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Appendix 11-2

Operational Noise Report

Sheskin South Wind Farm

SSE Renewables

14192-006
21 February 2023

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Executive Summary

TNEI was commissioned by SSE Renewables ('the Applicant') to undertake an operational noise assessment for the proposed Sheskin South Wind Farm (hereinafter referred to as 'the Proposed Development'). The aim of this was to assess the potential impact of operational noise from the Proposed Development on the nearest noise sensitive receptors.

The Irish Governments '*Wind Energy Development Guidelines, 2006*' (WEDG), produced by the Department of Environment Heritage and Local Government (DoEHLG), are the current guidelines for setting noise limits for wind energy developments. The information relating to noise in the WEDG, in parts, is very limited and it is widely agreed that the limits proposed in the WEDG were drafted to broadly align with the UK guidance ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'.* In 2013, the UK guidance was supplemented by a document produced by the Institute of Acoustics *'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). For this assessment the guidance contained in ETSU-R-97 and the IOA GPG has been used to supplement the WEDG.

The operational noise assessment has been undertaken in three stages:

1) deriving the Total WEDG Noise Limits (which are applicable to noise generated from all wind turbines in the area operating concurrently) at noise sensitive receptors;

2) predicting the likely effects (undertaking a cumulative noise assessment where required) to determine whether noise immissions at noise sensitive receptors will meet the Total WEDG Noise Limits; and

3) deriving 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 undertaking 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.

There are 23 Noise Sensitive Receptors (NSRs) in proximity (~2 km search area) to the Proposed Development. Of the 23 identified NSRs a total of seven NSRs were chosen as Noise Assessment Locations (NALs). The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Development. Additional receptors were also included to consider cumulative noise impacts. The modelling results for the NALs has been presented within the main body of this report whilst an assessment for all NSRs has been included within an Annex to the report. 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. For clarity all NSRs are labelled with the letter 'H', to ensure consistency with the labelling within the rest of the Environmental Impact Assessment Report (EIAR).

Wind speed data was measured using a LIDAR unit. The wind data measured at 110 m and 123 m height was used to calculate hub height wind speeds (at 115 m). These hub height wind speeds were then standardised to a height of 10m in accordance with current good practice.

Analysis of the measured data has been undertaken in accordance with the WEDG 2006, 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.

Two sets of noise limits have been derived; the Total WEDG Noise limits apply to the cumulative noise level of all turbines operating in the area including the Proposed Development, whilst the Site Specific Noise limits apply to operational noise from the Proposed Development only.

Based on the guidance in the WEDG 2006, the daytime Total WEDG Noise Limit was set at 40 dB(A) where background noise levels were <30 dB, and 45 dB(A) or background plus 5 dB whichever is the greater where background noise levels were >30 dB. The night time Total WEDG Noise Limit has been set at 43 dB(A) or background plus 5 dB whichever is the greater.

The 'Site Specific Noise Limits' were derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments (operational or consented) in proximity to the Proposed Development.

Predictions of wind turbine noise for the Proposed Development were made, based upon the sound power level data for a candidate wind turbine with a rotor diameter of 170 m, serrated trailing edge blades and a hub height of 115 m. The candidate turbine modelled is considered to be representative of the type of turbine that could be installed at the site.

Modelling was undertaken using the noise prediction model ISO 9613: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation',* 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 models of turbines were identified through an online search.

A cumulative assessment was undertaken at the NALs where predictions from the Proposed Development were found to be within 10 dB of the noise predictions from all other wind farm developments. The likely cumulative assessment undertaken at all seven NALs shows that the Proposed Development can operate concurrently with other wind farm developments in the area, whilst still meeting the Total WEDG Noise Limits at the receptors.

Site Specific Noise Limits have also been derived that take account (where required) of the other wind farm developments. Where wind turbine immissions from the other wind turbines at a given receptor were found to be at least 10 dB below the Total WEDG 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 from the other wind farm developments in the area were found to be within 10 dB of the Total WEDG Noise Limit, apportionment of the Total WEDG Noise Limits was undertaken in accordance with the IOA GPG.

