specific Noise Limit L_{A90}	35.0	35.0	35.0	35.0	35.1	36.1	37.3	37.3	37.1	38.3	40.3	42.1
	Predicted Wind Turbine Noise L_{A90}	-	-	26.4	28.1	31.5	35.0	36.7	36.7	36.7	36.7	36.7	36.7
	Exceedance Level	-	-	-8.6	-6.9	-3.6	-1.1	-0.6	-0.6	-0.4	-1.6	-3.6	-5.4

*Predicted noise levels inclusive of indicative mitigation.

Table 6.10 Site Specific Noise Limits Compliance Table – Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.9	40.0	33.0	33.0	33.0	33.0	33.0	33.8
	Predicted Wind Turbine Noise L_{A90}	-	-	22.7	24.4	27.8	31.3	33.0	33.0	33.0	33.0	33.0	33.0
	Exceedance Level	-	-	-20.3	-18.6	-14.1	-8.7	0.0	0.0	0.0	0.0	0.0	-0.8
NAL2 - High Appin	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	23.2	24.9	28.3	31.8	33.5	33.5	33.5	33.5	33.5	33.5
	Exceedance Level	-	-	-19.8	-18.1	-14.7	-11.2	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
NAL3 – Appin Lodge	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	20.0	21.7	25.1	28.6	30.3	30.3	30.3	30.3	30.3	30.3
	Exceedance Level	-	-	-23.0	-21.3	-17.9	-14.4	-12.7	-12.7	-12.7	-12.7	-12.7	-12.7
NAL4 – High Auchenbrack	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	19.2	20.9	24.3	27.8	29.5	29.5	29.5	29.5	29.5	29.5
	Exceedance Level	-	-	-23.8	-22.1	-18.7	-15.2	-13.5	-13.5	-13.5	-13.5	-13.5	-13.5
NAL5 - Kilnmark	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	18.5	21.9	25.4	27.0	27.0	27.0	27.0	27.0	27.0
	Exceedance Level	-	-	-26.3	-24.5	-21.1	-17.6	-16.0	-16.0	-16.0	-16.0	-16.0	-16.0
NAL6 - Auchenbrack	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	16.8	18.5	21.9	25.4	27.1	27.1	27.1	27.1	27.1	27.1
	Exceedance Level	-	-	-26.2	-24.5	-21.1	-17.6	-15.9	-15.9	-15.9	-15.9	-15.9	-15.9
NAL7 - Kirkconnel	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	13.7	15.5	18.9	22.4	24.0	24.0	24.0	24.0	24.0	24.0
	Exceedance Level	-	-	-29.3	-27.5	-24.1	-20.6	-19.0	-19.0	-19.0	-19.0	-19.0	-19.0

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL8 – Dalwhat Farm Cottage	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.5	16.2	19.6	23.1	24.8	24.8	24.8	24.8	24.8	24.8
	Exceedance Level	-	-	-28.5	-26.8	-23.4	-19.9	-18.2	-18.2	-18.2	-18.2	-18.2	-18.2
NAL9 - Corriedow	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	42.2	42.2	42.2
	Predicted Wind Turbine Noise L_{A90}	-	-	17.4	19.2	22.6	26.1	27.7	27.7	27.7	27.7	27.7	27.7
	Exceedance Level	-	-	-25.6	-23.8	-20.4	-16.9	-15.3	-15.3	-15.3	-14.5	-14.5	-14.5
NAL10 - Glenjaan	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.2	42.2	42.0	41.8	41.8	41.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.0	20.8	24.2	27.7	29.3	29.3	29.3	29.3	29.3	29.3
	Exceedance Level	-	-	-24.0	-22.2	-18.8	-15.3	-12.9	-12.9	-12.7	-12.5	-12.5	-12.5
NAL11 – Benbuie	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.2	42.1	42.0	41.9	41.7	41.7	41.7
	Predicted Wind Turbine Noise L_{A90}	-	-	25.7	27.4	30.8	34.3	36.0	36.0	36.0	36.0	36.0	36.0
	Exceedance Level	-	-	-17.3	-15.6	-12.2	-7.9	-6.1	-6.0	-5.9	-5.7	-5.7	-5.7
NAL12 – Blairoch Cairnhead	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.2	42.1	42.1	42.0	41.9	41.9	41.9
	Predicted Wind Turbine Noise L_{A90}	-	-	26.6	28.4	31.8	35.3	36.9	36.9	36.9	36.9	36.9	36.9
	Exceedance Level	-	-	-16.4	-14.6	-11.2	-6.9	-5.2	-5.2	-5.1	-5.0	-5.0	-5.0
NAL13 – Cairnhead (Bothy)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.0	41.9	41.8	41.8	41.7	41.7	41.7
	Predicted Wind Turbine Noise L_{A90}	-	-	26.4	28.1	31.5	35.0	36.7	36.7	36.7	36.7	36.7	36.7
	Exceedance Level	-	-	-16.6	-14.9	-11.5	-7.0	-5.2	-5.1	-5.1	-5.0	-5.0	-5.0

6.6.10 The assessment shows that the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods.

6.6.11 In the event that consent is granted for the Proposed Development it would be appropriate to set noise limits equal to the Site Specific Noise Limits contained Table 6.9 and Table 6.10.

6.7 Choice of Daytime Fixed Minimum Noise Limit (35 – 40 dB)

6.7.1 Having due regard to the guidance in ETSU-R-97 and considering the cumulative impacts of the Proposed Development operating in conjunction with other proposed, consented or operational schemes a fixed minimum limit of 40 dB has been adopted. This aligns with the approach adopted for the noise assessments for the consented Sanquhar II, among others. For Site Specific Noise Limits, the lowest Fixed Minimum Limit of 35 dB is proposed for daytime period.

6.7.2 If consent is granted for the Proposed Development it would be appropriate to set noise limits equal to the Site Specific Noise Limits contained within Table 6.9 and Table 6.10 which have been determined based on the use of a 40 dB daytime fixed minimum limit to set Total ETSU-R-97 Noise Limits and a 35 dB day time fixed minimum limit to set Site Specific Noise Limits. In the event that an alternative daytime fixed minimum limit is deemed appropriate new Site Specific Noise Limits would need to be calculated in accordance with the methodology presented in this report.

6.8 Micrositing

6.8.1 A 100 m micrositing distance is proposed. It should be noted that the need to include a concave ground profile correction and/or barrier correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits established in this report regardless of any increases and decreases in noise propagation caused by topography. Should consent be granted, the need to apply a concave ground profile/ barrier correction will need to be considered by the Applicant prior to the final selection of a turbine model for the site.

7 Summary and Conclusions

7.1.1 This report has assessed the potential impact of operational noise from the Proposed Development on the residents of nearby receptors. The guidance contained within ETSU-R-97 and current good practice (IOA GPG) has been used to assess the potential noise impact of the Proposed Development.

7.1.2 Background noise monitoring was undertaken by TNEI at three noise sensitive receptors neighbouring the Proposed Development. A total of thirteen noise sensitive receptors were chosen as Noise Assessment Locations. The assessment locations were chosen to represent the noise sensitive receptors located closest to the Proposed Development. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations considered representative of the expected background noise environment was used to assess the noise impact at those receptors.

7.1.3 Wind speed data was collected using a LiDAR unit located within the Proposed Development. The data collected at 120 m height (hub height used to derive the noise limits) were standardised to 10 m height, in accordance with current good practice.

7.1.4 Analysis of the measured data was undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits for each of the assessment locations. A Total ETSU-R-97 Noise Limit of 40 dB(A) daytime or background plus 5dB (whichever is the greater) and 43 dB(A) night-time or background plus 5dB (whichever is the greater) was used for this assessment.

7.1.5 There are a number of operational, consented and proposed (in planning) wind turbine developments in proximity to the Proposed Development. A cumulative assessment was undertaken where predicted levels from the Proposed Development were found to be within 10 dB of the predicted cumulative levels from other schemes in the area. The results show that the predicted cumulative wind farm noise immission levels would meet the Total ETSU-R-97 Noise Limits at all NALs during both the daytime and night-time periods subject to some mitigation being applied to the Proposed Development at NAL1 for certain wind speeds and directions as discussed below.

7.1.6 Site Specific Noise Limits have also been derived based on a daytime fixed minimum limit of 35 dB or background plus 5 dB and a night-time limit of 43 dB or background plus 5 dB. The limit derivation took account (where required) of the other consented and proposed (in planning) wind farms in the area. Where the noise immission from other wind farms at a given receptor were found to be at least 10 dB below the Total ETSU-R-97 Noise Limit; then the other wind farms would be using a negligible proportion of the limit. As such it is considered appropriate to allocate the entire noise limit to the Proposed Development. For receptors where turbine predictions were found to be within 10 dB of the Total ETSU-R-97 Noise Limits, apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with good practice.

7.1.7 An assessment was undertaken to determine whether the Proposed Development could operate within the Site Specific Noise Limits and it was found that at all receptors (excluding NAL1) wind turbine noise immission were below the Site Specific Noise Limits when considering the Vestas V162, 7.2 MW with serrated trailing edge blades as a candidate turbine.

7.1.8 At NAL1, an exceedance ranging from 0.7 dB to 3 dB was predicted between 6 ms^{-1} and 10 ms^{-1} during the daytime. Predicted noise levels have therefore been reduced to ensure that the Site Specific Noise Limits are met, this would be achieved by the adoption of low noise modes, but this would only be required for a limited range of wind speeds and wind directions.

7.1.9 There are a range of potential turbine models that could be installed on the site should consent be granted. When undertaking the modelling presented in this report TNEI has sought to adopt appropriate assumptions in terms of turbine models and dimensions, specifically:

- Topographical corrections have been considered in accordance with Section 5.3 of this report. Topographical blocking points have considered the highest candidate tip height (200 m), this is worst case as the model applies additional attenuation where the landform blocks line of sight between a turbine and a receptor. Consideration of concave ground profiles has considered the lowest hub height being considered (119 m) as this results in the greatest likelihood of concave ground corrections being calculated (which would increase the predicted levels).
- Sound power level data has been used for the Vestas V162, 7.2 MW with a hub height of 119 m and serrated trailing edge blades. This model is considered to be representative of the type of turbine that could be installed on the site.

7.1.10 There are a number of wind turbine makes and models that may be suitable for the Proposed Development. Should the proposal receive consent, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

8 Glossary of Terms

AOD: Above Ordnance Datum is the height above sea level.

Amplitude Modulation: a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past.

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

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

Bin: subset or group into which data can be sorted; in the case of wind speeds, bins are often centred on integer wind speeds with a width of 1 m/s. For example the 4 m/s bin would include all data with wind speeds of 3.5 to 4.5 m/s.

Dawn Chorus: noise due to birds which can occur at sunrise.

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

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

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

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

Directivity: the property of a sound source that causes more sound to be radiated in one direction than another.

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

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

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

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

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

L_{90}: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

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

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

Night-ime Hours: ETSU-R-97 defines the night time hours as 23.00 to 07.00 every day.

Quiet Daytime Hours: ETSU-R-97 defines the amenity hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.

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

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

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

Standardised Wind Speed: a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).

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

Wind Shear: the increase of wind speed with height above the ground.

9 References

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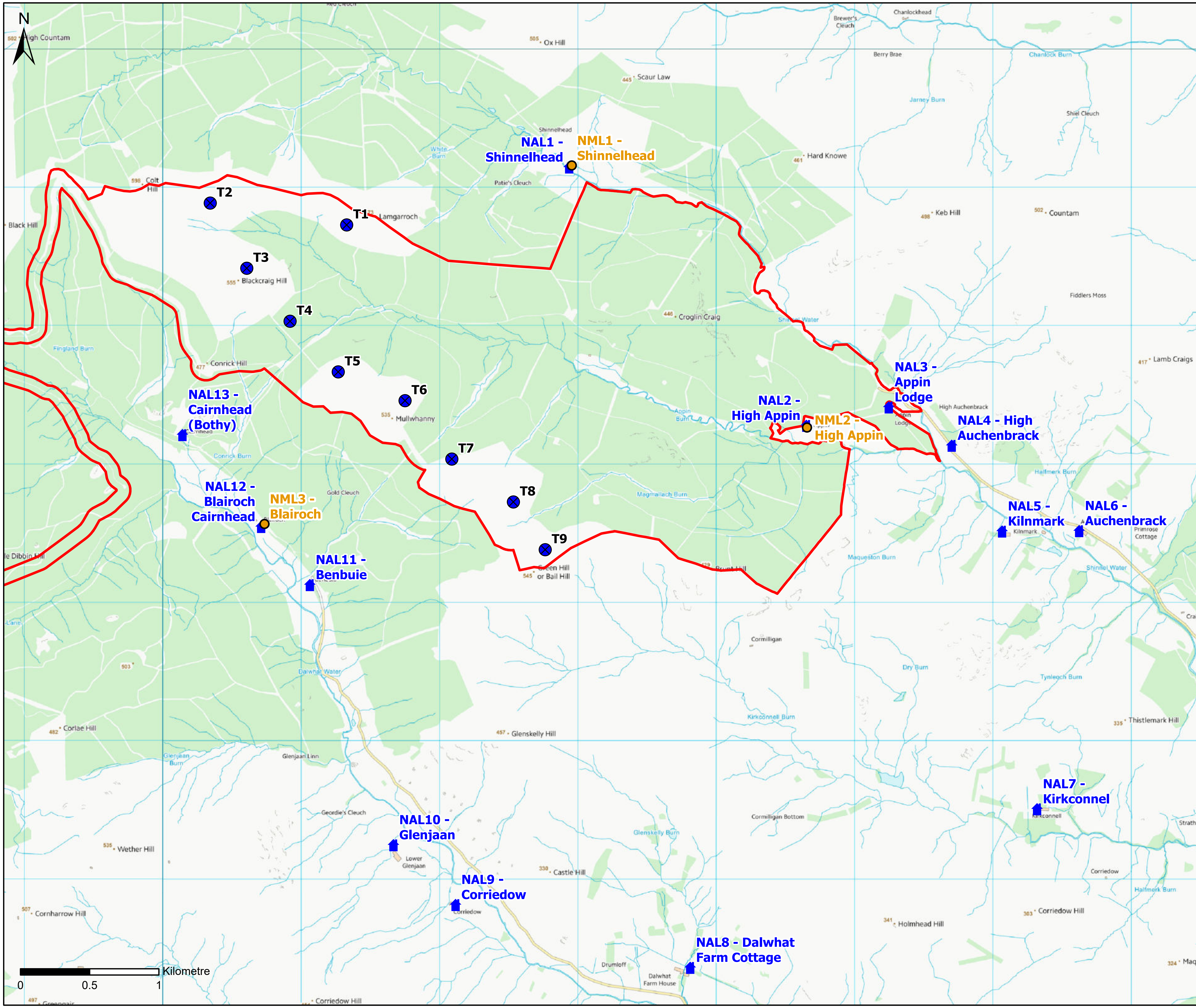
Annex 1 – Figures



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LEGEND

- Noise Monitoring Locations (NMLs)
- Noise Assessment Locations (NALs)
- Proposed Appin Wind Farm
- Red Line Boundary

Rev.	Date	Amendment Details	Drawn	Approved
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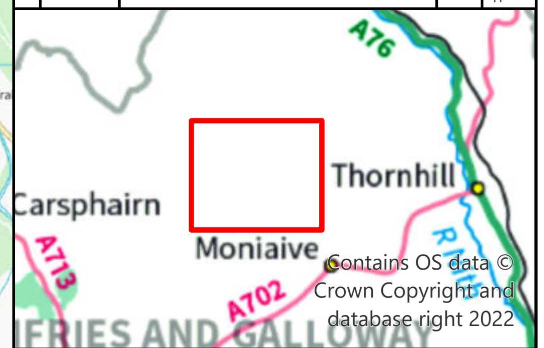

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Client: Statkraft

Drawing Status: FOR PLANNING

Project Title: APPIN WIND FARM

Drawing Title: FIGURE A1.1A: NOISE MONITORING AND ASSESSMENT LOCATIONS

Scale:	Original Size:	Spatial Reference:
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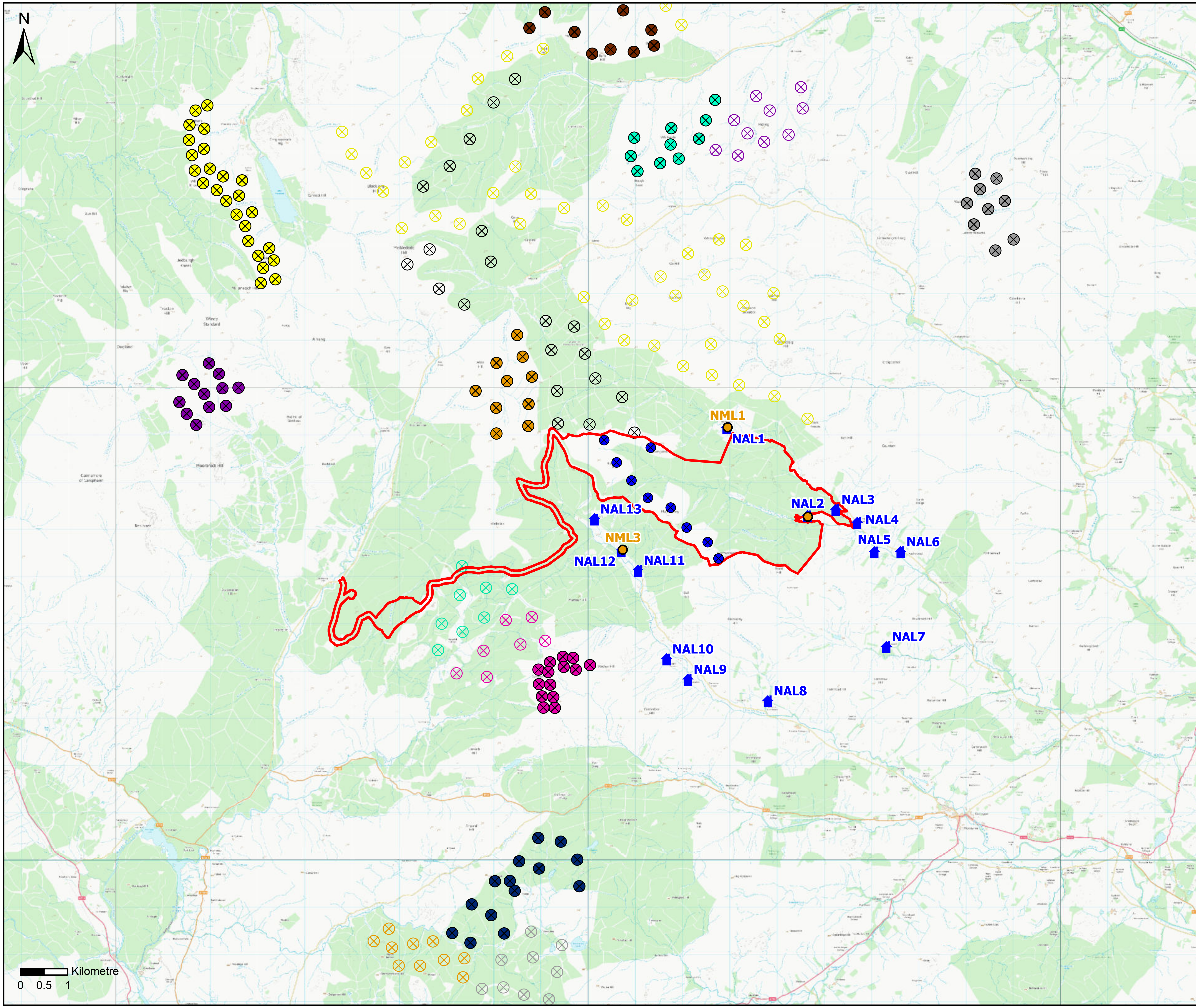
Drawing Number: 14711-014



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LEGEND

- Noise Monitoring Locations (NMLs)
- Noise Assessment Locations (NALs)
- Proposed Appin Wind Farm
- Red Line Boundary
- Afton
- Cornharrow
- Cloud Hill
- Euchanhead
- Glenshimmeroch
- Lorg
- Manquhill
- Margree
- Sanquhar Community Wind Farm
- Sanquhar II
- Troston Loch
- Twentyshilling
- Wether Hill
- Whiteside Hill
- Windy Rig

Rev.	Date	Amendment Details	Drawn	Approved
0	07/04/2025	FOR PLANNING	EH	AD

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Drawing Status: FOR PLANNING

Project Title: APPIN WIND FARM

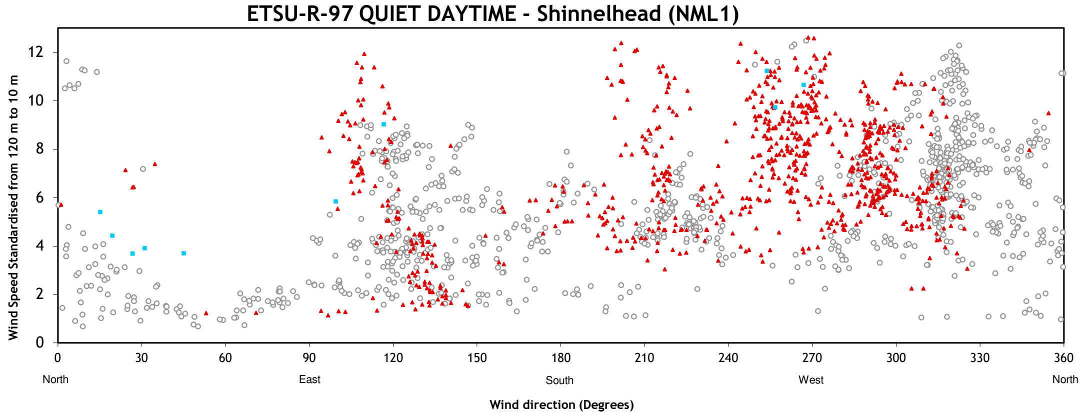
Drawing Title: FIGURE A1.1B: CUMULATIVE WIND TURBINE LOCATIONS

Scale: 1:75,000 | Original Size: A3 | Spatial Reference: British National Grid

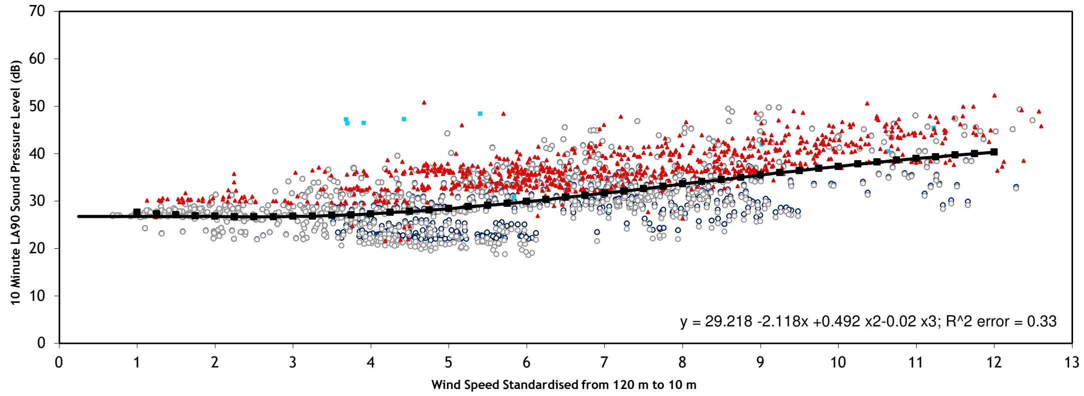
Drawing Number: 14711-015

ETSU-R-97 QUIET DAYTIME - Shinnelhead (NML1)

Wind Conditions Quiet Daytime



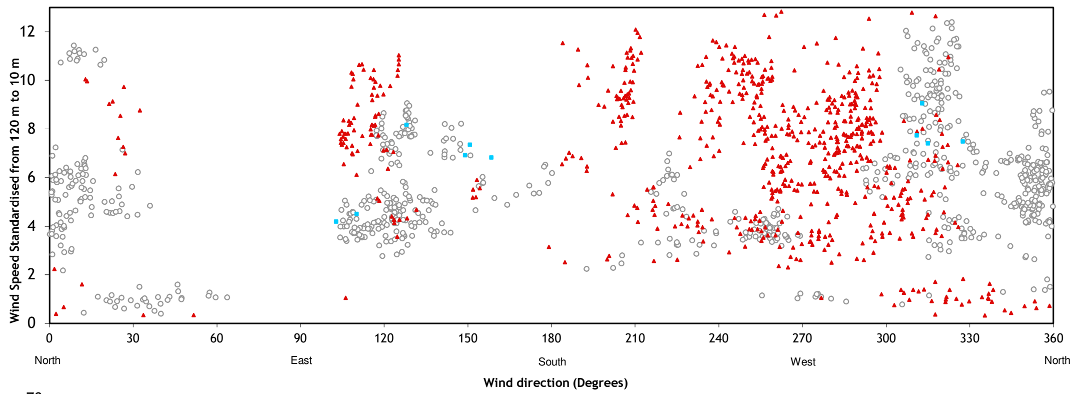
Regression Analysis Quiet Daytime



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	93	78	153	137	105	133	113	60	17	30	14	933
Prevailing Background	26.8	26.8	27.3	28.4	29.9	31.7	33.6	35.5	37.3	39	40.3	

ETSU-R-97 NIGHT-TIME - Shinnelhead (NML1)

Wind Conditions Night-Time



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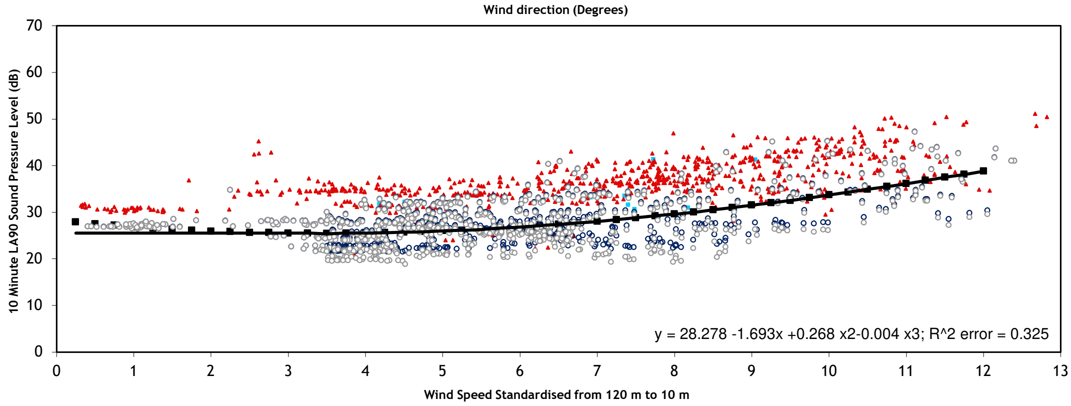


Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	8	49	169	149	128	85	55	39	25	28	12	747
Prevailing Background	25.5	25.5	25.5	26	26.8	28	29.6	31.5	33.7	36.1	38.8	

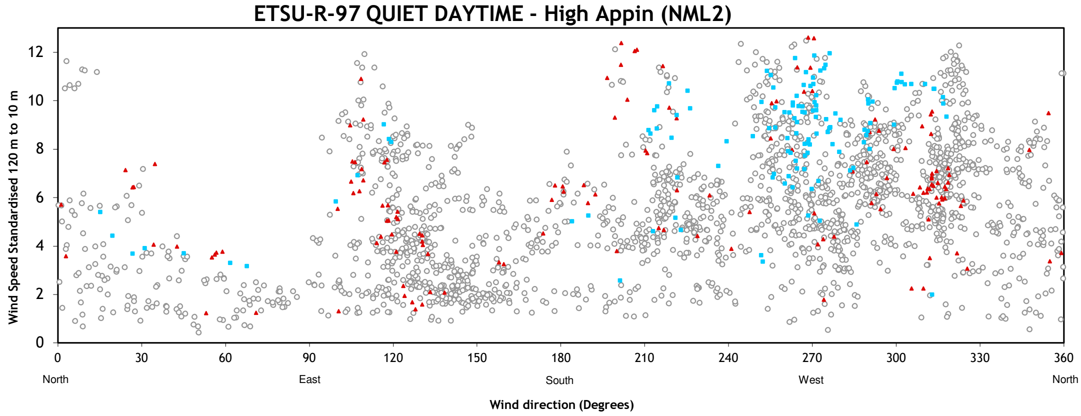
Legend:

- L_{A90} 10 Minute Calculated Background Noise
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction
- L_{A90} 10 Minute Measured Total Noise

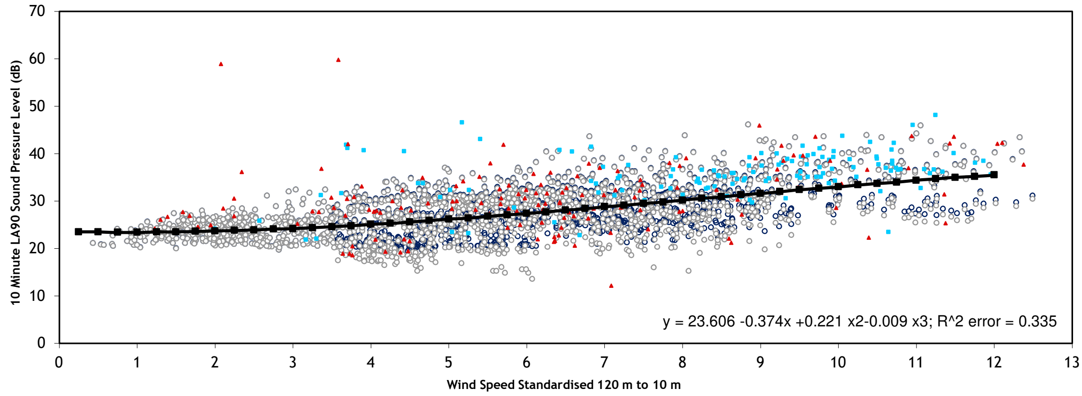
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Drawn	AD
Checked	GC
Date	02/04/2025
Document Reference	14711-Models

ETSU-R-97 QUIET DAYTIME - High Appin (NML2)

Wind Conditions Quiet Daytime



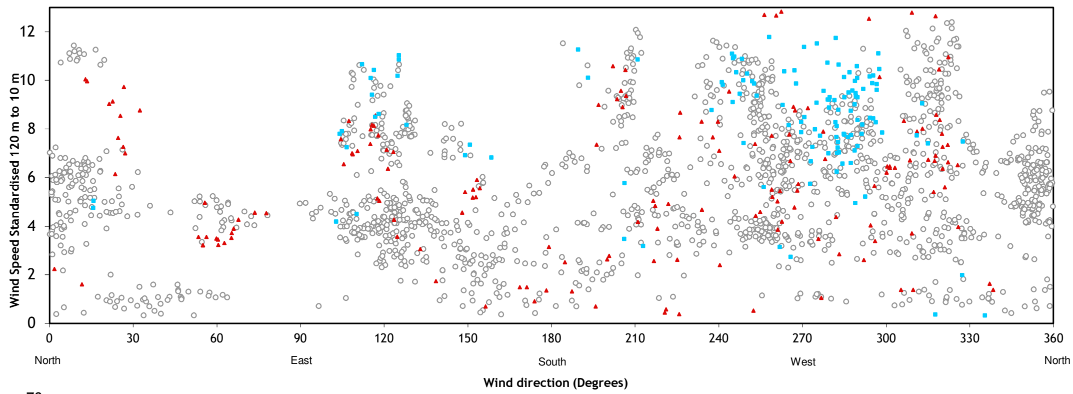
Regression Analysis Quiet Daytime



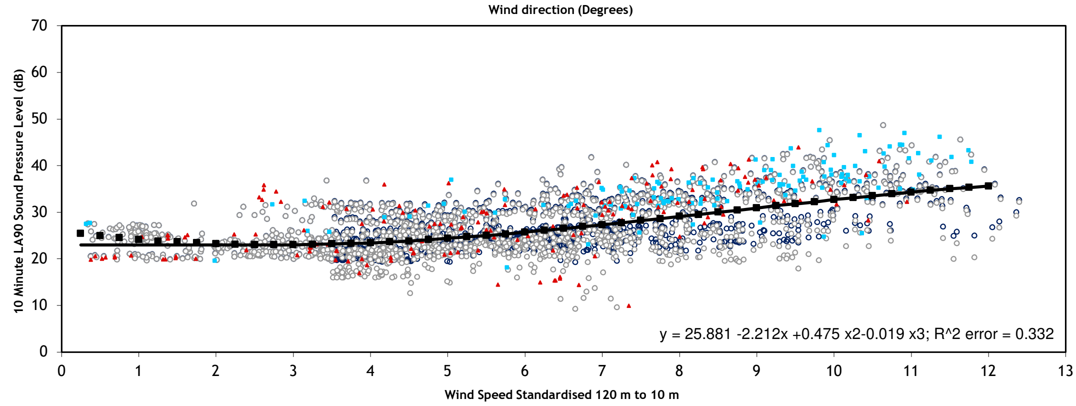
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	257	161	253	280	253	236	185	133	55	59	24	1896
Prevailing Background	23.7	24.2	25.1	26.2	27.4	28.8	30.2	31.6	33	34.4	35.5	

ETSU-R-97 NIGHT-TIME - High Appin (NML2)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	59	131	302	221	206	197	143	108	74	59	18	1518
Prevailing Background	23	23	23.4	24.4	25.7	27.3	29.1	30.9	32.7	34.3	35.6	

Legend:

- L_{A90} 10 Minute Calculated Background Noise
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction
- L_{A90} 10 Minute Measured Total Noise

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2b
Drawn	AD
Checked	GC
Date	02/04/2025
Document Reference	14711-Models

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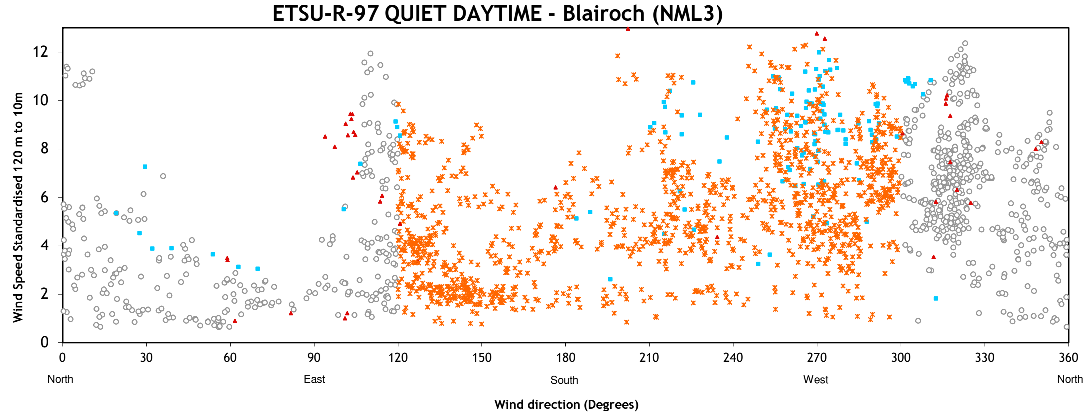
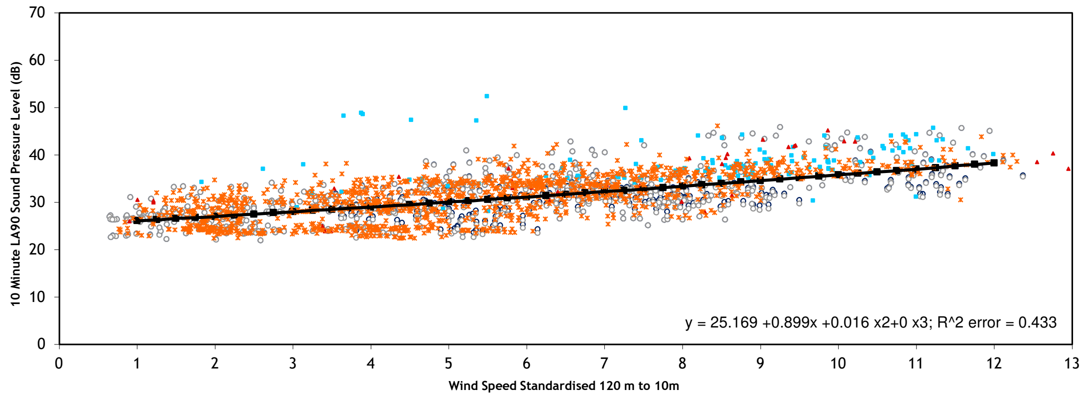
ETSU-R-97 QUIET DAYTIME - Blairoch (NML3)

Wind Conditions Quiet Daytime



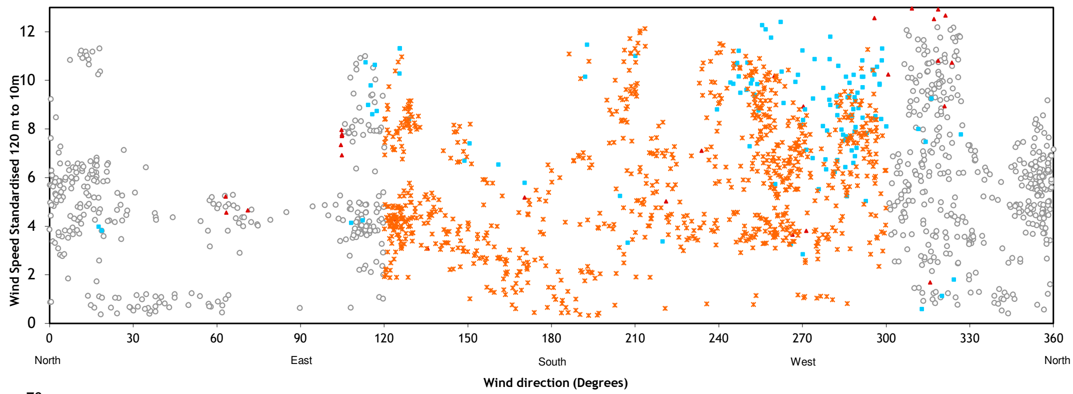
Regression Analysis Quiet Daytime



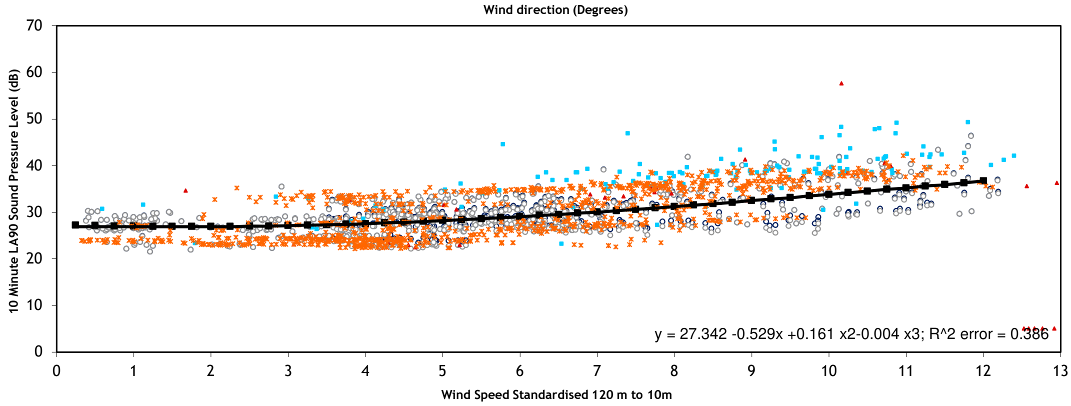
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	72	59	75	88	78	100	83	44	23	34	9	665
Prevailing Background	27	28	29	30.1	31.1	32.3	33.4	34.6	35.8	37	38.3	

ETSU-R-97 NIGHT-TIME - Blairoch (NML3)

Wind Conditions Night-Time



Regression Analysis Night-Time

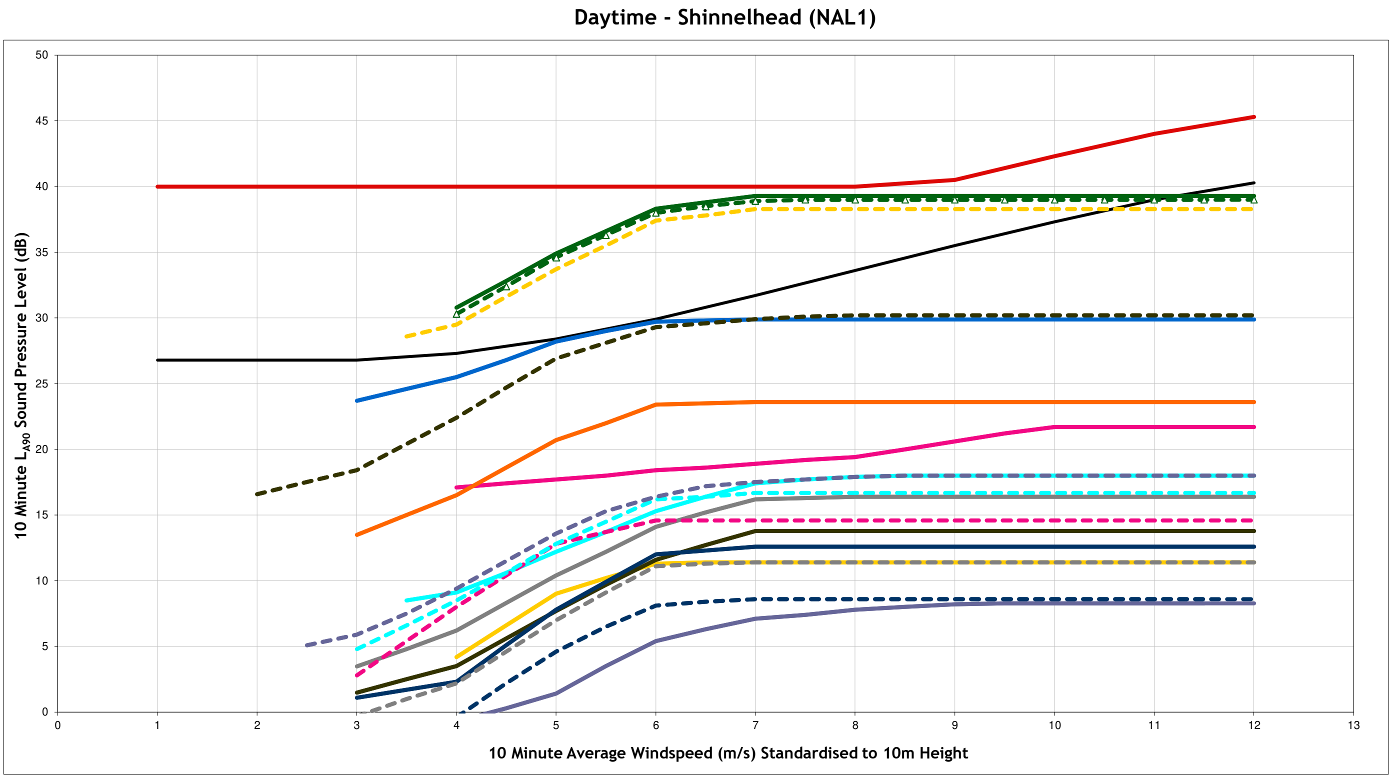


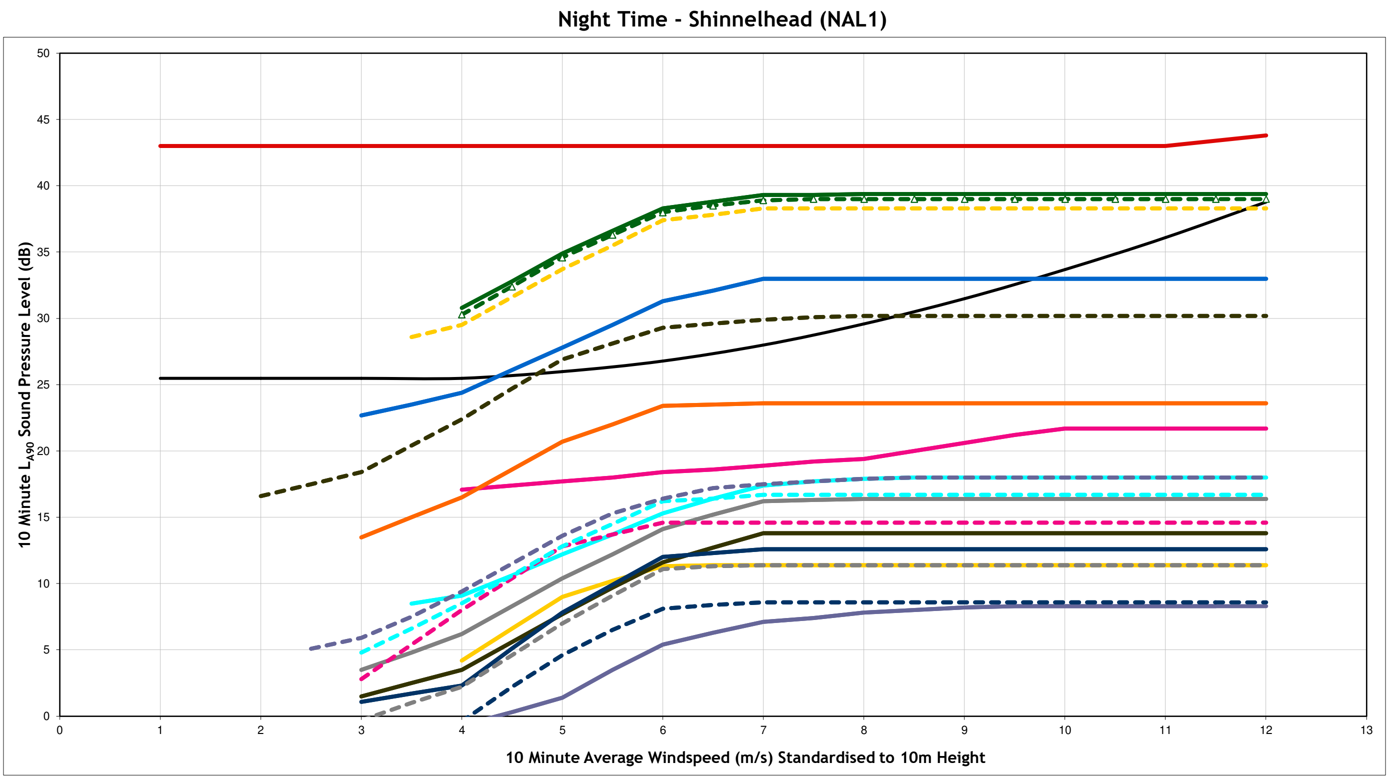
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	17	44	127	128	122	63	37	31	29	34	13	645
Prevailing Background	26.9	27.1	27.5	28.2	29	30	31.2	32.5	33.8	35.2	36.7	