Predicted noise levels indicate that at all noise assessment locations wind turbine noise immissions were below the Site Specific Noise Limits. A minor exceedance of the Site Specific Noise Limit was predicted at receptors NAL3 (0.1 dB daytime at 5 ms^{-1} and 0.4 dB night time at 7-9 ms^{-1}) and H02 (0.1 dB daytime at 5 ms^{-1} and night time at 7-9 ms^{-1}). In order to meet the Site Specific Noise Limits, turbine 18 would need to be operated in a lower noise mode for certain wind directions and wind speeds when considering the candidate turbine. The application of the lower noise mode to mitigate the exceedance at NAL3 would also mitigate the minor day and night time exceedance at H02 due to their proximity.

The use of Site Specific Noise Limits would ensure that the Proposed Development could operate concurrently with other consented or operational turbines in the area and would also ensure that the Proposed Development's individual contribution could be measured and enforced if required.

Should planning permission 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 planning permission the final choice of turbine would be subject to a competitive tendering process. As such, predictions of wind turbine noise are for the purposes of assessment only. The final choice of turbine would, however, need to meet the noise limits determined and contained within any condition imposed.

Contents

TABLES

ANNEXES

1 Introduction

1.1 Brief

1.1.1 TNEI was commissioned by SSE Renewables ('the Applicant') to undertake an operational noise assessment for the proposed Sheskin South Wind Farm (hereinafter referred to as 'the Proposed Development'). The following steps summarise the noise assessment process:

- Measure and analyse existing background noise levels and present the measured noise data with reference to existing government guidance and the recommendations of the Department of Environment Heritage and Local Government (DoEHLG), which are contained in the '*Wind Energy Development Guidelines, 2006*' [(1)] (WEDG 2006), in conjunction with the guidance produced by the United Kingdom's 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'* [(2)] and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* [(3)] (IOA GPG);
- Determine the Total WEDG 2006 noise limits applicable to all wind farms 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 a noise related planning condition should An Bord Pleanála be minded to grant planning permission;
- Undertake predictions of the operational wind turbine noise immissions from the Proposed Development that will be incident at neighbouring noise sensitive receptors;
- Compare the predictions of the operational wind turbine noise immissions from the Proposed Development against the site specific noise limits; and
- Assess the impact of noise from the Proposed Development with reference to existing government guidance and the recommendations of the Department of Environment Heritage and Local Government, which are contained in the WEDG 2006.

1.2 Background

1.2.1 The Proposed Development is located within an area of Coillte forestry 8 km north east of Bangor and 9 km south west of Glenamoy in County Mayo. The approximate Irish Transverse Mercator (ITM) reference for the centre if the site is 492870, 823674 and the proposed layout is shown on Figure A1.1 in Annex 1.

1.2.2 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine with a rotor diameter of 170 m, serrated trailing edge blades and a hub height of 115 m. The candidate turbine modelled is considered representative of the type of turbine that could be installed at the site.

1.2.3 The noise assessment has considered schemes that are operational, consented and proposed (planning application submitted). The schemes considered in the assessment are summarised in Table 1.1.

Table 1.1 Cumulative Wind Farm/ Turbine Developments

Wind Farm/ Wind Turbine	Number of Turbines	Status	Make and Model of Turbine Considered in Modelling
Oweninny 1	29	Operational	Siemens SWT 3.2-113
Oweninny 2	32	Under Construction	Nordex N117
ABO Sheskin	8	Under Construction	117 m rotor turbine

1.2.4 Corvoderry Wind Farm has not been considered in the assessment as it's planning permission expired mid October 2022. In addition, the operational Bellacorrick Wind Farm has not been considered as it is understood that it will be decommissioned as part of the construction phase of Oweninny 2 Wind Farm. Oweninny 3 has also not been considered as the scheme is pre-planning and therefore at this stage there is too much uncertainty regarding turbine locations and turbine parameters. Due to the separation distances between the turbines and the noise sensitive receptors considered within this assessment (>5 km), it is anticipated that the noise immissions from Oweninny 3 would have a negligible impact at the noise sensitive receptors located closest to the Proposed Development.

1.2.5 Figure A1.1a in Annex 1 shows the location of the above developments relative to the Proposed Development. The turbine type modelled for each of the schemes detailed in Table 1.1 was chosen using information contained within the Environmental Impacts Statements for the schemes or using information detailed on the specific project websites.

1.2.6 For a number of the consented schemes detailed in Table 1.1, noise related planning conditions have been set within the relevant Decision Notices, as detailed in Annex 2. 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 wind farms in the area.

1.2.7 For the purposes of assessing the other wind farms (detailed in Table 1.1) operating in conjunction with the Proposed Development the following terms have been referred to throughout:

- **'Total WEDG 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 WEDG Noise Limits' in accordance with current good practice (IOA GPG).

1.2.8 Note that the term 'noise emission' relates to the sound power level *emitted* from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level *received* 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;
- Regional Planning Policy;
- Local Policy;
- Department of Environment Heritage and Local Government (DoEHLG) '*Wind Energy Development Guidelines,'* 2006;
- 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 Planning Policy

2.2.1 The National Planning Framework 'Project Ireland 2040' [(4)] was adopted on 29 May 2018. The document sets out a number of National Policy Objectives, of which number 65 relates to noise.

2.2.2 National Policy Objective 65 states;

"Promote the pro-active management of noise where it is likely to have significant adverse impacts on health and quality of life and support the aims of the Environmental Noise Regulations through national planning guidance and Noise Action Plans."

2.2.3 The document does not contain specifics with regards to the assessment of noise. Rather, it states (page 5):

'The National Planning Framework, is a planning framework to guide development and investment over the coming years. It does not provide every detail for every part of the country; rather it empowers each region to lead in the planning and development of their communities, containing a set of national objectives and key principles from which more detailed and refined plans will follow.'

Accordingly, it is necessary to look at regional and local guidance and policy for further direction.

2.3 Regional Spatial and Economic Strategies (RSES) 2020-2032

2.3.1 The RSES provides a strategy for delivering effective region development in the Northern and Western Region of Ireland. In relation to renewable energy it states (page 163):

'It is important that our region sets out its ambitions concerning renewable energy in this context and shows its ability to help contribute to achieving national targets.'

2.3.2 The RSES does not include any information specific to noise but states the following:

'The forthcoming Renewable Electricity Policy and Development Framework will aim to identify strategic areas for the sustainable development of renewable electricity projects of scale, in a sustainable manner, compatible with environmental and cultural heritage, landscape and amenity considerations. The development of the Wind Energy Guidelines and the Renewable Electricity Development Plan will also facilitate informed decision making, in relation to renewable energy infrastructure.'

2.3.3 The Department of Environment, Climate and Communications (DECC) is currently preparing the Renewable Electricity and Policy Development Framework (REPDF).

2.4 Local Policy

2.4.1 The Mayo County Development Plan (2021-2027) has not yet been formally adopted but is understood to be in the final draft stages. Chapter 11 *'Climate Action & Renewable Energy'* of Volume 1 states (Section 11.7.2) that local authorities must be consistent with following national plans, policies and strategies when considering renewables energy projects, which include the:

"….. Wind Energy Development Guidelines, Planning Guidelines (2006), as amended or replaced"

2.4.2 Section 8.8.1 of Volume 2, 'Wind Energy' states that:

'Planning applications for wind energy development shall be in compliance with DoEHLG Wind Energy Development Guidelines 2006 (including any new guidelines when issued) and the Renewable Energy Strategy for Mayo.'

2.4.3 The current Renewable Energy Strategy for County Mayo (2011 – 2020) states that prior to the development of a renewable energy project:

'Impacts from noise during the construction phase and the operation phase of renewable energy projects shall be considered to avoid, prevent and reduce on a prioritised basis exposure to unacceptable levels of environmental noise….. Due regard shall be taken of the parameters outlined in the Noise Action Plan for the County Mayo and Noise Regulations 2006.'

2.4.4 The Noise Action Plan for the County Mayo and Noise Regulations 2006 has now been replaced by County Mayo Local Authorities Noise Action Plan 2018-2023.

2.4.5 In relation to wind farm developments, the document refers to the WEDG 2006 and states:

'this DoEHLG document suggests a "lower fixed limit of 45dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations". The latter requirement may be relaxed in areas with low background levels. A fixed limit of 43dB(A) at night-time is deemed appropriate, as there is no requirement to protect external amenity. These guidelines are currently under review and due to be published in Revised form shortly.'

2.5 Wind Energy Development Guidelines, 2006

2.5.1 The current guidelines for setting noise limits are detailed in the Department of Environment Heritage and Local Government (DoEHLG), *'Wind Energy Development Guidelines, 2006'* (WEDG).

2.5.2 The information relating to noise in the WEDG is very limited (for example there is no guidance on where or how to measure background noise levels and how to correlate these with wind speed on the proposed wind farm site. There is also no mention of how to consider cumulative effects). The WEDG 2006 guidelines do, however, include guidance on how to derive limits for daytime and night time periods.