Legend:

- L_{A90} 10 Minute Calculated Background Noise
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction
- L_{A90} 10 Minute Measured Total Noise

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2c
Drawn	AD
Checked	GC
Date	02/04/2025
Document Reference	14711-Models





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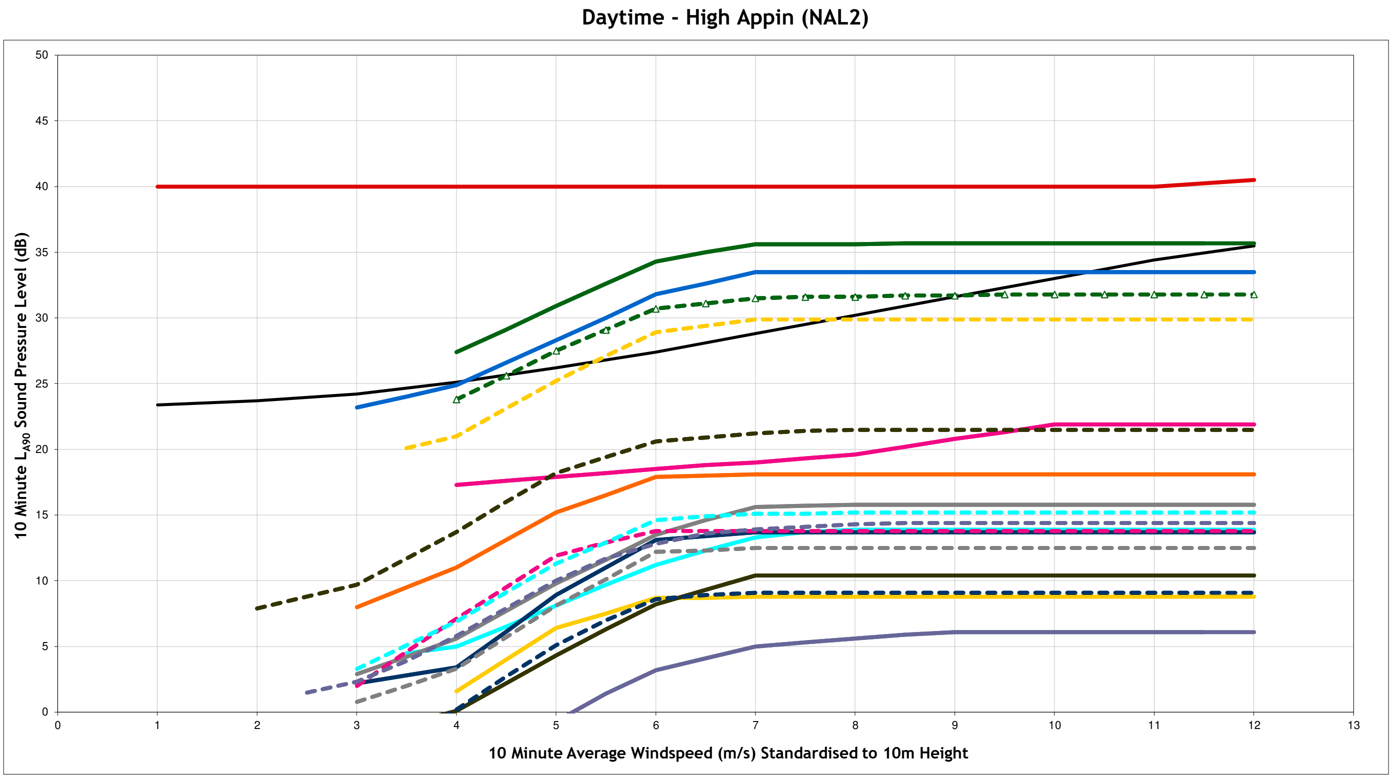
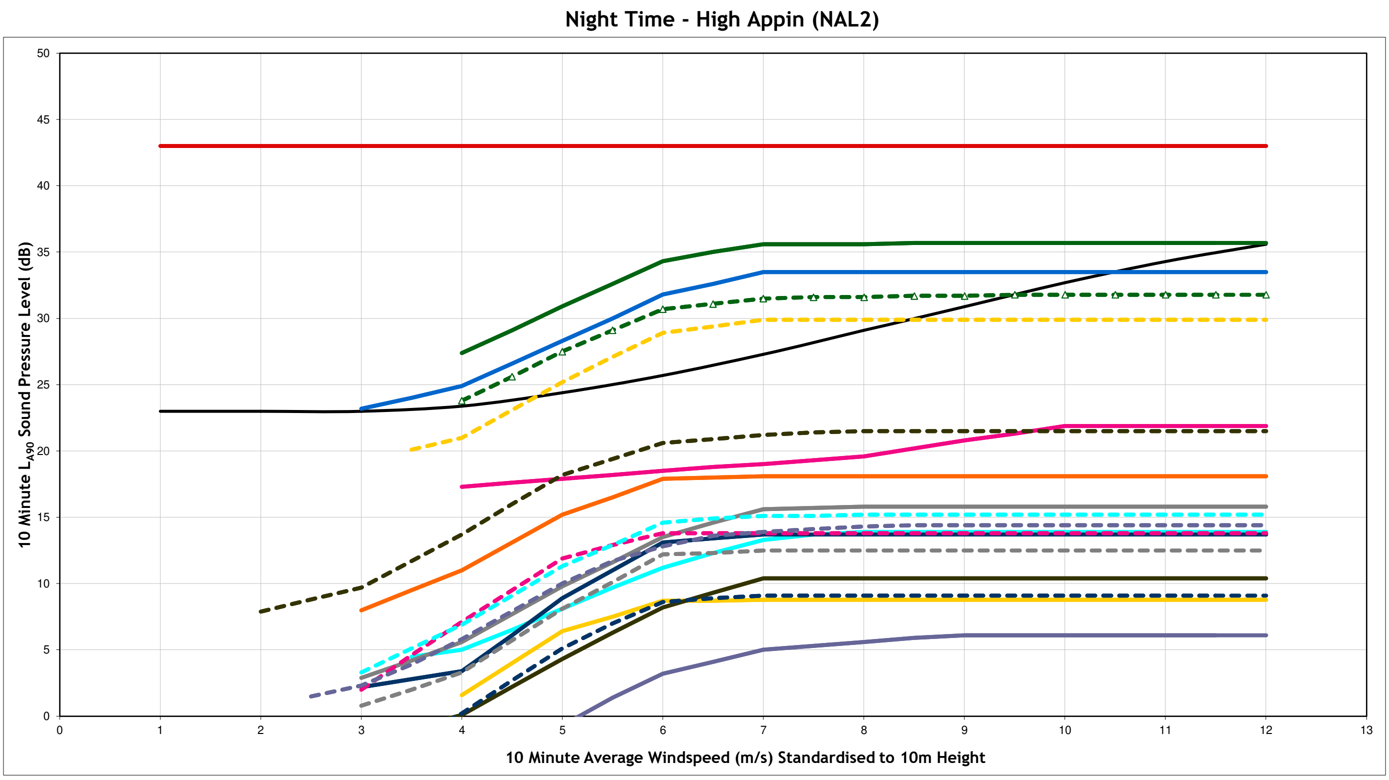
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Shinnelhead (NAL1)
Figure Number	Figure A1.3a
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models





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- Background Noise Trendline
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- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions High Appin (NAL2)
Figure Number	Figure A1.3b
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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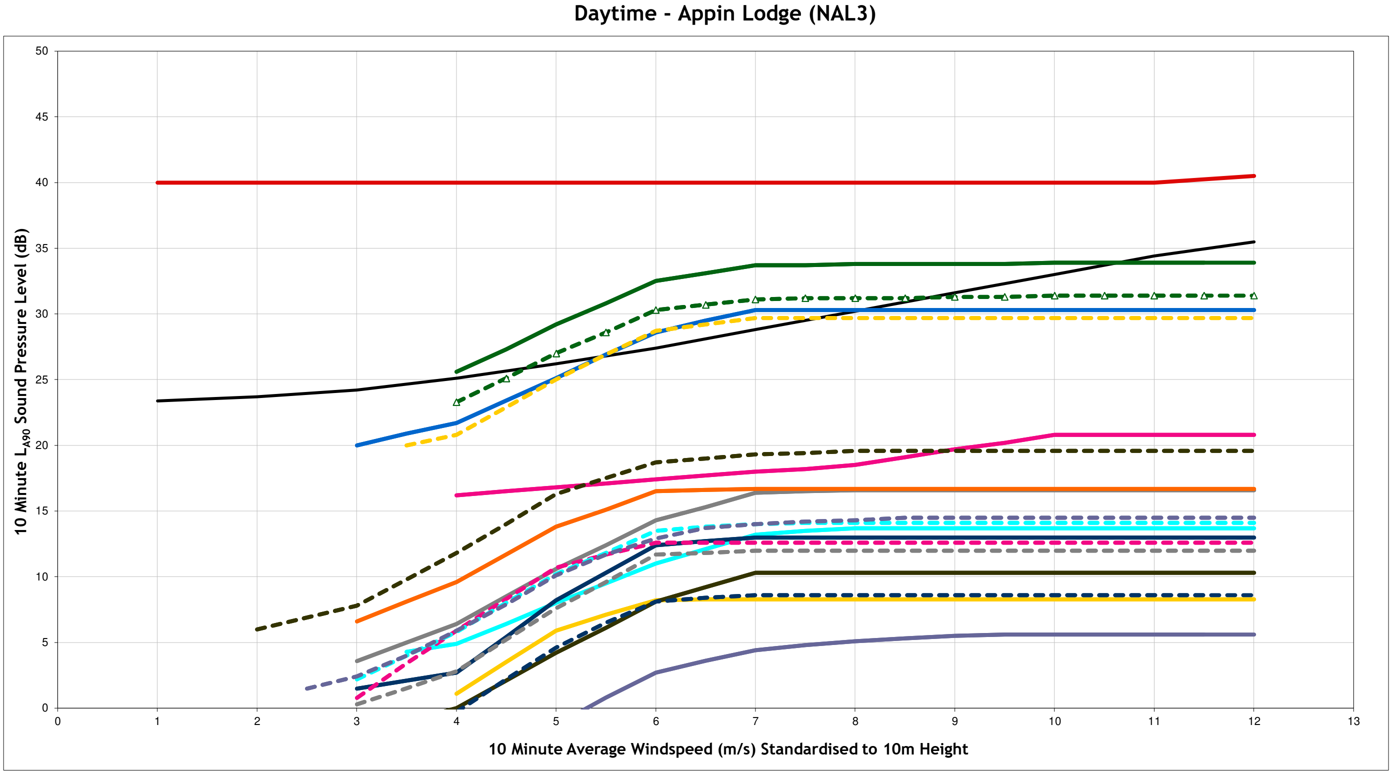

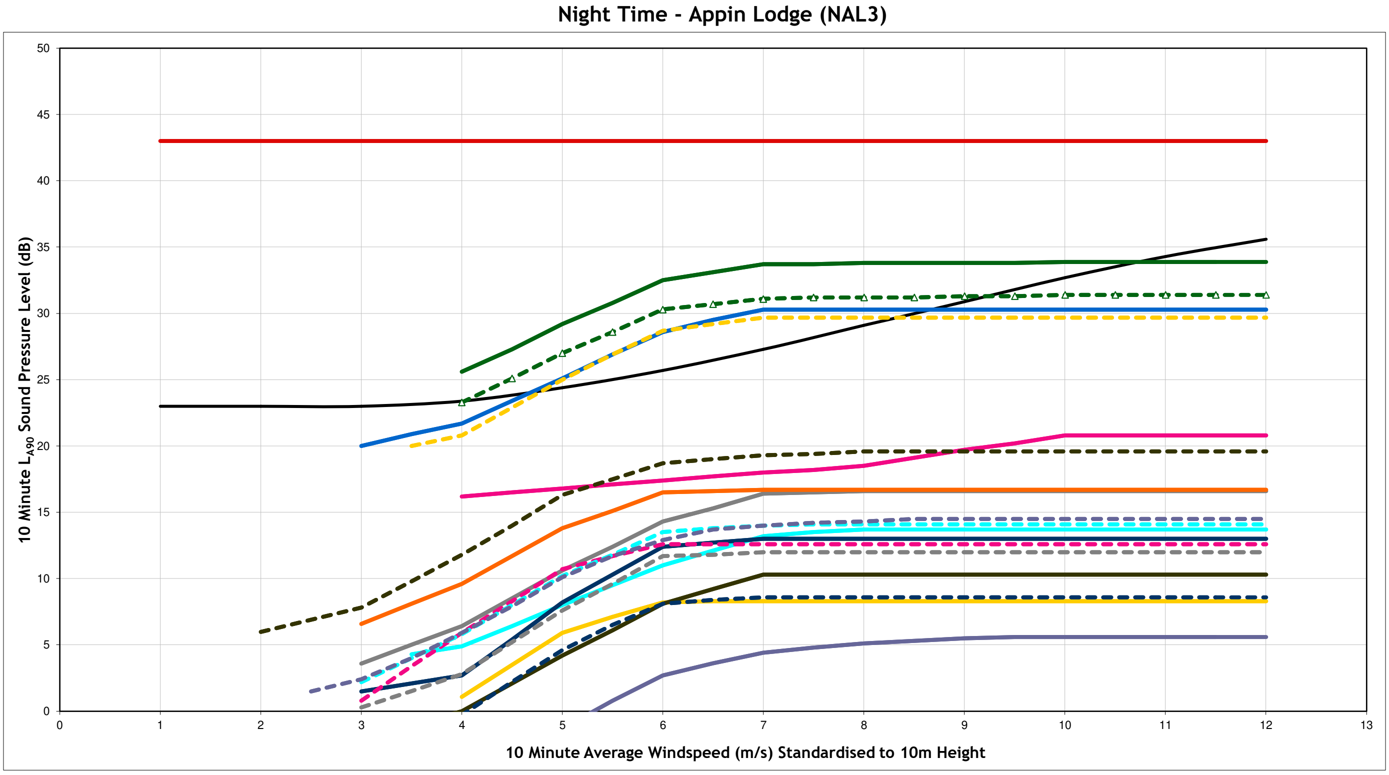

Legend:

- Background Noise Trendline
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- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Appin Lodge (NAL3)
Figure Number	Figure A1.3c
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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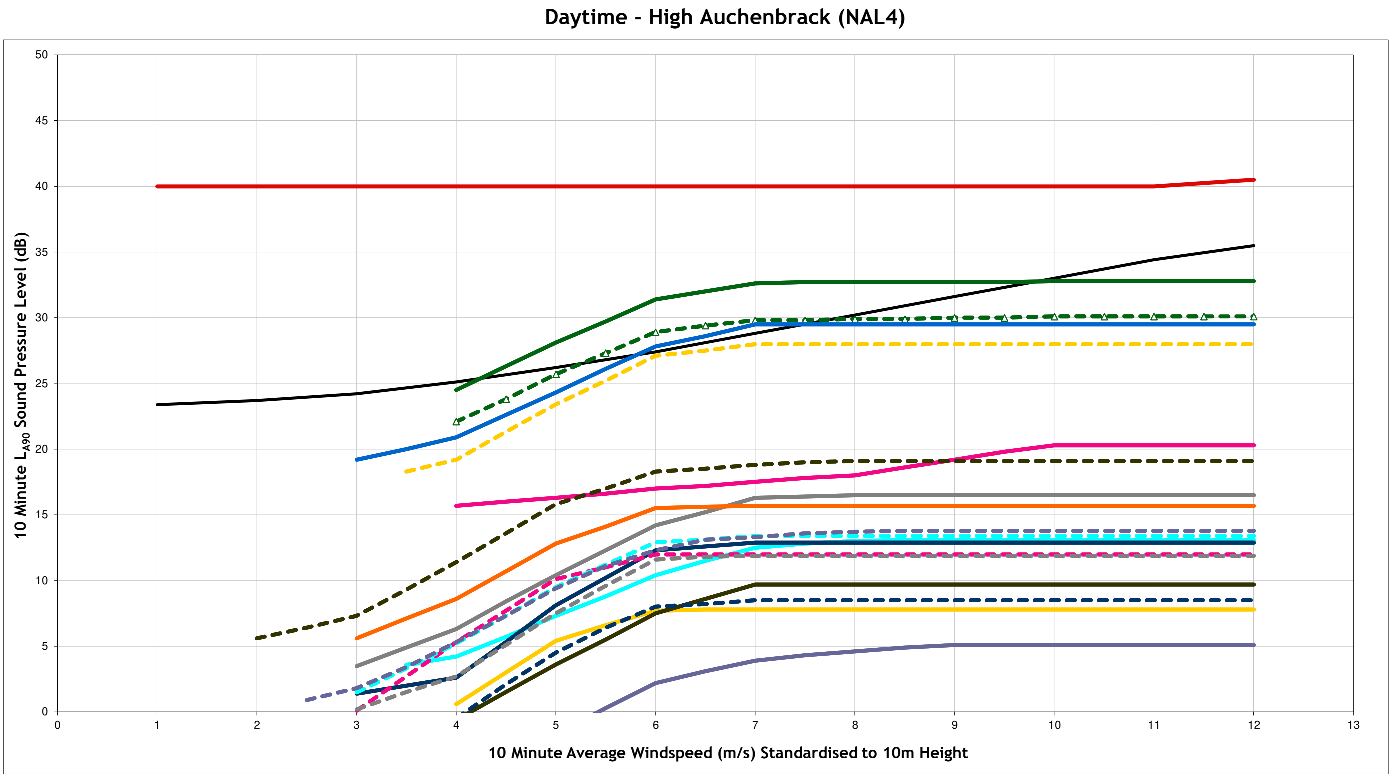

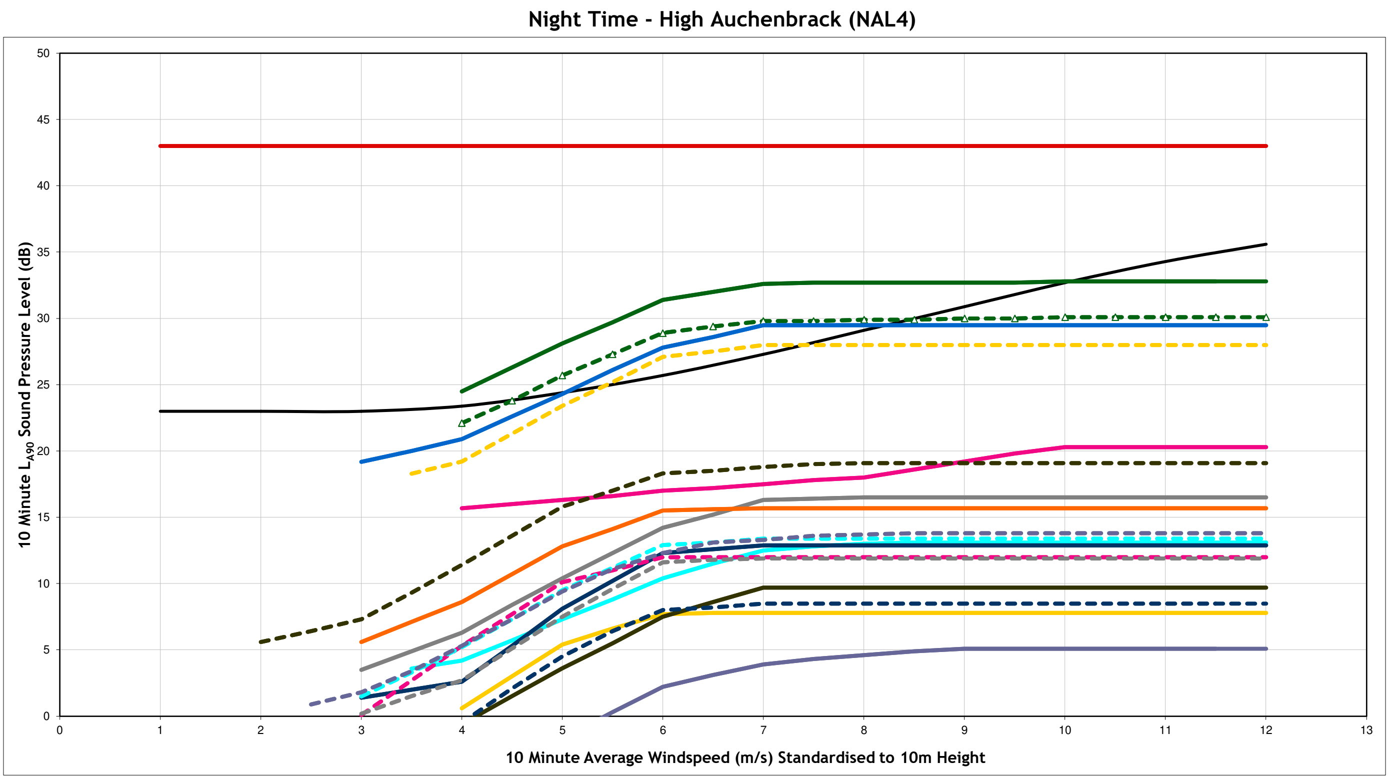

Legend:

Background Noise Trendline
Total ETSU-R-97-Limit
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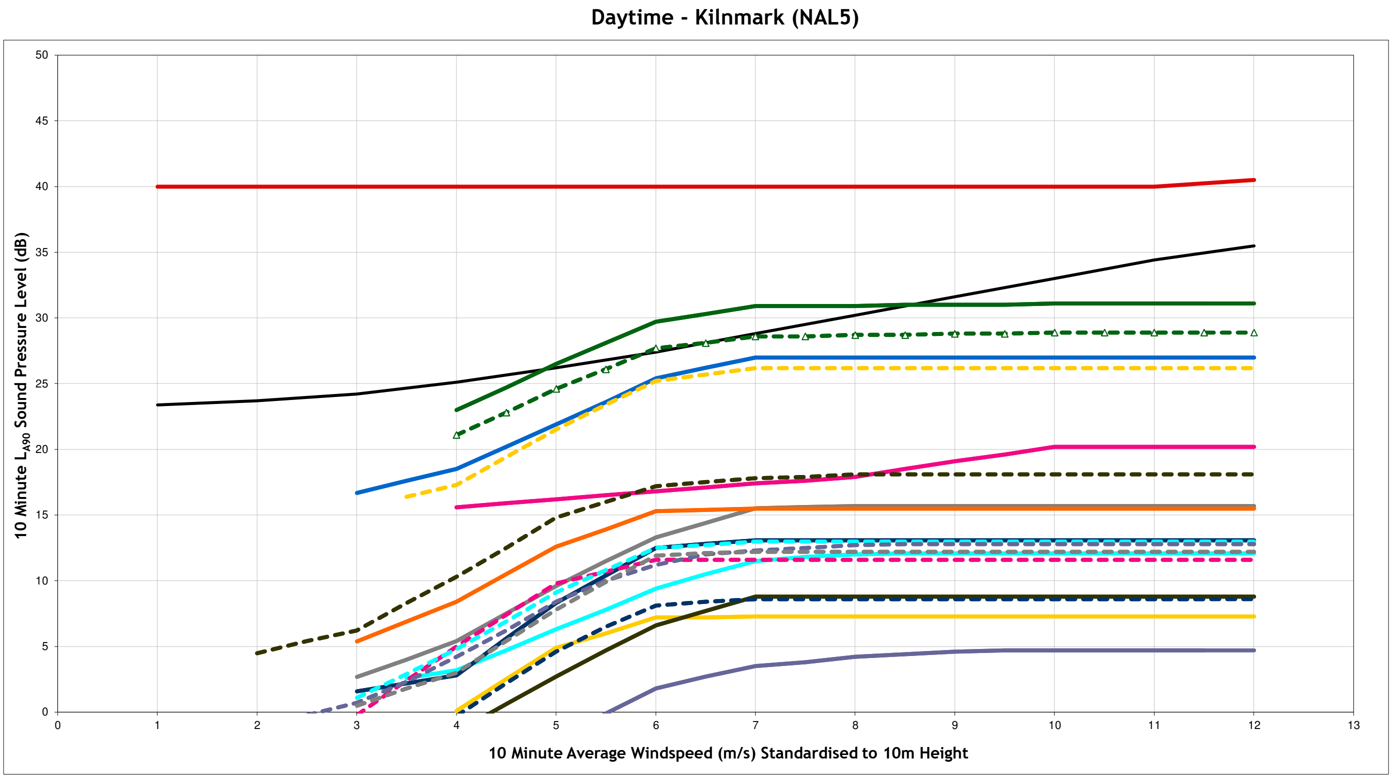
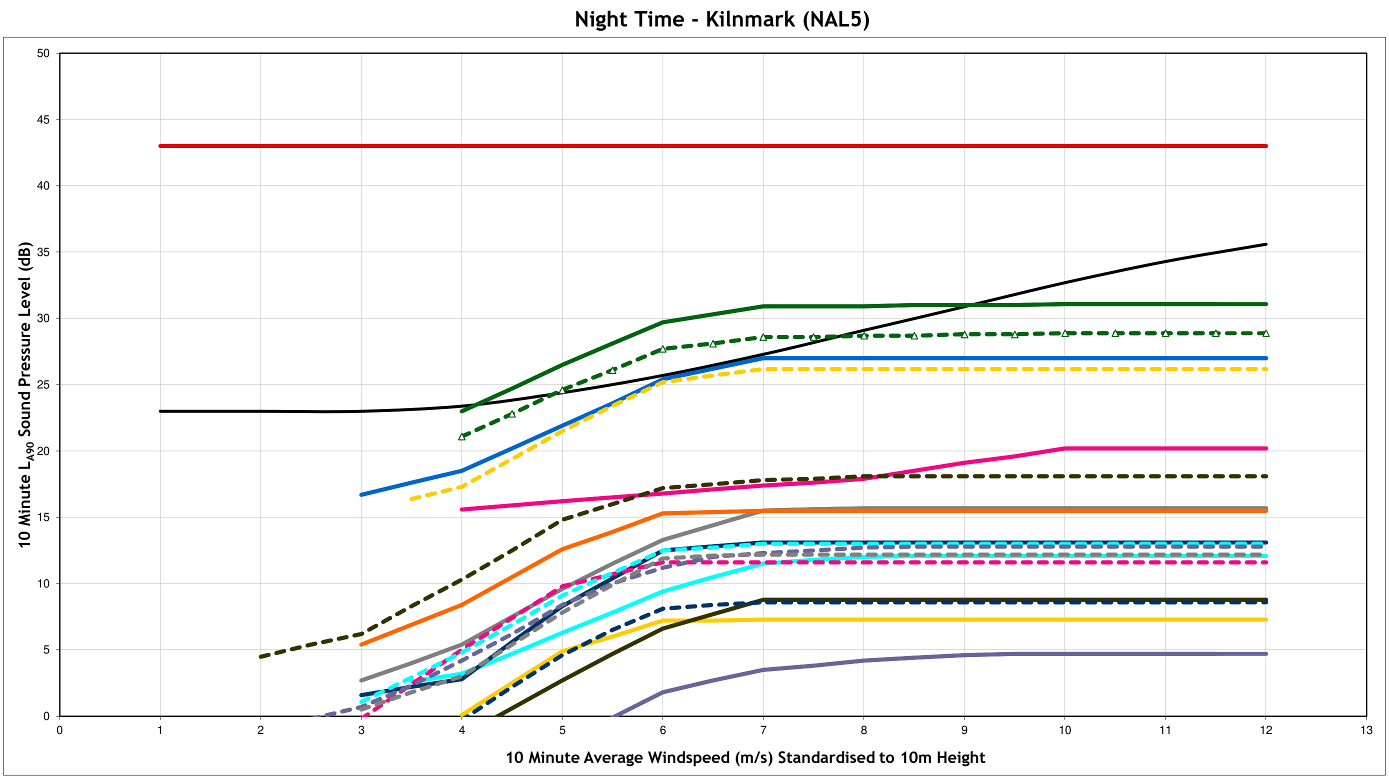
Cumulative (exc. the Proposed Development)
Proposed Development
Wether Hill
Afton
Sanquhar Community Wind Farm
Whiteside Hill
Windy Rig
Twentyshilling
Troston Loch
Lorg
Cornharrow
Sanquhar II
Euchanhead
Manquhill
Cloud Hill
Margree
Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions High Auchenbrack (NAL4)
Figure Number	Figure A1.3d
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models





Legend:

Background Noise Trendline	Troston Loch
Total ETSU-R-97-Limit	Lorg
Cumulative (inc. the Proposed Development)	Cornharrow
Cumulative (exc. the Proposed Development)	Sanquhar II
Proposed Development	Euchanhead
Wether Hill	Manquhill
Afton	Cloud Hill
Sanquhar Community Wind Farm	Margree
Whiteside Hill	Glenshimmeroch
Windy Rig	
Twentyshilling	

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Kilnmark (NAL5)
Figure Number	Figure A1.3e
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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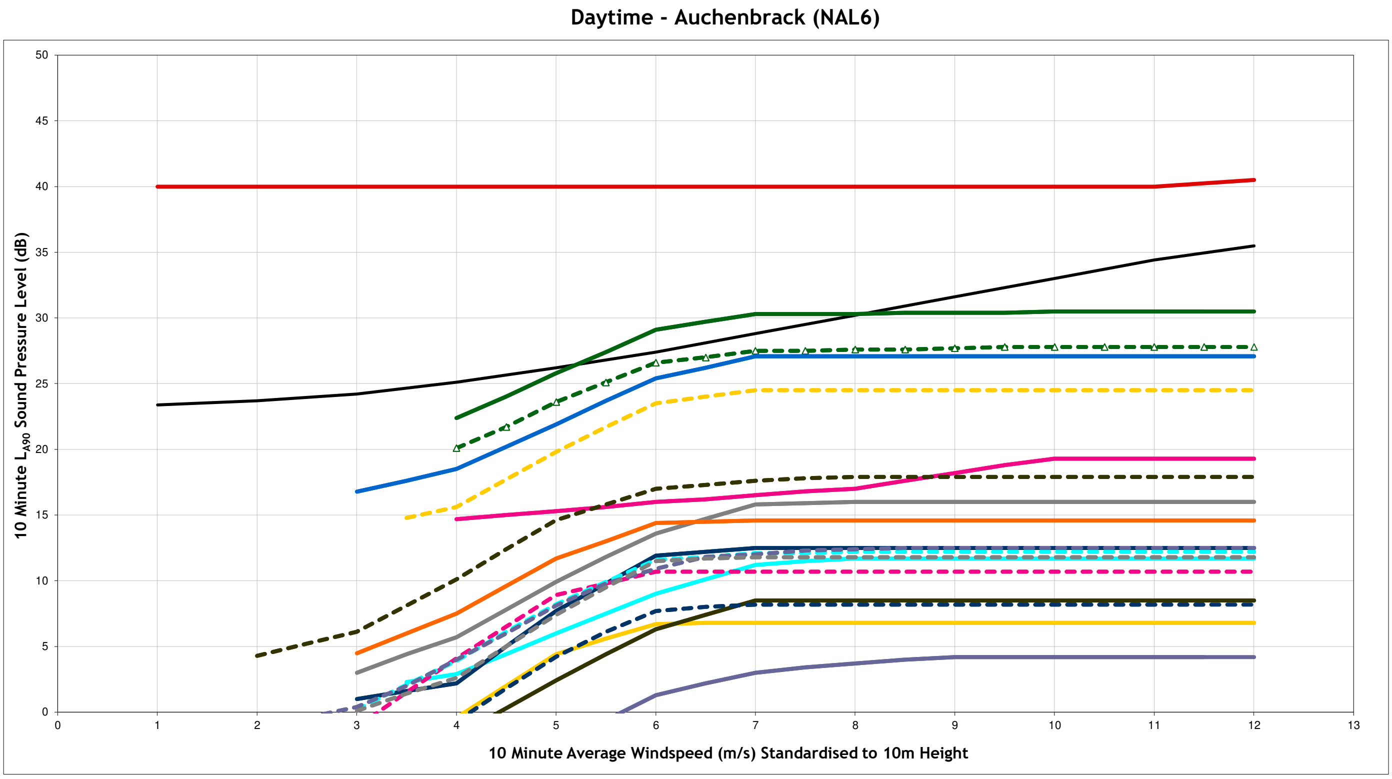

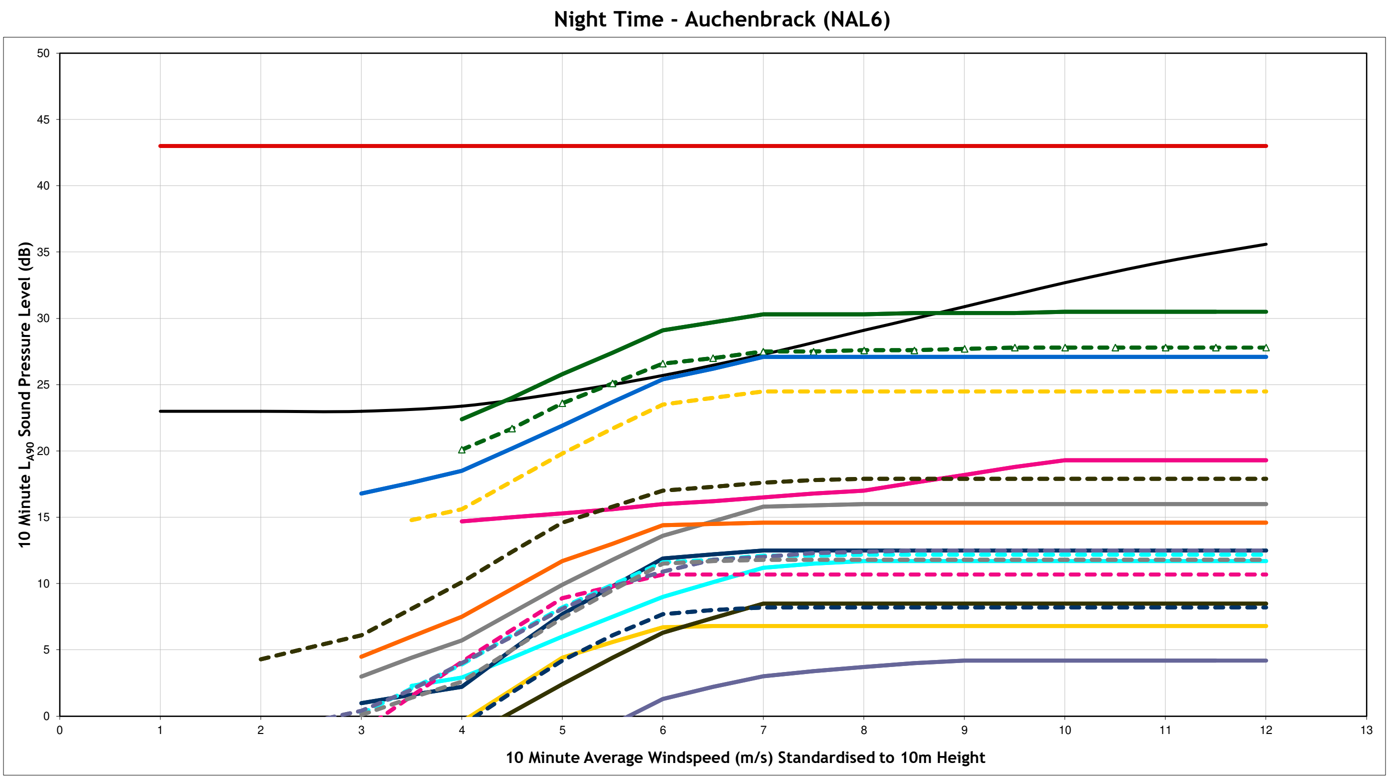

Legend:

- Background Noise Trendline
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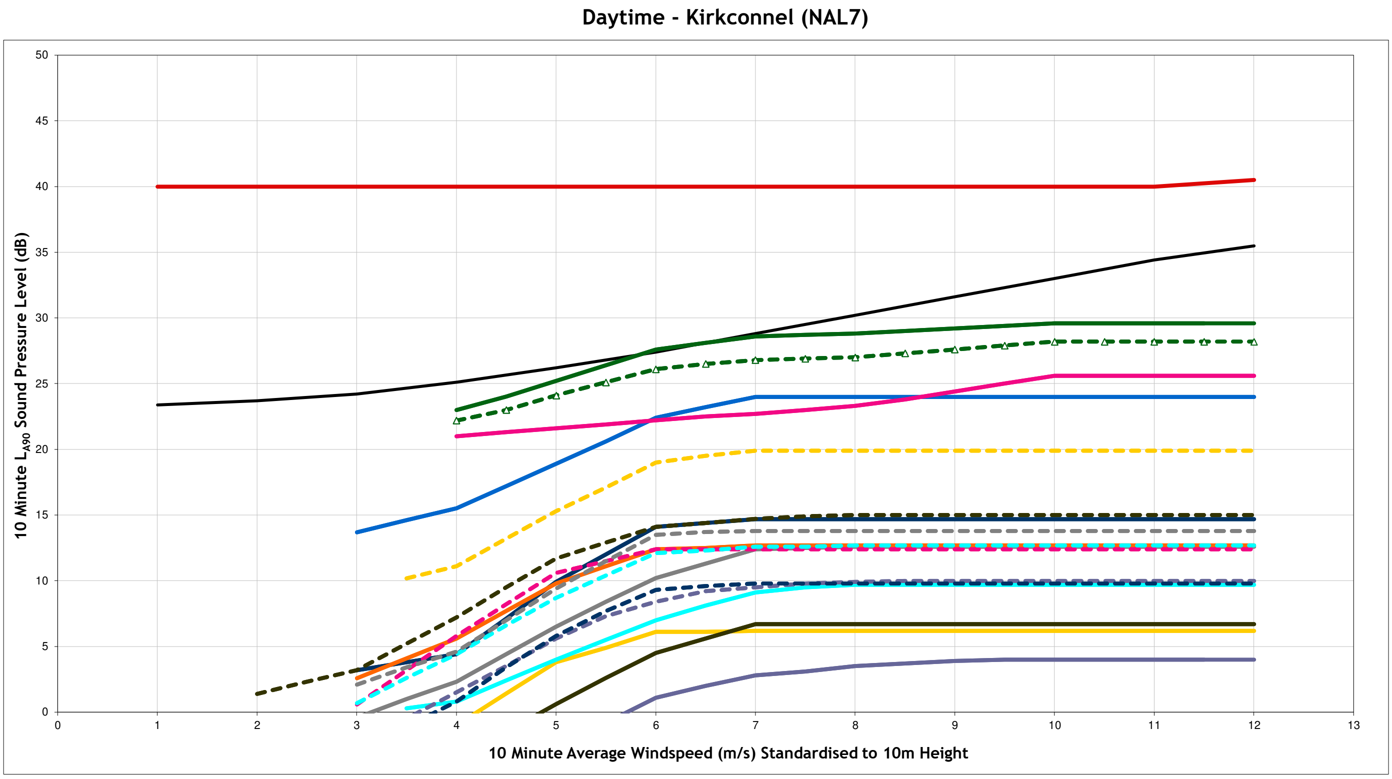
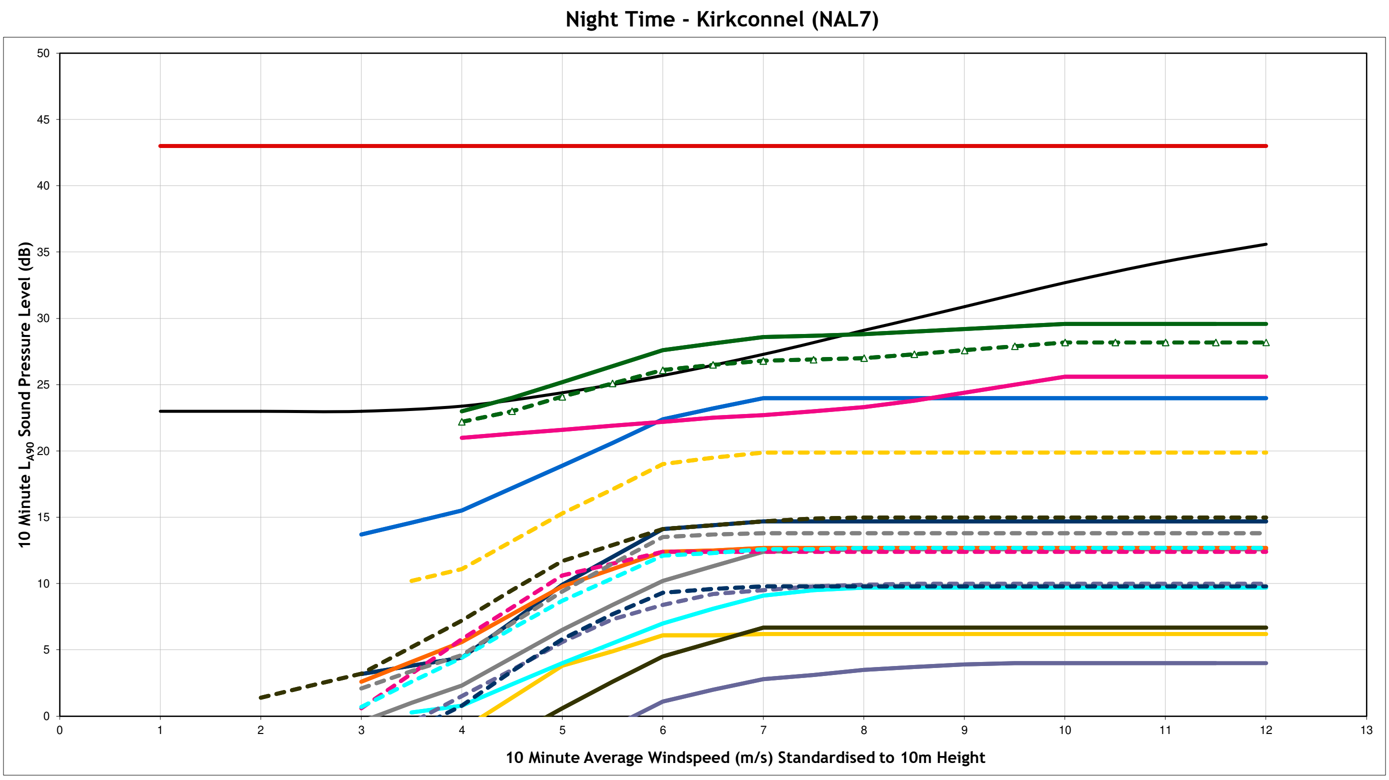
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Auchenbrack (NAL6)
Figure Number	Figure A1.3f
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models





Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Kirkconnel (NAL7)
Figure Number	Figure A1.3g
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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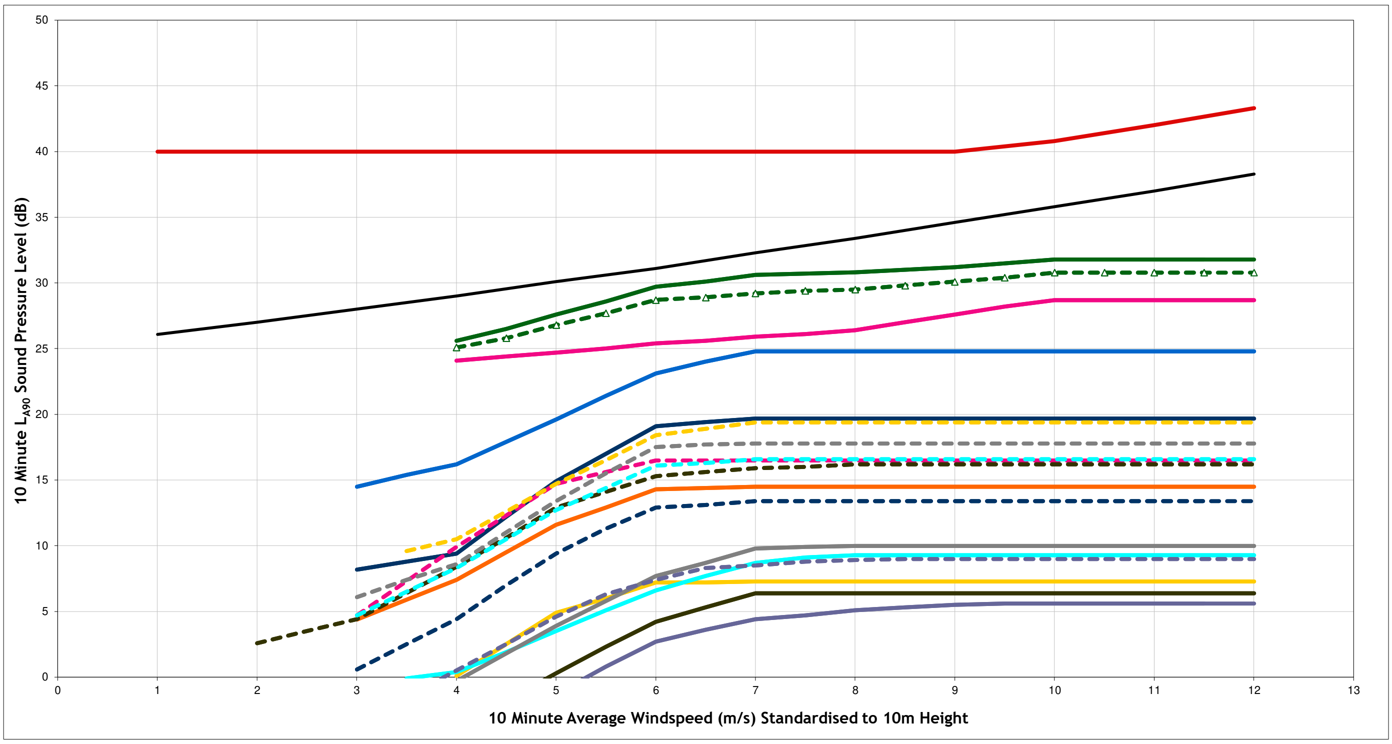
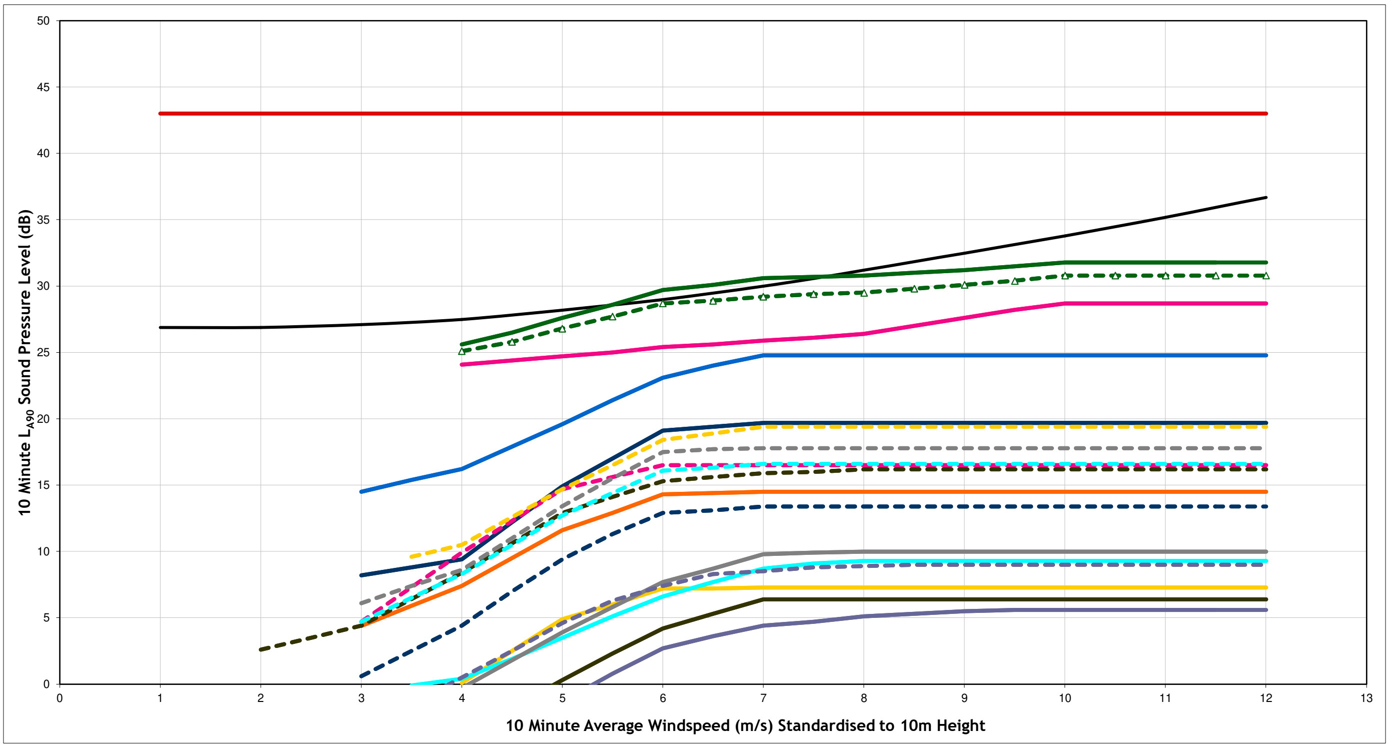
Daytime - Corriedow (NAL9)



Night Time - Corriedow (NAL9)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Corriedow (NAL9)
Figure Number	Figure A1.3i
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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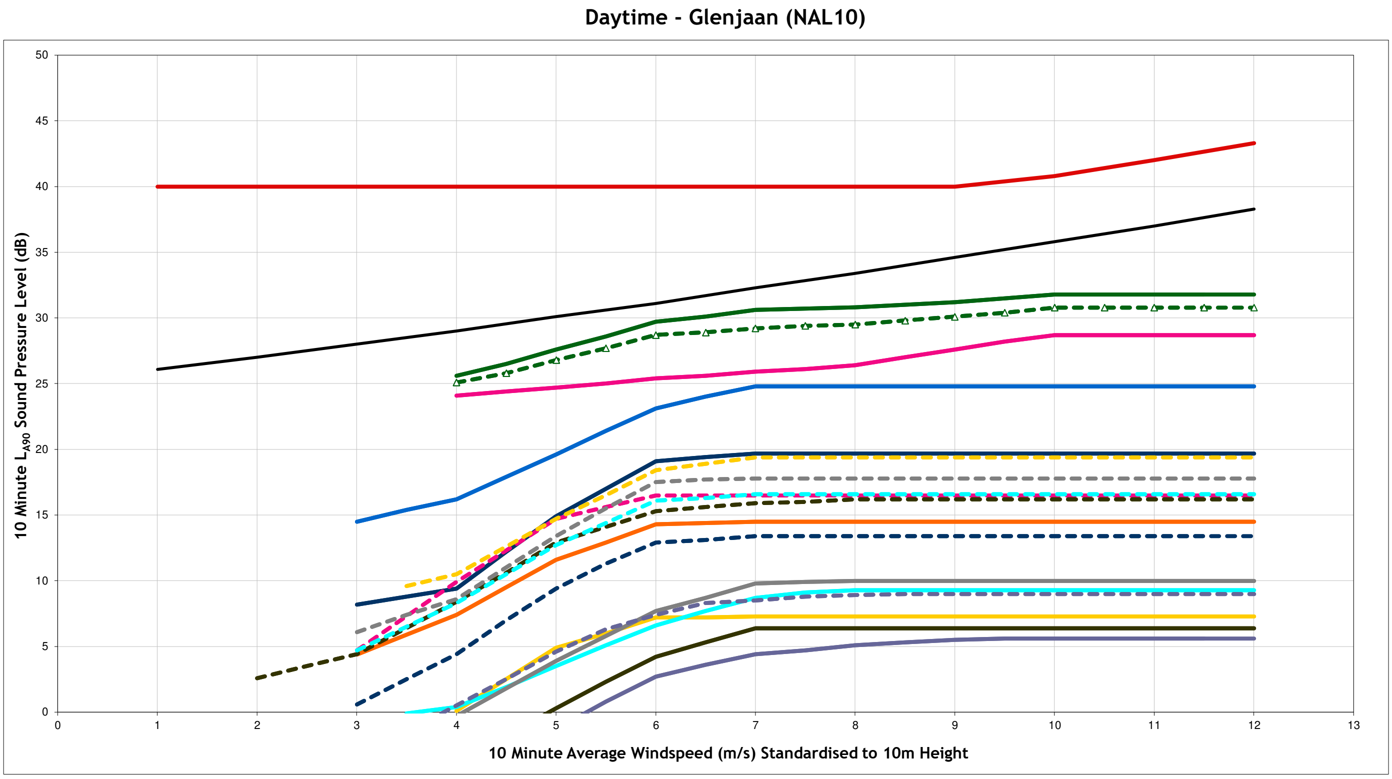

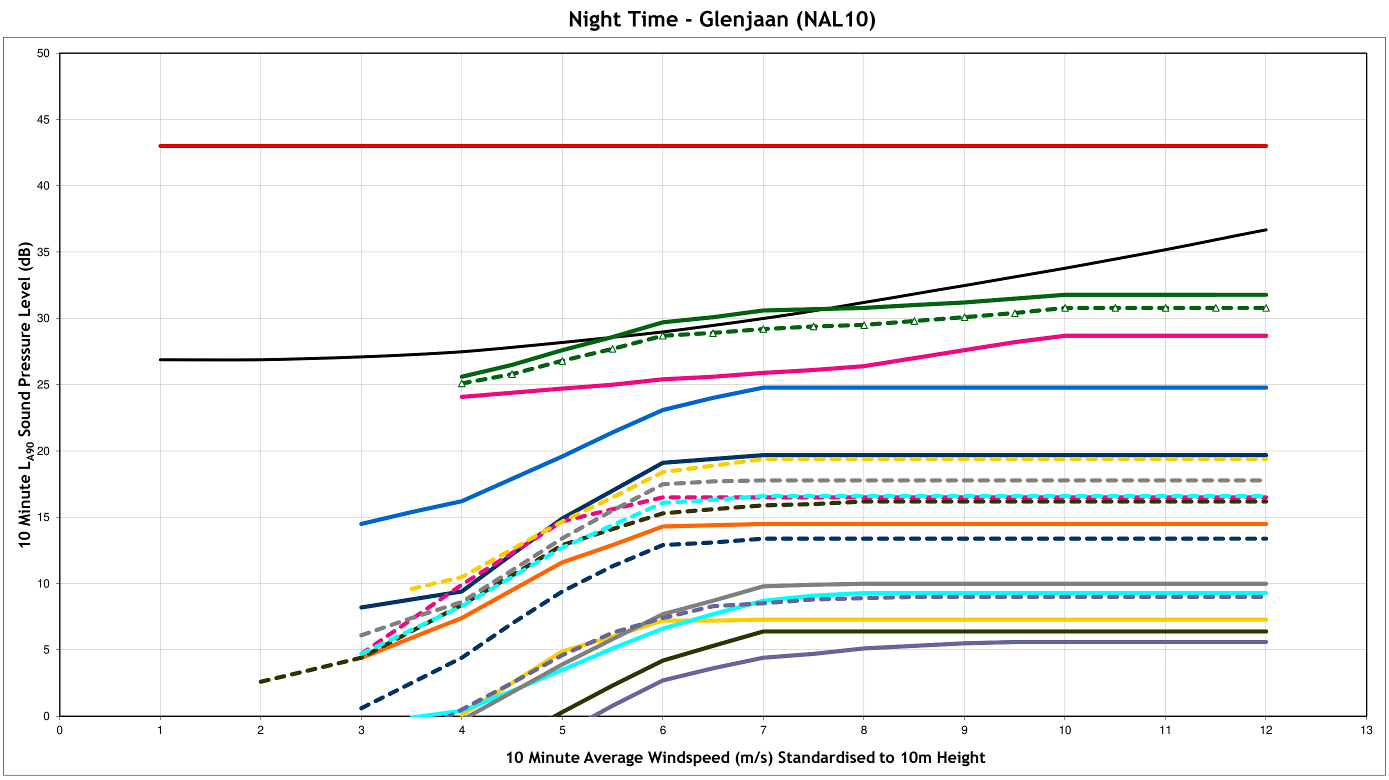

Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Glenjaan (NAL10)
Figure Number	Figure A1.3j
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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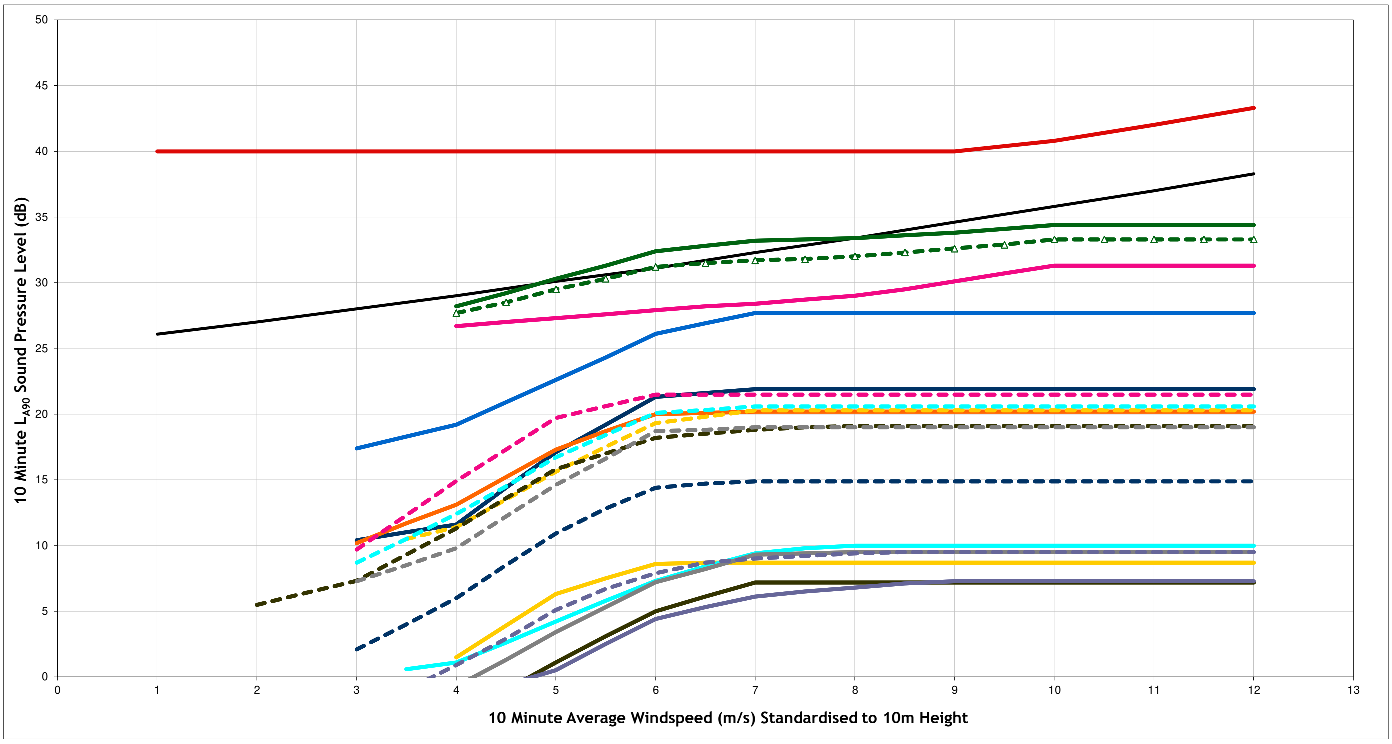
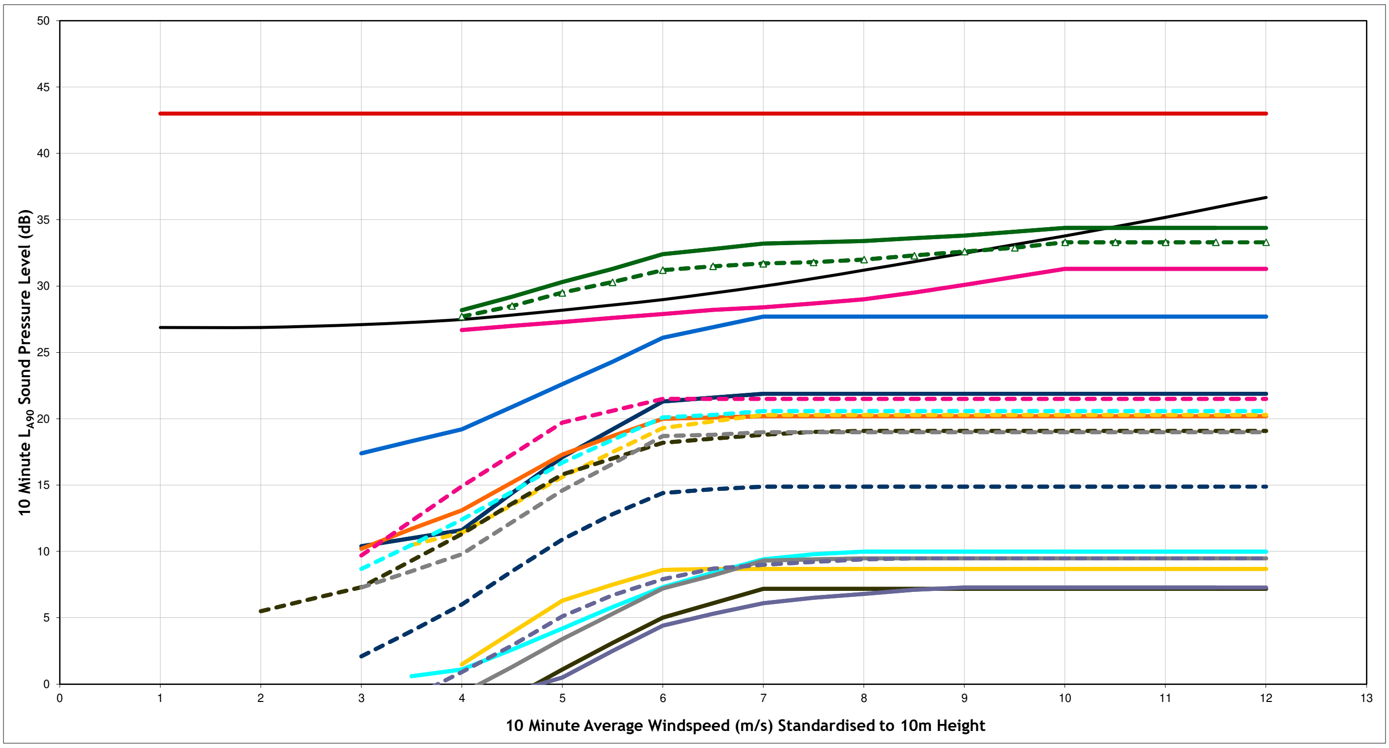
Daytime - Benbuie (NAL11)



Night Time - Benbuie (NAL11)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Benbuie (NAL11)
Figure Number	Figure A1.3k
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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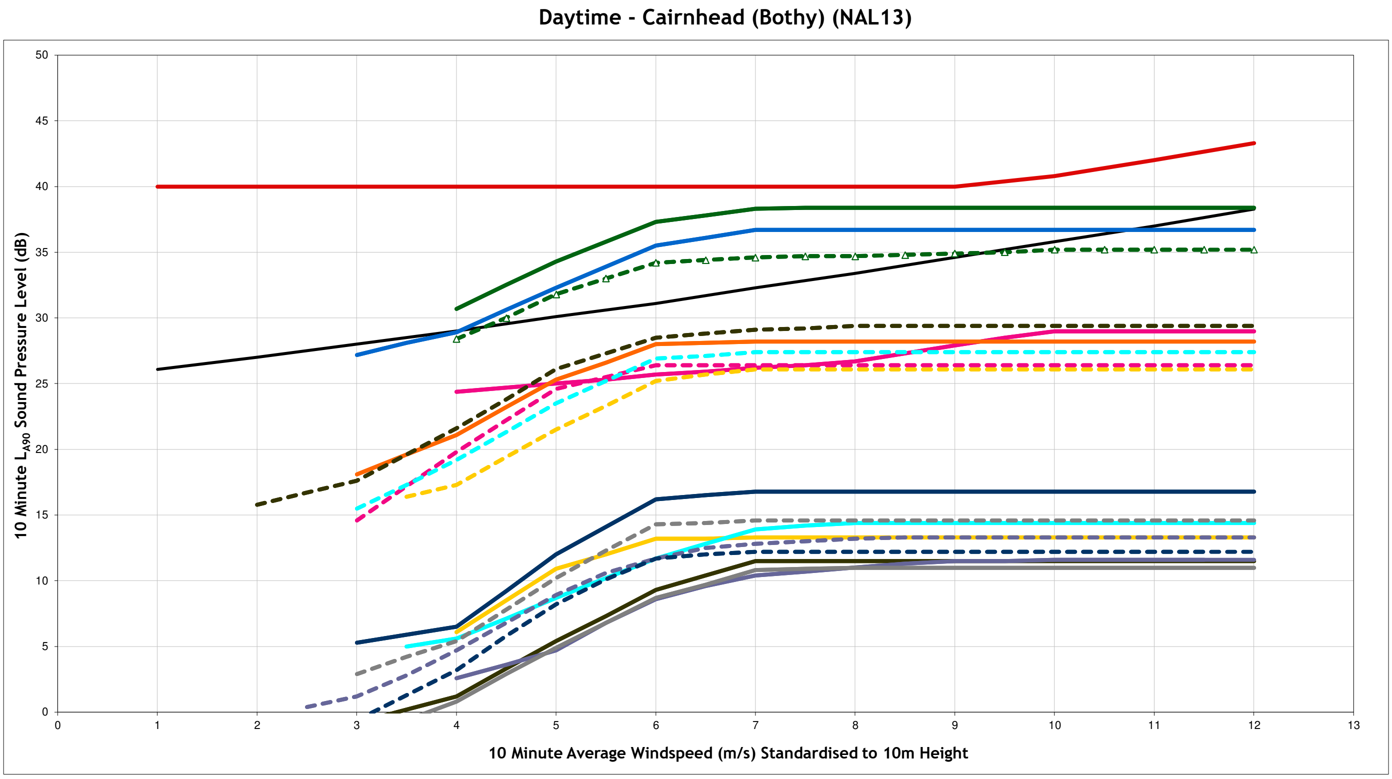

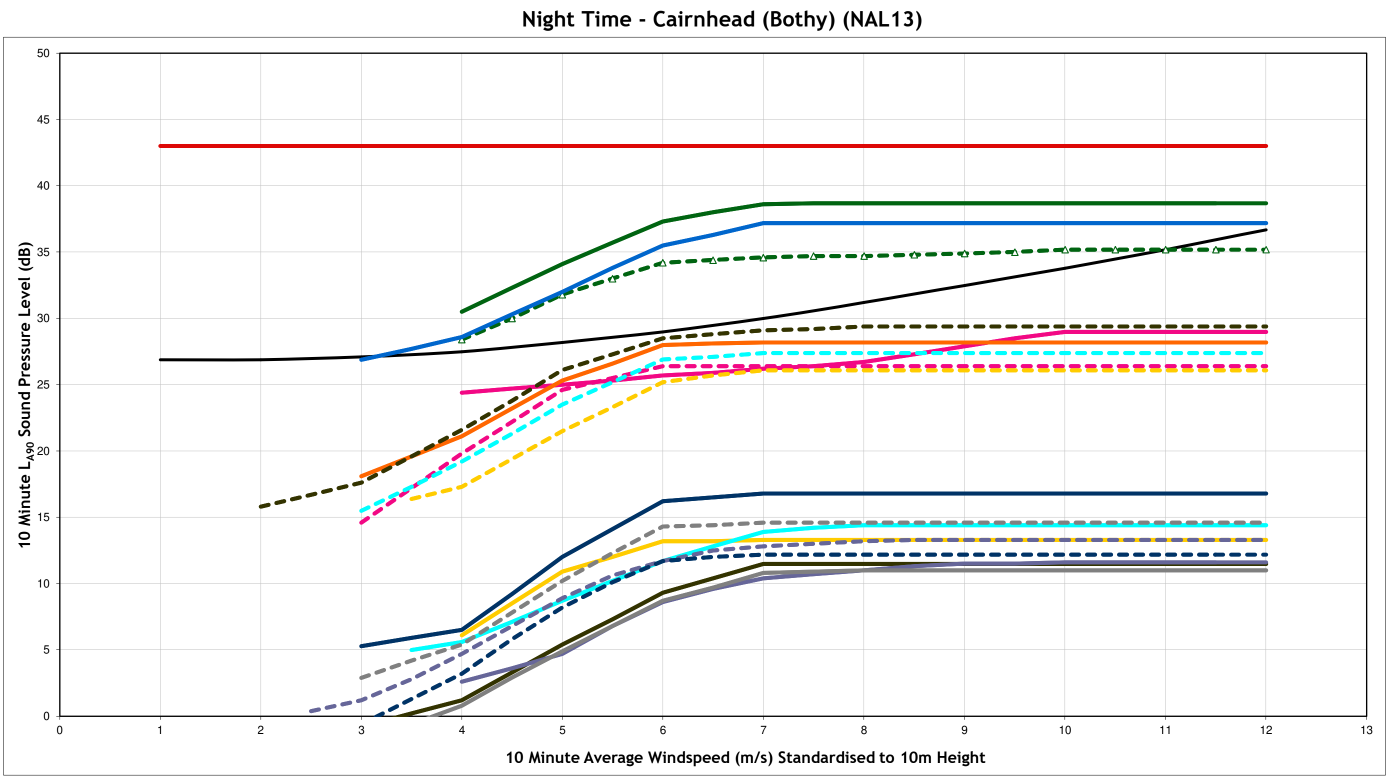

Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Cairnhead (Bothy) (NAL13)
Figure Number	Figure A1.3m
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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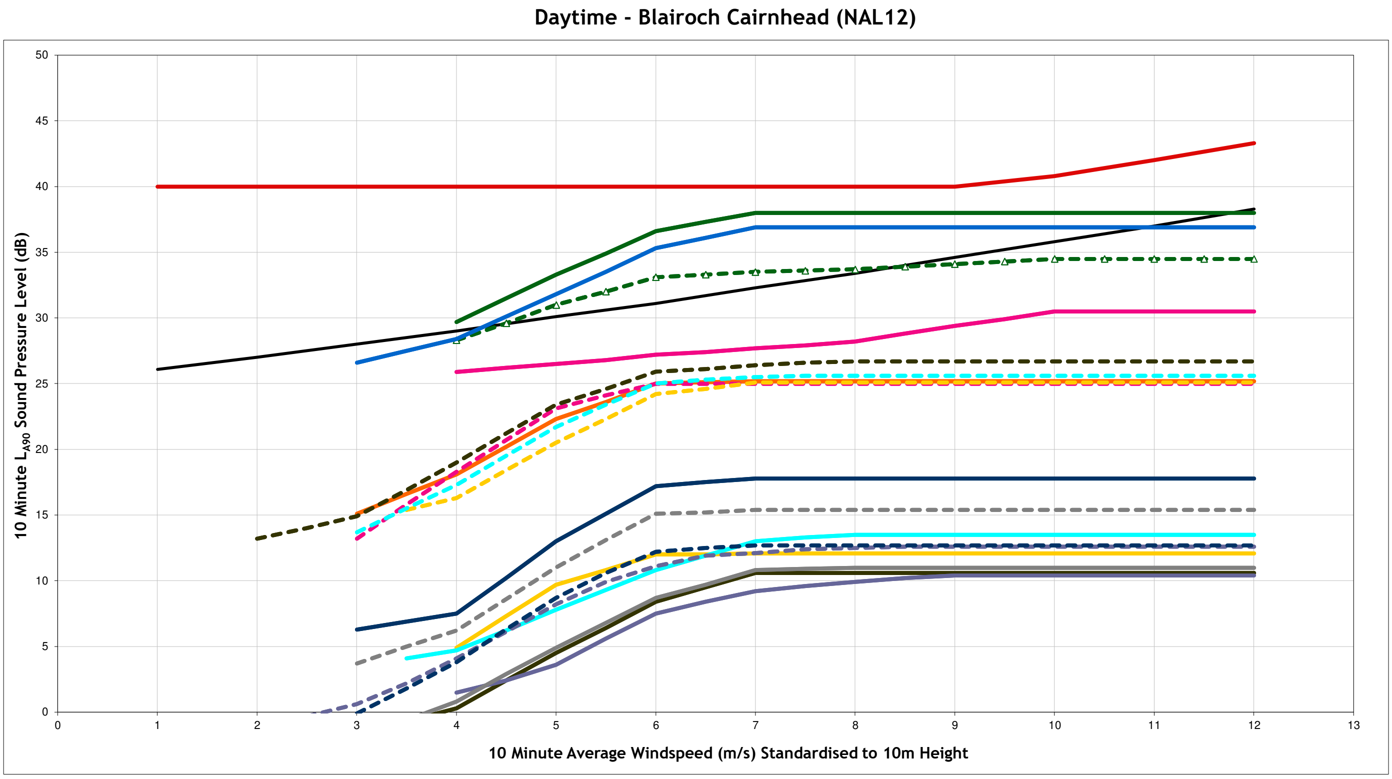
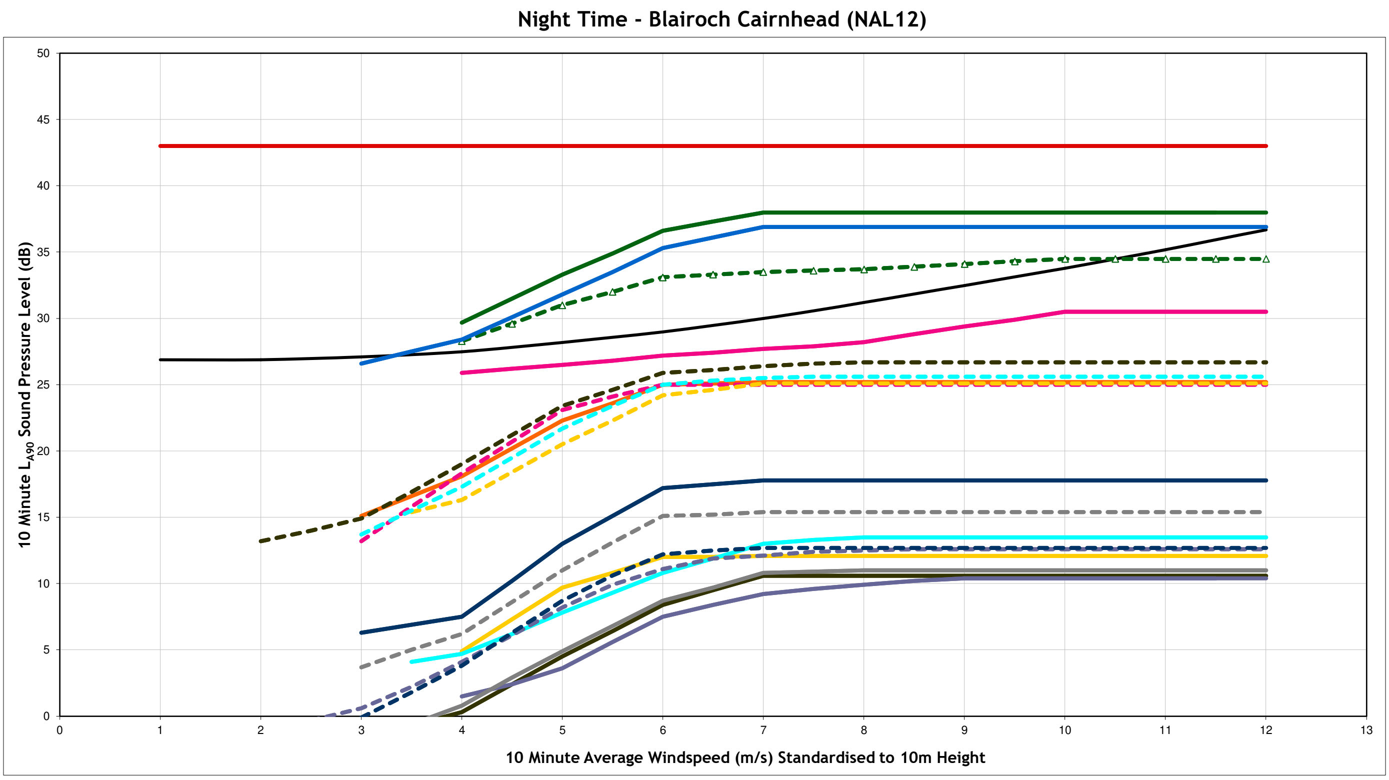


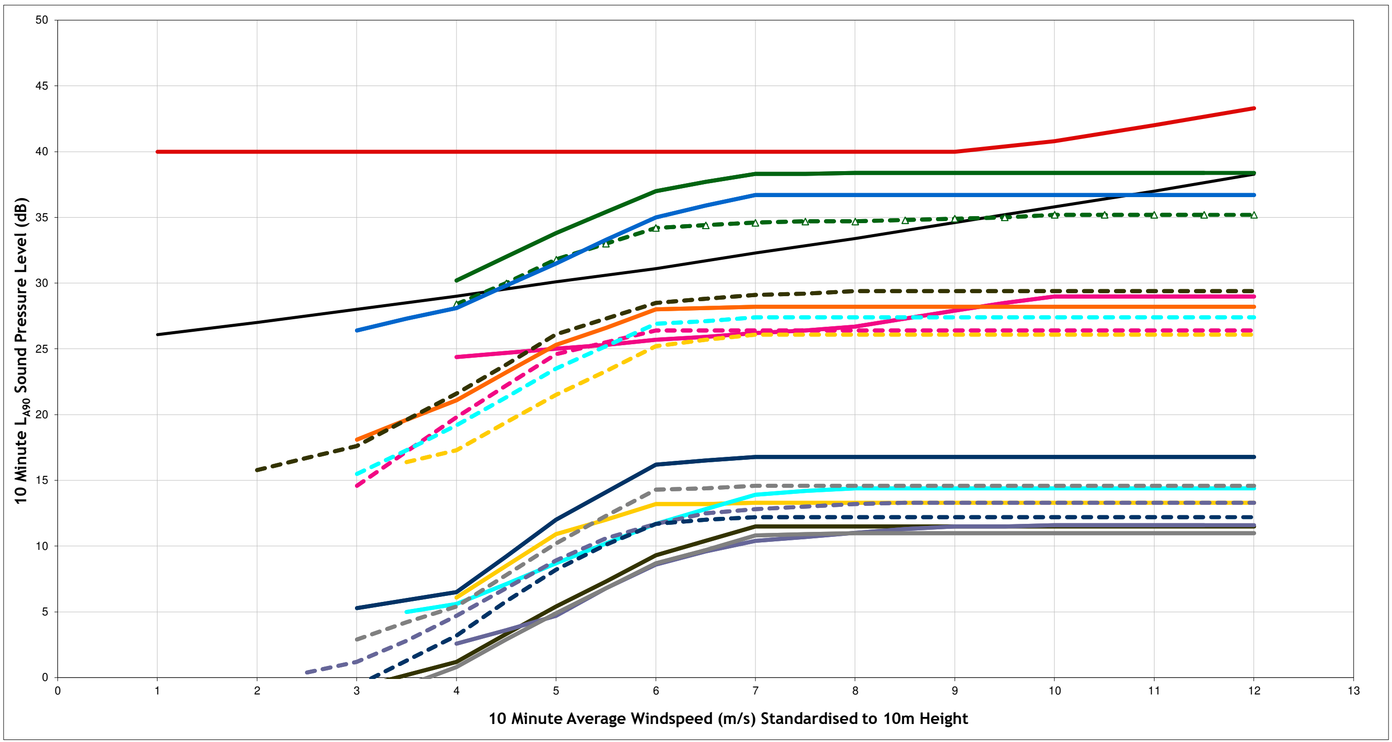


Legend:

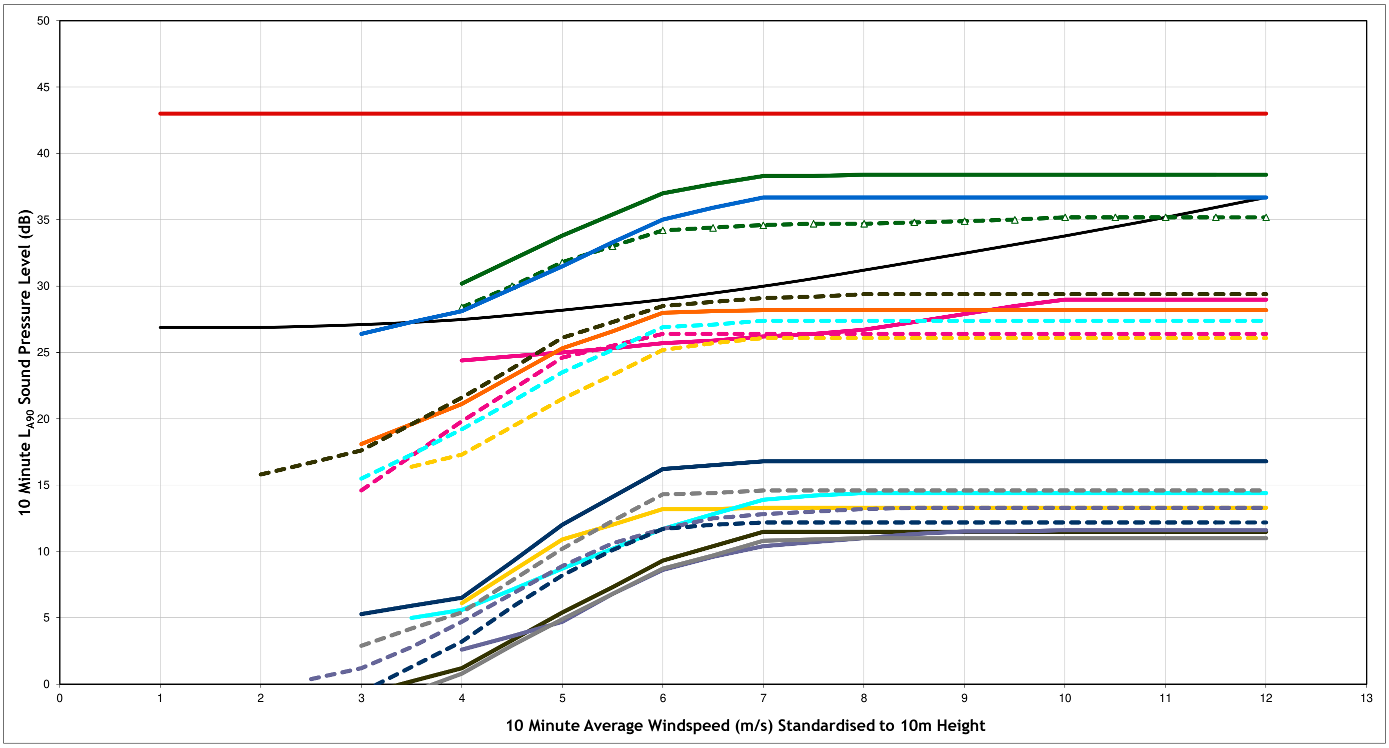
- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Blairoch Cairnhead (NAL12)
Figure Number	Figure A1.3l
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

Daytime - Cairnhead (Bothy) (NAL13)



Night Time - Cairnhead (Bothy) (NAL13)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative (inc. the Proposed Development)
- Cumulative (exc. the Proposed Development)
- Proposed Development
- Wether Hill
- Afton
- Sanquhar Community Wind Farm
- Whiteside Hill
- Windy Rig
- Twentyshilling
- Troston Loch
- Lorg
- Cornharrow
- Sanquhar II
- Euchanhead
- Manquhill
- Cloud Hill
- Margree
- Glenshimmeroch

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Likely Predictions Cairnhead (Bothy) (NAL13)
Figure Number	Figure A1.3m
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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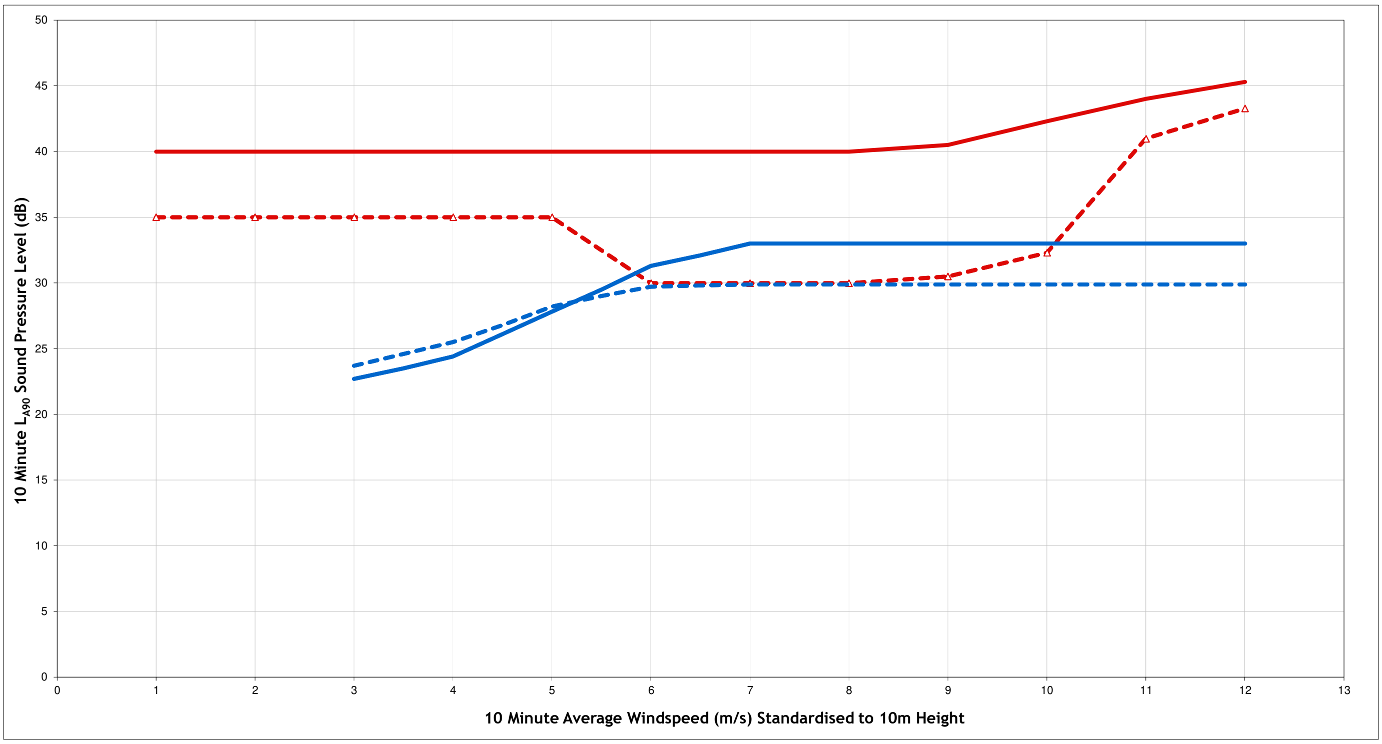
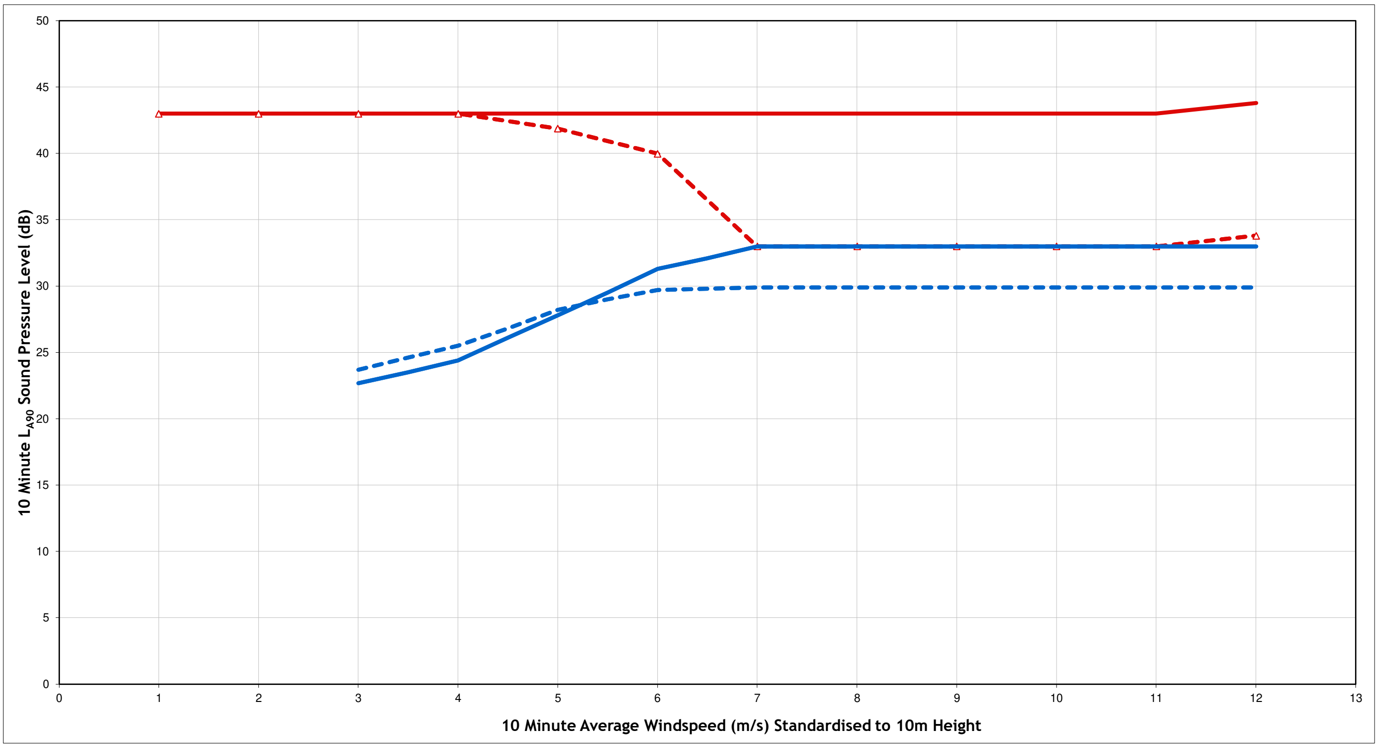
Daytime - Shinnelhead (NAL1)