2.5.3 The daytime limits take account of existing background noise levels and include a fixed limit of 45 dB or background + 5 dB, whichever is the greater, except in low background noise environments where a fixed minimum limit in the range 35-40 dB should be considered. TNEIs interpretation of these limits is that turbine noise should not exceed:

- 45 dB $L_{A90,\ 10\ min}$ or background noise + 5 dB, whichever is the greater, for daytime hours (applicable where background noise levels are greater than 30 dB L_{A90}); or,
- 35 to 40 dB $L_{A90,\ 10\ min}$ where background noise is less than 30 dB L_{A90};

2.5.4 The WEDG states that a *"fixed limit of 43dB(A) will protect sleep inside properties during the night",* however, whilst it is not explicit within the WEDG guidance, the addition of a night time 'background noise +5 dB' parameter is commonly applied in wind turbine noise assessments. This is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála. On that basis, the night time noise limits used in this assessment have been based on 43 dB or background noise + 5 dB, whichever is the greater.

2.5.5 It is widely agreed that the limits proposed in the WEDGs were drafted to broadly align with the UK guidance *ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms'*. In 2013 this UK guidance was supplemented by a document produced by the Institute of Acoustics' (IOA) *'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). Given the lack of detail in parts of the WEDG, information contained in ETSU-R-97 and the IOA GPG is often used to supplement the WEDGs and to inform wind farm noise assessments in Ireland.

Draft 2019 WEDG

2.5.6 It is noted that the WEDG are currently under review and a set of 'draft 2019 WEDG' updated guidelines were issued for consultation in December 2019. The draft 2019 WEDG included reference to, and reliance upon, some elements of ETSU-R-97 and the IOA GPG, however, significant concerns were raised during the consultation process regarding the noise section of the draft 2019 WEDGs and at the time of writing this report, no further updates have been issued. Given the limitations of the draft 2019 WEDGs and the likelihood that significant changes would need to be made to them before they could be adopted, an assessment using those draft guidelines has not been undertaken.

2.5.7 Timelines for the conclusion of the WEDGs review are unclear. It is possible that an updated version of the WEDG will be issued (although it is expected that it would be materially different to the draft 2019 WEDGs), it is also conceivable that Government will choose to adopt ETSU-R-97 or a document which builds on the guidance in ETSU-R-97.

2.5.8 The guidance in the WEDG 2006 have been used to assess operational noise from the Proposed Development. In the absence of detailed guidance being included within the WEDG 2006 the assessment methodology has been supplemented by the guidance in ETSU-R-97 and the IOA GPG where appropriate.

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. The 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 ETSU-R-97 states that noise 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 metre measurement height.

2.6.7 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.

2.6.8 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.

2.6.9 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}.

2.6.10 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.'

2.6.11 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.

2.6.12 As detailed above, for this assessment the ETSU-R-97 guidance will be used to supplement the guidance provided within the WEDG. The noise limits have been derived in accordance with WEDG 2006.

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 noise 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 by all Governments within the UK.

2.7.4 As with ETSU-R-97, for this assessment the recommendations included in the IOA GPG have been used to supplement the guidance provided within the WEDG.

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

2.7.6 To summarise, the assessment of operational noise from the Proposed Development has been undertaken in accordance with WEDG 2006, supplemented by the guidance presented in ETSU-R-97 and the IOA GPG where appropriate.

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 either 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 [(6)].

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 [(7)]. 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 [(8)], 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 [(9)]. 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 [(10)] 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 [(11)] 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 [(12)] 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 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 [13] 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 [14] 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 At the time of writing there has been no official response to those recommendations from the IOA Noise Working Group and, as yet, no endorsement from any UK Government Minister or Department. The recommendation to impose a planning condition and the associated penalty scheme is at odds with the advice from the IOA GPG, which currently 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.'

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 the WEDG, 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);
- Establish for each NML the 'Total WEDG Noise Limits' on analysis of the measured background noise levels;
- Identify the locations of all nearby noise sensitive receptors (NSRs) and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise dataset;
- 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 WEDG Noise Limits;
- Determine the 'Site Specific Noise Limits,' which take account of the noise limit already allocated to, or could theoretically be used by, other wind farm developments 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 fully consider cumulative noise, the assessment has been split into three separate stages:

- Stage 1 – determine existing Total WEDG Noise Limits, which are already set for other wind farms within the vicinity of the Proposed Development at each NAL or establish the Total WEDG Noise Limits for each NAL (where noise limits are not already set) based on the measured background noise levels;
- Stage 2 – undertake a cumulative assessment for locations where noise predictions from the Proposed Development are within 10 dB of the total noise predictions from any other wind farms/turbine developments in the area, or where cumulative predictions (excluding the Proposed Development) are greater than 30 dB; and
- Stage 3 – establish the Proposed Development's Site Specific Noise Limits (at levels below the Total WEDG 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'.