Night Time - Shinnelhead (NAL1)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)
- Proposed Development (Mode Management in effect)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Shinnelhead (NAL1)
Figure Number	Figure A1.4a
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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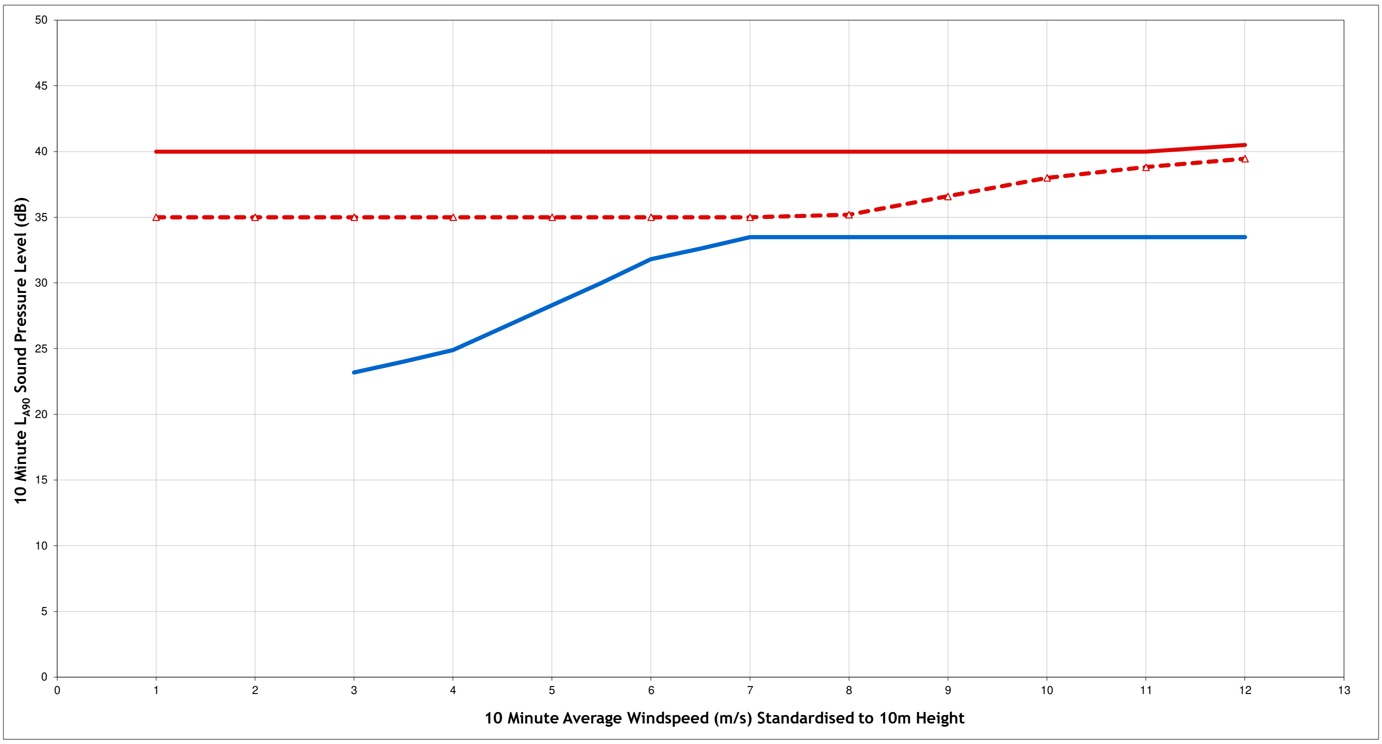
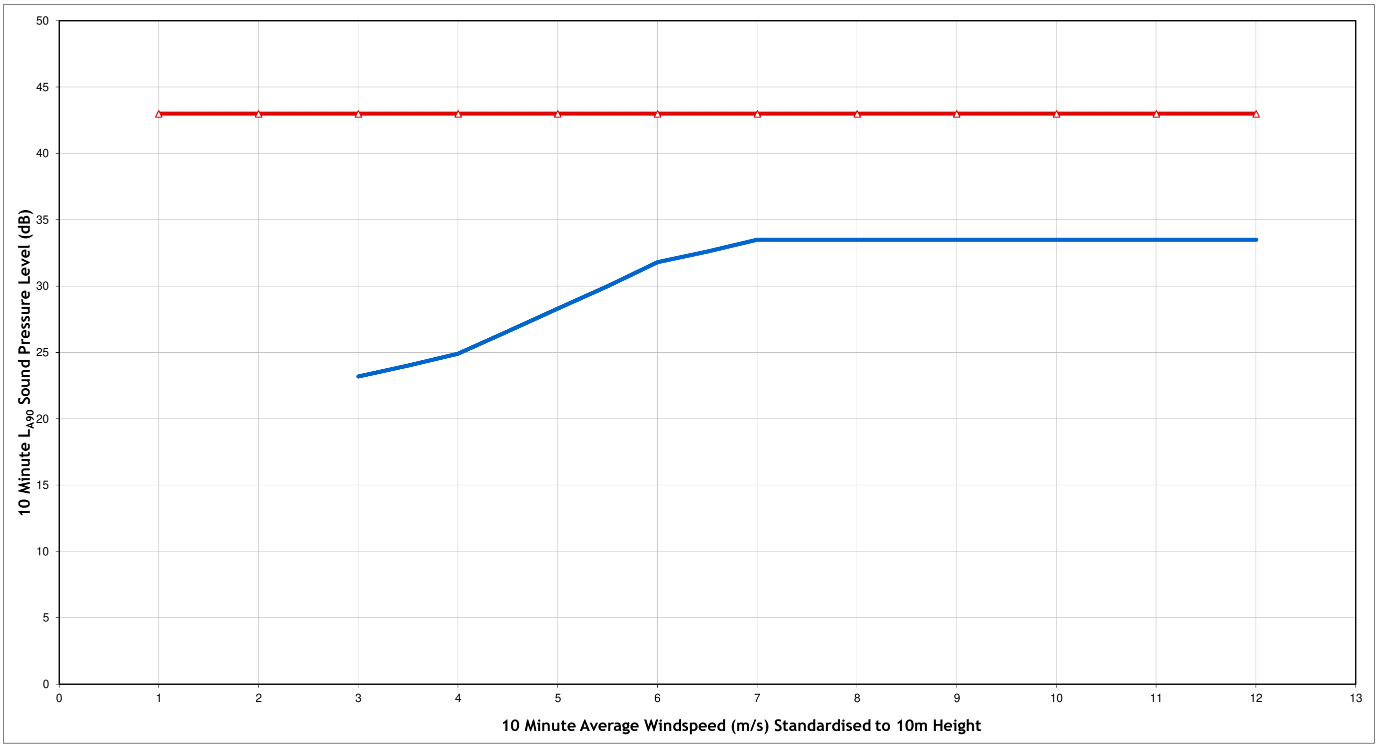
Daytime - High Appin (NAL2)



Night Time - High Appin (NAL2)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits High Appin (NAL2)
Figure Number	Figure A1.4b
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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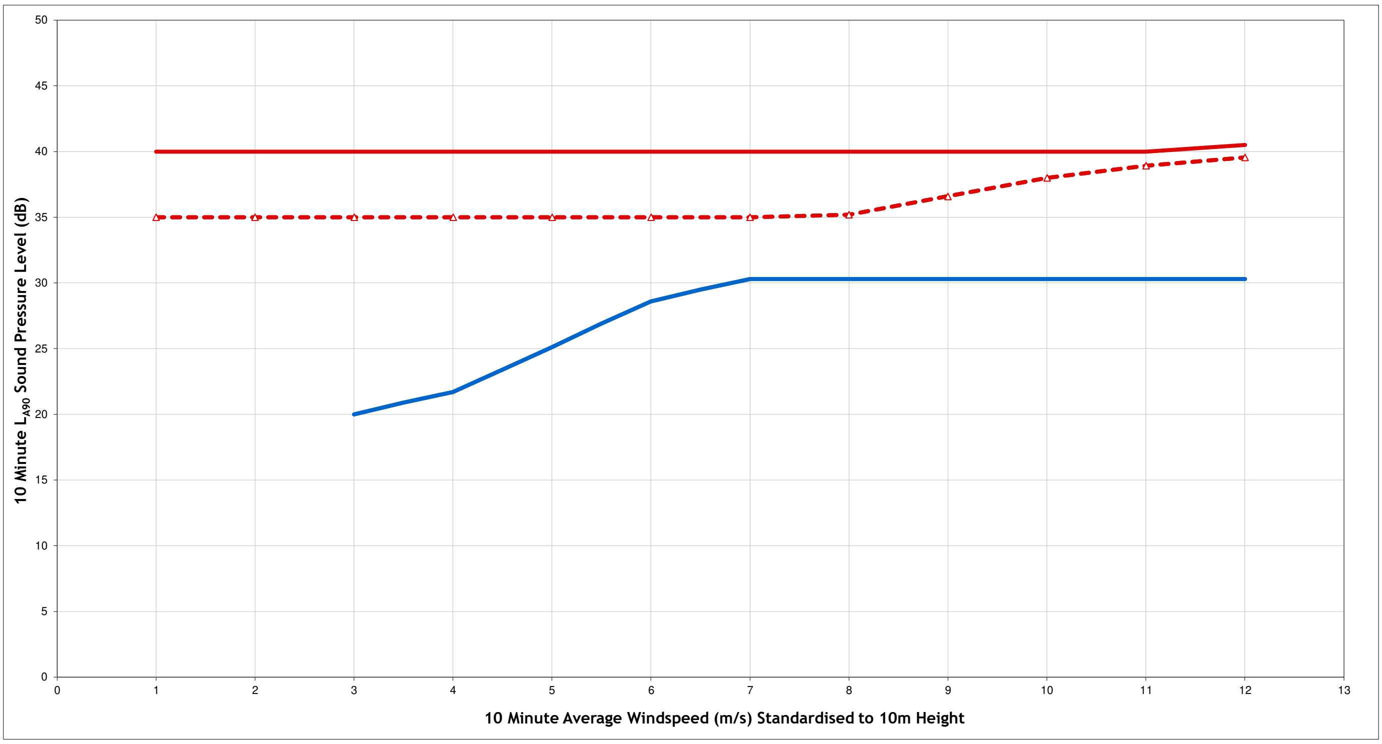
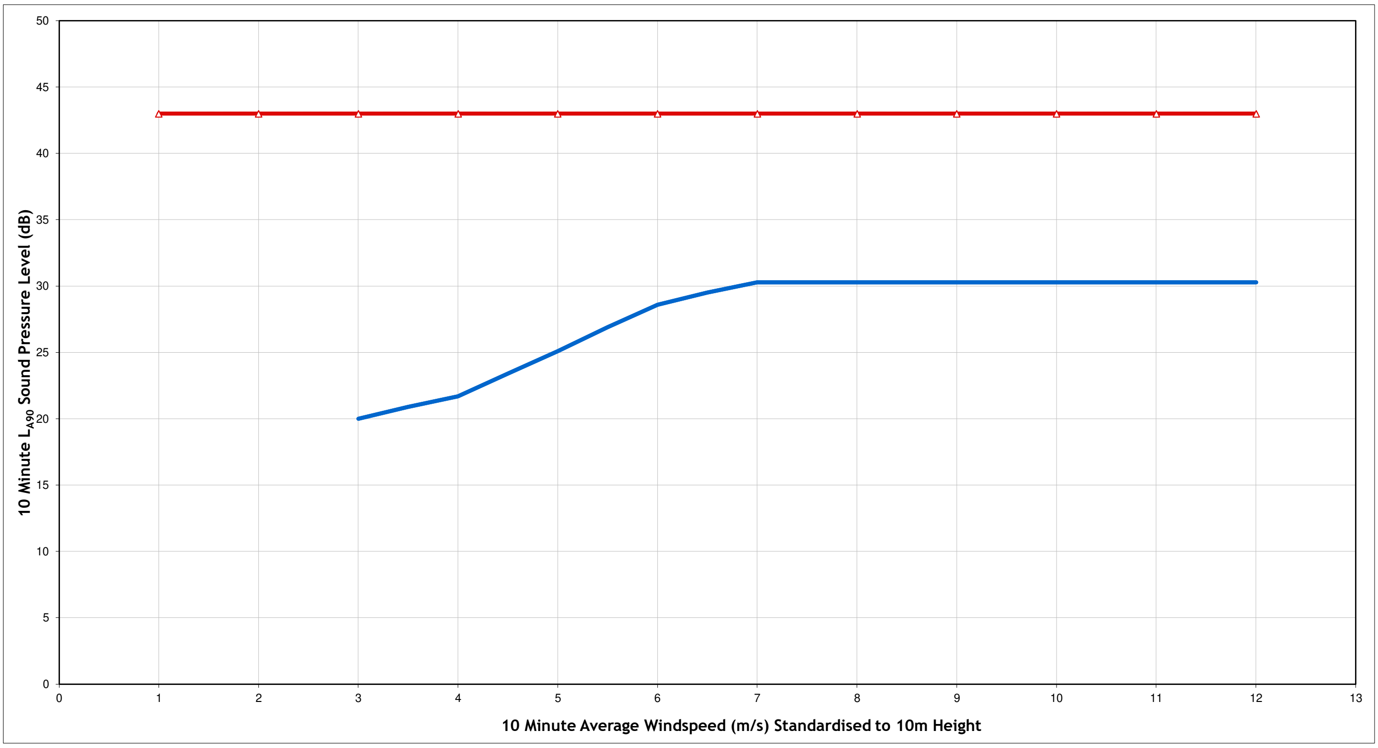
Daytime - Appin Lodge (NAL3)



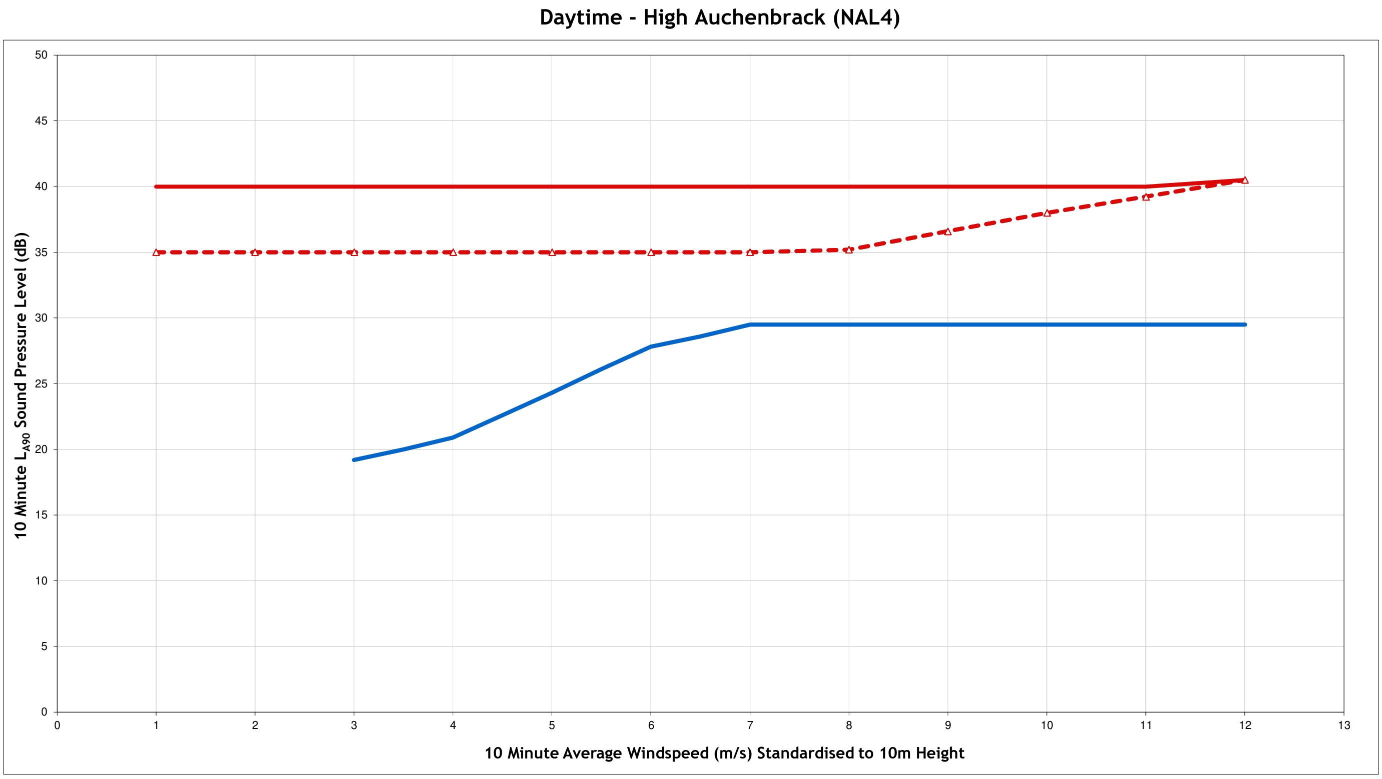
Night Time - Appin Lodge (NAL3)

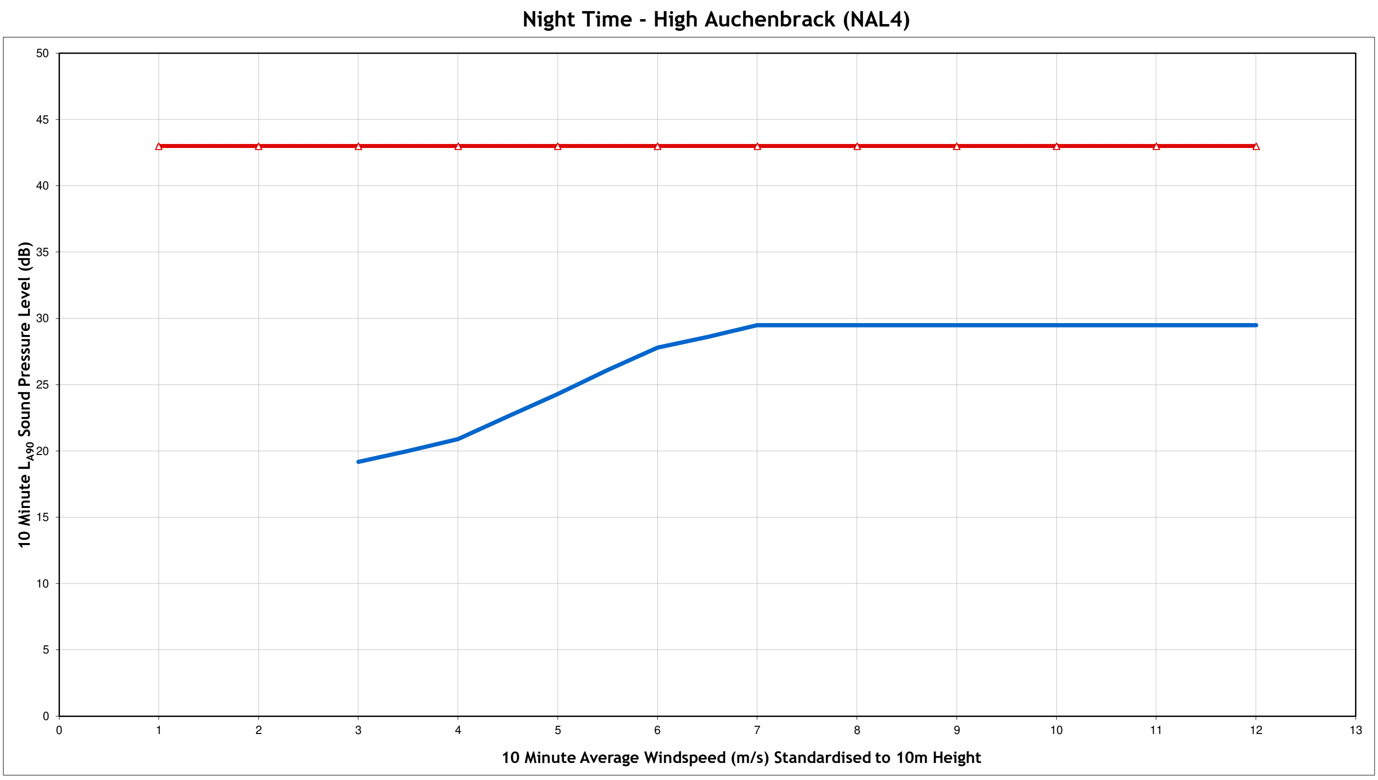


Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Appin Lodge (NAL3)
Figure Number	Figure A1.4c
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models





Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits High Auchenbrack (NAL4)
Figure Number	Figure A1.4d
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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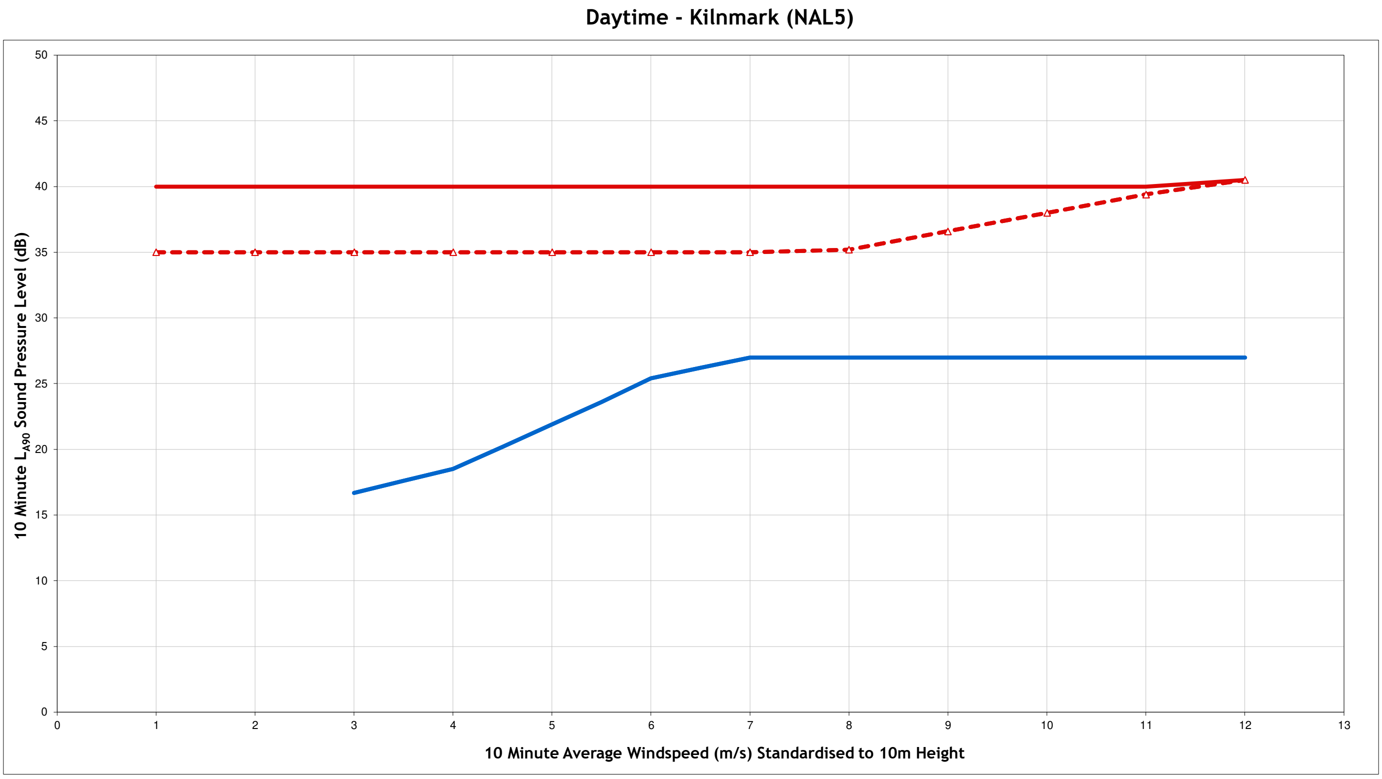

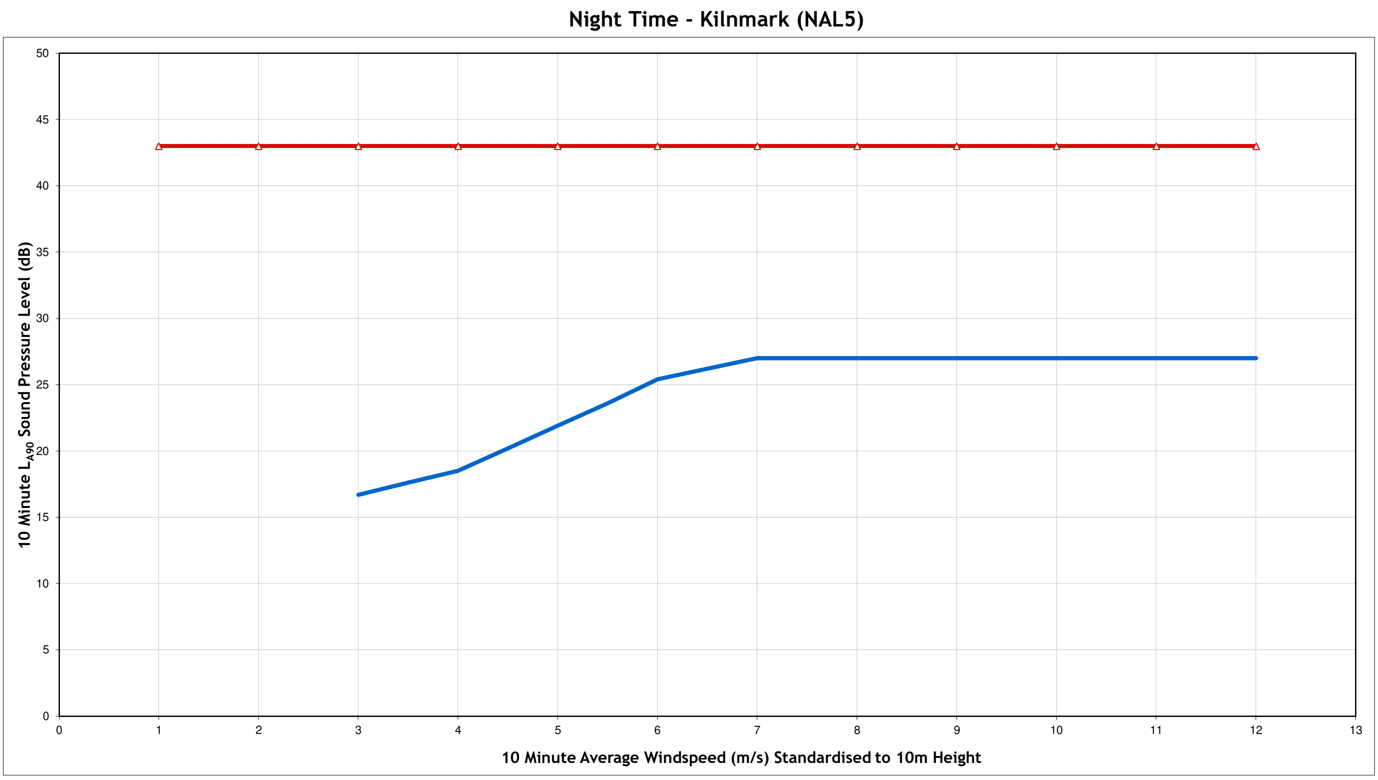

Legend:

Total ETSU-R-97-Limit

Site Specific Limits

Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Kilnmark (NAL5)
Figure Number	Figure A1.4e
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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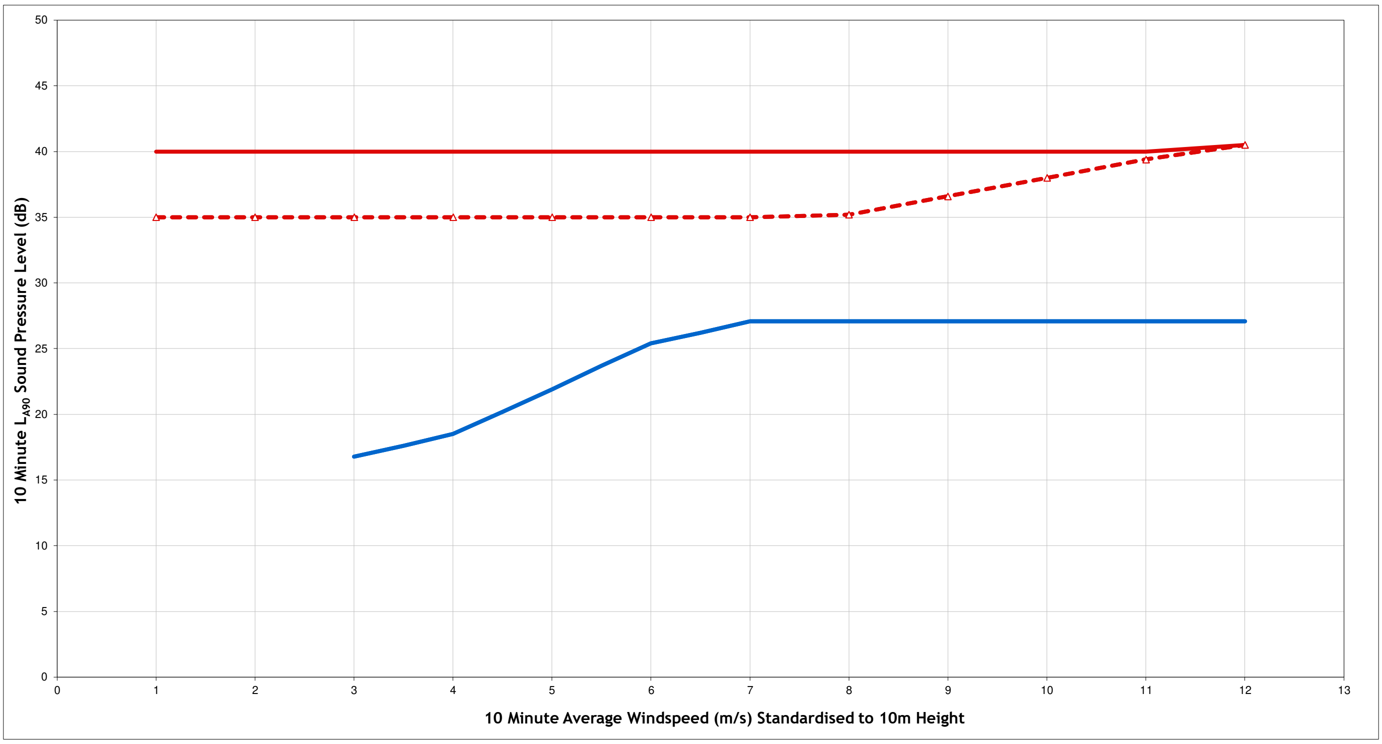
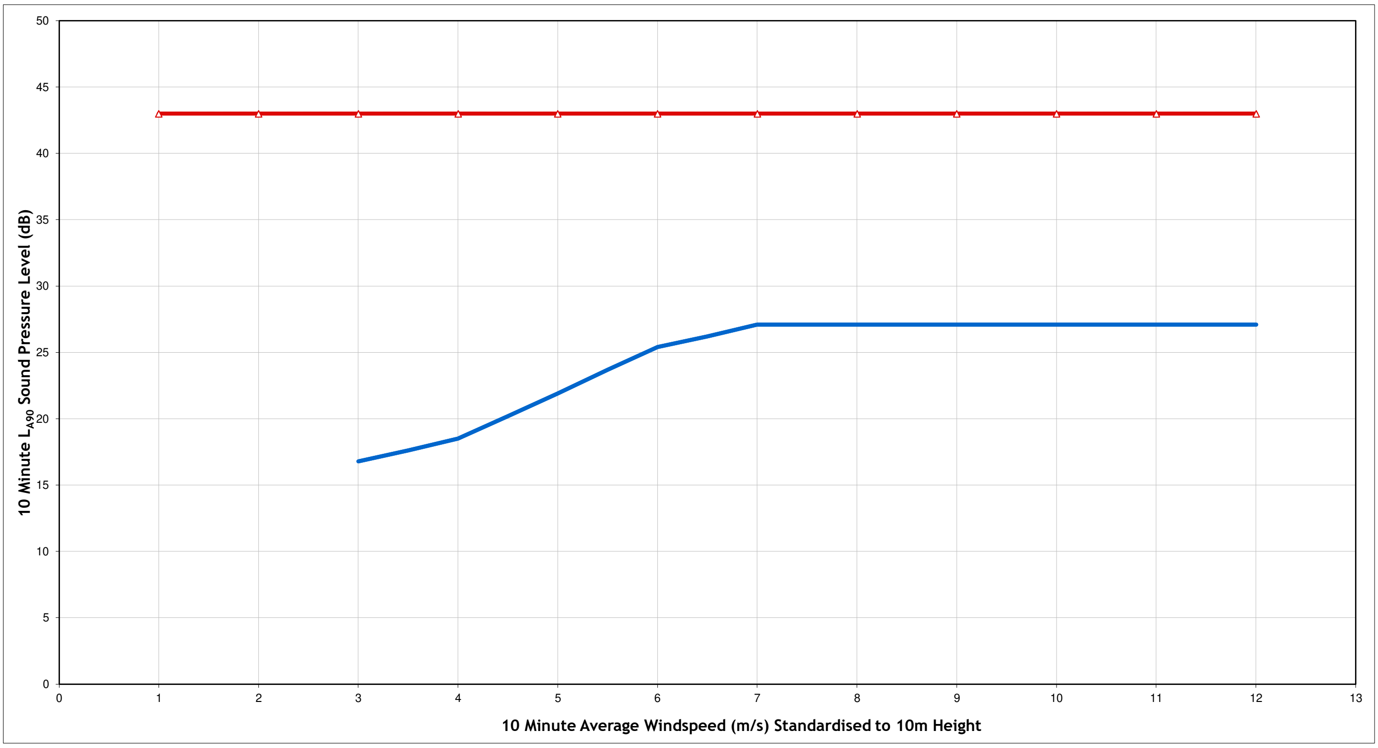
Daytime - Auchenbrack (NAL6)



Night Time - Auchenbrack (NAL6)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Auchenbrack (NAL6)
Figure Number	Figure A1.4f
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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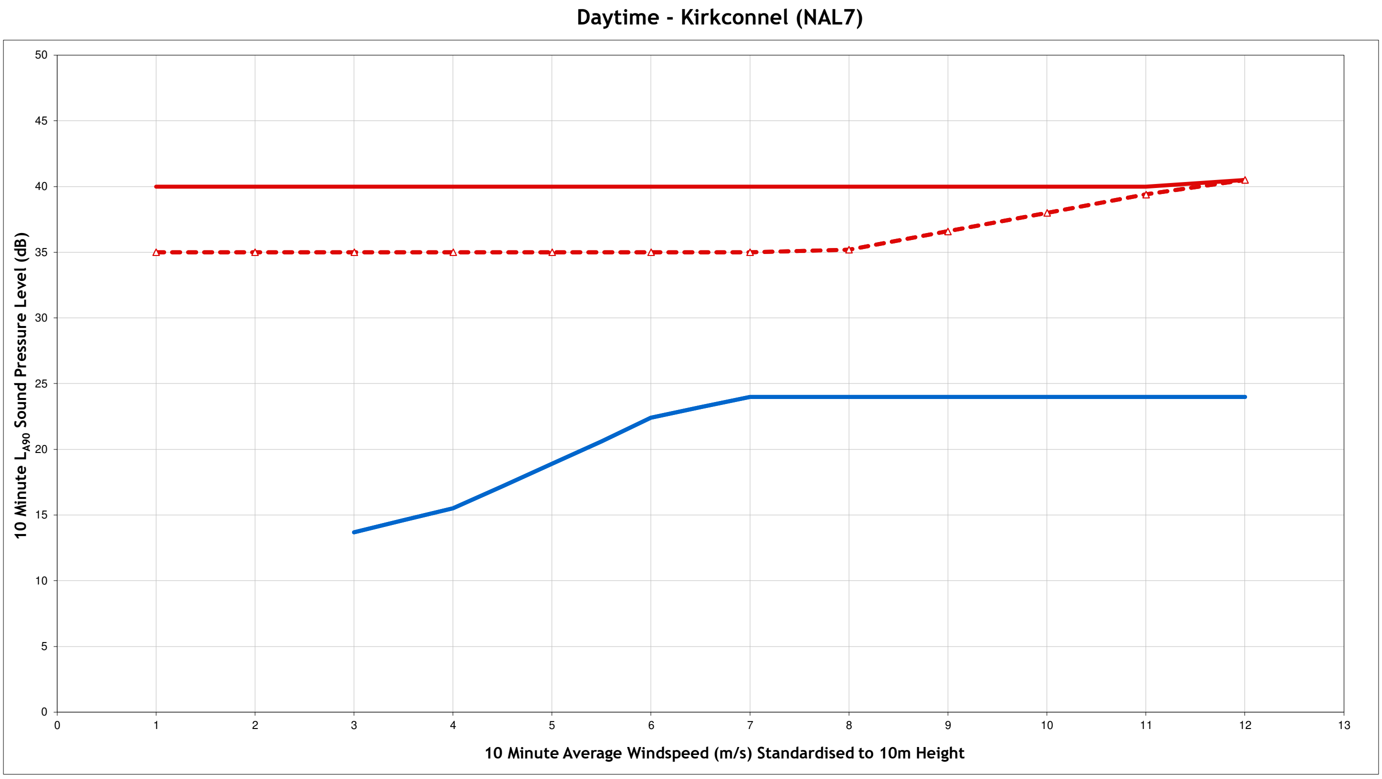

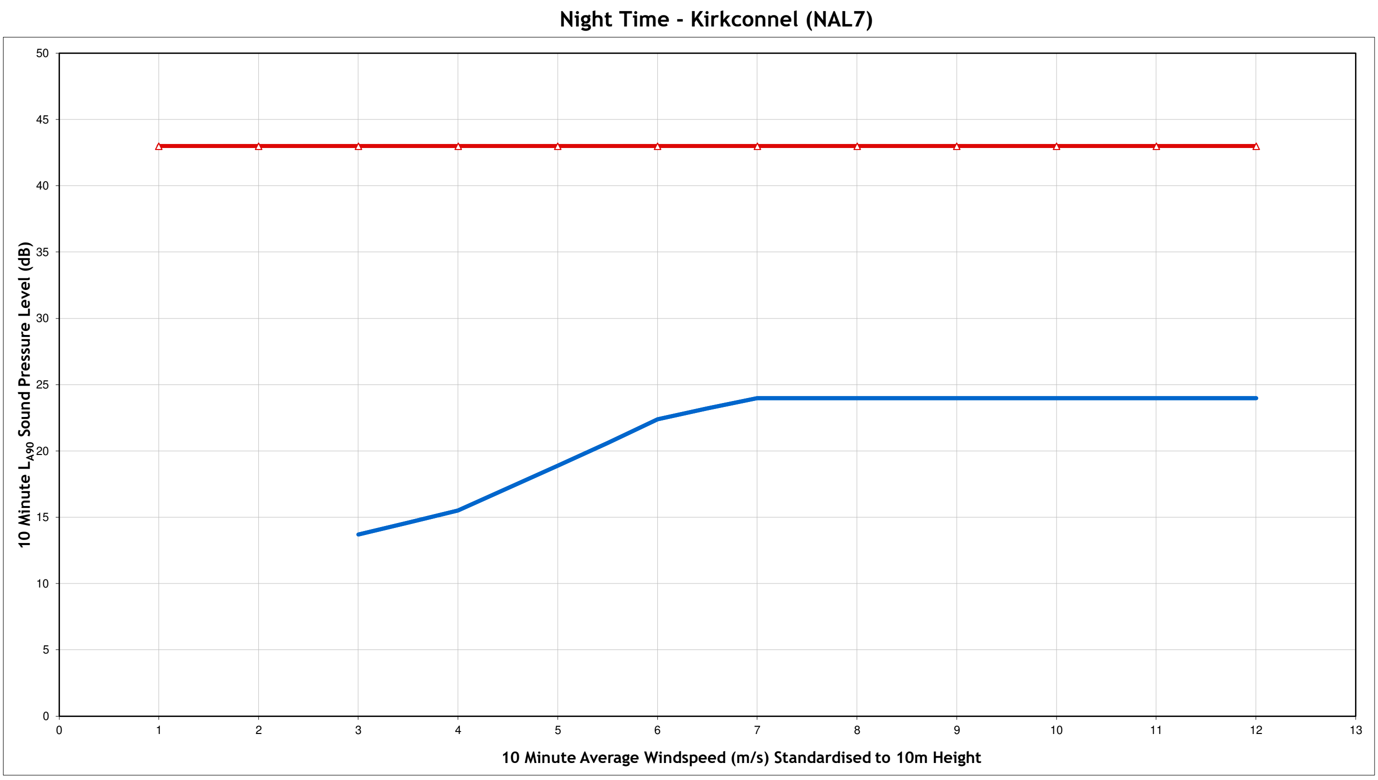

Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Kirkconnel (NAL7)
Figure Number	Figure A1.4g
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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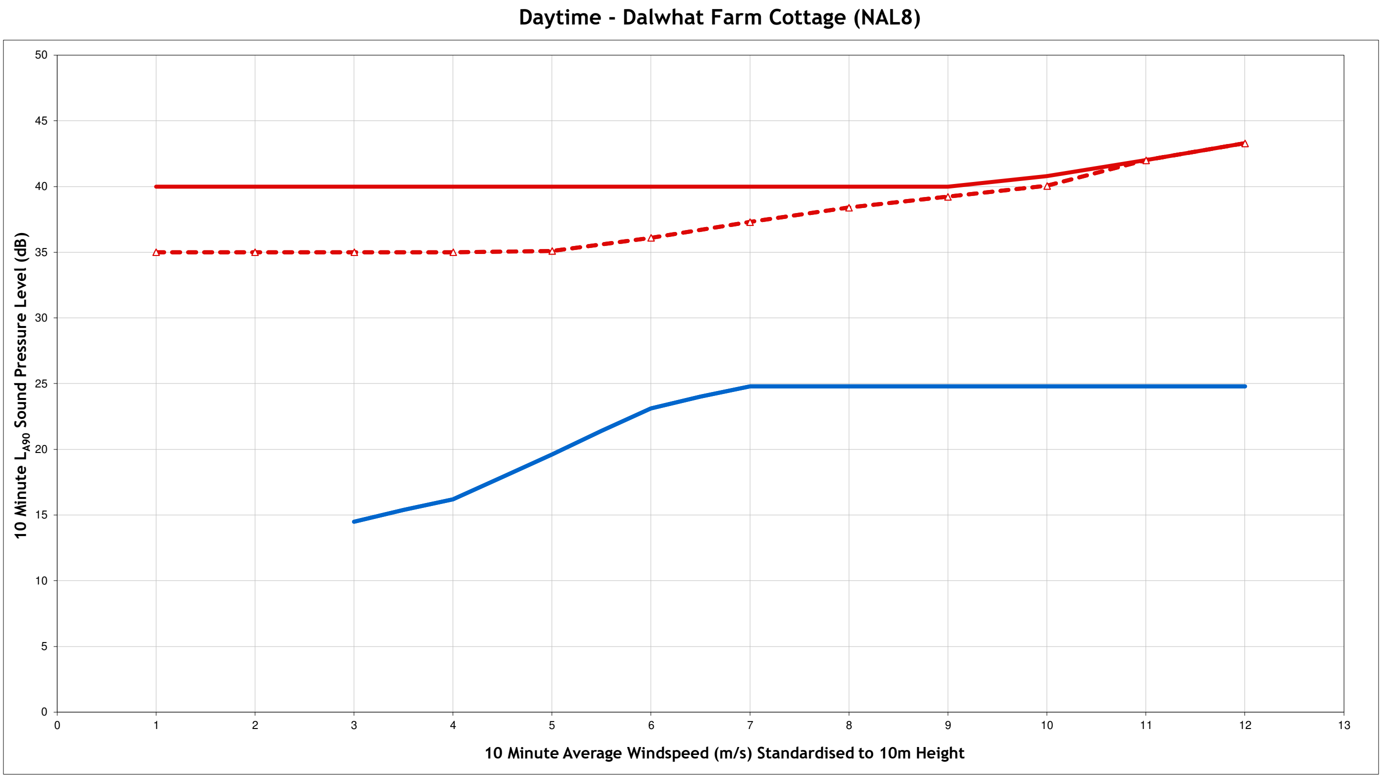

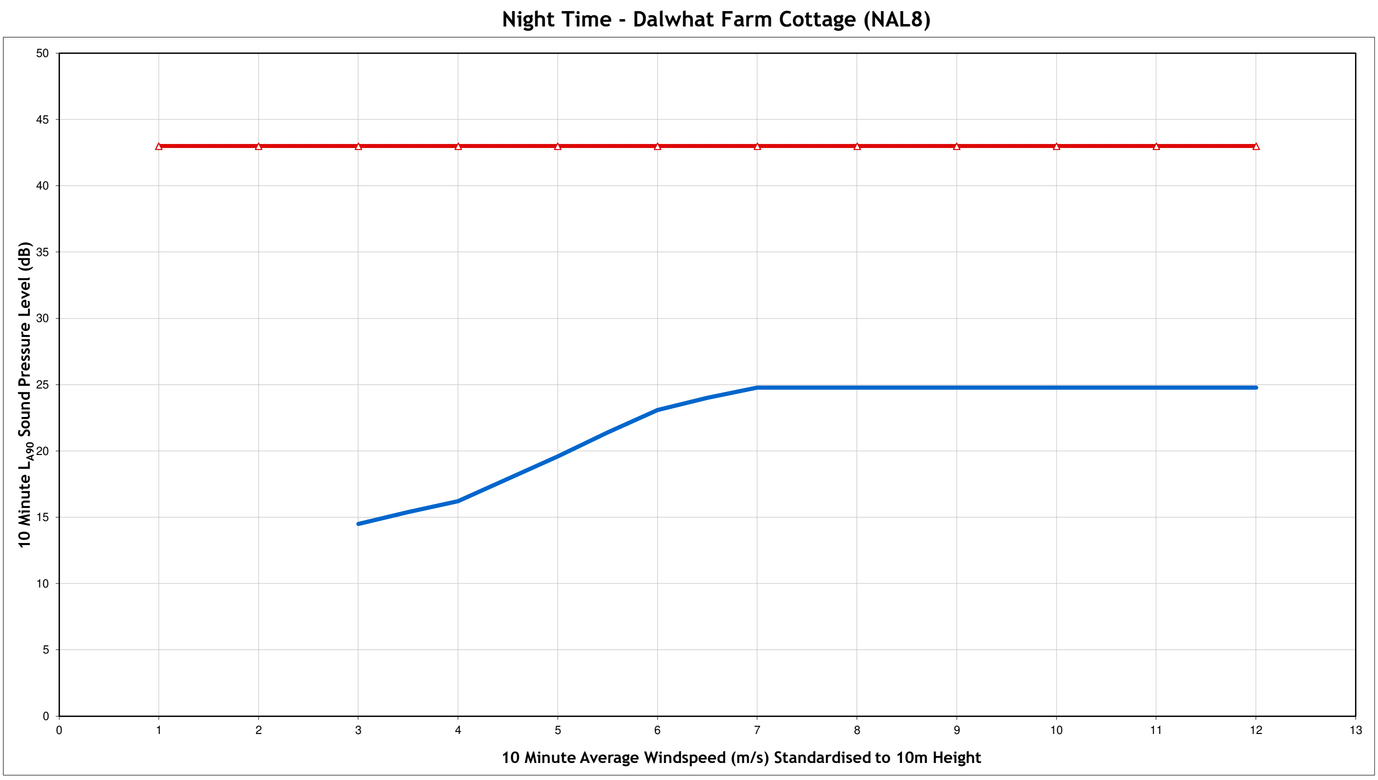

Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Dalwhat Farm Cottage (NAL8)
Figure Number	Figure A1.4h
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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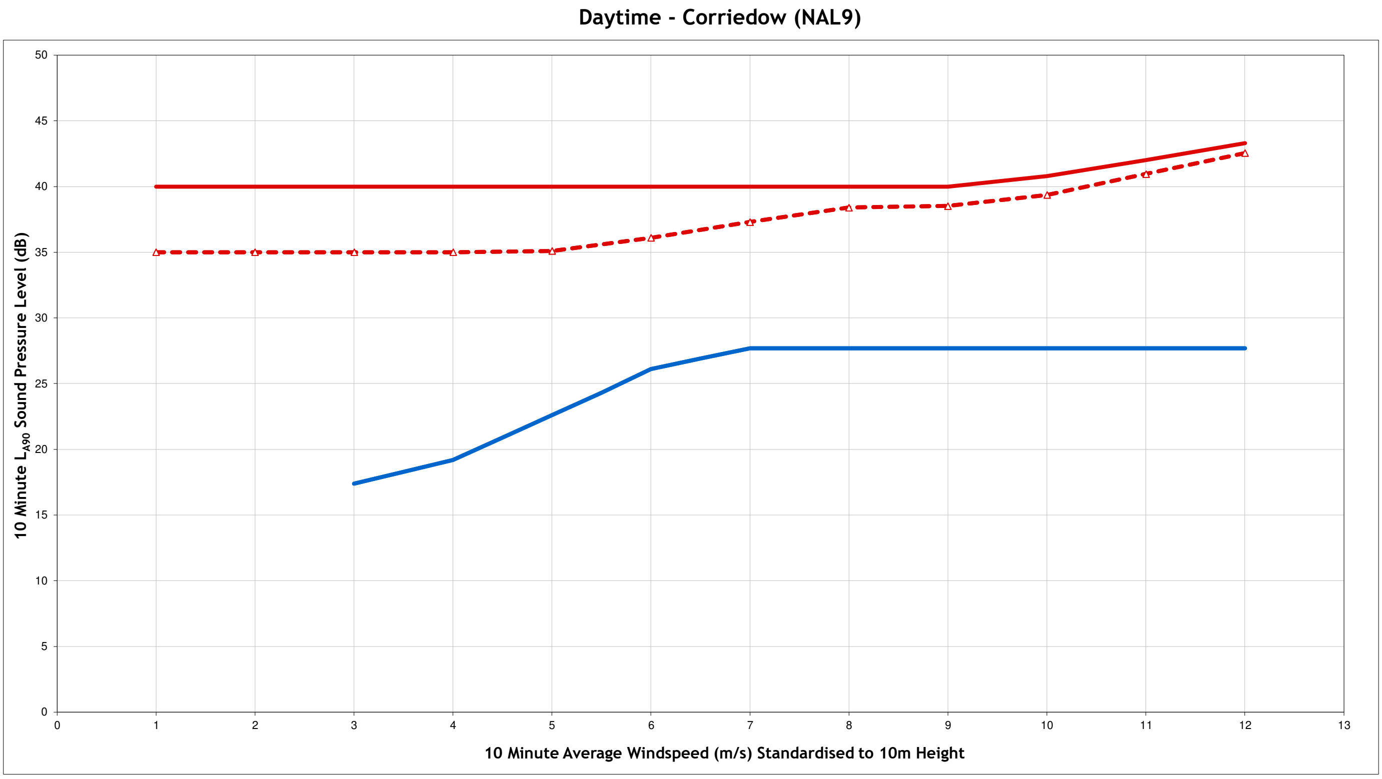

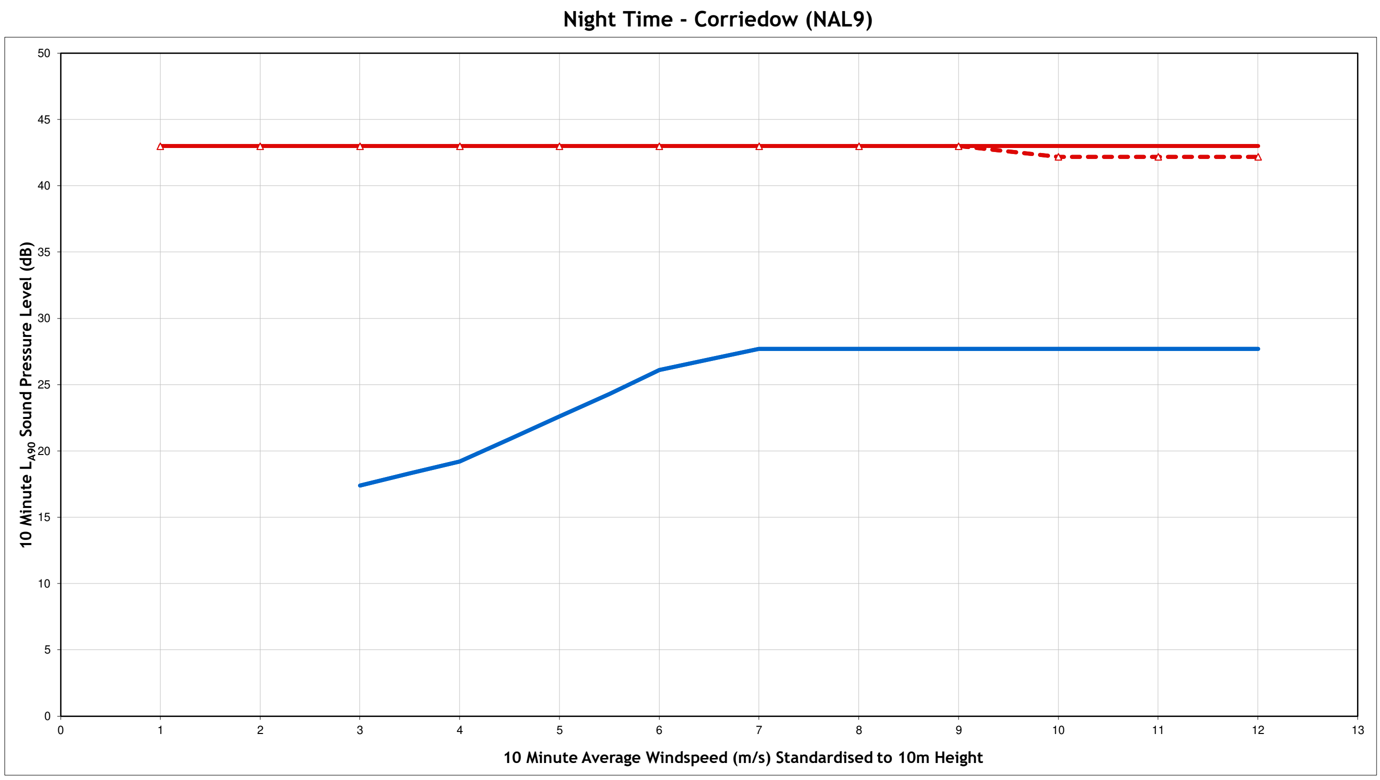

Legend:

Total ETSU-R-97-Limit

Site Specific Limits

Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Corriedow (NAL9)
Figure Number	Figure A1.4i
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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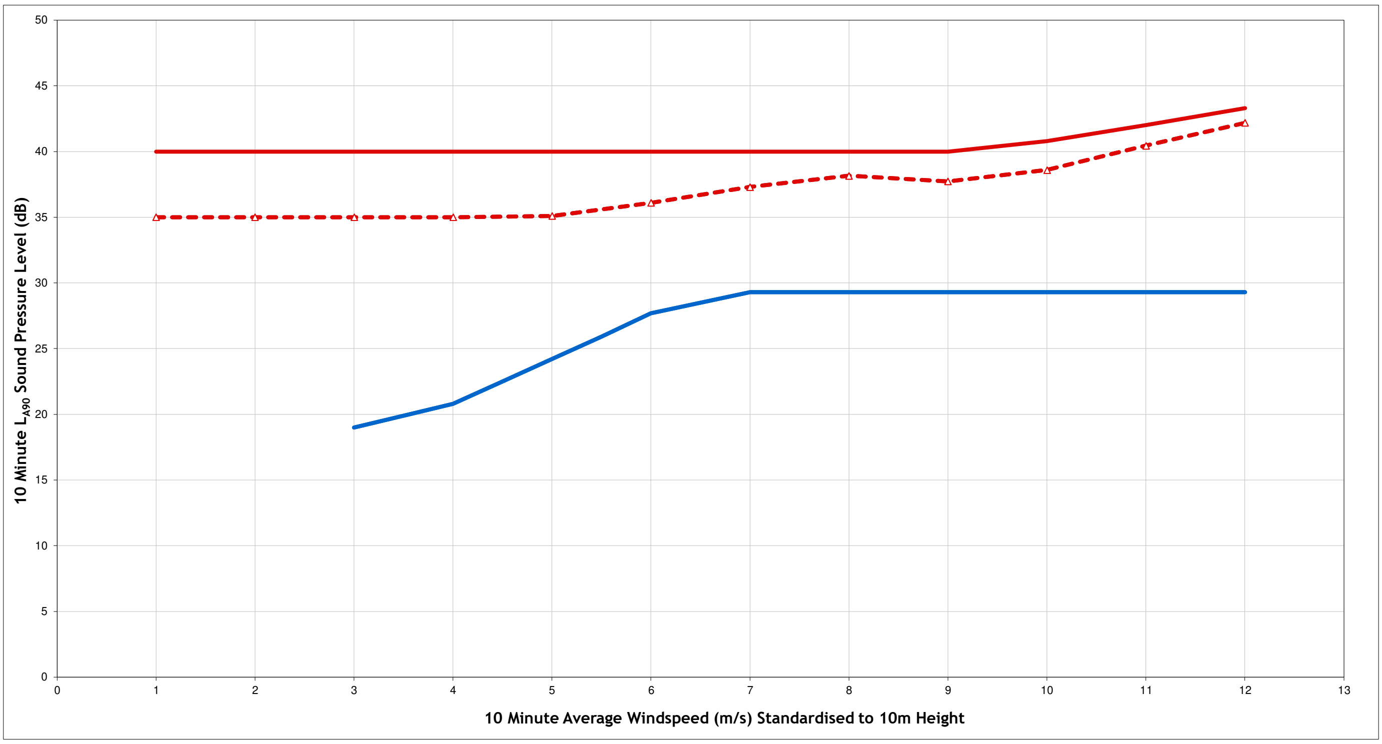
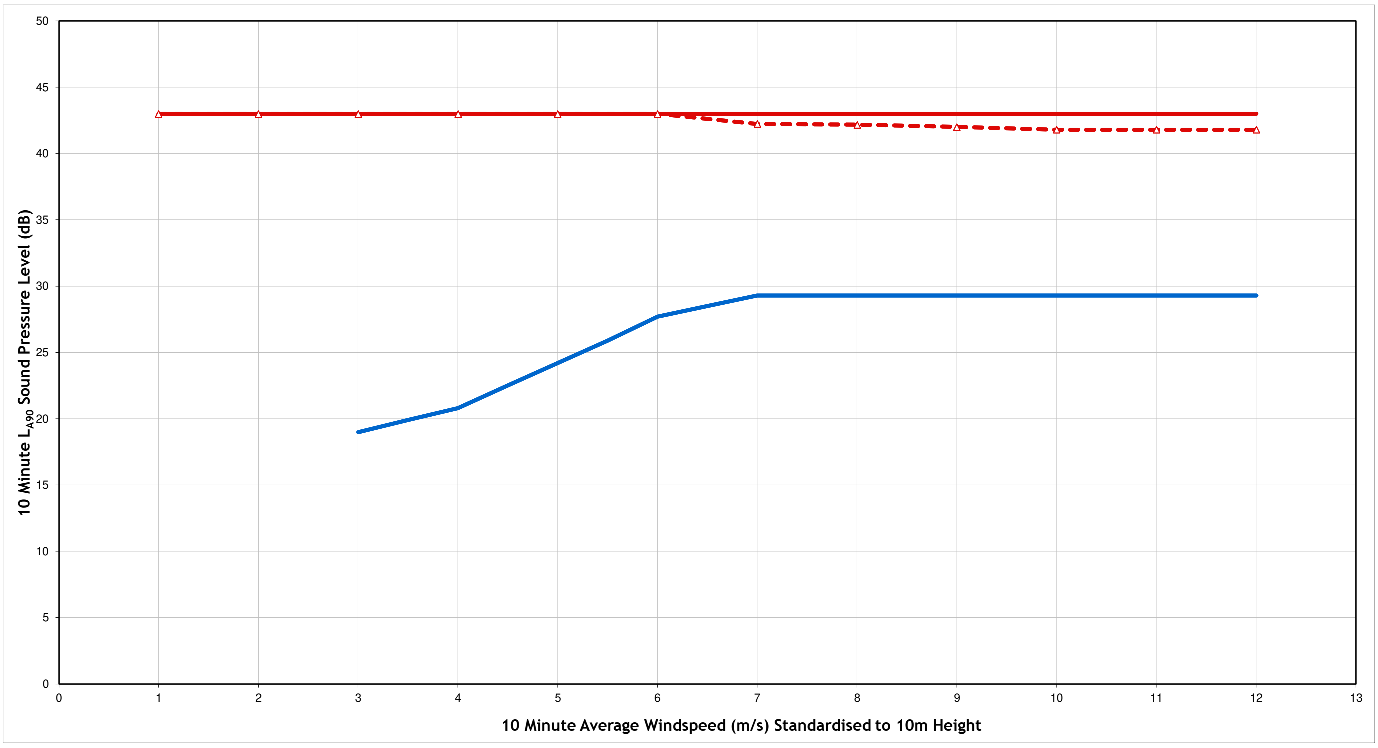
Daytime - Glenjaan (NAL10)



Night Time - Glenjaan (NAL10)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Glenjaan (NAL10)
Figure Number	Figure A1.4j
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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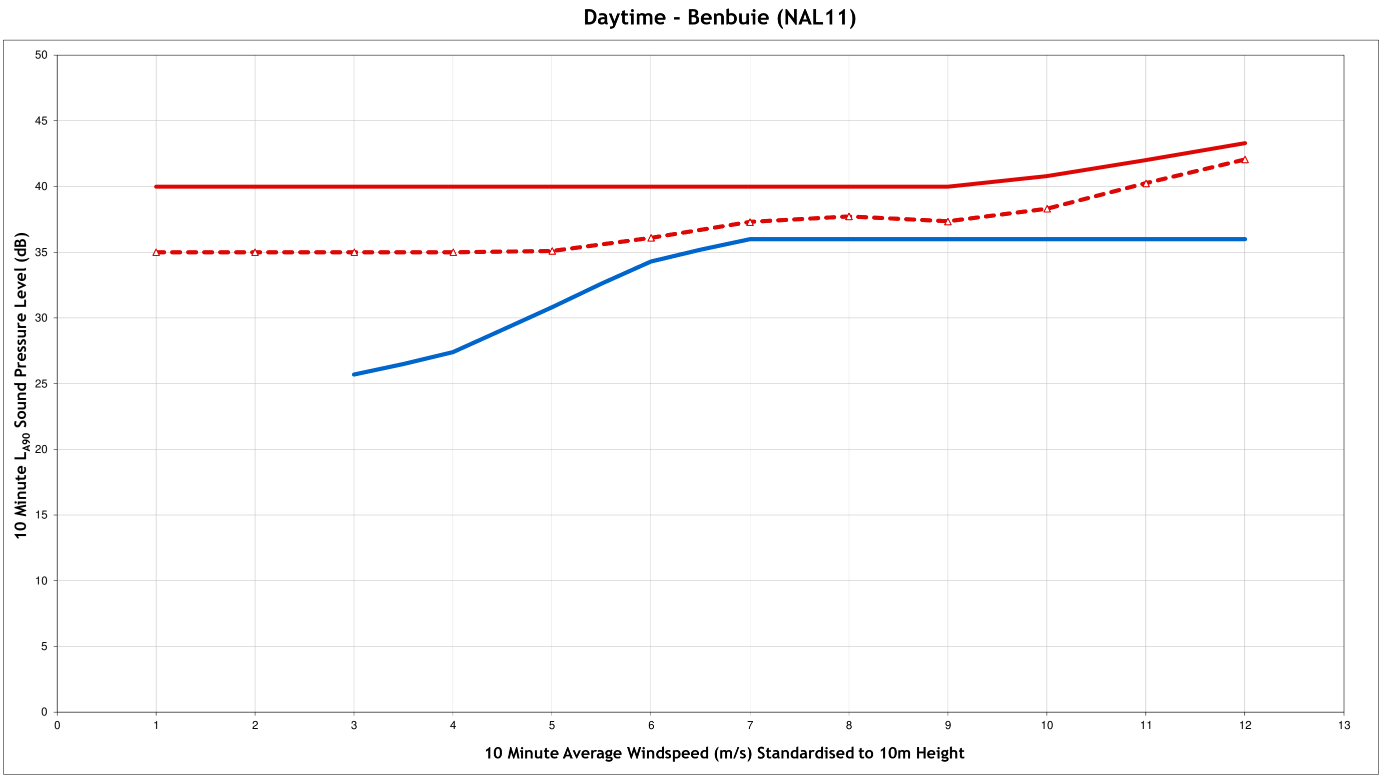

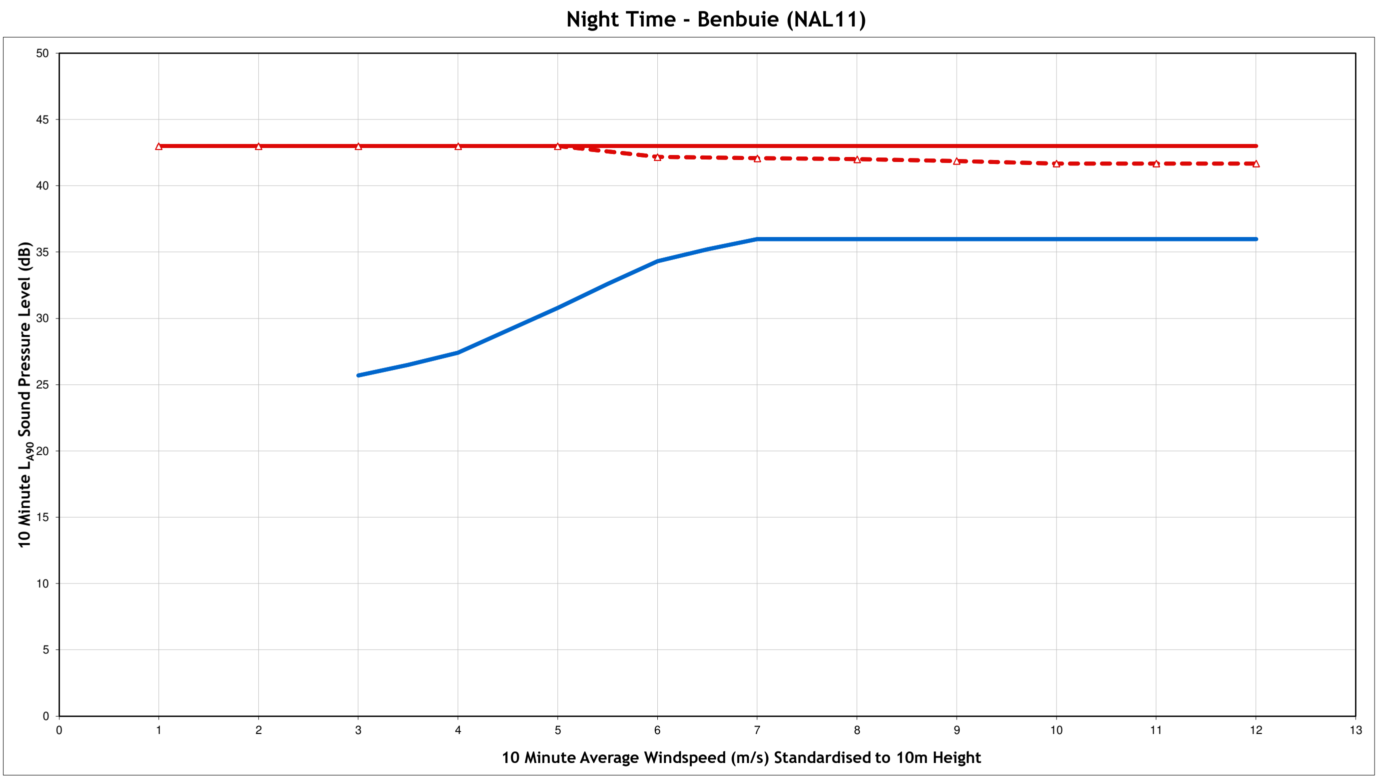

Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Benbuie (NAL11)
Figure Number	Figure A1.4k
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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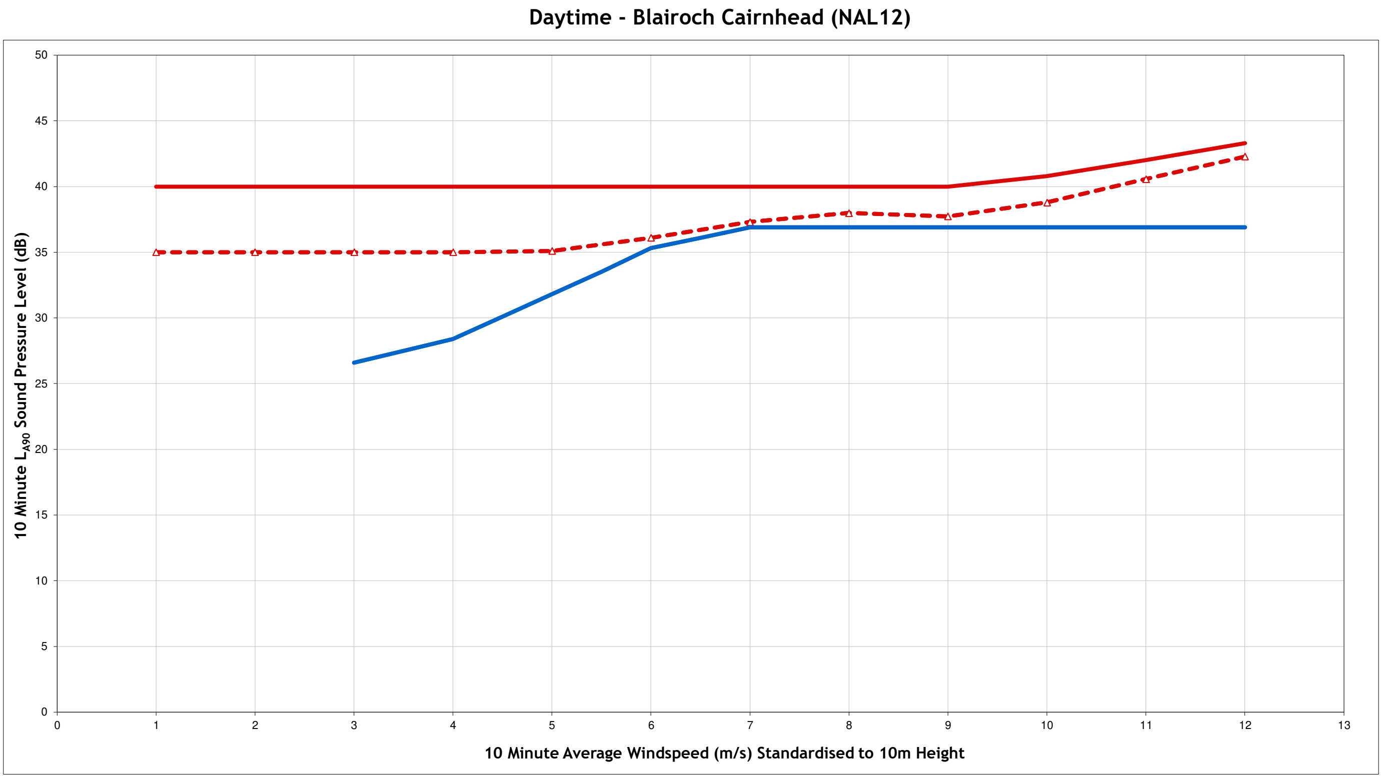

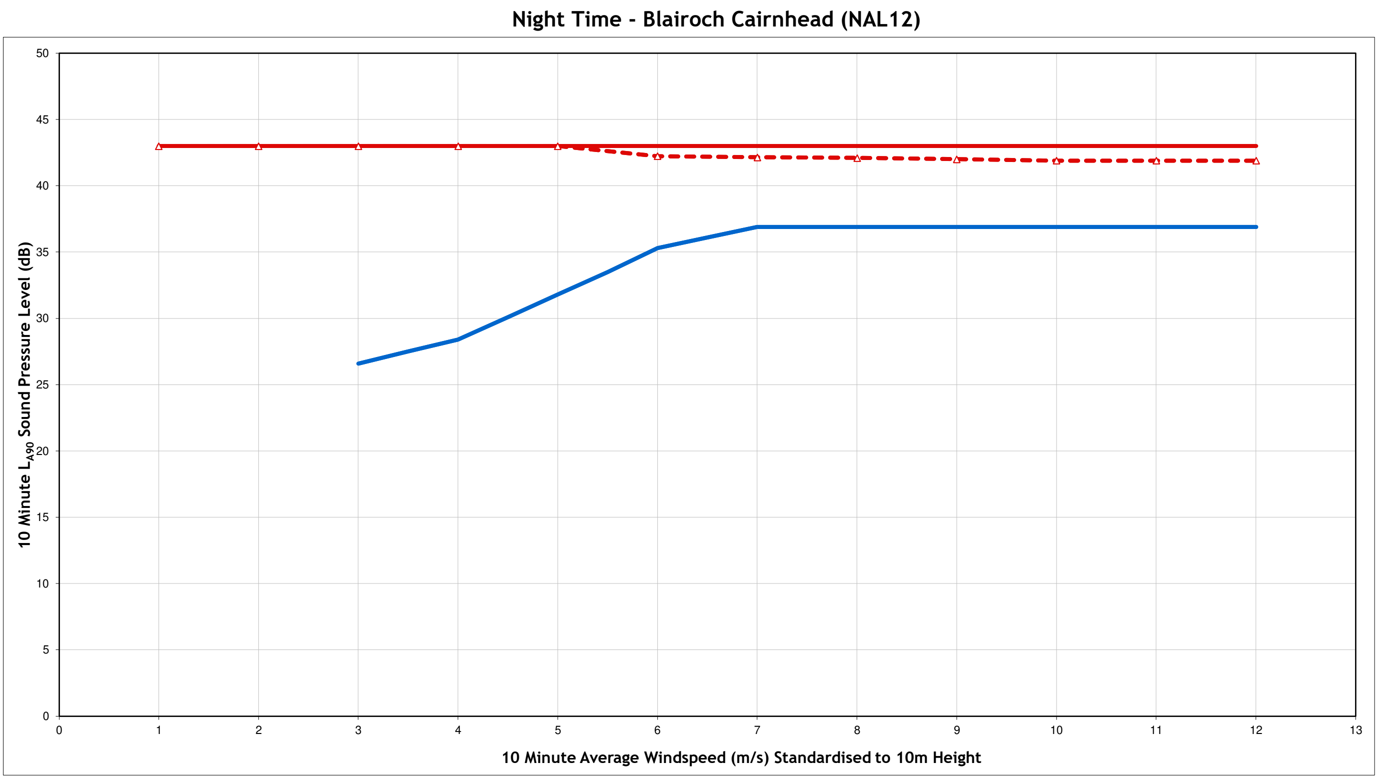

Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Blairoch Cairnhead (NAL12)
Figure Number	Figure A1.4l
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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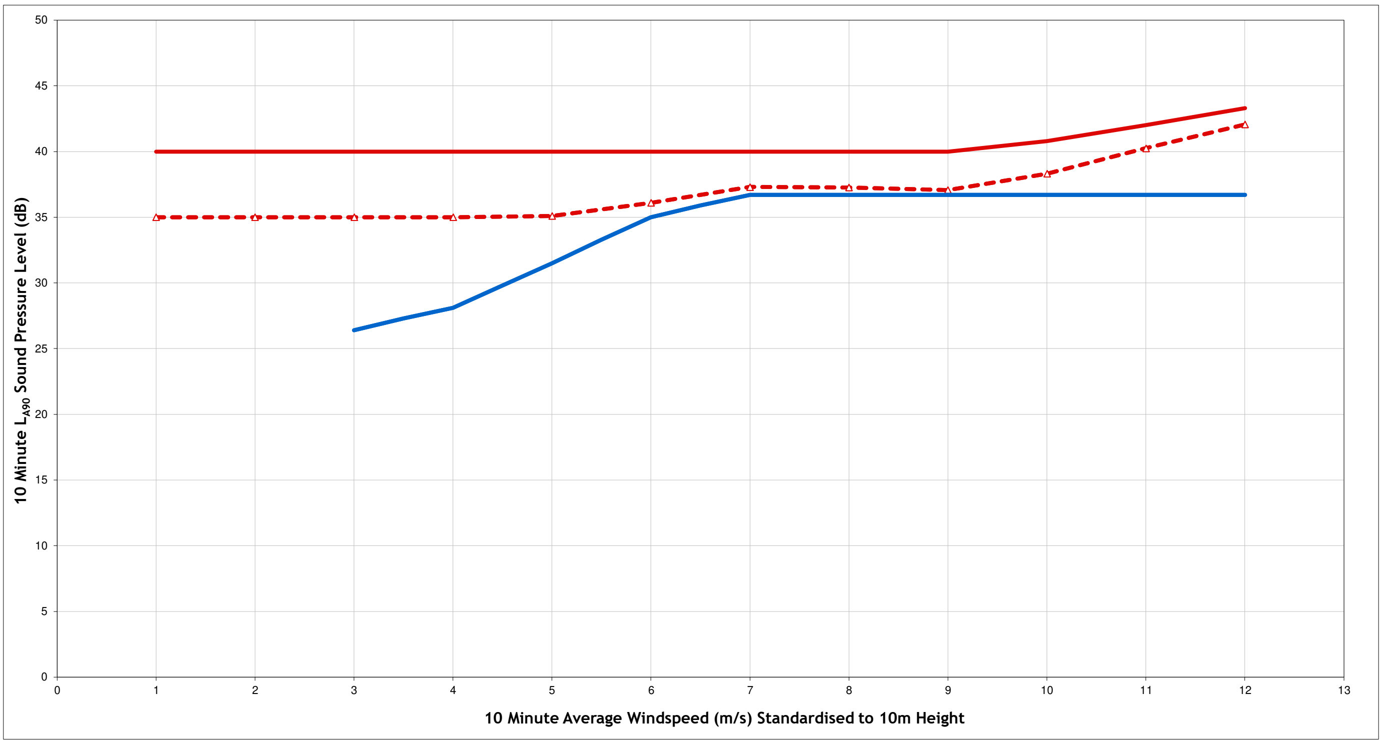
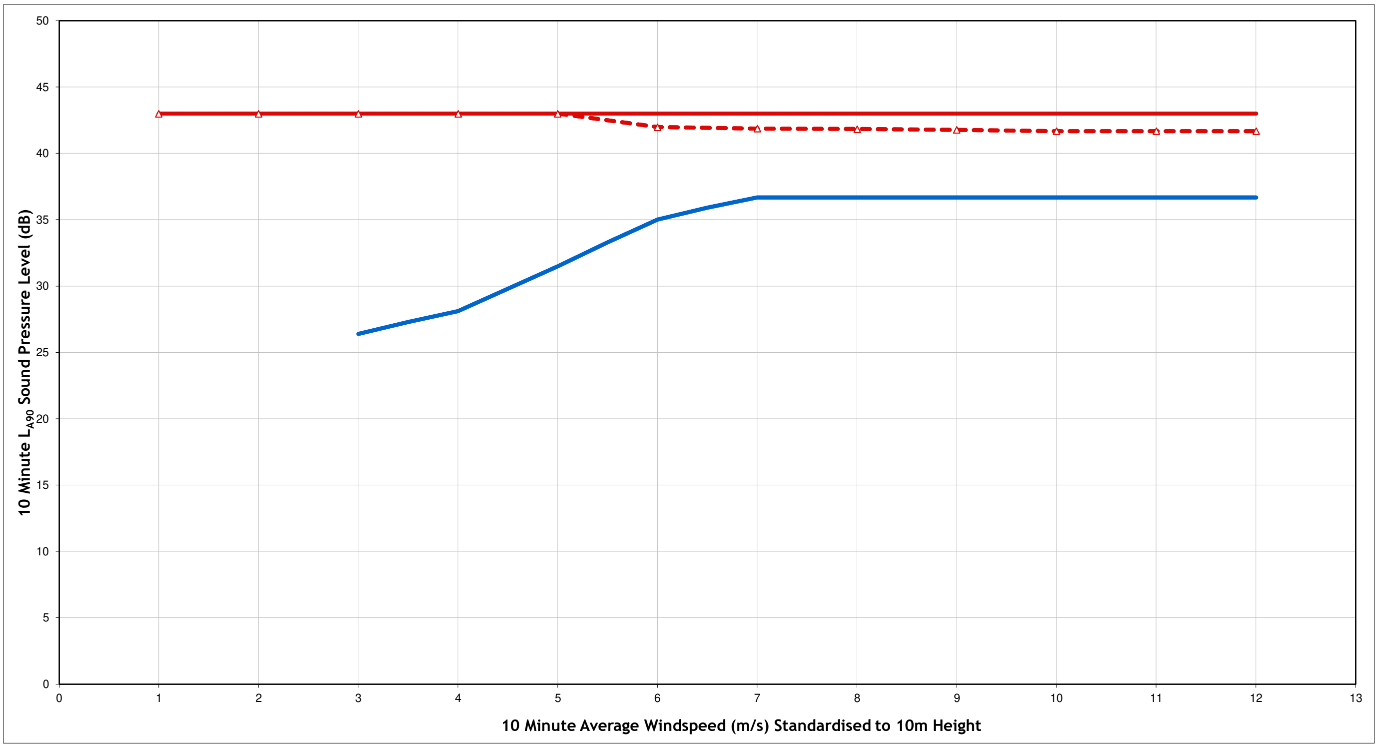
Daytime - Cairnhead (Bothy) (NAL13)



Night Time - Cairnhead (Bothy) (NAL13)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development (Full Mode)

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Noise Assessment - Site Specific Noise Limits Cairnhead (Bothy) (NAL13)
Figure Number	Figure A1.4m
Scale	NTS
Drawn	AD
Checked	GC
Date	23/04/2025
Document Reference	14711-Models

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Annex 2 – Correspondence with the Environmental Health Department at the Council

15 June, 2022

Ref: 14711-004 R0

Copy: Sent by email only

William Jackson
Environmental Health Officer
Environmental Health (Safety Services)
Council Offices
Buccleuch Street
Dumfries
DG1 2AD

Dear Mr Jackson,

PROPOSED APPIN WIND FARM ON LAND TO THE WEST OF THORNHILL AND NORTH WEST OF MONIAIVE, DUMFRIES AND GALLOWAY: NOISE ASSESSMENT

Appin Wind Farm Limited on behalf of Statkraft UK Limited ('hereinafter referred to as the Applicant') is proposing to develop a wind farm ('the proposed development') on land approximately 12.5 km to the west of Thornhill and 7 km north west of the village of Moniaive. The Applicant submitted a Scoping Report for the proposed development in March 2022, although we note that no comments from Environmental Health Department has been included within Dumfries and Galloway Council's overarching Scoping response. An indicative turbine layout is shown on the enclosed Figure 1.

Noise would be emitted from the proposed development during the construction, operation and decommissioning phases. Noise emitted during the construction and decommissioning phases would be temporary and short term in nature and can be minimised through careful construction practices. Operational noise would be controlled through the use of appropriate noise limits, which would be imposed to protect the amenity of neighbouring properties without unduly restricting wind energy development. Operational noise limits need to be derived at an early stage of the development to ensure they are satisfied throughout the design process.

We do not propose to separately consider decommissioning noise from the proposed development as the potential effects associated with this phase of the development are likely to be less than those occurring during construction and are likely to be of shorter duration. Hence, the construction noise assessment is considered to be the worst case.

TNEI Services Ltd (TNEI) has been appointed by the Applicant to undertake the noise assessment for the proposed development, and prior to commencing the noise assessment we would like to agree with you the noise assessment methodology and proposed background noise monitoring locations.

Construction Noise

A construction noise assessment will be undertaken to determine the potential noise impacts during the construction phase of the wind farm development. The construction noise assessment will be undertaken in accordance with the methodology outlined in British Standard (BS) 5228-1:2009+A1:2014 and ISO 9613-2:1996 (*'Acoustics - Attenuation of sound during propagation outdoors -Part 2: General method of calculation'*). Impacts will

Newcastle
7th Floor, West One
Forth Banks
Newcastle Upon Tyne
NE1 3PA
Tel: +44(0)191 211 1400

be assessed using criteria contained within BS 5228 and, where appropriate, mitigation measures will be proposed.

Operational Noise

An operational noise assessment will be undertaken in accordance with ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* (ETSU-R-97) and the Institute of Acoustics document *'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). In relation to wind turbine noise PAN 1/2011 *'Planning and Noise'* refers to the Scottish Governments 'Onshore Wind Turbines' web based document which states that:

"ETSU-R-97 describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available".

and;

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

The noise limits derived in the assessment would inform appropriate noise related planning conditions should an application be made and should Scottish Ministers be minded to grant consent.

ETSU-R-97

ETSU-R-97 describes the findings of the Working Group on Noise from Wind Turbines, the aim of which was to provide information and advice to developers and planners on the environmental assessment of operational noise from wind turbines.

ETSU-R-97 recommends noise limits should be set at 5 dB(A) above existing background noise levels, or a fixed minimum limit of 35-40 dB during the daytime and 43 dB during the night-time periods where background noise levels are low, and that these limits should reflect the variation in background noise with wind speed. Different limits apply to those properties that have a financial interest in the wind energy development (45 dB or background plus 5 dB (whichever is the greater) for both daytime and night-time). There are no financially involved properties at this stage.

The choice of quiet daytime fixed minimum limits should be considered in light of the guidance contained within ETSU-R-97 and the IOA GPG. Extracts of the guidance contained within ETSU-R-97 and the IOA GPG are included in Annex 1. Noise limits established at properties in accordance with ETSU-R-97 shall be applicable to all existing / proposed (in planning) wind farms in the area and will henceforth be referred to as the 'Total ETSU-R-97 Noise Limits'. We would be very keen to work with Dumfries and Galloway Council with a view to agreeing suitable daytime fixed minimum limits at an early stage to ensure the development can be designed accordingly.

Given the noise limits already allocated to other schemes in the area, TNEI propose to set the Total ETSU-R-97 Noise Limits based on the upper daytime fixed minimum noise limit of 40 dB, as proposed in the Scoping Report. A Site Specific Noise Limit would then be derived taking account of the noise limits already allocated to, or the limit that may be used by, other wind farm developments in the area.

The Site Specific Noise Limits will be derived using the principles contained within the IOA GPG (which may include the use of the controlling property principal / determining if there is significant headroom etc). The Site Specific Noise Limits will be the limits that the proposed development would have to operate within, should consent be granted. We would welcome the opportunity to discuss the choice of Site Specific daytime fixed minimum limits with you once background noise data becomes available to ensure that the scheme is designed appropriately in light of data measured at the site.

Paragraph 5.4.11 of the IOA GPG states; *"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."*

Where there is significant headroom we propose to utilise the available headroom to derive the Site Specific Noise Limits for the proposed development and consider a +2 dB addition to predicted cumulative levels (excluding the proposed development) to be "an *appropriate margin to cover factors such as potential increases in noise".* We would be grateful if the Council would confirm its agreement to this approach.

In order to establish Total ETSU-R-97 Noise Limits in accordance with ETSU-R-97 it is necessary to determine the relationship between wind speed measured at the proposed development site and background noise levels measured at the closest noise sensitive receptors. This requires the installation of noise monitoring equipment at representative properties surrounding the site as well as the installation of wind monitoring equipment on the site itself.

It is proposed that a LiDAR unit will be in place on-site for the duration of the noise survey, which will be used to collect wind speed and direction data at various heights. Data from the LiDAR will be used to determine the wind speed at turbine hub height which will then be adjusted to a height of 10 m using a standardised roughness length of 0.05 m to derive 'wind speed as standardised to 10 m height'. Wind speed as standardised to 10 m height will be used in the assessment. This is consistent with method A or B as outlined in the IOA GPG (on page 10 of 40). At least one rain logger will be installed at one (or more) of the noise monitoring locations to record any periods of rainfall. A series of simultaneous ten-minute measurements will be taken by each piece of equipment over a period of at least two weeks.

Background noise levels will be monitored at a height of between 1.2 m and 1.5 m above ground, in line with the ETSU-R-97 / IOA GPG guidance. The noise monitoring equipment will be located in a free-field position at least 3.5 m away from hard reflective surfaces where practicable and within the residential amenity area.

The following steps summarise the proposed entire noise assessment process for this scheme:

- measure the background noise levels at each receptor. This will involve the continuous logging of the $L_{A90,\,10min}$ values at each receptor for a minimum period of two weeks;
- obtain simultaneous ten minute average wind speed data from the proposed development site;
- filter baseline noise data to remove any unrepresentative readings (such as periods of rainfall) and split the data into night-time and quiet daytime hours;

- determine the daytime and night-time criterion curves (i.e. Total ETSU-R-97 noise limits) from the measured background noise levels at the nearest neighbours using regression analysis and recommendations within ETSU-R-97 and the IOA GPG;
- specify the type and noise emission characteristics of all existing / proposed wind farms using candidate / operational wind turbine data, and undertake predictions and compare the total cumulative predicted noise levels to the Total ETSU-R-97 Noise Limits;
- undertake a cumulative noise assessment (if required) and derive suitable Site Specific Noise Limits for the proposed development using the guidance in the IOA GPG; and
- compare the predicted wind farm noise immission levels for the proposed development with the Site Specific Noise Limit.

We have undertaken some initial modelling based on the draft 25 turbine layout that was submitted with the Scoping report. In line with current good practice, noise predictions have been undertaken using the propagation model contained within Part 2 of International Standard ISO 9613:1996, *Acoustics – Attenuation of sound during propagation outdoors – Part 2 General method of calculation*. The model assumes mixed ground conditions and data for a candidate turbine, the Vestas V150 6.0 MW, which was chosen to be representative of the turbine that could be installed at the site. Figure 1 shows the neighbouring properties to the proposed development that may fall within the 35 dB(A) L_{90} contour. It should be noted that the predictions shown on the contour plot do not account for topography, which could decrease the predicted level (if the landform blocks the path from the turbines to receptors) or could increase the level (if any concave ground profiles exist). Topographical corrections will be considered in detail and included in the final noise assessment where required.

Prior to commencing the noise survey we would like to agree suitable locations at which to monitor background noise levels in order to provide a representative dataset for the area. Figure 1 shows the predicted noise contours from the proposed development based on the most current layout and the proposed background noise monitoring locations.

We believe noise monitoring equipment installed at three dwellings would provide a sufficient sample of representative background noise data for the area. The proposed monitoring locations are also detailed in Table 1 below.

Table 1 - Suggested Noise Monitoring Locations (NMLs) for the Proposed Development

Property/Location	Justification
NML1 - Shinnelhead (272939, 599143)	Nearest receptor to the north of the site.
NML 2 - High Appin (274656, 597263)	Nearest receptor to the east of the site.
NML3 - Benbuie (271059, 596151)	Nearest receptor to the south of the site.

Monitoring at the locations listed in Table 1 is subject to consent from the owners/occupiers as well as on-site observations to ensure the properties proposed are suitable and representative. If we are unable to gain access to monitor at the proposed properties, representative alternative locations will be selected and we will inform you of the alternative locations.

The properties identified for the assessment will be the closest ones to the site in each direction. Hence, it can be assumed that if noise limits can be achieved at these locations then limits will also be achieved at other properties located at greater distances from the wind farm.

Table 2 details a building that is not considered to be a noise sensitive receptor as it is uninhabitable and as such will not be included as noise monitoring location or a noise assessment location. If you have any further information regarding the status of this building or would like to discuss this further we would be grateful if you could let us know. The building is shown as a green dot on Figure 1.