4.2 Consultation

Scoping Opinion (dated 3 August 2021)

4.2.1 Mayo County Council stated the following in relation to noise:

'4. Establish baseline noise conditions at noise sensitive receptors prior to works commencing on site.

Submit a noise impact assessment for the proposed development.'

4.3 Stage 1 Assessment Methodology - Setting the Total WEDG Noise Limits

Identify Existing Noise Limits

4.3.1 Noise limits have already been established at some of the closest receptors to the north, east and south of the site as part of the planning conditions set for ABO Sheskin Wind Farm and Oweninny Wind Farms.

4.3.2 Extracts of the Decision Notices containing the noise conditions are included in Annex 2.

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 usually vary, 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 of wind speed measurement may be adopted. For this assessment wind speeds recorded at the two heights closest to hub height (110 m and 123 m) were used to calculate hub height wind speeds (115 m) in line with 'Method A' of Section 2.6.3 of the IOA GPG to fully take account of wind shear.

Noise Impact Criteria in the WEDG

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 the daytime and night time Total WEDG Noise Limits for each NAL.

4.3.7 The Total WEDG Noise Limits for the daytime have been set at;

- 40 dB(A) where background noise levels are below 30 dB; and,

- 45 dB(A) or background noise plus 5 dB, whichever is the greater, where background noise levels are greater than 30 dB.

4.3.8 Total WEDG Noise Limits at night time has been set at;

- 43 dB(A) or background plus 5 dB, whichever is the greater.

4.3.9 This 'Total' limit relates to noise from all wind farm developments in the area (including the Proposed Development). The limit was chosen with due regard to the guidance in the WEDG and with due consideration given to the limits already adopted for other wind farm developments in the area.

4.3.10 The acceptable limits for wind turbine operational noise are clearly defined for all time periods by the application of the WEDG 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 WEDG Noise Limits. Depending on the levels of background noise, the satisfaction of the WEDG 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 Stage 2 Assessment Methodology - Likely effects & cumulative assessment

4.4.1 The WEDG do not include any information on the assessment of cumulative noise impacts, therefore, the guidance provided within the IOA GPG has been adopted, which contains a detailed section on cumulative noise and 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 NSRs proximate to the Proposed Development and other nearby operational, consented and proposed wind farm developments to determine whether the wind turbine noise immissions from the Proposed Development were within 10 dB of the wind turbine noise immissions from other wind farm developments. Where predictions were found to be within 10 dB of each other, a cumulative noise assessment was undertaken, however, if wind turbine immissions were more than 10 dB apart, a cumulative noise assessment was not required.

Noise Prediction / Propagation Model

4.4.3 The ISO 9613-2: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* [15] model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors. 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, but the full method has been used for this assessment.

4.4.4 Guidance on noise prediction and propagation modelling is not provided within the WEDG, however, the IOA GPG recognises the standard as appropriate for the prediction of wind turbine noise.

4.4.5 There is currently no standard approach to specifying error bands on noise predictions, however, Table 5 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."

4.4.6 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.

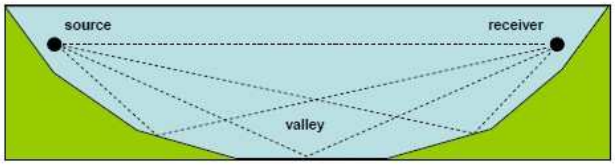
4.4.9 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, 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 4.4.11 to 4.4.14. Any differences in ground height between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

4.4.11 The IOA GPG discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. Although barrier screening effects in ISO 9613-2 can make corrections of up to 15 dB, 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.

4.4.12 The IOA GPG also 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

4.4.13 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).

4.4.14 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.

4.5 Noise Propagation Parameters

4.5.1 The noise immission levels have been calculated using the full ISO 9613-2 model with a receiver height of 4.0 m above local ground level, mixed ground (G=0.5) and air absorption based on a temperature of 10 °C and 70 % relative humidity. The modelling parameters reflect current good practice as detailed within the IOA GPG.