Table 2 - Building not considered noise sensitive receptor

Property/Location	Justification
Cairnhead (270100, 597213)	The building is uninhabitable.

Cumulative Noise Assessment

TNEI is aware that there are a number of operational, consented and/or proposed wind farm schemes in the area including Whiteside Hill, Wether Hill, Cornharrow, Sanquhar Six, Lorg, Twentyshilling, Euchanhead and Sanquhar II. We would be grateful if you could bring to our attention any other wind farm developments that you are aware of in the area that may merit consideration within the cumulative noise assessment.

If possible, we would be very keen for you or one of your colleagues to attend the installation of the noise monitoring equipment in order for you to agree the exact noise monitoring locations.

Summary

To enable us to progress the assessment I would be very grateful if you confirm whether:

- You are happy with the proposed assessment methods outlined above (BS 5228, ETSU-R-97 and the IOA GPG);
- You agree that decommissioning noise can be scoped out of the EIAR;
- You agree to the use of Total ETSU-R-97 Noise Limits based on the upper daytime fixed minimum noise limit of 40 dB and a fixed limit of 43dB during the night;
- You agree with the proposed approach that, in line with IOA GPG, the cumulative assessment and derivation of Site Specific Noise Limits for the proposed development will utilise available significant headroom with an appropriate margin +2 dB above predicted noise levels;
- You agree with the general monitoring locations proposed (subject to exact siting);
- You agree that the building detailed in Table 2 and shown in green on Figure 1 does not need to be considered as a noise sensitive receptor;
- You or one of your colleagues will attend the noise kit installation (which it is anticipated will take place in July but we will confirm the date closer to the time); and
- If the Council is aware of any schemes which should be included in the cumulative noise assessment or any other dwellings which should be considered in the assessment of noise impacts.

We are proposing to install the noise monitoring equipment in July therefore, we would appreciate a response to this letter at your earliest convenience. If you have any immediate concerns or queries, please do not hesitate to contact me or my colleague Jim Singleton. We look forward to hearing from you soon.

Yours sincerely,

[redacted]

Gemma Clark
BSc(Hons), MSc, AMIOA

Principal Consultant
[redacted]

Reviewed and approved by:

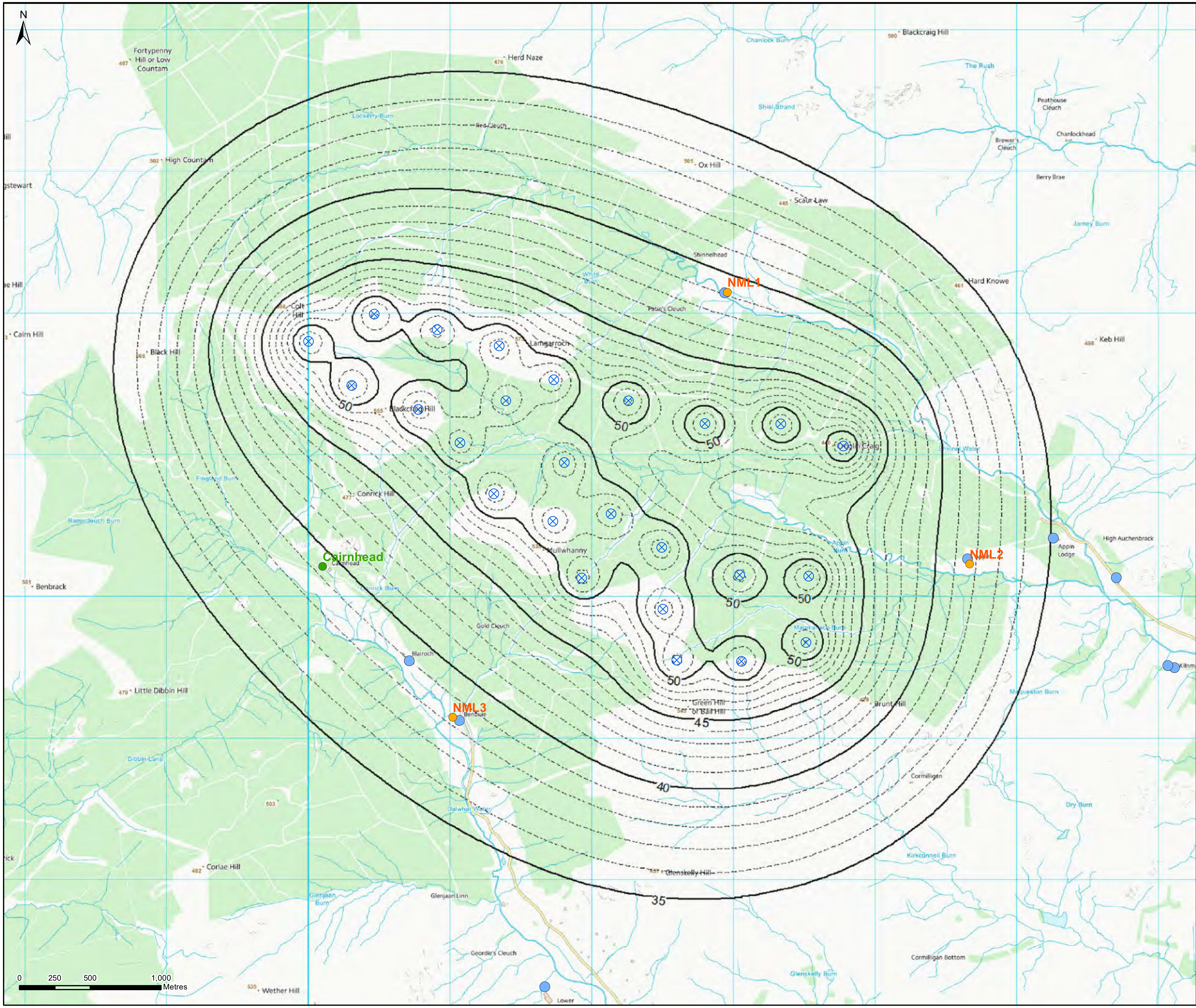
[redacted]

Jim Singleton
BSc(Hons), Dip, MIOA

Environment & Engineering Team Manager
[redacted]

Enc. Figure 1 – Proposed Noise Monitoring Locations

Annex 1 - Determining the Fixed Part of the Daytime Amenity Noise Limit



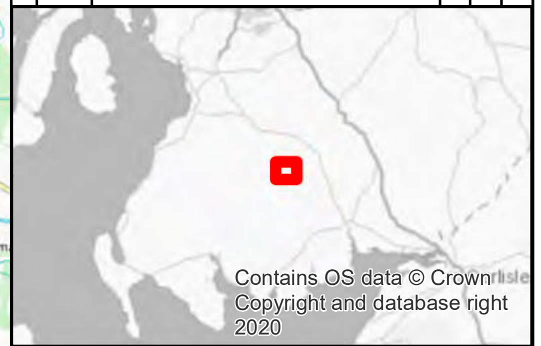
Contains Ordnance Survey data © Crown copyright and database right 2022

Legend

- Proposed Turbine Location
- Proposed Noise Monitoring Location
- Noise Sensitive Receptor
- Cairnhead - non residential
- Predicted Wind Turbine Noise dB(A), based on Vestas V150 wind turbine* (5dB increments)
- Predicted Wind Turbine Noise dB(A), based on Vestas V150 wind turbine* (1dB increments)

*Noise Predictions have been undertaken using mixed ground (G=0.5) at a receiver height of 4m above ground level. The contour plot models the highest noise output predicted between 0 and 10m/s as standardised to 10m height.
Noise contours do not account for topographical corrections due to terrain, accordingly predictions should be treated as indicative only.

Rev.	Date	Amendment Details	Drw'n	Chk'd	App'd
01	13/06/22	Second Issue	WC	GC	GC
00	25/05/22	First Issue	WC	GC	GC



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tnei

Client

Statkraft

Drawing Status: PRE PLANNING

Project Title: Appin Wind Farm

Drawing Title: Figure 1 - Proposed Noise Monitoring Locations

Scale	Designed	Drawn	Checked	Approved
1:25,000	WC	WC	GC	GC
Original Size: A3	Date: 25/05/2022	Date: 25/05/2022	Date: 26/05/2022	Date: 26/05/2022

Drawing Number: 14711-005

Revision: 1

Annex 1: Determining the Fixed Part of the Daytime Amenity Noise Limit

In relation to determining the fixed part of the Daytime Amenity Noise Limit the ETSU-R-97 notes (on page 65) that:

"The actual value chosen for the daytime lower limit, within the range of 35-40 dB(A), should depend upon a number of factors:

• Number of dwellings in the neighbourhood of the wind farm.

The planning process is trying to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate. Developers still have to consider the interests of individuals as protected under the Environmental Protection Act 1990. It is our belief however, in accordance with the report of the Welsh Affairs Committee [23], that there have been no cases of complaints of noise at levels similar to those caused by wind farms leading to a successful prosecution as a statutory nuisance. It should be noted however that the Welsh Affairs Committee also reports that although the noise may not be a statutory nuisance it can clearly be a cause for distress and disturbance, particularly if residents have been promised inaudibility and the noise has a particular quality leading to complaints.

• The effect of noise limits on the number of kWh generated.

Similar arguments can be made when considering the effect of noise limits on uptake of wind energy generated. A single wind turbine causing noise levels of 40 dB(A) at several nearby residences would have less planning merit (noise considerations only) than 30 wind turbines also causing the same amount of noise at several nearby residences.

• Duration and level of exposure.

The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30 dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35 dB(A). This approach is difficult to formulate precisely and a degree of judgement should be exercised."

The IOA GPG adds some further guidance:

"3.2.2 The day amenity noise limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas. The daytime amenity noise limits are formed in two parts: Part 1 is a simple relationship between the prevailing background noise level (with wind speed) with an allowance of +5 dB; Part 2 is a fixed limit during periods of quiet. ETSU-R-97 describes three criteria to consider when determining the fixed part of the limit in the range of 35 dB to 40 dB L_{A90}, all of which should be considered. They are:

1) the number of noise-affected properties;

2) the potential impact on the power output of the wind farm; and

3) the likely duration and level of exposure.

3.2.3 The rationale for a choice of this limit, or factors which would assist the determining authority in this respect should be set out in the assessment. It is beneficial to the decision maker to display both sets of limits to illustrate the range available and/or the noise limit for the development if agreed previously with the LPA.

3.2.4 Current practice on the three criteria is as follows:

1. The number of neighbouring properties will depend on the nature of the area, (rural, semi-rural, urban) and is sometimes considered in relation to the size of the scheme and study area. The predicted 35 dB L_{A90} contour (at maximum noise output up to 12 m/s) can provide a guide to the dwellings to be considered in this respect.

2. This is in practice mainly based on the relative generating capacity of the development, as larger schemes have relatively more planning merit (for noise) according to the description in ETSU-R-97. In cases when the amenity fixed limit has little or no impact on the generating capacity (i.e. noise is not a significant design constraint) then a reduced limit may be applied.

3. This last test is more difficult to formulate. But ETSU-R-97 notes that the likely excess of turbine noise relative to background noise levels should be a relevant consideration. In rural areas, this will often be determined by the sheltering of the property relative to the wind farm site. Account can also be taken of the effects of wind directions (including prevailing ones at the site) and likely directional effects. For cumulative developments, in some cases the effective duration of exposure may increase because of cumulative effects.

3.2.5 It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration, and therefore are difficult for noise consultants to fully determine. However this is described as part of ETSU-R-97 and therefore represents a relevant consideration when determining applicable noise limits. Furthermore, it is necessary, as part of the EIA process to evaluate the noise impacts, which is arguably not fully possible without a complete determination of the ETSU-R-97 limits. Finally, consideration of cumulative noise impacts may require the determination of partial noise limits which may be difficult to obtain unless the amenity noise limit is precisely determined.

3.2.6 Other planning considerations, such as the identification in local planning policy of areas of preferred wind farm development, may also influence or determine the choice of the absolute fixed amenity noise limit.”

Gemma Clark

From: Gemma Clark
Sent: 01 September 2022 21:01
To: Jackson, William
Cc: Donald McArthur
Subject: RE: 14711 - Proposed Appin Wind Farm - Noise Consultation
Attachments: 14711 - Appin Wind Farm Noise Kit Installation Report- R0.pdf

Dear Mr Jackson,

Further to my emails below, please find attached a copy of the installation report for the noise equipment installed at receptors proximate to the proposed Appin Wind Farm.

Kind regards

Gemma

Gemma Clark
Principal Consultant

Manchester | Newcastle | Glasgow | Cape Town | Dublin

[redacted]

From: Gemma Clark
Sent: 10 August 2022 15:03
To: Jackson, William [redacted]
Cc: Donald McArthur [redacted]
Subject: RE: 14711 - Proposed Appin Wind Farm - Noise Consultation

Dear Mr Jackson,

Further to the emails below, I just wanted to let you that we are proposing to install the noise monitoring equipment this Friday (12th August) so if you would like to attend the installation of the equipment then please let me know.

Kind regards

Gemma

Gemma Clark
Principal Consultant

Manchester | Newcastle | Glasgow | Cape Town | Dublin

[redacted]

From: Gemma Clark
Sent: 04 July 2022 09:51
To: Jackson, William [redacted]
Cc: Donald McArthur [redacted]
Subject: RE: 14711 - Proposed Appin Wind Farm - Noise Consultation

Dear Mr Jackson,

Further to the email below, I was wondering whether you have had the chance yet to consider our proposed noise monitoring locations/ assessment methodology for the proposed Appin Wind Farm.

Kind regards

Gemma

Gemma Clark
Principal Consultant

Manchester | Newcastle | Glasgow | Cape Town | Dublin

[redacted]

From: Gemma Clark
Sent: 15 June 2022 17:45
To: Jackson, William [redacted]
Cc: Donald McArthur [redacted]
Subject: 14711 - Proposed Appin Wind Farm - Noise Consultation

Dear Mr Jackson,

As you may already be aware, Statkraft is considering developing a wind farm on land approximately 7 km north west of the village of Moniaive. TNEI has been commissioned to undertake the noise assessment work for the proposed development and would like to agree in advance the methodologies proposed for the noise assessment and the proposed noise monitoring locations.

Please find attached a consultation letter detailing our methodology and proposed noise monitoring locations for your consideration. We are proposing to install the noise monitoring equipment in July so would appreciate a response at your earliest convenience.

If you have any questions or require additional information, please do not hesitate to contact me. I look forward to hearing from you.

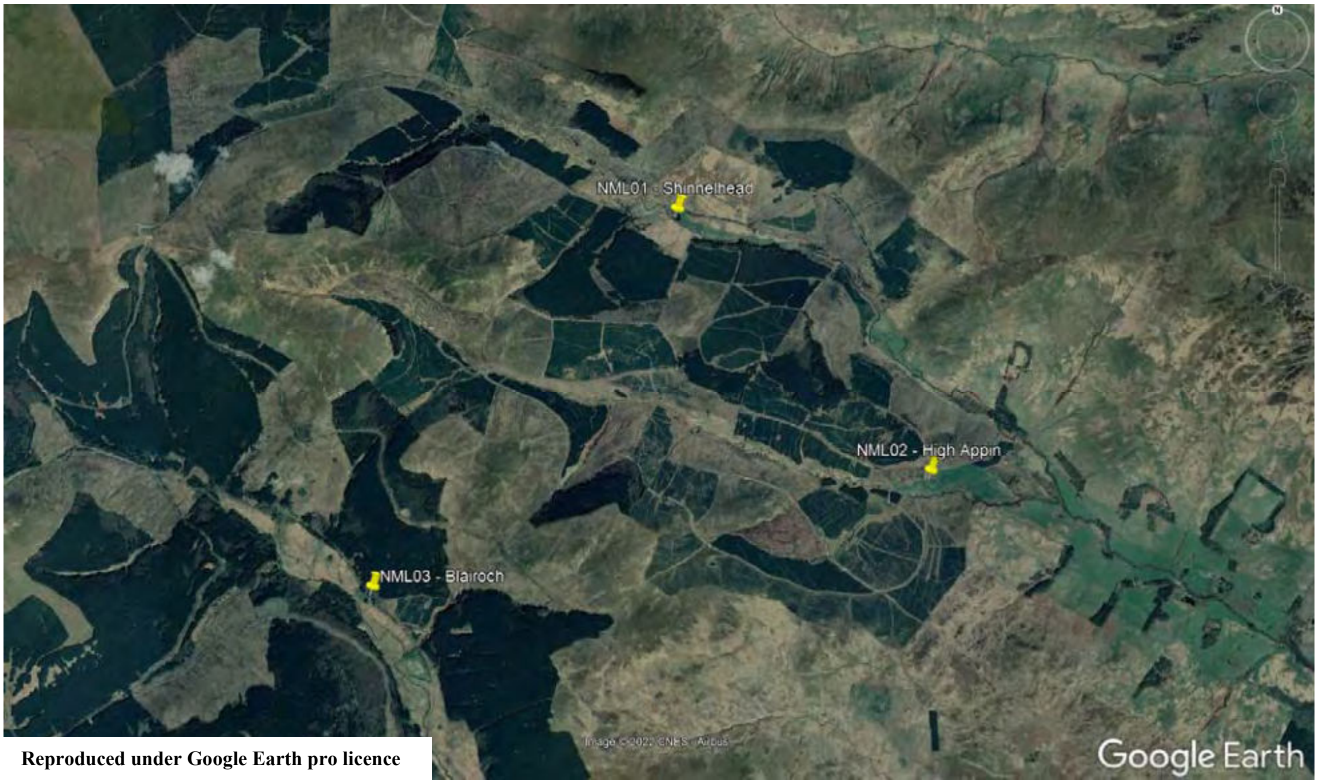
Kind regards

Gemma

Gemma Clark
Principal Consultant

Annex 3 – Field Data Sheets and Installation Report

Appin Wind Farm Baseline Noise Survey - Installed Noise Monitoring Locations



Present during the course of the installation:

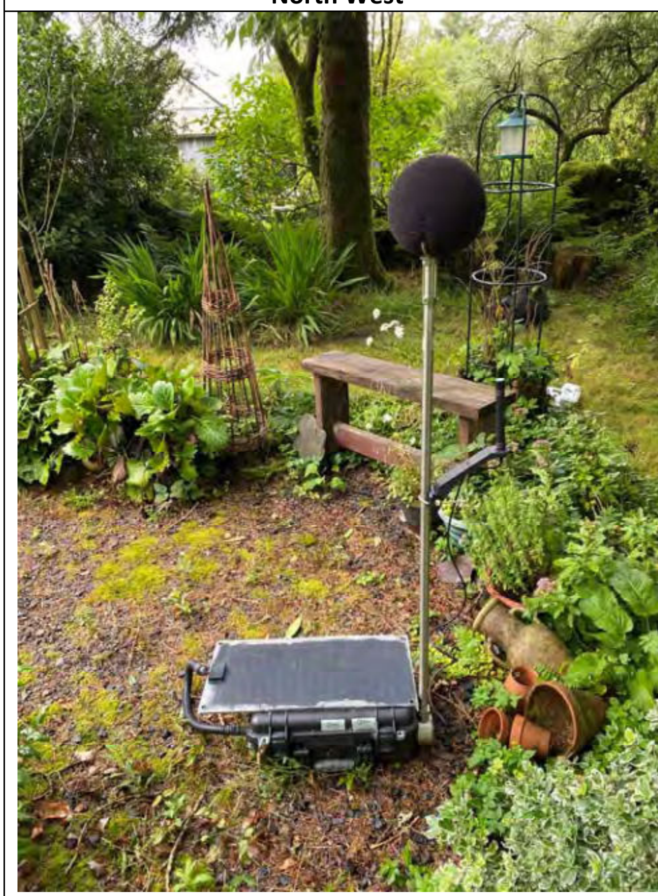
- Ewan Watson, Senior Consultant, TNEI Services Ltd

Unless specified, all noise meters were installed at least 3.5 m from any hard-reflecting surface except the ground and less than 20 m from the dwelling and away from obvious noise sources, such as boiler flues.

Detailed information and pictures for each of the installed locations are provided below. The original full-size pictures are available on request. It should be noted that due to conflicting resident availability, NML02 and NML03 were installed on the 12th August 2022, whereas NML01 was installed on the later date of the 23rd August 2022.

Noise Monitoring Location and Latitude Longitudes

NML	Lat Long
NML01 - Shinnelhead	55.270136°, -4.001129°
NML02 - High Appin	55.253561°, -3.973541°
NML03 - Blairoch	55.246290°, -4.034862°

NML01 - Shinnelhead	
	
North West	North East
	

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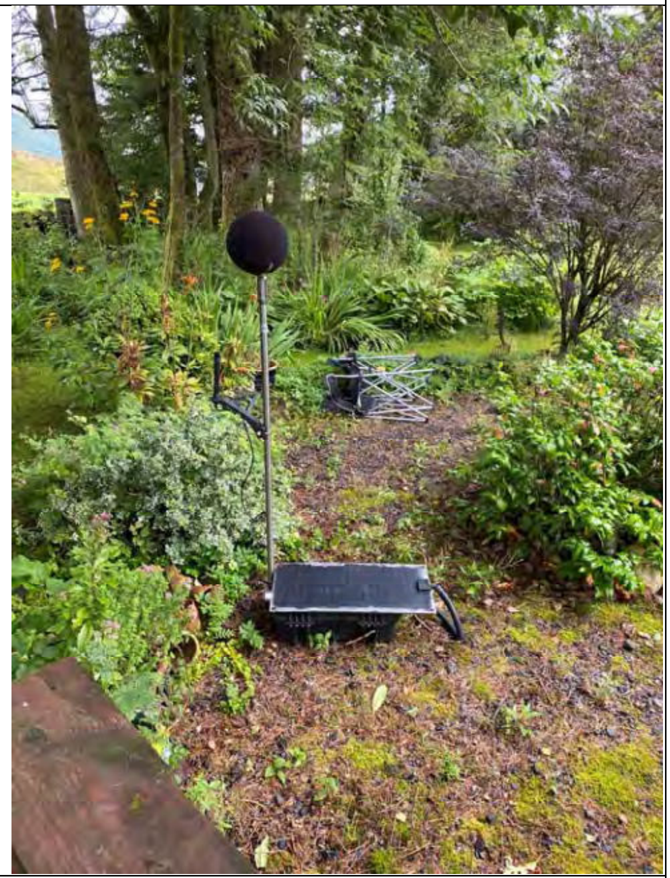
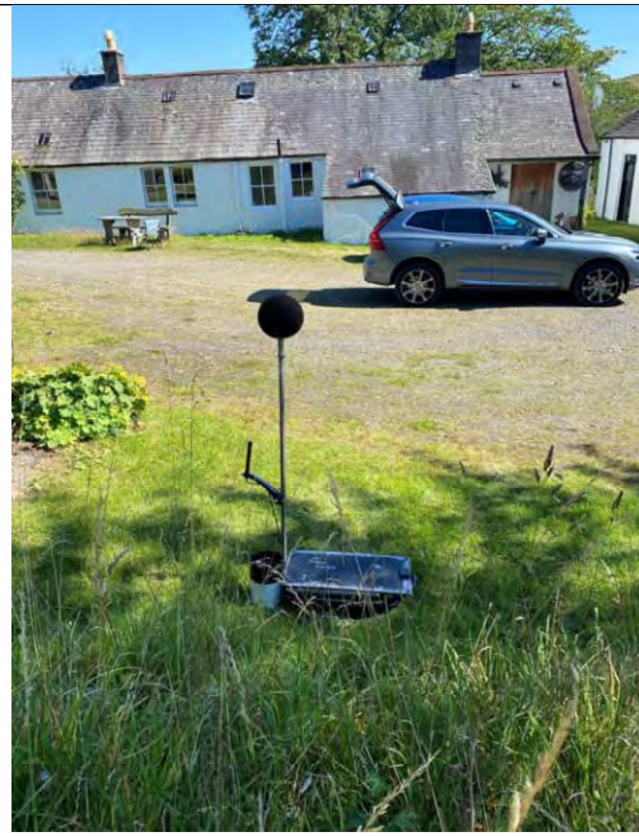
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">Installed at NML01, located to the north of the proposed Appin Wind Farm site.

The noise monitoring equipment was installed to the north east of the property, in the back garden area. The equipment was sited so as to obscure the line-of-sight to the river in order to mitigate the noise emitted from the flow of the river. River noise was prominent at this location and was clearly audible. In addition to this, a small hydro generator was sited at the riverbank, to the south west of the property. The generator was emitting noise whilst TNEI staff were onsite, but the kit was sited so that the residential buildings mitigated the majority of the noise emissions. It is unclear as to whether the generator is likely to emit noise at all times of the day. The resident also has a workshop onsite, and as a result, industrial noise sources such as sawing and hammering were heard intermittently.

The flow of the river, birdsong, resident activity and wind in the surrounding foliage were the main noise sources observed.</td></tr>
</table>

NML02 – High Appin	
	
North West	North East
	

<table>
<tr><th>South West</th><th>South East</th></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Description</td></tr>
<tr><td colspan="2">Installed at NML02, located to the east of the proposed Appin Wind Farm site.

The noise monitoring equipment was installed to the north of the property, on the grassy verge at the courtyard entrance area, in front of the two buildings. This was in order to mitigate any noise from the river located to the south of the property. No river noise was noted upon installation, but the conditions were dry and any river flow was likely to be slow at the time of the visit.

Birdsong, insects, wind in the surrounding foliage and distant traffic were the main noise sources observed, as well as the occasional plane overhead.

A rain gauge was installed at the location.</td></tr>
</table>

NML03 – Blairoch	
	
North East	**North West**
	

South West	South East
	

Description

Installed at NML03, located to the west/south west/south of the proposed Appin Wind Farm site.

The noise monitoring equipment was installed to the north east of the property, within the small grassy amenity area behind the property. This was in order to mitigate any noise from the felling activities that were taking place to the south west of the property. Noise from the felling operations was noted upon installation but these were greatly reduced behind the property (where the kit was sited) and were not constant in nature.

Birdsong, wind in the surrounding foliage, dogs barking and felling activities were the main noise sources observed.

A rain gauge was installed at the location.

Noise Monitoring Field Data Sheet

Project Title	Appin Wind Farm	Project Number	14711
Client	Statkraft	Surveyor	EW

MONITORING LOCATION

Location Name	Noise Monitoring Location 1 (NML01) – Shinnelhead
Description	The noise monitoring equipment was installed to the north of the property at the far end of the amenity area as to increase distance from audible river to the south. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground).
Approximate National Grid Reference	272958, 599160
Noise sources noted during installation, weekly inspection and removal	Wind induced noise and birdsong, river to the south audible, occasional overhead aircraft. Some noise from residents was audible.

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM045	Rion NL-52	00386758	23/02/2022
Pre Amplifier	SLM045	NH-25	76908	23/02/2022
Microphone	SLM045	UC-59	12755	23/02/2022
Calibrator	CAL008	Rion NC-75	35002724	21/03/2022

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0101	09:30 23/08/2022	09:58 06/10/2022	94.0	93.6	-0.4	23/08: Installation – sounds of residents using hand tools in nearby workshop audible, birdsong, internet installation at the property occurring. River and hydrogenator on the other side of the property audible. 06/10: Maintenance – River behind property audible, birdsong, no noise from workshop audible, hydro generator not as prominent as during installation, wind induced noise in foliage, occasional overhead aircraft audible.
0102	10:20 06/10/2022	08:35 20/10/2022	94.0	94.1	0.1	20/10: Decommissioning – River behind property audible, birdsong, wind induced noise in foliage, occasional overhead aircraft audible.

PHOTOGRAPHS

 NML01 – North	 NML01 –East
 NML01 – South	 NML01 – West

Noise Monitoring Field Data Sheet

Project Title	Appin Wind Farm	Project Number	14711
Client	Statkraft	Surveyor	EW

MONITORING LOCATION

Location Name	Noise Monitoring Location 2 (NML02) – High Appin
Description	The noise monitoring equipment was installed to the north of the property. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground).
Approximate National Grid Reference	274653 , 697262
Noise sources noted during installation, weekly inspection and removal	Wind induced noise and birdsong, river to the south audible, occasional overhead aircraft. Some noise from residents audible.

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM052	Rion NL-52	00410234	12/08/2021
Pre Amplifier	SLM052	NH-25	10676	12/08/2021
Microphone	SLM052	UC-59	18979	12/08/2021
Calibrator	CAL008	Rion NC-75	35002724	21/03/2022

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	13:20 12/08/2022	10:17 23/08/2022	94.0	94.1	0.1	12/08: Installation – Insects and birdsong, occasional and distant road traffic and aircraft noise audible. River not audible, wind induced noise in foliage. Warm and dry, light breeze. 23/08: Maintenance – Insects and birdsong, river not audible, occasional overhead aircraft audible, wind induced noise in foliage.
0202	10:30 23/08/2022	11:40 20/09/2022	94.0	93.9	-0.1	20/09: Maintenance – River not audible, birdsong, wind induced noise in foliage, occasional overhead aircraft audible.
0203	12:00 20/09/2022	09:04 20/10/2022	94.0	94.0	0.0	20/10: Decommissioning - River faintly audible, birdsong, wind induced noise in foliage, occasional overhead aircraft audible.

PHOTOGRAPHS

 NML02 – North west	 NML02 – North east
 NML02 – South east	 NML02 – South west

Noise Monitoring Field Data Sheet

Project Title	Appin Wind Farm	**Project Number**	14711
Client	Statkraft	**Surveyor**	EW

MONITORING LOCATION

Location Name	Noise Monitoring Location 3 (NML03) – Blairoch
Description	The noise monitoring equipment was installed to the north of the property. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground).
Approximate National Grid Reference	270732 , 596568
Noise sources noted during installation, weekly inspection and removal	Wind induced noise and birdsong, occasional sound of river to audible, occasional felling noise clearly audible. Some noise from residents.

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM022	Rion NL-32	00703291	23/02/2022
Pre Amplifier	SLM022	NH-21	33382	23/02/2022
Microphone	SLM022	UC-53A	317043	23/02/2022
Calibrator	CAL008	Rion NC-75	35002724	21/03/2022

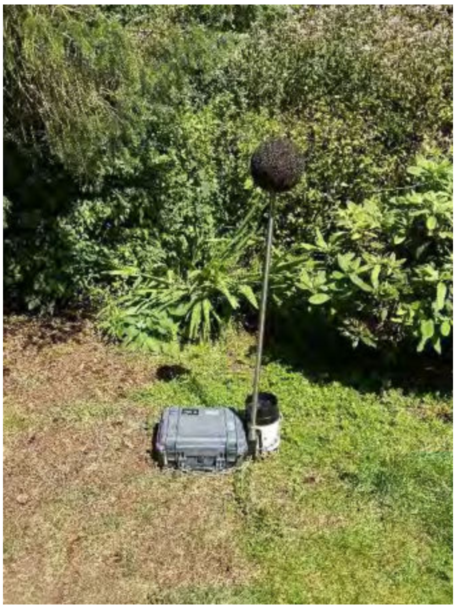
NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0301	12:40 12/08/2022	12:37 23/08/2022	94.0	93.8	-0.2	12/08: Installation –Birdsong, dogs barking, felling noise behind property faintly audible audible. Light breeze and noise in foliage. Warm and dry. 23/08: Maintenance –Birdsong, river faintly audible, distant felling noise clearly audible, wind induced noise in foliage. Warm and dry.
0302	12:50 23/08/2022	11:24 20/09/2022	94.0	93.9	-0.1	20/09: Maintenance – Birdsong, river faintly audible, felling not audible, wind induced noise in foliage. Noise from resident gardening.
0303	11:40 20/09/2022	11:10 20/10/2022	94.0	94.0	0.0	20/10: Decommissioning – Birdsong, river not audible, felling in distance audible, wind induced noise in foliage, noise from residents.

PHOTOGRAPHS

 NML03 – North west	 NML03 – North east
 NML03 – South east	 NML03 – South west

Annex 4 – Calibration Certificates

CERTIFICATE OF CALIBRATION

Date of Issue: 21 March 2022

Certificate Number: UCRT22/1402

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages	
Approved Signatory	[redacted]
K. Mistry	

Customer: TNEI
Floor 7
80 St. Vincent Street
Glasgow
G2 5UB

Order No. 5001

Test Procedure: Procedure TP 14 Calibration of Sound Calibrators (60942:2017)

Description: Acoustic Calibrator

Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-75	35002724

Public evidence of Type Approval Yes Approved by PTB

The calibrator has been tested as specified in Annex B of IEC 60942:2017. As public evidence was available, from a testing organisation responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2017, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2017.

ANV Job No. UKAS22/03202

Date Received 18 March 2022

Date Calibrated 21 March 2022

Previous Certificate
Dated 04 February 2021
Certificate No. UCRT21/1160
Laboratory 0653

Measurements

The sound pressure level generated by the calibrator (averaged over a 20 to 25 second period) in its WS2 configuration was measured five times (rotating the calibrator on the microphone each time) by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below.

The frequency of the sound from the calibrator was measured five times over a 20 to 25 second period and the average frequency calculated.

The total distortion + noise of the sound from the calibrator was measured, using a rejection filter distortion factor meter, five times over a 20 to 25 second period and the average distortion + noise calculated.

Test Microphone	*Manufacturer*	*Type*
	Brüel & Kjær	4134

Nominal Setting dB / Hz	Mean Level dB rel 20 µPa	Frequency	Distortion + Noise
94 / 1000	93.97 ± 0.10	1000.00 ± 0.12Hz	(0.12 ± 0.02) %

Environmental conditions during tests	Start	End		
Temperature	23.44	23.38	±	0.30 °C
Humidity	35.6	35.8	±	3.0 %RH
Ambient Pressure	101.740	101.736	±	0.030 kPa

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties refer to the measured values only with no account being taken of the ability of the instrument to maintain its calibration.

A small correction factor may need to be applied to the sound pressure level quoted above if the device is used to calibrate a sound level meter which is fitted with a free-field response microphone. See manufacturers handbook for details.

Note: Calibrator adjusted prior to calibration? NO

Additional Comments The results on this certificate only relate to the items calibrated as identified above.

None

Calibrated by: [redacted] R 1

END

CERTIFICATE OF CALIBRATION

Date of Issue: 23 February 2022 **Certificate Number: TCRT22/1160**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry [redacted]

Customer	TNEI Floor 7 80 St Vincent Street Glasgow G2 5UB
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703291
Rion	Firmware		1.400
Rion	Pre Amplifier	NH-21	33382
Rion	Microphone	UC-53A	317043
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 22 February 2022 ANV Job No. TRAC22/02079

Date Calibrated 23 February 2022

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	17 September 2020	TCRT20/1547	ANV Measurement Systems

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No		See comment on page 3
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No		See comment on page 3
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No		See comment on page 3
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	17 February 2022		
Calibrator cert. number	UCRT22/1246		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.03	dB	Calibration reference sound pressure level
Calibrator frequency	1002.04	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End			
Temperature	23.62	23.74	±	0.30	°C
Humidity	38.9	38.1	±	3.00	%RH
Ambient Pressure	101.07	101.03	±	0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.2	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z	
	9.7	dB	UR	16.9	dB	UR	23.8	dB
Uncertainty of the electrical self generated noise ±							0.12	dB

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ………" are set to NO above, then the following applies.

No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: [redacted] R 2

…………………………………………………. END ………………………………………………….

<u>Additional Comments</u>

None

CERTIFICATE OF CALIBRATION

Date of Issue: 23 February 2022 **Certificate Number: TCRT22/1162**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signator [redacted]
K. Mistry

Customer	TNEI Floor 7 80 St Vincent Street Glasgow G2 5UB
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00386758
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	76908
Rion	Microphone	UC-59	12755
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 10. SLM 61672-3:2013
Procedures from IEC 61672-3:2013 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2013 Yes
If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013

Date Received 22 February 2022 ANV Job No. TRAC22/02079
Date Calibrated 23 February 2022

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	10 September 2020	TCRT20/1518	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number

TCRT22/1162

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-52/NL-42 Description for IEC 61672-1		
SLM instruction manual ref / issue	No. 56034 21-03	Source	Rion
Date provided or internet download date	19 March 2021		

	Case Corrections	Wind Shield Corrections	Mic Pressure to Free Field Corrections
Uncertainties provided	Yes	Yes	Yes

Total expanded uncertainties within the requirements of IEC 61672-1:2013	YES

Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	17 February 2022		
Calibrator cert. number	UCRT22/1246		
Calibrator cal cert issued by Lab	ANV Measurement Systems		
Calibrator SPL @ STP	94.03	dB	Calibration reference sound pressure level
Calibrator frequency	1002.04	Hz	Calibration check frequency
Reference level range	Single	dB	
Accessories used or corrected for during calibration -	None		

Environmental conditions during tests	Start	End		
Temperature	23.85	23.70	± 0.30	°C
Humidity	38.3	36.2	± 3.00	%RH
Ambient Pressure	100.97	100.86	± 0.03	kPa

Indication at the Calibration Check Frequency

Initial indicated level	94.1	dB	Adjusted indicated level	94.0	dB
Uncertainty of calibrator used for Indication at the Calibration Check Frequency ±				0.10	dB

Self Generated Noise

Microphone installed -	Less Than	17.6	dB	A Weighting

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	10.7	dB	UR	15.3	dB	UR	22.4	dB	UR

Self Generated Noise reported for information only and not used to assess conformance to a requirement

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by ISO.

Additional Comments

None

END

Calibrated by: [redacted]

R 2

MEASUREMENT SYSTEMS

CERTIFICATE OF CONFORMANCE

Date of Issue	**12 August 2021**
Customer	**TNEI Services Ltd**
Certificate Number	**CONF082105**

	Manufacturer	**Type**	**Serial Number**
Sound Level Meter	Rion	NL-52	00410234
Preamplifier	Rion	NH-25	10676
Microphone	Rion	UC-59	18979

This is to certify that the instrument was tested and calibrated at the Manufacturer's factory according to their specification and that the product satisfied all the relevant requirements of the following Standards:

IEC 61672-1:2013 Class 1.

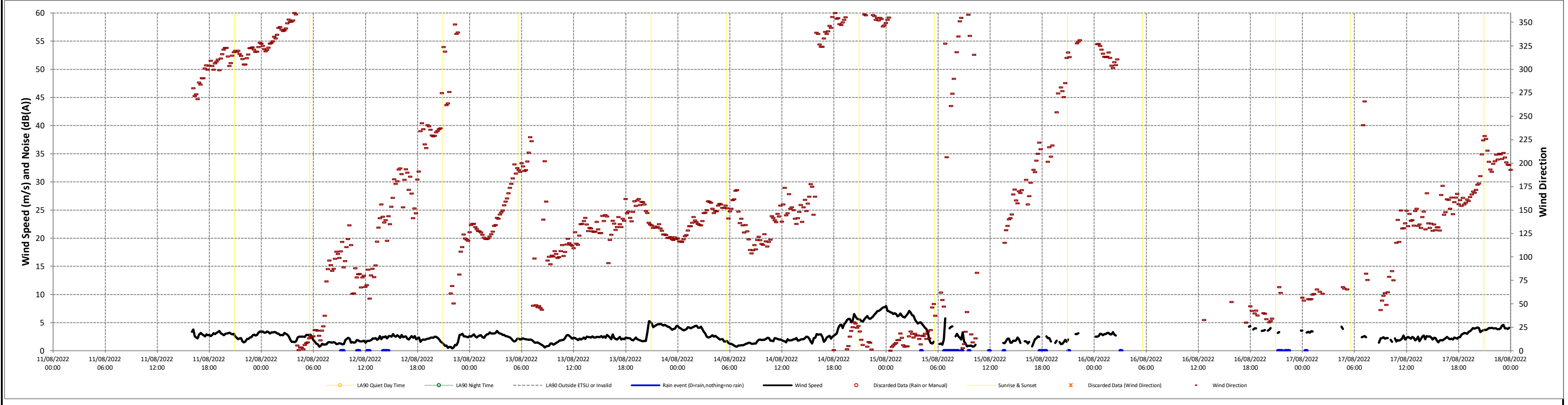
The instrument also received a functional check by ANV Measurement Systems prior to despatch in the UK, in accordance with our standard procedures.