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

4.5.3 A topographical assessment has been undertaken between each NSR and wind turbine location to determine whether any concave ground profiles exist between the source and receiver. Analysis undertaken using a combination of CadnaA [17] 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 7.

4.5.4 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 NSR 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 7. 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.

4.5.5 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 planning permission 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.

4.5.6 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.

4.5.7 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.

4.5.8 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.

4.5.9 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 in detailed in **Error! Reference source not found.** These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required.

Table 4.1 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

4.6 Stage 3 Assessment Methodology - Site Specific Noise Limits

4.6.1 Summary Box 21 of the IOA GPG states:

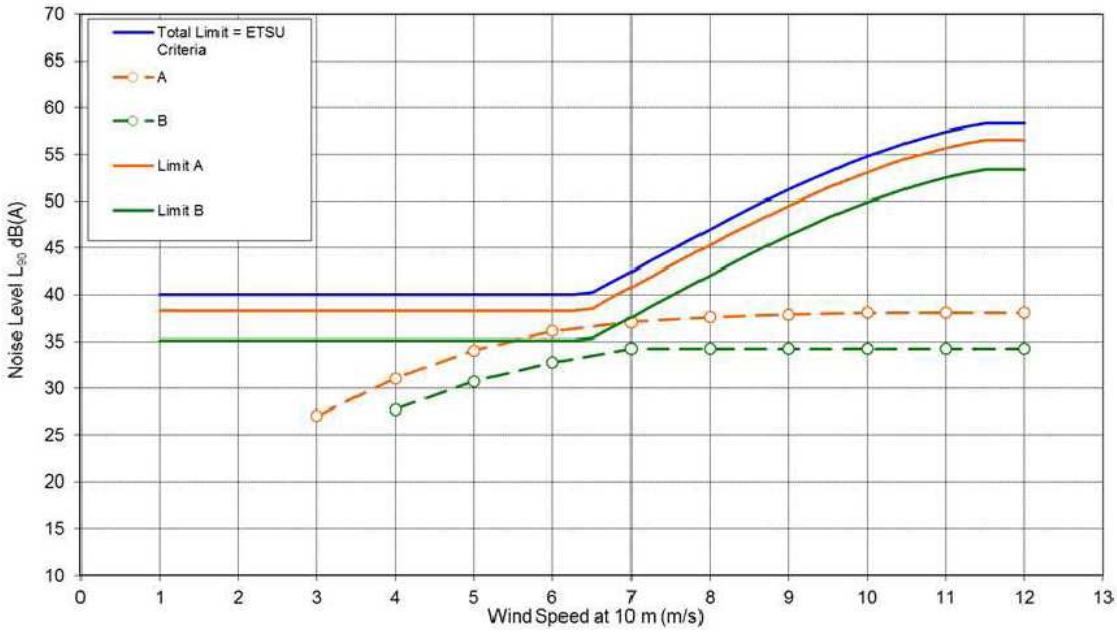
'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

4.6.2 In order to determine Site Specific Noise Limits at receptors in proximity to the Proposed Development (where required), the guidance detailed within Section 5.4 of the IOA GPG has been considered. The options detailed within Section 5.4 are summarised below.

Limit Apportionment

4.6.3 Limit apportionment considers the noise limit already allocated to other wind farms in the area (see Annex 2). This approach is demonstrated in Graph 4.1 below which is reproduced from the Section 5.4 of the IOA GPG. In this example the total limit (shown in blue) is shared between a consented wind farm (A) and a proposed development (B). The two noise limits for a given receptor (the solid orange and green lines) when added together equate to the total noise limit, and the predicted levels for each wind farm (the dashed lines) meet the specific limits established for consented wind farm and the Proposed Development.

Graph 4.1: Limit Apportionment Example



Significant Headroom

4.6.4 The limit derivation can also be undertaken with consideration of 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.'

4.6.5 With this in mind, and where appropriate, an additional 2 dB buffer has been added to the cumulative turbine noise predictions from the other wind farm 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 wind farm developments.

10 dB Rule

4.6.6 Where predicted wind turbine noise levels from the individual wind farm/ turbine schemes are found to be >10 dB below the Total WEDG Noise Limits then it has been deemed appropriate to allocate the entire noise limit to the Proposed Development.

Controlling Property

4.6.7 As detailed in Sections 5.4.9 and 5.4.10 of the IOA GPG, the 'controlling property' principal has also been adopted where appropriate. Section 5.4.9 states:

'It may be the case that for the existing wind farm to operate to the total ETSU-R-97 noise limits at a key cumulative receptor it would have to breach the noise limit at another receptor (i.e. a receptor closer to the existing wind farm than the key cumulative receptor). Consideration could then be given to the available 'headroom' at the key cumulative receptor such a scenario permits.

4.6.8 The controlling property principle was adopted at the closest property to Oweninny Wind Farm (Phases 1 and 2) whereby the predicted turbine noise levels for Oweninny (Phase 1 and 2) were increased by 4.1 dB to meet the consented limits. Further information can be found in Table 6.7 below.

4.6.9 Further information on the approaches adopted for the setting of the Site Specific Noise Limits is provided in Section 6.5 below.

5 Baseline

5.1 Identification of Potential Noise Receptors

5.1.1 A desk based review was undertaken to identify potential noise sensitive receptors within proximity to the Proposed Development.

5.1.2 Of the identified receptors, a total of three Noise Monitoring Locations (NMLs) were selected as being appropriate locations to determine a representative baseline for all of the identified NSRs. The NMLs were to the north, west-southwest and south of the Proposed Development.

5.1.3 The NMLs were selected following a detailed review of the area using aerial photography. Where possible, locations were selected that 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 WEDG Noise Limits. Data was recorded over the period 2 December 2020 to 19 March 2021 at each of the NMLs simultaneously.

5.2.2 The equipment at NML3 malfunctioned during the second maintenance visit, therefore, it was replaced with another sound level meter. No data was lost as the meter was recording upon arrival and was calibrated prior to being switched off. An error appeared on the screen when it was powered back on and therefore it could not be restarted. Noise monitoring equipment at the other NMLs functioned correctly for the full duration of the survey.

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

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

Table 5.1 Noise Monitoring Locations

NML	X (ITM*)	Y (ITM*)
NML1	491353	825479
NML2	494273	829996
NML3	493766	822338

**Irish Transverse Mercator (ITM)*

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 that 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 0.1 dB as detailed in the FDS (included in Annex 3) therefore no correction has been applied to the noise data.

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), and away from obvious local sources of noise such as boiler flues, fans and running water[1]. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 During the first two months of the survey, there were some periods of significant rainfall, which appears to have resulted in increased flow within the watercourses located in proximity to NML1 and 2. On that basis the data collected during that period was removed from the noise assessment. A period of additional data was also removed from NML2 at the end of the survey due to a period of elevated noise levels.

5.3.6 At NML3, a period of data were excluded from the end of the survey (from 12/02 to 19/03) due to banding within the data indicating the influence of an atypical noise source. It is unclear what the noise source was, as it did not occur earlier in the noise survey.

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

5.4 Meteorological Data

5.4.1 The WEDG state on Page 29 that:

'Noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed.'

5.4.2 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.'

[1] NML1 and 2 were influenced on occasion by a nearby watercourse. The affected data were clearly identifiable in the time series graphs and have been removed in accordance with good practice.

5.4.3 Concurrent wind speed and direction were recorded using a LIDAR unit, which was located within the site (ITM reference 493244, 825379). The meteorological data was collected and provided by the Applicant. The installation report and calibration information for the LIDAR can be provided upon request. Average 10 minute wind speed and direction data were collected over the same time-scale as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

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

5.4.5 A tipping bucket rain gauge was installed at NML2 and NML3 for the duration of the noise survey to record periods of rainfall, time synchronised to the sound measurements. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were analysed and any 10 minute periods that contained registered rainfall events, plus the preceding 10 minute periods, were excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2c (Annex 1) as blue squares.

5.5 Influence of Existing Turbines on Background Measurements

5.5.1 ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise, whilst 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.

5.5.2 The closest operational wind farm to the NMLs is Oweninny 1 Wind Farm which is over 4.5 km away at its closest point. The contribution to overall background noise levels from Oweninny 1 Wind Farm at the NMLs used for this assessment is likely to be negligible and therefore this has not been considered further.

5.5.3 Directional Filtering of Background Noise

5.5.4 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.

5.5.5 For this site there are no dominant local noise sources so no directional filtering was undertaken.

5.6 Analysis of Measured Data

5.6.1 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 (dawn chorus) 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 derived prevailing background noise levels from the baseline survey.