Signed[redacted]............. Position. Calibration Technician Date. 12 August 2021

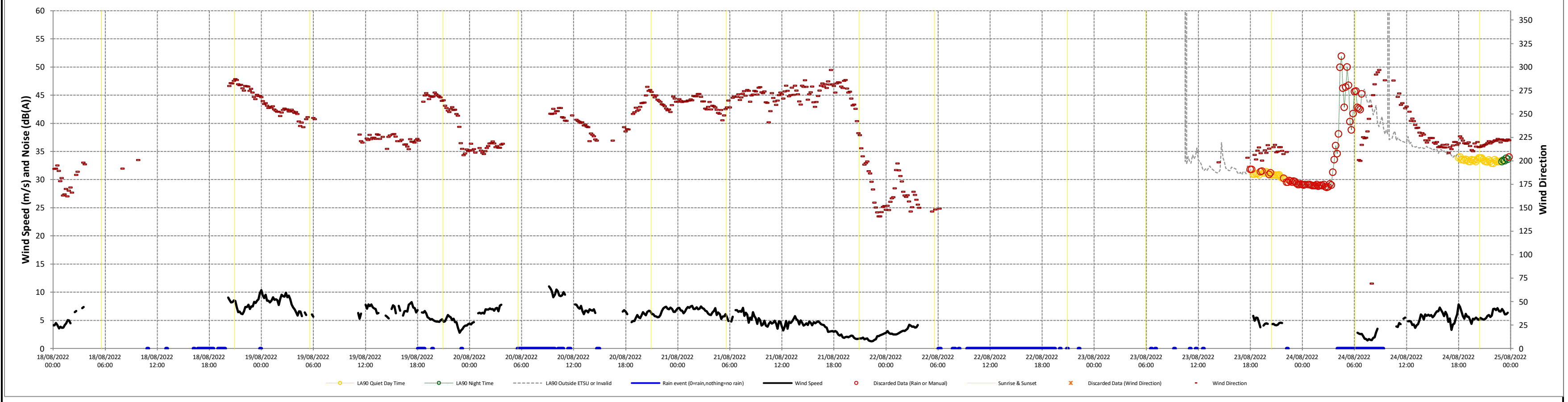
B. Bogdan

Annex 5 – Time Series Graphs

11/08/2022 to 18/08/2022

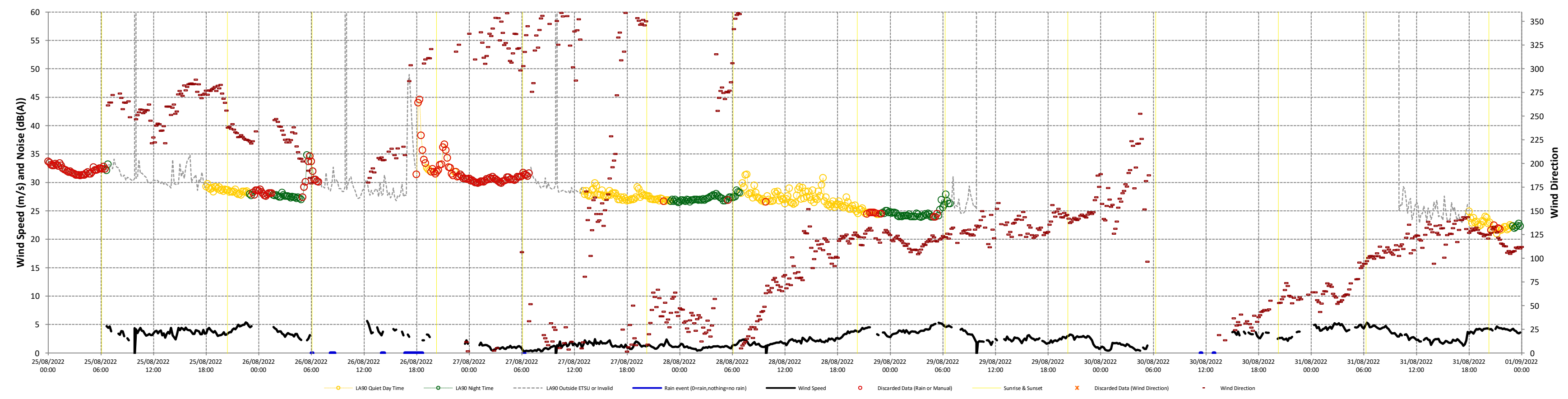


18/08/2022 to 25/08/2022

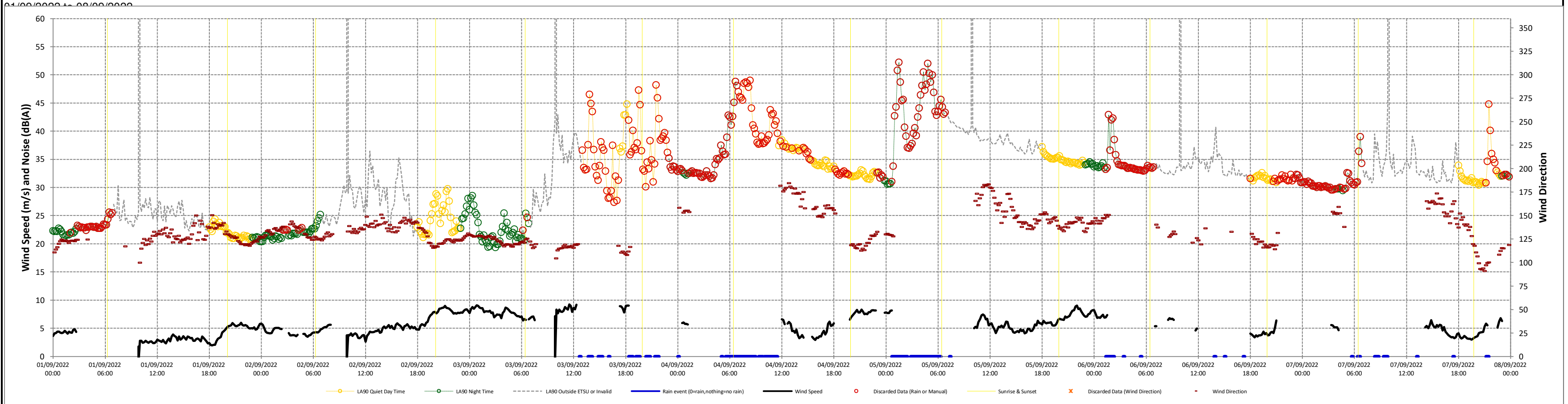


Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 1 of 6
Date	28/04/2025

25/08/2022 to 01/09/2022

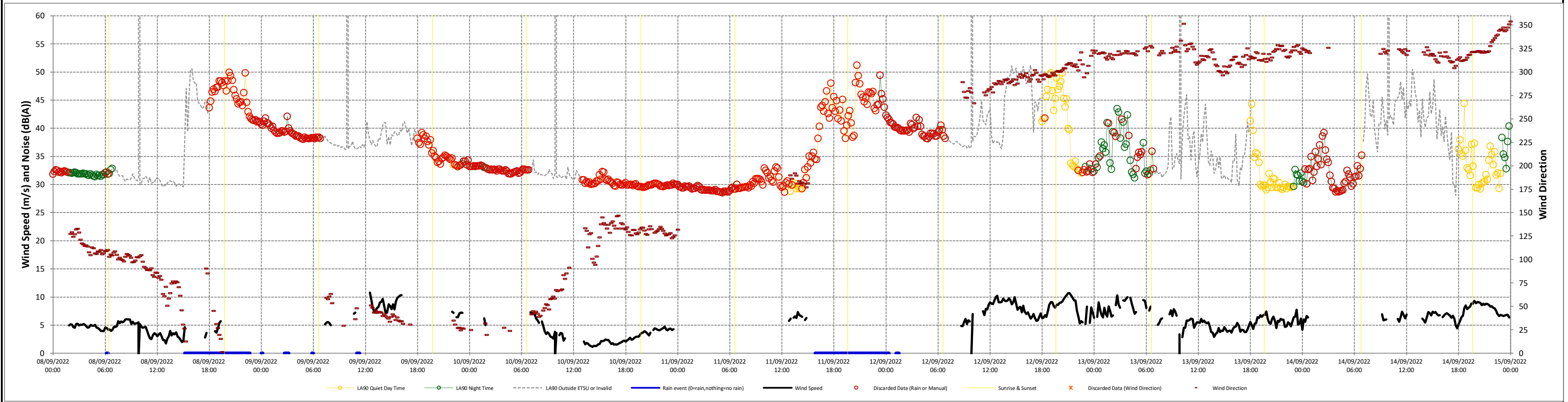


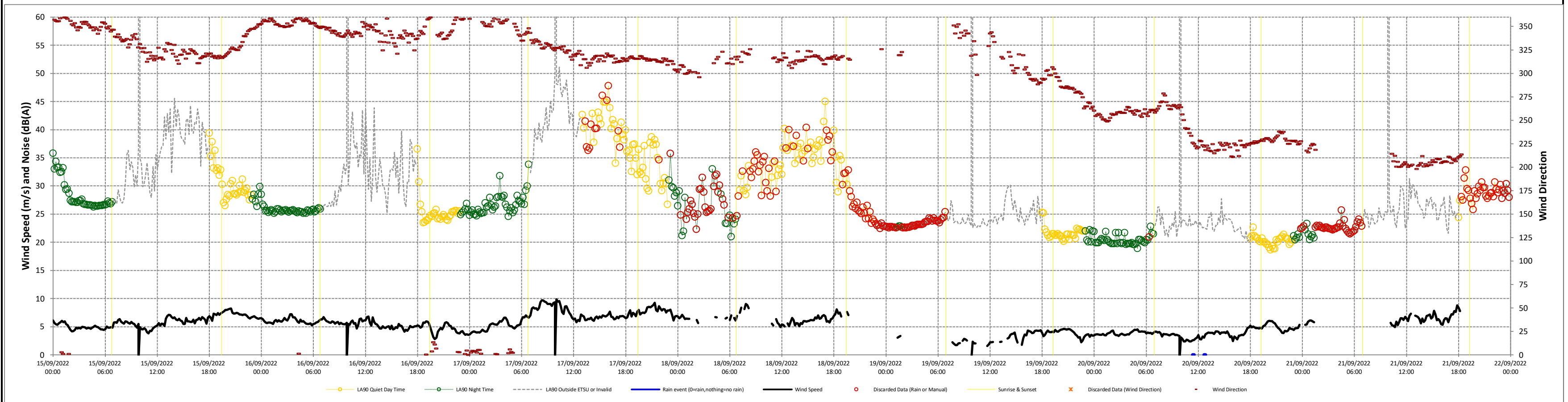
01/09/2022 to 08/09/2022



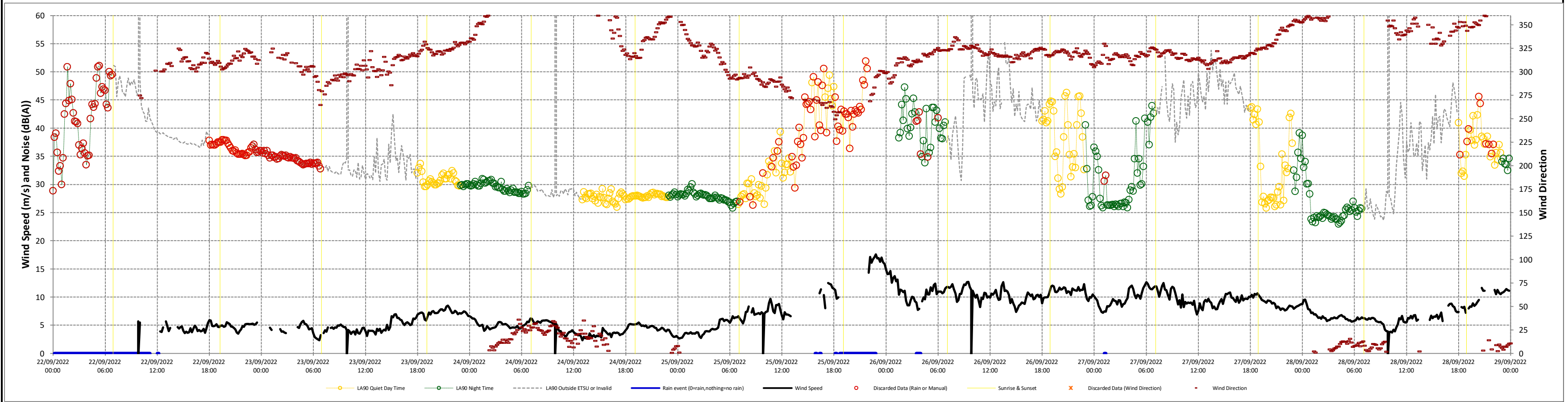
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 2 of 6
Date	28/04/2025

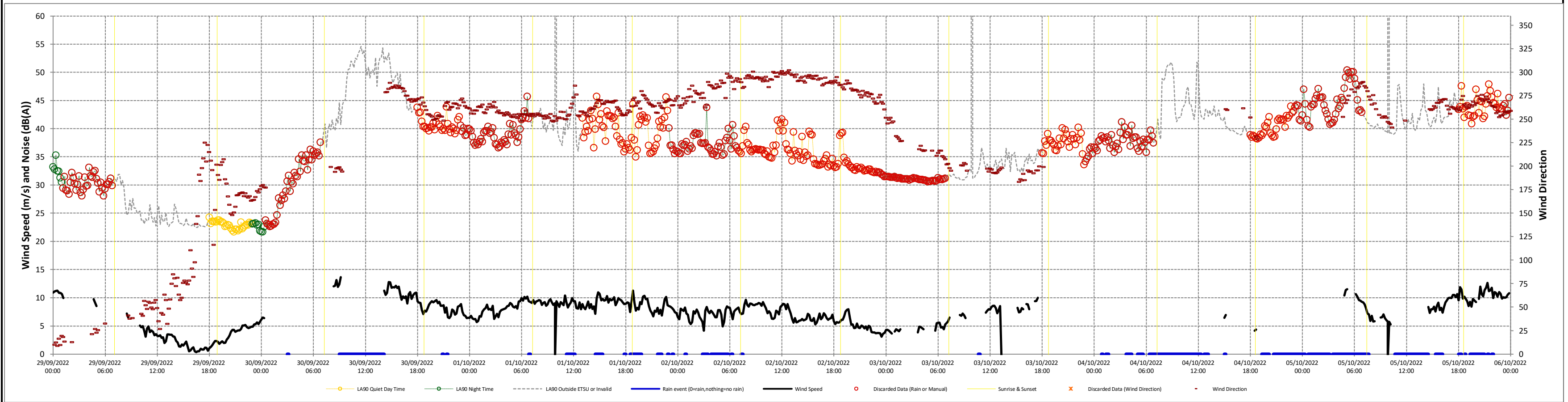
tnei





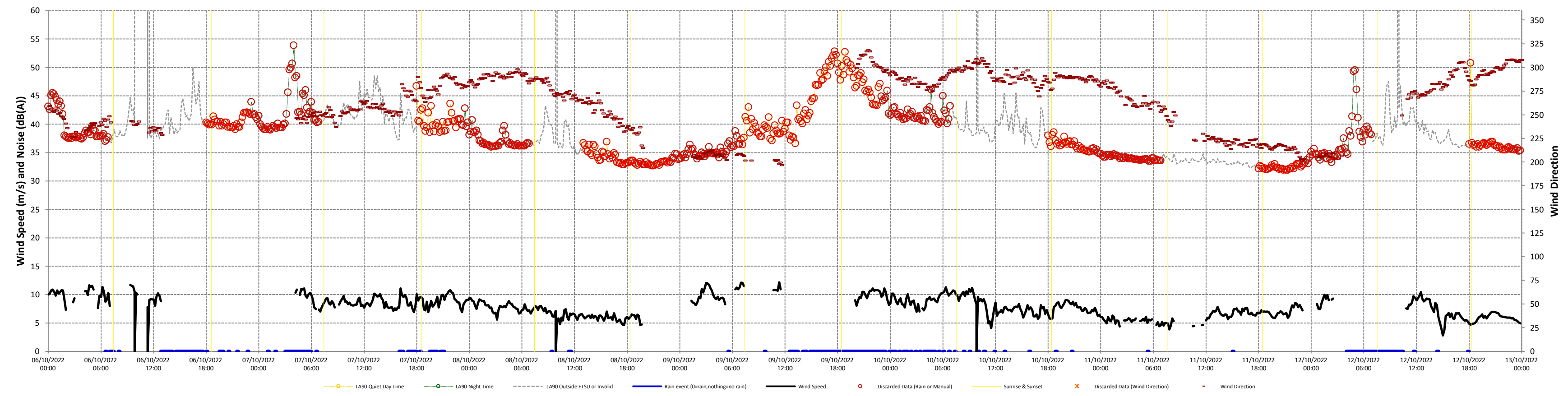
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 3 of 6
Date	28/04/2025

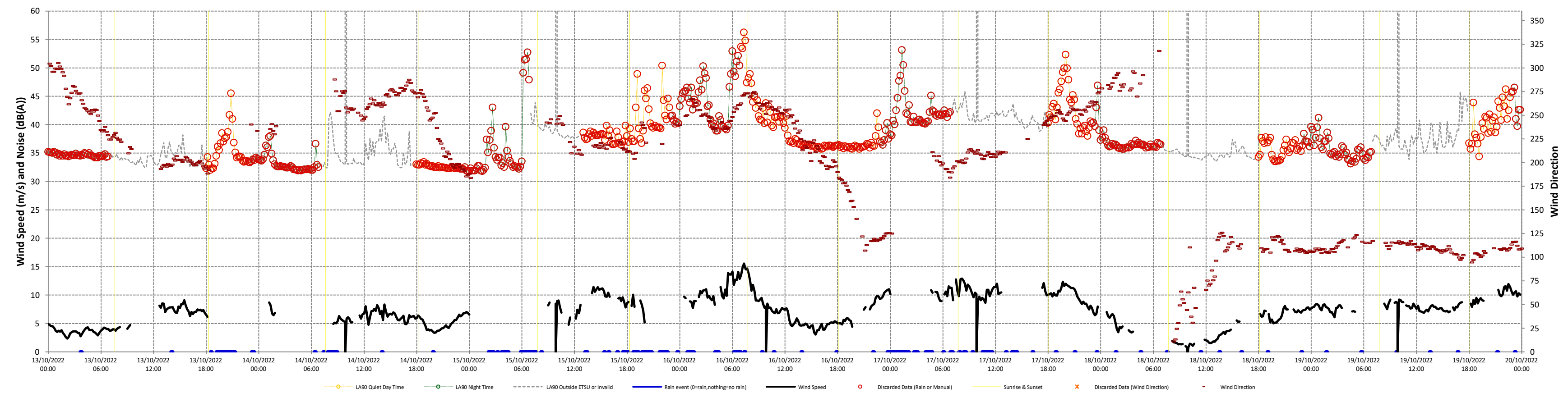




Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 4 of 6
Date	28/04/2025

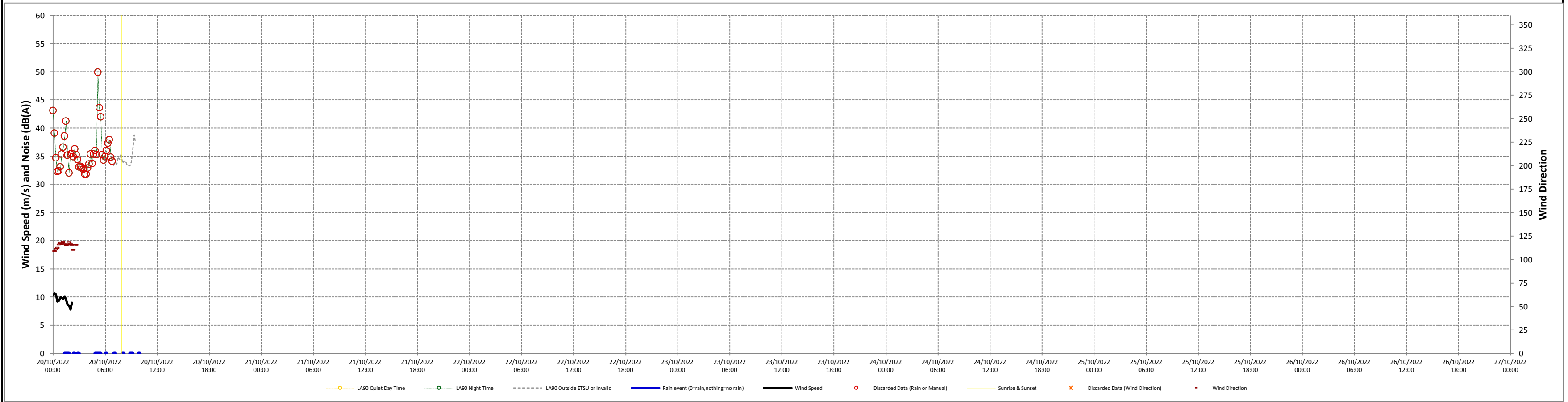
tnei





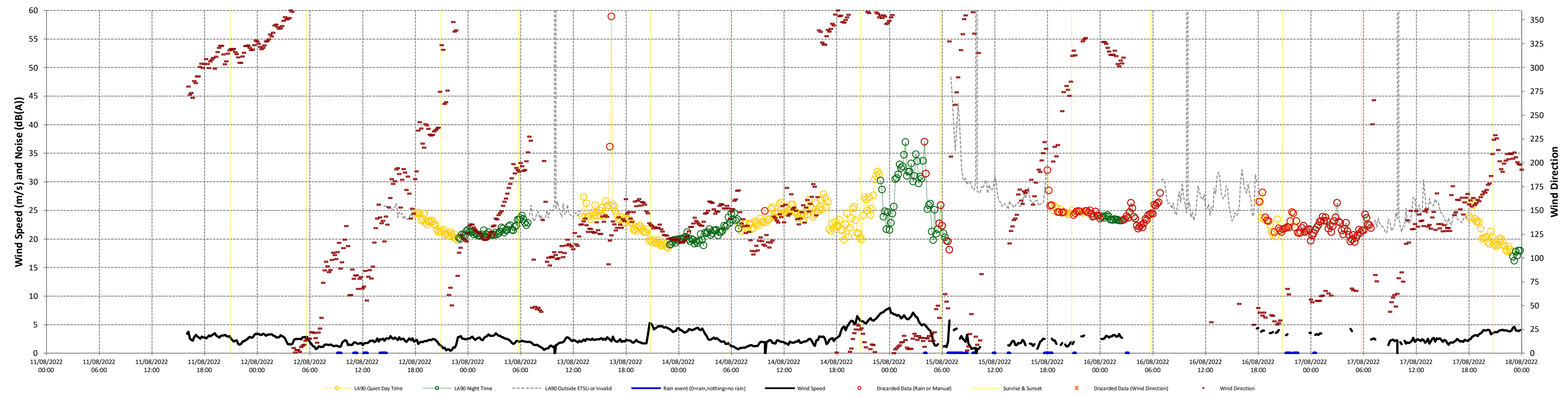
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 5 of 6
Date	28/04/2025

tnei

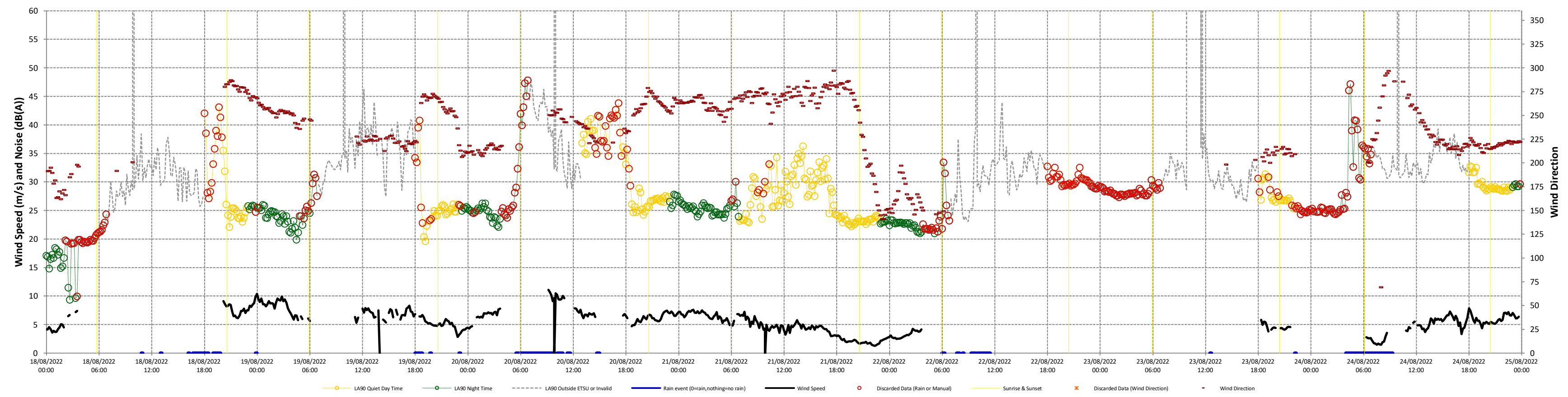


Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Shinnelhead Page 6 of 6
Date	28/04/2025

11/08/2022 to 18/08/2022

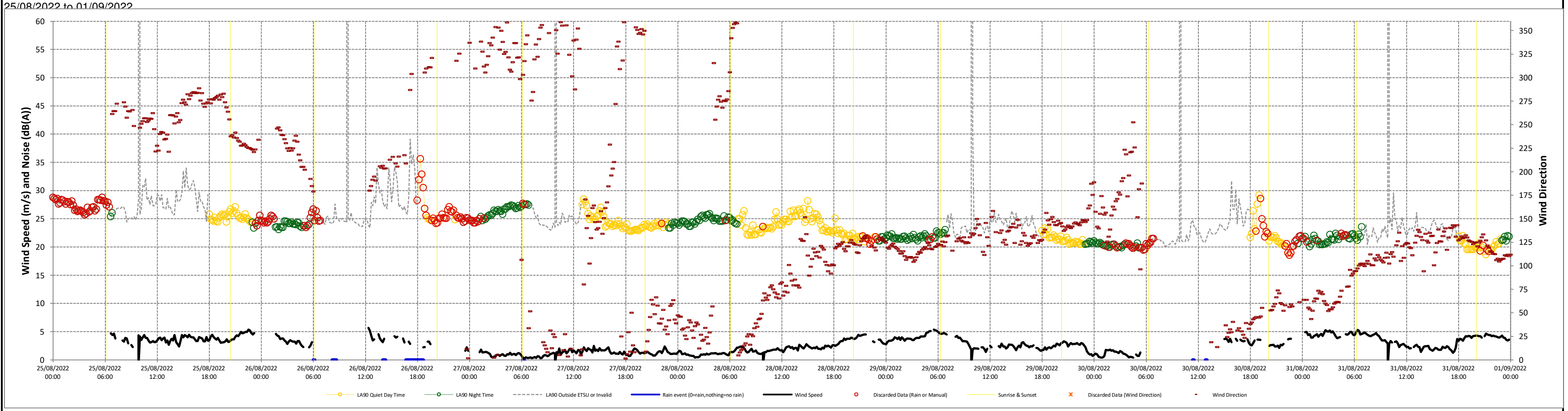


18/08/2022 to 25/08/2022

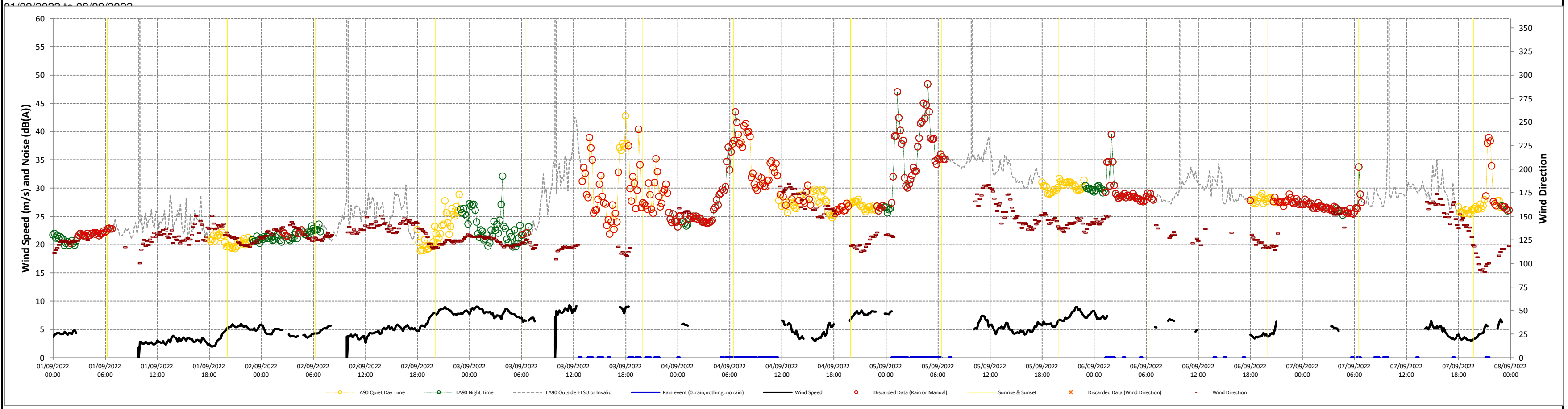


Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for High Appin Page 1 of 6
Date	02/04/2025

25/08/2022 to 01/09/2022

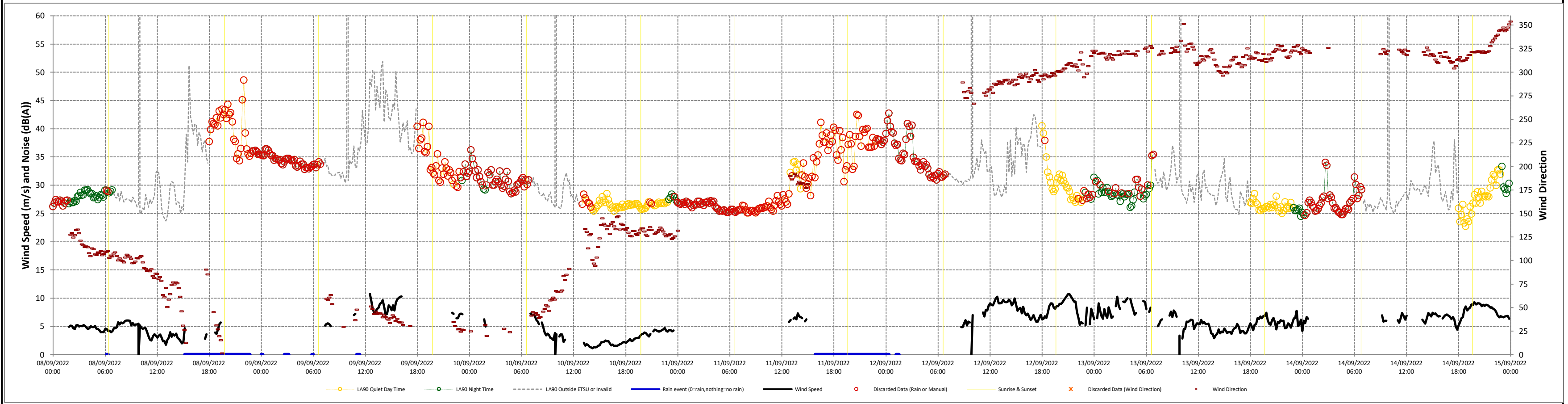


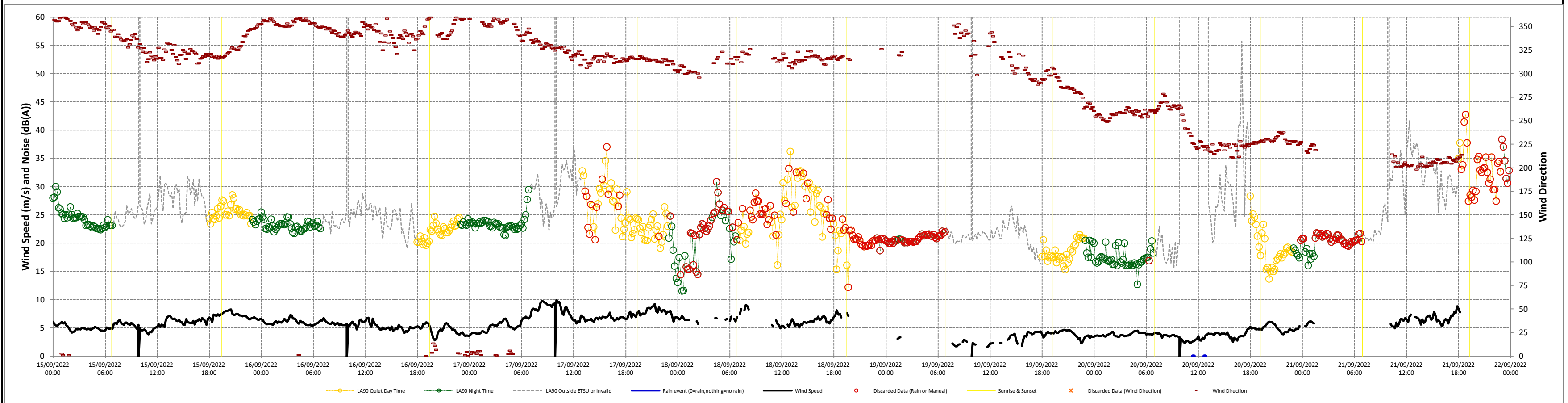
01/09/2022 to 08/09/2022



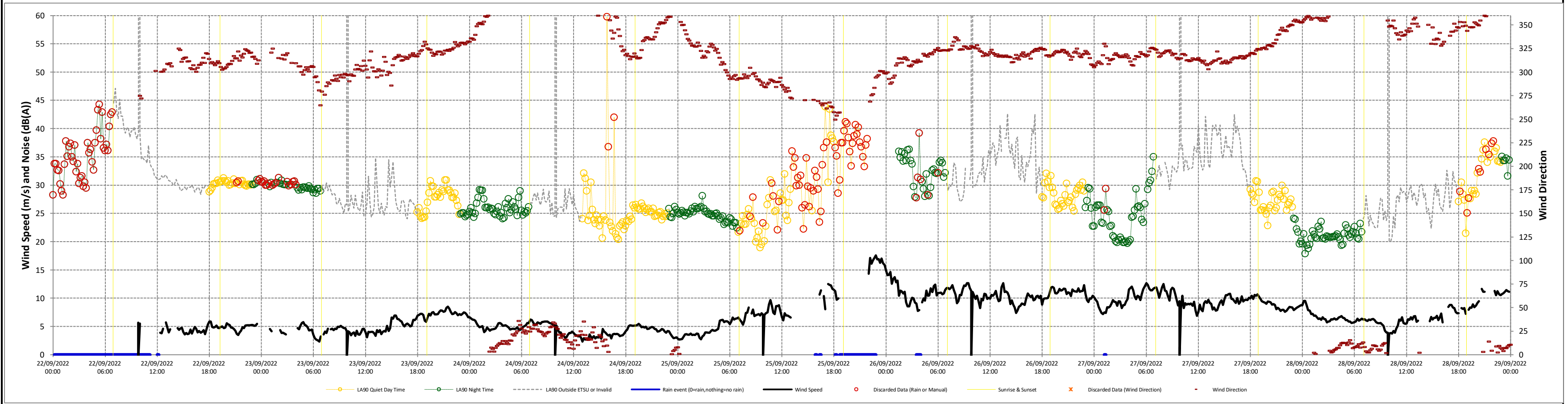
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for High Appin Page 2 of 6
Date	02/04/2025

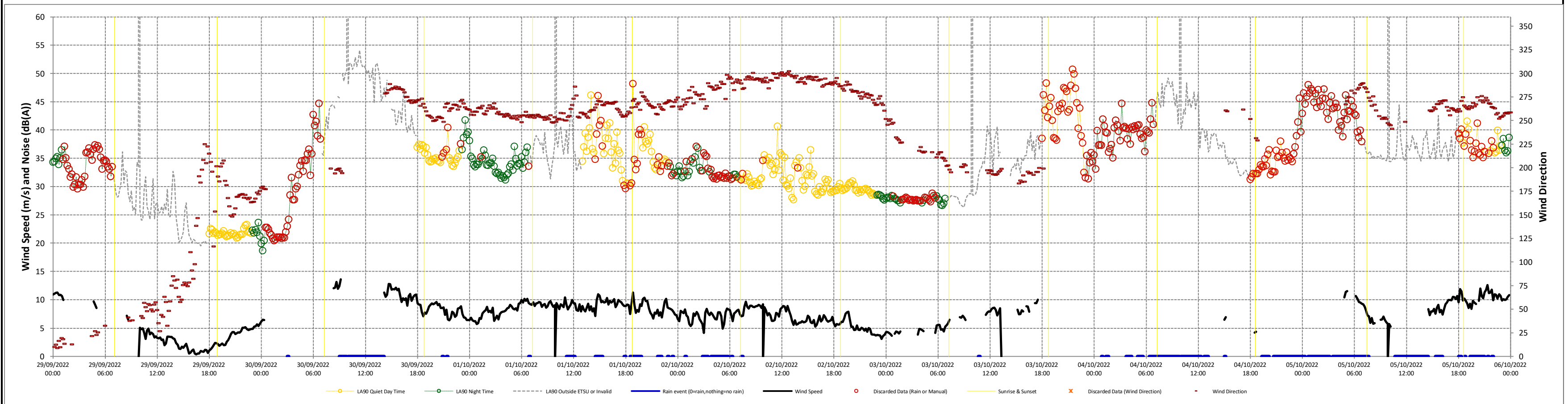
tnei



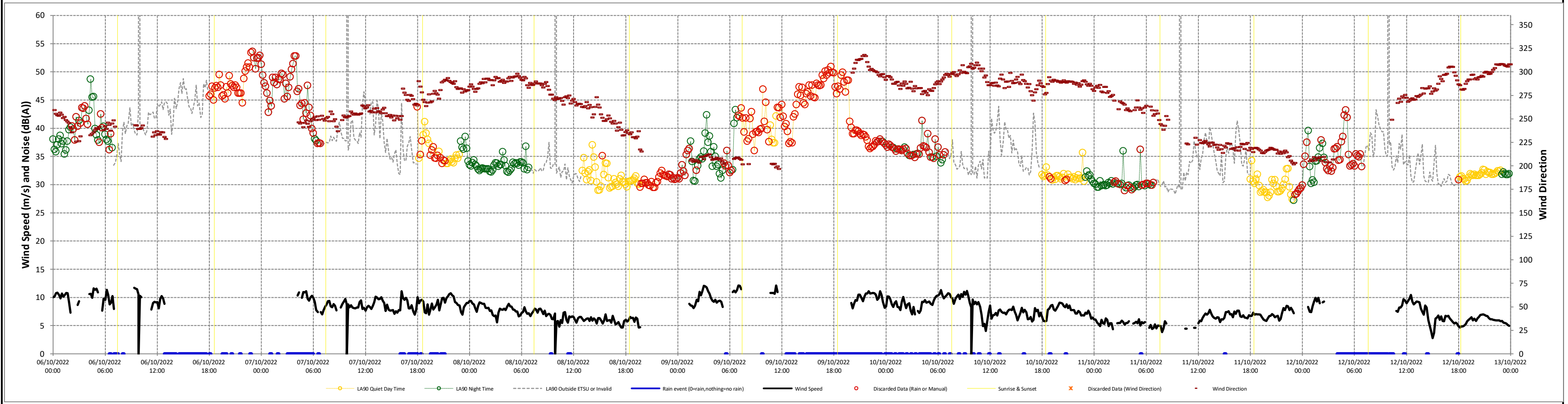


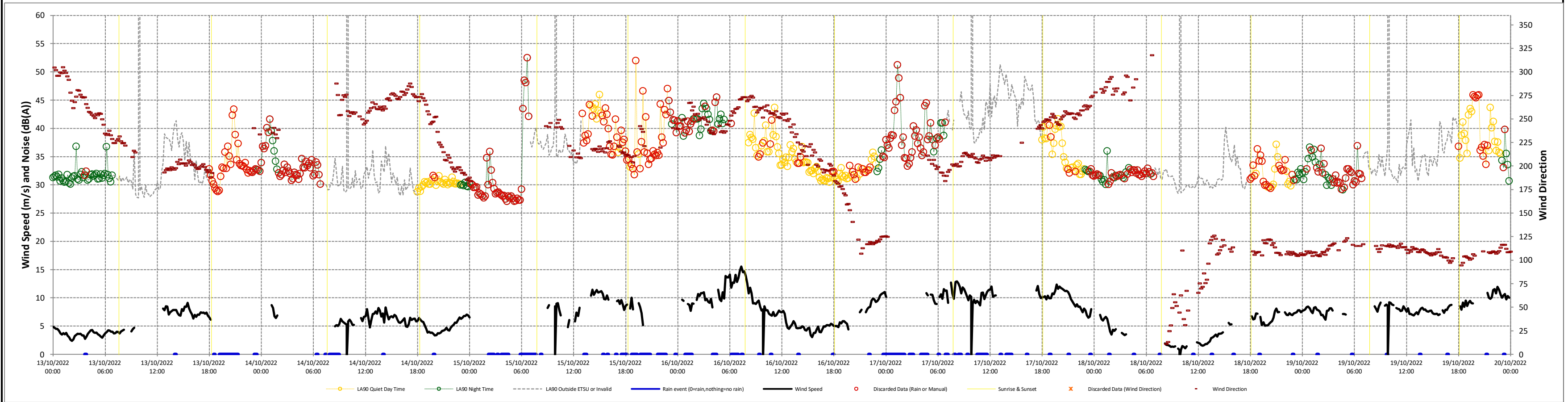
Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for High Appin Page 3 of 6
Date	02/04/2025





Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for High Appin Page 4 of 6
Date	02/04/2025





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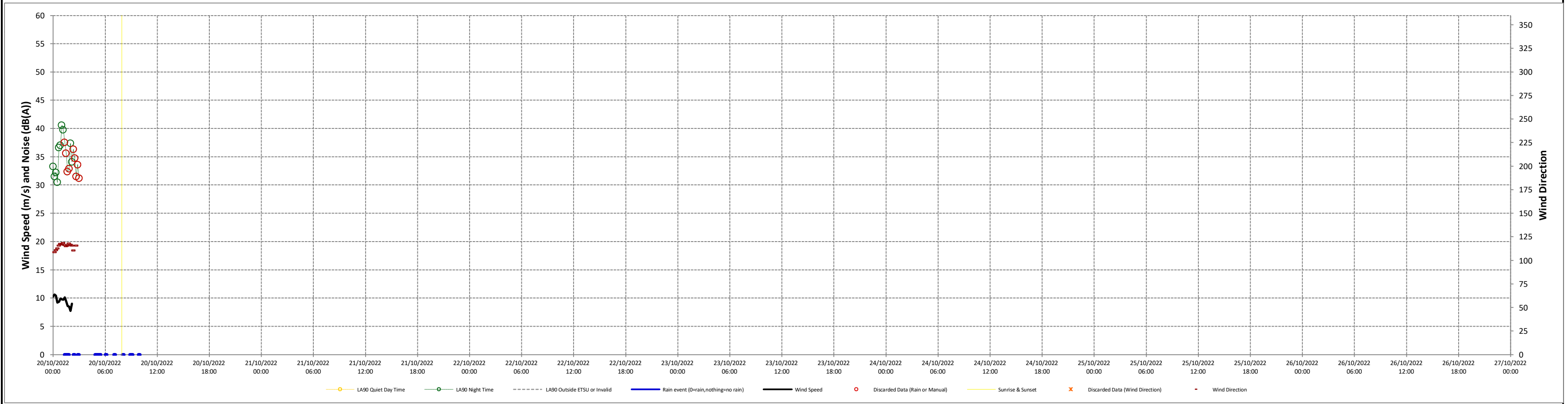

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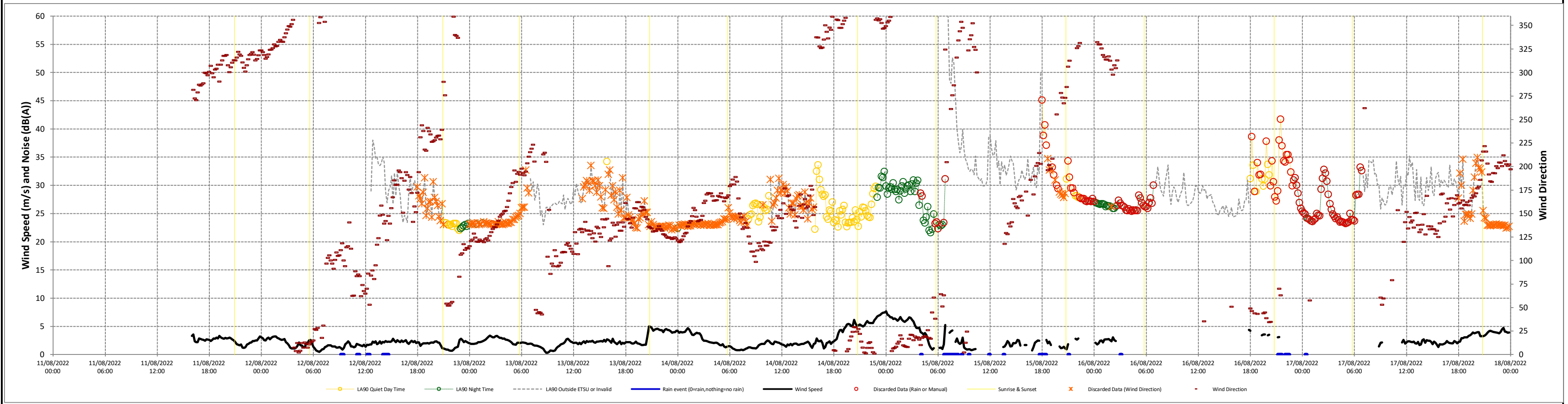
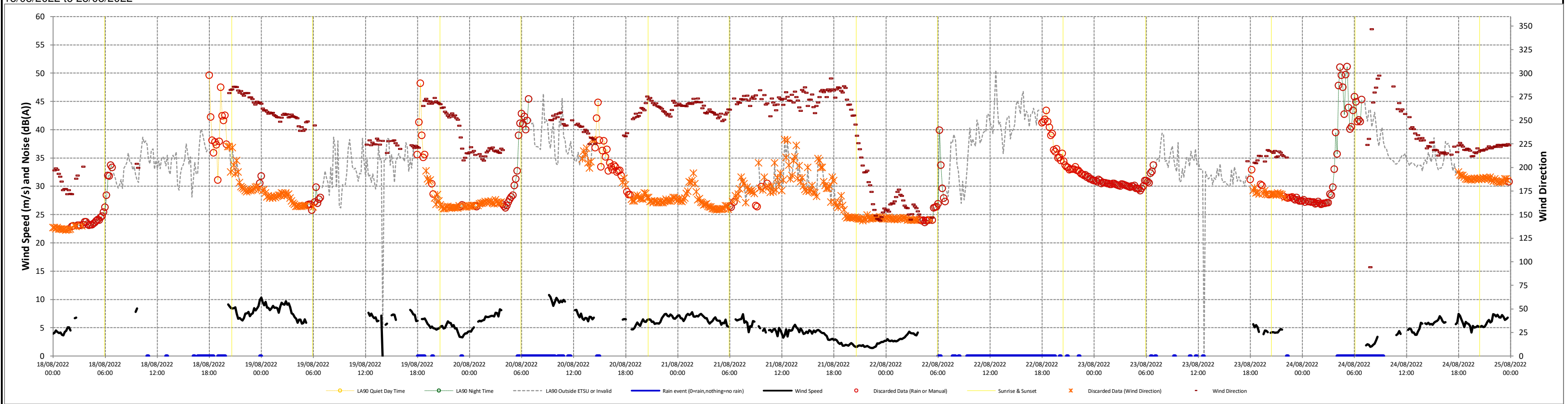
11/08/2022 to 18/08/2022



18/08/2022 to 25/08/2022



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Client	Appin Wind Farm Limited
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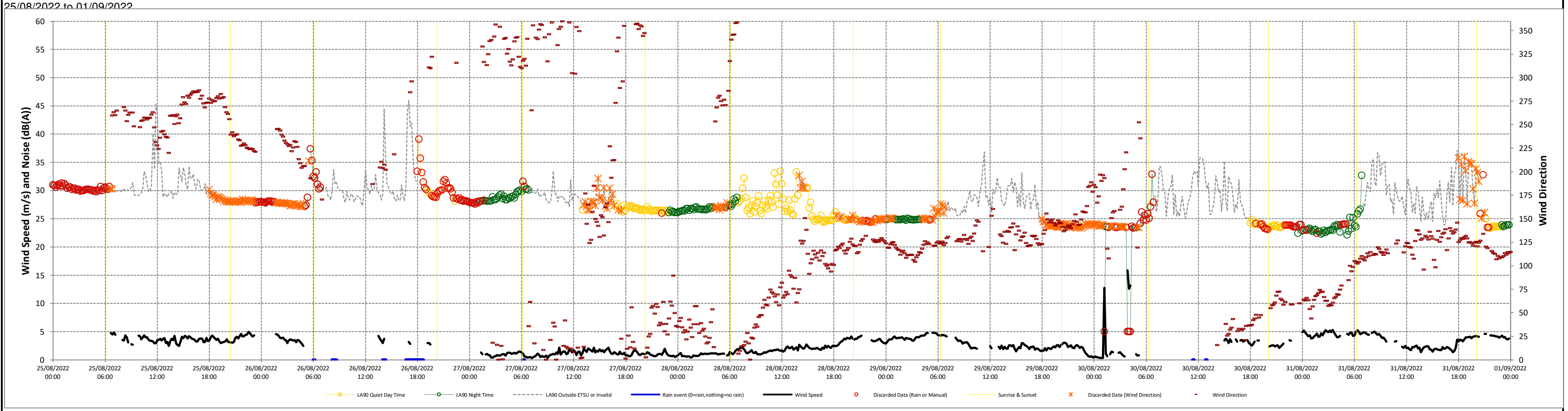
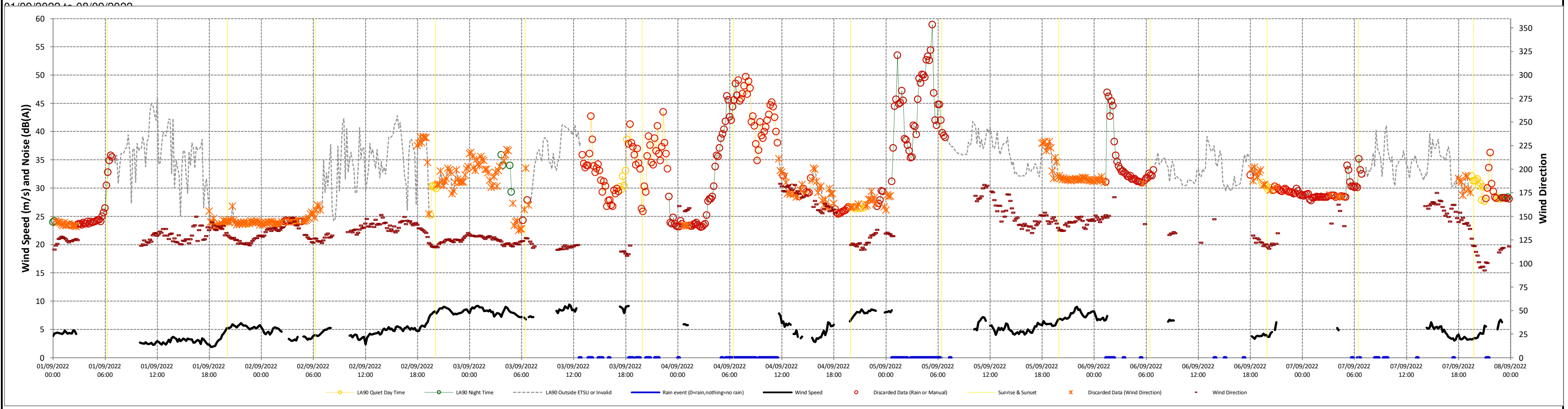
25/08/2022 to 01/09/2022



01/09/2022 to 08/09/2022



Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Blairoch Page 2 of 6
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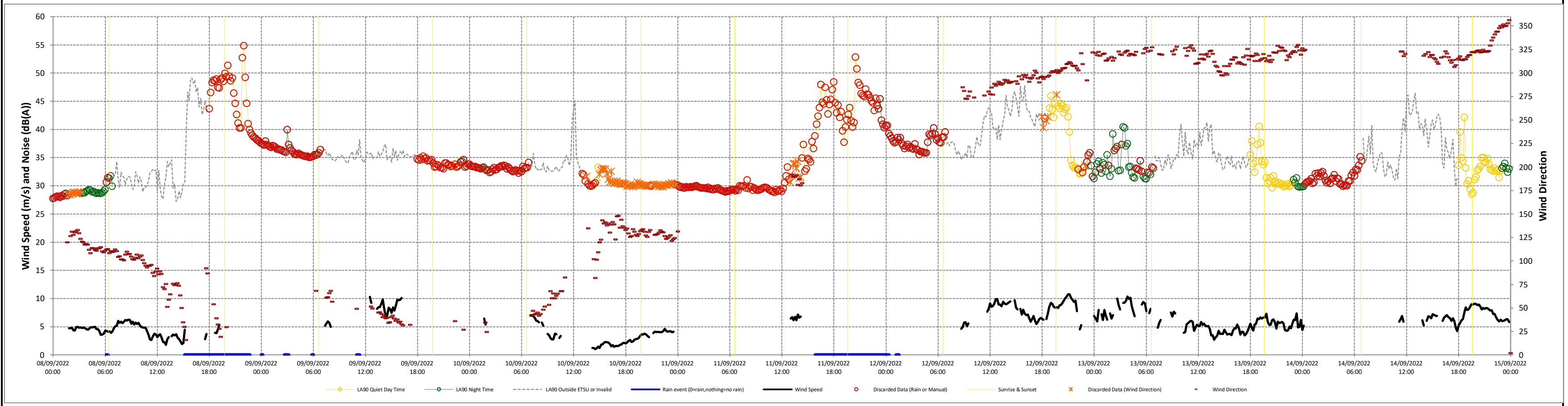

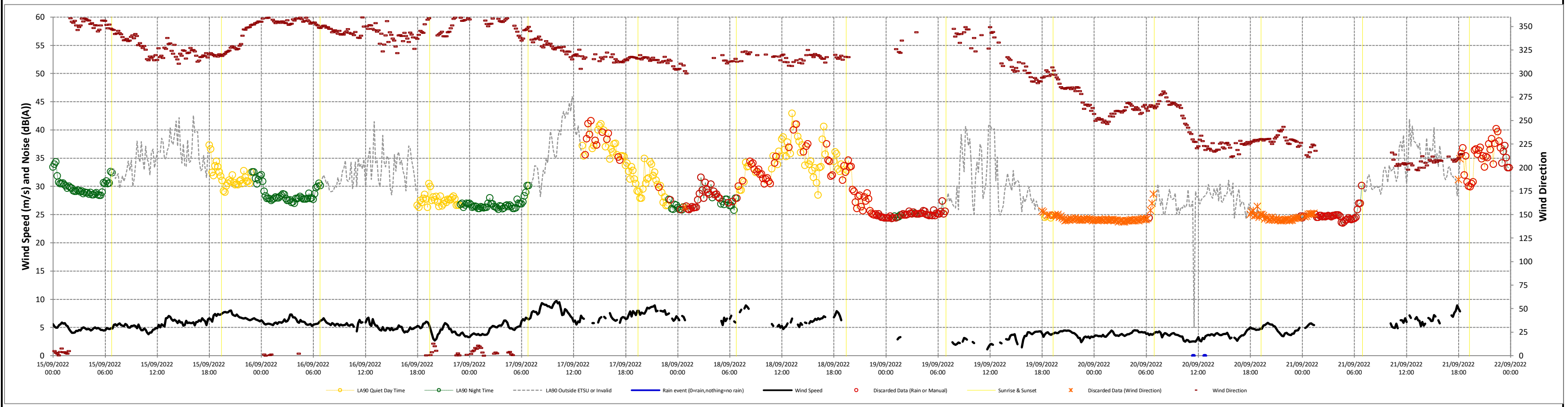

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
Title	Time Serie for Blairoch Page 3 of 6
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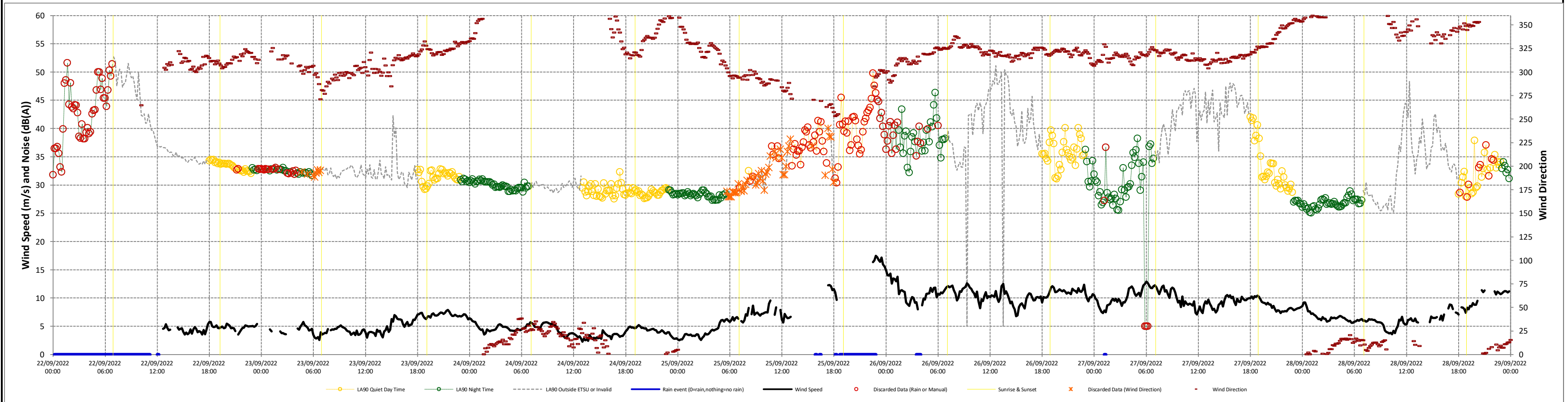

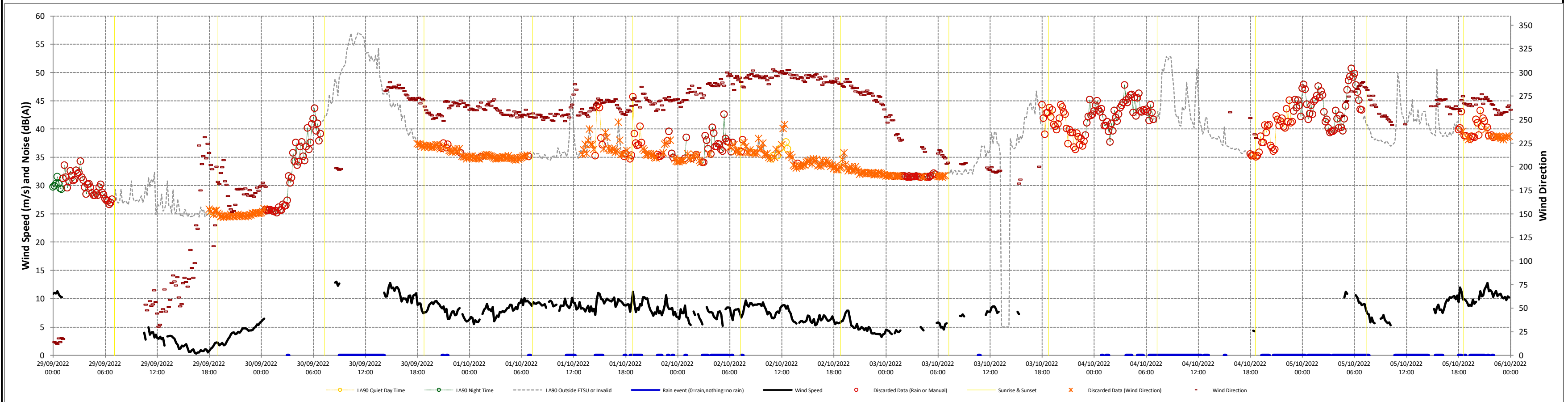

Project	Appin Wind Farm
Client	Appin Wind Farm Limited
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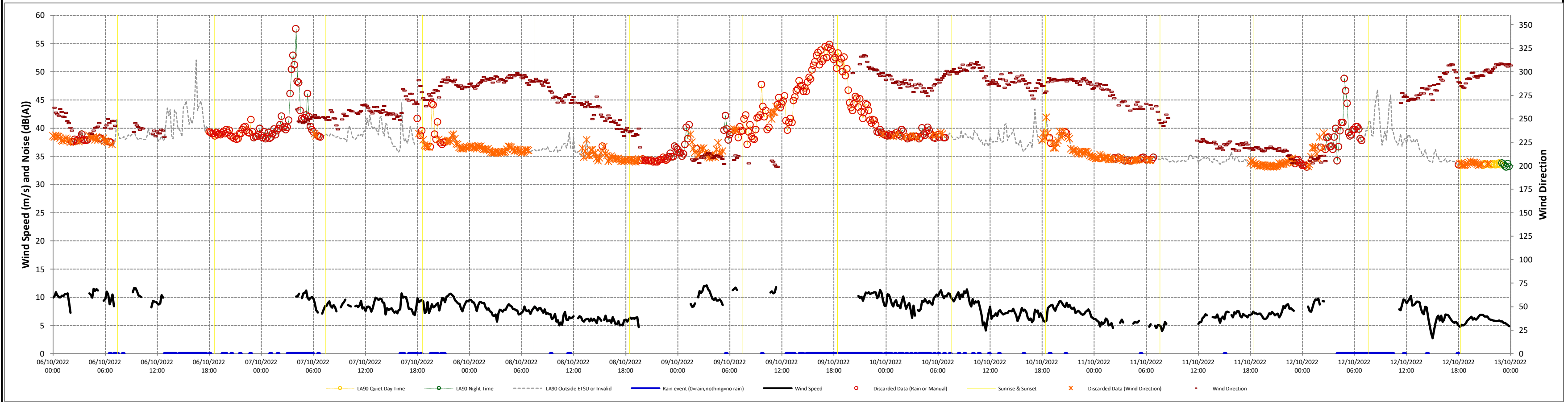

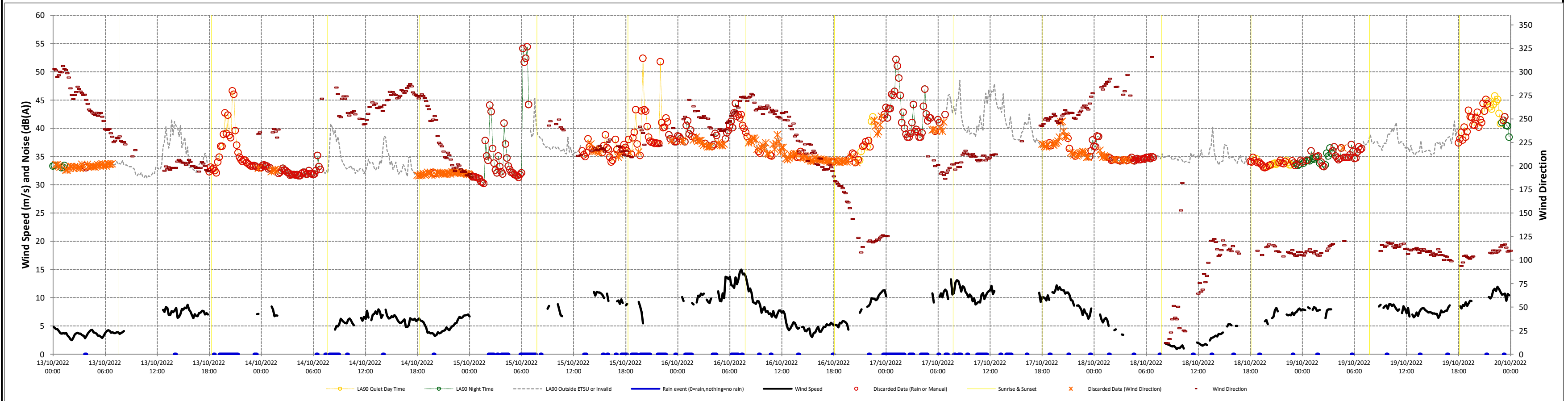

Project	Appin Wind Farm
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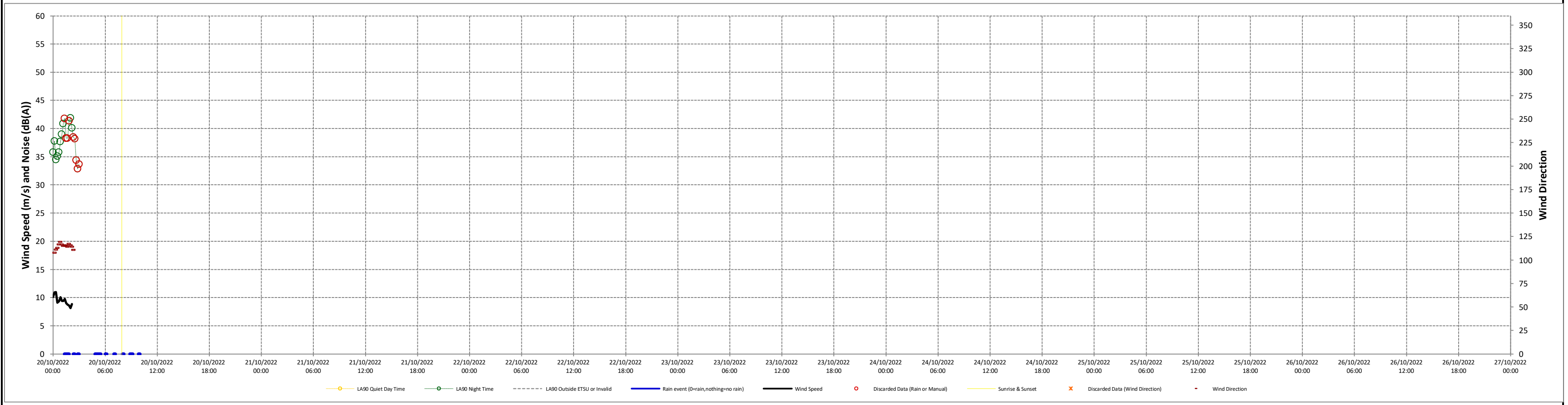

Project	Appin Wind Farm
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Annex 6 – Turbine Coordinates, Topographical Corrections and Cumulative Predictions

Table A6.1: Topographical (concave ground/ barrier) Noise Prediction Adjustment Table

Notes/Comments

Requirement to include a concave ground profile correction of +3dB has been calculated in accordance with section 4.3.9 of the IOA GPG (July 2011)

A barrier correction of -2dB is included where the landform completely obscures a turbine at the noise assessment location

Where analysis indicates that both are required the barrier correction take precedence and a correction of -2dB is applied

Wind Farm	Hub	T ID	Noise Senstive Receptor												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Wether Hill	60.0	1	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	2	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	3	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	4	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	5	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	6	-2	-2	-2	-2	-2	-2	3	3	-2	-2	-2	-2	-2
Wether Hill	60.0	7	-2	-2	-2	-2	-2	-2	3	3	-2	-2	-2	-2	-2
Wether Hill	60.0	8	-2	-2	-2	-2	-2	-2	3	3	-2	-2	3	-2	-2
Wether Hill	60.0	9	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	10	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	11	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	12	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2
Wether Hill	60.0	13	-2	-2	-2	-2	-2	-2	3	3	-2	-2	-2	-2	-2
Wether Hill	60.0	14	-2	-2	-2	-2	-2	-2	3	3	-2	-2	3	-2	-2
Afton	78.0	15	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	16	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	17	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	18	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	19	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	20	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	21	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	22	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	23	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	24	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	25	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	26	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	27	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	28	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	29	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	30	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	31	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	32	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	33	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	60.0	34	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	60.0	35	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	60.0	36	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	60.0	37	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	78.0	38	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Afton	60.0	39	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	40	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	41	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	42	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	43	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	44	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	45	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	46	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	47	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar Community Wind Farm	74.0	48	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	49	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	50	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	51	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	52	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	53	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	54	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	55	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	56	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	57	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Whiteside Hill	69.5	58	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	59	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	60	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

Wind Farm	Hub	T ID	Noise Senstive Receptor												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Windy Rig	75.0	61	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	62	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	63	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	64	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	65	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	66	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	67	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	68	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	69	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Windy Rig	75.0	70	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	71	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	72	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	73	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	74	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	75	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	76	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	77	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	78	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Twentyshilling	81.2	79	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	80	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	81	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	82	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	83	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	84	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	85	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	86	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	87	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	88	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	89	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	90	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	91	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	92	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Troston Loch	83.0	93	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Lorg	119.0	94	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	-2	-2	-2
Lorg	119.0	95	-2	-2	-2	-2	0	0	-2	-2	3	3	0	0	-2
Lorg	119.0	96	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Lorg	119.0	97	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	-2	-2	-2
Lorg	119.0	98	-2	-2	-2	-2	-2	-2	-2	-2	3	0	-2	-2	-2
Lorg	119.0	99	-2	-2	-2	-2	0	0	-2	-2	0	0	-2	-2	-2
Lorg	119.0	100	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Lorg	119.0	101	-2	0	-2	-2	0	0	-2	-2	3	3	0	-2	-2
Lorg	119.0	102	-2	-2	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2
Lorg	119.0	103	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Cornharrow	122.5	104	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Cornharrow	123	105	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Cornharrow	123	106	-2	-2	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	0
Cornharrow	123	107	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Cornharrow	123	108	-2	-2	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	0
Cornharrow	123	109	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Cornharrow	123	110	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Sanquhar II	119	111	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	112	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	113	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	114	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	115	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	116	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	117	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	118	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	119	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	120	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	121	3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	122	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	123	-2	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	124	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	125	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	126	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2	-2	-2

Wind Farm	Hub	T ID	Noise Senstive Receptor												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Sanquhar II	119	127	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	128	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	129	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	130	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	131	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	132	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	133	0	-2	0	0	3	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	134	0	-2	0	0	3	0	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	135	0	-2	3	3	3	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	136	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	137	0	-2	3	3	3	3	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	138	0	-2	3	3	3	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	139	0	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	140	3	3	0	0	0	0	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	141	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	142	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	143	-2	-2	0	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	144	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	145	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	146	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	147	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	148	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	149	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	150	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	151	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	119	152	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	81	153	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sanquhar II	81	154	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	155	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	156	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	157	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	158	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	159	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	160	-2	-2	-2	0	-2	0	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	161	0	-2	-2	-2	-2	-2	-2	-2	3	-2	-2	-2	-2
Euchanhead	155	162	0	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	163	3	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	164	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	165	0	-2	-2	-2	-2	-2	-2	-2	0	-2	-2	-2	-2
Euchanhead	155	166	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	167	0	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	168	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	169	3	-2	-2	-2	-2	3	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	170	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	171	-2	-2	-2	-2	-2	-2	-2	-2	0	0	-2	-2	-2
Euchanhead	155	172	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Euchanhead	155	173	-2	0	-2	-2	0	0	-2	-2	0	0	0	-2	-2
Euchanhead	155	174	0	0	-2	0	0	0	-2	-2	0	3	0	0	-2
Euchanhead	155	175	0	0	-2	0	0	0	-2	-2	-2	0	-2	-2	-2
Manquhill	125	176	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	177	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	178	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	179	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	180	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Manquhill	125	181	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	182	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Manquhill	125	183	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Coud Hill	105	184	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	185	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	186	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	187	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	188	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	189	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	190	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	191	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Coud Hill	105	192	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

Wind Farm	Hub	T ID	Noise Senstive Receptor												
			1	2	3	4	5	6	7	8	9	10	11	12	13
Coud Hill	105	193	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	194	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	195	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	196	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	197	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	198	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	199	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	200	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	201	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Margree	119	202	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	105	203	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	204	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	105	205	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	105	206	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	207	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	105	208	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	209	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	210	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	211	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Glenshimmeroch	125	212	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Appin T1	119	213	0	3	-2	0	3	3	-2	-2	-2	0	-2	-2	-2
Appin T2	119	214	0	3	-2	0	3	3	-2	-2	3	3	0	0	-2
Appin T3	119	215	-2	3	-2	3	3	3	-2	-2	3	3	0	0	-2
Appin T4	119	216	-2	3	-2	3	0	0	-2	-2	0	0	0	0	-2
Appin T5	119	217	0	3	3	3	0	3	-2	-2	0	3	0	0	0
Appin T6	119	218	0	3	3	3	3	3	-2	-2	-2	0	0	0	0
Appin T7	119	219	-2	0	0	0	0	0	0	-2	-2	-2	0	0	0
Appin T8	119	220	-2	3	3	3	0	3	0	0	-2	-2	0	0	0
Appin T9	119	221	-2	3	3	3	0	3	3	0	0	-2	-2	0	0

Table A6.2: Wind Farms/ Turbines Modelled

Wind Farm	Easting	Northing	Hub Height	Tip Height
Wether Hill	269055	593222	60.0	91.0
Wether Hill	269024	593460	60.0	91.0
Wether Hill	268962	593720	60.0	91.0
Wether Hill	268951	594028	60.0	91.0
Wether Hill	269195	594182	60.0	91.0
Wether Hill	269466	594298	60.0	91.0
Wether Hill	269685	594275	60.0	91.0
Wether Hill	270042	594123	60.0	91.0
Wether Hill	269297	593218	60.0	91.0
Wether Hill	269264	593446	60.0	91.0
Wether Hill	269199	593708	60.0	91.0
Wether Hill	269159	593976	60.0	91.0
Wether Hill	269485	594085	60.0	91.0
Wether Hill	269742	594026	60.0	91.0
Afton	261940	605974	78.0	118.0
Afton	261689	605862	78.0	118.0
Afton	261561	605561	78.0	118.0
Afton	261875	605480	78.0	118.0
Afton	261551	605239	78.0	118.0
Afton	261865	605055	78.0	118.0
Afton	261615	604919	78.0	118.0
Afton	261673	604593	78.0	118.0
Afton	261992	604635	78.0	118.0
Afton	261849	604325	78.0	118.0
Afton	262272	604470	78.0	118.0
Afton	262139	604178	78.0	118.0
Afton	262675	604385	78.0	118.0
Afton	262341	603952	78.0	118.0
Afton	262608	604063	78.0	118.0
Afton	262559	603661	78.0	118.0
Afton	262885	603710	78.0	118.0
Afton	262743	603417	78.0	118.0
Afton	262807	603100	78.0	118.0
Afton	263250	602950	60.0	100.0
Afton	263018	602789	60.0	100.0
Afton	263346	602691	60.0	100.0
Afton	263120	602530	60.0	100.0
Afton	263380	602291	78.0	118.0
Afton	263070	602210	60.0	100.0
Sanquhar Community Wind Farm	271343	607571	74.0	130.0
Sanquhar Community Wind Farm	271398	607240	74.0	130.0
Sanquhar Community Wind Farm	270967	607108	74.0	130.0
Sanquhar Community Wind Farm	270476	607158	74.0	130.0

Sanquhar Community Wind Farm	270745	607985	74.0	130.0
Sanquhar Community Wind Farm	270089	607069	74.0	130.0
Sanquhar Community Wind Farm	269714	607527	74.0	130.0
Sanquhar Community Wind Farm	269085	607945	74.0	130.0
Sanquhar Community Wind Farm	268760	607612	74.0	130.0
Whiteside Hill	270905	604899	69.5	121.2
Whiteside Hill	271047	604579	69.5	121.2
Whiteside Hill	271528	604749	69.5	121.2
Whiteside Hill	271748	605145	69.5	121.2
Whiteside Hill	271764	605490	69.5	121.2
Whiteside Hill	270979	605290	69.5	121.2
Whiteside Hill	271920	604847	69.5	121.2
Whiteside Hill	272351	605270	69.5	121.2
Whiteside Hill	272494	605657	69.5	121.2
Whiteside Hill	272692	606090	69.5	121.2
Windy Rig	261348	599691	75.0	125.0
Windy Rig	261413	600263	75.0	125.0
Windy Rig	261974	600511	75.0	125.0
Windy Rig	261662	600073	75.0	125.0
Windy Rig	262184	600292	75.0	125.0
Windy Rig	261875	599863	75.0	125.0
Windy Rig	261502	599444	75.0	125.0
Windy Rig	261978	599585	75.0	125.0
Windy Rig	262259	599984	75.0	125.0
Windy Rig	262600	599996	75.0	125.0
Windy Rig	262334	599612	75.0	125.0
Windy Rig	261706	599210	75.0	125.0
Twentyshilling	278200	604525	81.2	139.7
Twentyshilling	278300	604200	81.2	139.7
Twentyshilling	278650	604425	81.2	139.7
Twentyshilling	278171	603452	81.2	139.7
Twentyshilling	278825	603950	81.2	139.7
Twentyshilling	278475	603775	81.2	139.7
Twentyshilling	278625	602900	81.2	139.7
Twentyshilling	279012	603135	81.2	139.7
Twentyshilling	278025	603900	81.2	139.7
Troston Loch	267126	588450	83.0	149.9
Troston Loch	267511	588243	83.0	149.9
Troston Loch	267538	589057	83.0	149.9
Troston Loch	267951	588828	83.0	149.9
Troston Loch	268029	589546	83.0	149.9
Troston Loch	268447	589344	83.0	149.9
Troston Loch	268224	588441	83.0	149.9
Troston Loch	268541	589969	83.0	149.9
Troston Loch	268963	589816	83.0	149.9
Troston Loch	268345	589552	83.0	149.9
Troston Loch	268947	590464	83.0	149.9
Troston Loch	269424	590385	83.0	149.9
Troston Loch	269773	590004	83.0	149.9
Troston Loch	269817	589441	83.0	149.9
Lorg	267619	599928	119.0	200.0

Lorg	268060	599026	119.0	200.0
Lorg	268062	600520	119.0	200.0
Lorg	268286	600137	119.0	200.0
Lorg	268056	599572	119.0	200.0
Lorg	268741	599651	119.0	200.0
Lorg	268616	600652	119.0	200.0
Lorg	268735	599187	119.0	200.0
Lorg	268812	600230	119.0	200.0
Lorg	268500	601112	119.0	200.0
Cornharrow	268809	595138	122.5	200.0
Cornharrow	267216	593949	122.5	200.0
Cornharrow	269093	594637	122.5	200.0
Cornharrow	268257	595076	122.5	200.0
Cornharrow	268568	594560	122.5	200.0
Cornharrow	267787	594426	122.5	200.0
Cornharrow	267858	593871	122.5	200.0
Sanquhar II	269049	607171	119.0	200.0
Sanquhar II	268288	607015	119.0	200.0
Sanquhar II	267673	606542	119.0	200.0
Sanquhar II	267437	605867	119.0	200.0
Sanquhar II	266682	605196	119.0	200.0
Sanquhar II	266119	604768	119.0	200.0
Sanquhar II	265660	604150	119.0	200.0
Sanquhar II	265306	604543	119.0	200.0
Sanquhar II	264993	604941	119.0	200.0
Sanquhar II	264794	605413	119.0	200.0
Sanquhar II	266055	603373	119.0	200.0
Sanquhar II	266769	603637	119.0	200.0
Sanquhar II	267282	603469	119.0	200.0
Sanquhar II	267993	604117	119.0	200.0
Sanquhar II	268463	604679	119.0	200.0
Sanquhar II	268566	603463	119.0	200.0
Sanquhar II	268793	604105	119.0	200.0
Sanquhar II	269493	603801	119.0	200.0
Sanquhar II	270312	603852	119.0	200.0
Sanquhar II	270823	603554	119.0	200.0
Sanquhar II	269912	601914	119.0	200.0
Sanquhar II	270352	601350	119.0	200.0
Sanquhar II	270767	600999	119.0	200.0
Sanquhar II	271405	600887	119.0	200.0
Sanquhar II	272015	600451	119.0	200.0
Sanquhar II	272602	600916	119.0	200.0
Sanquhar II	272622	600262	119.0	200.0
Sanquhar II	273200	600051	119.0	200.0
Sanquhar II	273949	599815	119.0	200.0
Sanquhar II	274648	599339	119.0	200.0
Sanquhar II	270939	601845	119.0	200.0
Sanquhar II	271536	602350	119.0	200.0
Sanquhar II	271853	601945	119.0	200.0
Sanquhar II	272117	602837	119.0	200.0
Sanquhar II	272772	603135	119.0	200.0

Sanquhar II	273344	603022	119.0	200.0
Sanquhar II	272466	602391	119.0	200.0
Sanquhar II	272850	602033	119.0	200.0
Sanquhar II	273291	601732	119.0	200.0
Sanquhar II	273929	601996	119.0	200.0
Sanquhar II	273733	601390	119.0	200.0
Sanquhar II	274058	601025	119.0	200.0
Sanquhar II	271644	608084	81.0	149.0
Sanquhar II	271979	607680	81.0	149.0
Euchanhead	268456	606531	155.0	230.0
Euchanhead	268000	606036	155.0	230.0
Euchanhead	267494	605259	155.0	230.0
Euchanhead	267071	604688	155.0	230.0
Euchanhead	266509	604256	155.0	230.0
Euchanhead	267749	603314	155.0	230.0
Euchanhead	266646	602924	155.0	230.0
Euchanhead	267942	602664	155.0	230.0
Euchanhead	266175	602607	155.0	230.0
Euchanhead	266848	602093	155.0	230.0
Euchanhead	267381	601757	155.0	230.0
Euchanhead	269104	601408	155.0	230.0
Euchanhead	269707	601291	155.0	230.0
Euchanhead	269225	600793	155.0	230.0
Euchanhead	269933	600718	155.0	230.0
Euchanhead	270156	600193	155.0	230.0
Euchanhead	269348	599928	155.0	230.0
Euchanhead	270724	599799	155.0	230.0
Euchanhead	269363	599239	155.0	230.0
Euchanhead	270032	599218	155.0	230.0
Euchanhead	270983	599044	155.0	230.0
Manquhill	266825	594440	125.0	200.0
Manquhill	266902	595000	125.0	200.0
Manquhill	267343	594828	125.0	200.0
Manquhill	267286	595606	125.0	200.0
Manquhill	267803	595130	125.0	200.0
Manquhill	267333	596216	125.0	200.0
Manquhill	267838	595761	125.0	200.0
Manquhill	268394	595730	125.0	200.0
Cloud Hill	272702	605026	105.0	180.0
Cloud Hill	273094	605660	105.0	180.0
Cloud Hill	273179	604912	105.0	180.0
Cloud Hill	273731	605202	105.0	180.0
Cloud Hill	273847	605863	105.0	180.0
Cloud Hill	273377	605381	105.0	180.0
Cloud Hill	274247	605353	105.0	180.0
Cloud Hill	274508	606358	105.0	180.0
Cloud Hill	273562	606171	105.0	180.0
Cloud Hill	274545	605910	105.0	180.0
Margree	267755	587268	118.5	200.0
Margree	268208	587299	118.5	200.0
Margree	268643	587146	118.5	200.0

Margree	269174	587046	118.5	200.0
Margree	268168	587884	118.5	200.0
Margree	268832	587935	118.5	200.0
Margree	269345	587628	118.5	200.0
Margree	268795	588479	118.5	200.0
Margree	269447	588195	118.5	200.0
Glenshimmeroch	265463	588279	105.0	180.0
Glenshimmeroch	265784	588542	125.0	200.0
Glenshimmeroch	265849	588142	105.0	180.0
Glenshimmeroch	265991	587759	105.0	180.0
Glenshimmeroch	266299	588225	125.0	200.0
Glenshimmeroch	266443	587757	105.0	180.0
Glenshimmeroch	266717	588273	125.0	200.0
Glenshimmeroch	266949	587881	125.0	200.0
Glenshimmeroch	267382	587916	125.0	200.0
Glenshimmeroch	267353	587511	125.0	200.0
Appin T1	271329	598727	119.0	200.0
Appin T2	270343	598885	119.0	200.0
Appin T3	270607	598414	119.0	200.0
Appin T4	270920	598031	119.0	200.0
Appin T5	271268	597665	119.0	200.0
Appin T6	271751	597457	119.0	200.0
Appin T7	272089	597035	119.0	200.0
Appin T8	272534	596725	119.0	200.0
Appin T9	272764	596380	119.0	200.0

Table A6.3: Likely Effects Calculations

		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Shinnelhead	Predicted Wind Turbine Noise L_{A90} Proposed Development (Full Mode)	-	-	22.7	24.4	27.8	31.3	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	30.3	34.6	38.0	38.9	39.0	39.0	39.0	39.0	39.0
	Difference	-	-	-	-5.9	-6.8	-6.7	-5.9	-6.0	-6.0	-6.0	-6.0	-6.0
NAL2 - High Appin	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	23.2	24.9	28.3	31.8	33.5	33.5	33.5	33.5	33.5	33.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.8	27.5	30.7	31.5	31.6	31.7	31.8	31.8	31.8
	Difference	-	-	-	1.1	0.8	1.1	2.0	1.9	1.8	1.7	1.7	1.7
NAL3 - Appin Lodge	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	20.0	21.7	25.1	28.6	30.3	30.3	30.3	30.3	30.3	30.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.3	27.0	30.3	31.1	31.2	31.3	31.4	31.4	31.4
	Difference	-	-	-	-1.6	-1.9	-1.7	-0.8	-0.9	-1.0	-1.1	-1.1	-1.1
NAL4 - High Auchenbrack	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	19.2	20.9	24.3	27.8	29.5	29.5	29.5	29.5	29.5	29.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	22.1	25.7	28.9	29.8	29.9	30.0	30.1	30.1	30.1
	Difference	-	-	-	-1.2	-1.4	-1.1	-0.3	-0.4	-0.5	-0.6	-0.6	-0.6
NAL5 - Kilnmark	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	16.7	18.5	21.9	25.4	27.0	27.0	27.0	27.0	27.0	27.0
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	21.1	24.6	27.7	28.6	28.7	28.8	28.9	28.9	28.9
	Difference	-	-	-	-2.6	-2.7	-2.3	-1.6	-1.7	-1.8	-1.9	-1.9	-1.9
NAL6 - Auchenbrack	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	16.8	18.5	21.9	25.4	27.1	27.1	27.1	27.1	27.1	27.1
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	20.1	23.6	26.6	27.5	27.6	27.7	27.8	27.8	27.8
	Difference	-	-	-	-1.6	-1.7	-1.2	-0.4	-0.5	-0.6	-0.7	-0.7	-0.7
NAL7 - Kirkconnel	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	13.7	15.5	18.9	22.4	24.0	24.0	24.0	24.0	24.0	24.0
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	22.2	24.1	26.1	26.8	27.0	27.6	28.2	28.2	28.2
	Difference	-	-	-	-6.7	-5.2	-3.7	-2.8	-3.0	-3.6	-4.2	-4.2	-4.2
NAL8 - Dalwhat Farm Cottage	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	14.5	16.2	19.6	23.1	24.8	24.8	24.8	24.8	24.8	24.8
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	25.1	26.8	28.7	29.2	29.5	30.1	30.8	30.8	30.8
	Difference	-	-	-	-8.9	-7.2	-5.6	-4.4	-4.7	-5.3	-6.0	-6.0	-6.0
NAL9 - Corriedow	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	17.4	19.2	22.6	26.1	27.7	27.7	27.7	27.7	27.7	27.7
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	27.7	29.5	31.3	31.7	32.0	32.6	33.3	33.3	33.3
	Difference	-	-	-	-8.5	-6.9	-5.2	-4.0	-4.3	-4.9	-5.6	-5.6	-5.6
NAL10 - Glenjaan	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	19.0	20.8	24.2	27.7	29.3	29.3	29.3	29.3	29.3	29.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	29.4	31.0	32.6	33.1	33.4	34.1	34.8	34.8	34.8
	Difference	-	-	-	-8.6	-6.8	-4.9	-3.8	-4.1	-4.8	-5.5	-5.5	-5.5
NAL11 - Benbuie	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	25.7	27.4	30.8	34.3	36.0	36.0	36.0	36.0	36.0	36.0
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	29.6	31.6	33.4	33.8	34.1	34.6	35.2	35.2	35.2
	Difference	-	-		-2.2	-0.8	0.9	2.2	1.9	1.4	0.8	0.8	0.8
NAL12 - Blairoch Cairnhead	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	26.6	28.4	31.8	35.3	36.9	36.9	36.9	36.9	36.9	36.9
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	28.3	31	33.1	33.5	33.7	34.1	34.5	34.5	34.5
	Difference	-	-		0.1	0.8	2.2	3.4	3.2	2.8	2.4	2.4	2.4
NAL13 - Cairnhead (Bothy)	Predicted Wind Turbine Noise L_{A90} Proposed Development	-	-	26.4	28.1	31.5	35	36.7	36.7	36.7	36.7	36.7	36.7
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	28.4	31.8	34.2	34.6	34.7	34.9	35.2	35.2	35.2
	Difference	-	-		-0.3	-0.3	0.8	2.1	2.0	1.8	1.5	1.5	1.5

Annex 7 – Turbine Data

Table A7.1: Sound Power Level Data

Wind Farm	Turbine	Hub height modelled	Uncertainty Included	Reference Wind Speed (ms^{-1}) Standardised to 10m Height									
				3	4	5	6	7	8	9	10	11	12
Wether Hill	Siemens SWT-1.3-62, 1.3 MW, Standard Blades	60.0	2.0	-	102.9	103.5	104.1	104.7	105.2	106.4	107.5	107.5	107.5
Afton	Gamesa G80, 2 MW, Standard Blades	78.0	2.0	-	-	102.5	104.9	105.1	105.1	105.1	105.1	105.1	105.1
Sanquhar Community Wind Farm	Vestas V112, 3.6 MW, STE Blades	74.0	2.0		96.8	102.2	106.3	108.3	108.5	108.5	108.5	108.5	108.5
Whiteside Hill	GE 2.85-103, 2.85 MW, Standard Blades	69.5	2.0	97.0	98.1	101.2	104.4	106.5	107.0	107.0	107.0	107.0	107.0
Windy Rig	Nordex N100/3300, 3.3 MW, Standard Blades	75.0	2.0	97.5	98.5	100.5	104.8	106.4	107.0	107.5	107.5	107.5	107.5
Twentyshilling	Vestas V117, 4.2 MW, STE Blades	81.5	2.0	95.0	97.8	101.9	105.7	107.8	108.0	108.0	108.0	108.0	108.0
Troston Loch	Nordex N133, 4.8 MW, Standard Blades	83.0	2.0	-	95.2	100.6	104.7	106.3	107.0	107.0	107.0	107.0	107.0
Lorg	Vestas V162, 5.6 MW, Standard Blades	119.0	Restricted data, available on request. Maximum sound power as modelled is 108.8 dB.										
Cornharrow	Siemens-Gamesa SG6.6-155, 6.6 MW, Standard Blades	122.5	2.0	95.2	100.4	105.2	107.0	107.0	107.0	107.0	107.0	107.0	107.0
Sanquhar II (1)	Vestas V162, 6.2 MW, STE Blades	119.0	Restricted data, available on request. Maximum sound power as modelled is 106.8 dB.										
Sanquhar II (2)	Vestas V136, 4.5 MW, STE Blades	82.0	2.0	93.4	96.6	101.4	105.2	105.9	105.9	105.9	105.9	105.9	105.9
Margree	Nordex N163/5.X, 5.7 MW, Standard Blades, Mode 0	118.2	Restricted data, available on request. Maximum sound power as modelled is 111.2 dB.										
Manquhill	Vestas V150, 6 MW, STE Blades	125.0	2.0	95.0	98.6	103.0	106.3	106.8	106.9	106.9	106.9	106.9	106.9
Glenshimmeroch (1)	Vestas V150, 4.2 MW, STE Blades	105.0	2.0	93.9	97.7	102.6	106.4	106.9	106.9	106.9	106.9	106.9	106.9
Glenshimmeroch (2)	Vestas V150, 4.2 MW, STE Blades	125.0	2.0	94.1	98.1	103.2	106.7	106.9	106.9	106.9	106.9	106.9	106.9
Euchanhead	Vestas V150, 5.6 MW, STE Blades	155.0	2.0	95.1	99.1	103.6	106.0	106.6	106.9	106.9	106.9	106.9	106.9
Cloud Hill	Vestas V150, 5.6 MW, STE Blades	105.0	2.0	94.6	98.3	102.6	105.6	106.2	106.9	106.9	106.9	106.9	106.9
Appin (1)	Vestas V162, 7.2 MW, STE Blades, Mode PO7200	119.0	Restricted data, available on request. Maximum sound power as modelled is 108.3 dB.										
Appin (2)	Vestas V162, 7.2 MW, STE Blades, Mode SO1	119.0	Restricted data, available on request. Maximum sound power as modelled is 105.5 dB.										
Appin (3)	Vestas V162, 7.2 MW, STE Blades, Mode SO2	119.0	Restricted data, available on request. Maximum sound power as modelled is 104 dB.										
Appin (4)	Vestas V162, 7.2 MW, STE Blades, Mode SO3	119.0	Restricted data, available on request. Maximum sound power as modelled is 103 dB.										
Appin (5)	Vestas V162, 7.2 MW, STE Blades, Mode SO5	119.0	Restricted data, available on request. Maximum sound power as modelled is 101 dB.										

Table A7.2: Octave Band Data

Scheme	Turbine Modelled	Reference Wind Speed (m/s)	Octave Band (Hz)								
			63	125	250	500	1000	2000	4000	8000	Overall
Wether Hill	Siemens SWT-1.3-62, 1.3 MW, Standard Blades	8.0	89.3	95.9	98.8	97.9	97.8	98.1	92.5	84.3	105.2
Afton	Gamesa G80, 2 MW, Standard Blades	8.0	85.3	92.5	97.5	100.1	99.5	96.1	90.0	80.2	105.1
Sanquhar Community Wind Farm	Vestas V112, 3.6 MW, STE Blades	10.0	85.7	94.6	99.2	102.5	104.4	99.8	95.4	83.0	108.5
Whiteside Hill	GE 2.85-103, 2.85 MW, Standard Blades	7.0	87.7	95.1	97.7	99.3	100.7	100.5	94.8	76.1	106.4
Windy Rig	Nordex N100/3300, 3.3 MW, Standard Blades	10.0	85.6	92.3	94.9	99.0	103.1	102.5	96.7	82.1	107.5
Twentyshilling	Vestas V117, 4.2 MW, STE Blades	7.0	88.1	95.3	100.1	102.4	102.2	99.5	94.3	86.6	107.8
Troston Loch	Nordex N133, 4.8 MW, Standard Blades	8.0	88.0	95.1	99.9	102.3	102.9	100.4	92.9	80.6	108.0
Lorg	Vestas V162, 5.6 MW, Standard Blades	Restricted data, available on request.									
Cornharrow	Siemens-Gamesa SG6.6-155, 6.6 MW, Standard Blades	7.0	85.6	93.1	99.0	100.5	101.6	100.4	94.7	78.9	107.0
Sanquhar II (1)	Vestas V162, 6.2 MW, STE Blades	Restricted data, available on request.									
Sanquhar II (2)	Vestas V136, 4.5 MW, STE Blades	6.0	84.5	92.7	98.0	100.3	99.6	95.9	89.2	79.6	105.2
Margree	Nordex N163/5.X, 5.7 MW, Standard Blades, Mode 0	Restricted data, available on request.									
Manquhill	Vestas V150, 6 MW, STE Blades	7.0	87.4	95.2	100.1	102.0	100.9	96.7	89.6	79.5	106.8
Glenshimmeroch (1)	Vestas V150, 4.2 MW, STE Blades	8.0	88.3	95.6	100.2	101.9	100.9	97.0	90.4	80.9	106.9
Glenshimmeroch (2)	Vestas V150, 4.2 MW, STE Blades	8.0	88.3	95.6	100.2	101.9	100.9	97.0	90.4	80.9	106.9
Euchanhead	Vestas V150, 5.6 MW, STE Blades	7.0	87.3	95.1	99.9	101.8	100.6	96.5	89.4	79.3	106.6
Cloud Hill	Vestas V150, 5.6 MW, STE Blades	7.0	87.3	95.1	99.9	101.8	100.6	96.5	89.4	79.3	106.6
Appin (1)	Vestas V162, 7.2 MW, STE Blades, Mode PO7200	Restricted data, available on request.									
Appin (2)	Vestas V162, 7.2 MW, STE Blades, Mode SO1	Restricted data, available on request.									
Appin (3)	Vestas V162, 7.2 MW, STE Blades, Mode SO2	Restricted data, available on request.									
Appin (4)	Vestas V162, 7.2 MW, STE Blades, Mode SO3	Restricted data, available on request.									
Appin (5)	Vestas V162, 7.2 MW, STE Blades, Mode SO5	Restricted data, available on request.									