Table 5.2 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	24.4*	24.4	24.9	26.1	27.9	30.2	32.9	36.0	39.3	42.7	46.3	49.8
NML2	26.7	27.5	28.6	29.9	31.4	33.2	35.2	37.5	40.0	42.7	45.7	48.9
NML3	28.4*	28.4*	28.4*	28.4	29.4	31.0	33.1	35.5	38.0	40.6	43.2	45.5

**restricted where derived minimum occurs at lower wind speeds. See Section 5.7.4.*

Table 5.3 Summary of Prevailing Background Noise Levels during Night time Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	24.6*	24.6	25.0	26.1	27.8	30.0	32.7	35.7	39.1	42.6	46.3	50.0
NML2	26.8	27.7	28.9	30.3	32.0	33.9	36.0	38.4	41.0	43.8	46.8	50.1
NML3	26.5*	26.5*	26.5	27.0	28.1	29.5	31.4	33.7	36.3	39.2	42.4	45.8

**restricted where derived minimum occurs at lower wind speeds. See Section 5.7.4.*

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 - A1.2c (Annex 1). There is a set of graphs for each NML, which show the range of wind speeds and directions recorded during the survey, the 10 minute average wind speed plotted against the recorded $L_{A90,\ 10min}$ noise level, and a calculated 'best fit' polynomial regression line for both quiet daytime and night time periods. Each Figure also includes a table with the number of measured data points per integer wind speed bin and the prevailing measured background noise level. An additional set of graphs showing the excluded data have been included within Annex 5.

5.7.3 The 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, for NML1 and NML3 the polynomial background curve for low wind speed conditions have been restricted at wind speeds below that where the derived minimum occurs. This is presented on the Figures, where the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit is shown as a dashed black line. A summary is also included in Table 5.4 below.

Table 5.4 Analysis of Measured Datasets

NML	Quiet Daytime	Night Time
NML1	Restricted below 2 ms^{-1} (minimum level recorded)	Restricted below 2 ms^{-1} (minimum level recorded)
NML2	No restrictions applied	No restrictions applied
NML3	Restricted below 4 ms^{-1} (minimum level recorded)	Restricted below 3 ms^{-1} (minimum level recorded)

5.7.5 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 wind speeds higher than the maximum where noise levels were measured have been set equal to those derived for lower wind speeds, as per Section 3.1.20 of the IOA GPG.

5.7.6 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, which was achieved for all NMLs and all time periods.

5.7.7 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a - A1.2c (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 Sensitive Receptors and Noise Assessment Locations

6.1.1 A total of seven NSRs were chosen as Noise Assessment Locations (NALs) to represent the individual or clusters of NSRs located closest to the Proposed Development. The modelling results for the NALs are presented within the main body of this report, however, an assessment for every individual NSR has also been included within Annex 6 for completeness.

6.1.2 Each NAL and NSR is shown on Figure A1.1 (Annex 1). All NALs and NSRs are labelled with the letter 'H', to ensure consistency with the labelling of these receptors within the rest of the Environmental Impact Assessment Report (EIAR).

6.1.3 During the initial search to identify the closest receptors, a dwelling immediately to the east of the site known as 'Sheskin Lodge' was identified. The building is referred to as a ruin on OS mapping for the area. Accordingly, due to the status of the dwelling, it has not been considered as a noise sensitive receptor.

6.1.4 Predictions of noise at the NALs ensures that the assessment reports the worst case (loudest) noise immission level expected at each group of NSRs. Table 6.1 details which NML has been used to set noise limits for each NAL and a similar table detailing which NML has been used to set limits at each NSR has also been included within Annex 6.

Table 6.1 Noise Assessment Locations

NAL/ NSR ID	X (ITM) (m)	Y (ITM) (m)	Elevation (m AOD)	Approximate Distance to Nearest Sheskin South Turbine* (m)	Background Noise Data Used
NAL1 (H18)	491517	825521	134	1,348 (T5)	NML1
NAL2 (H23)	494271	830004	134	1,707 (T12)	NML2
NAL3 (H01)	493866	822407	115	1,611 (T18)	NML3
NAL4 (H03)	493743	822357	118	1,580 (T18)	NML3
NAL5 (H13)	493014	822026	100	1,655 (T18)	NML3
NAL6 (H16)	491561	822376	89	1,654 (T17)	NML3
NAL7 (H22)	490697	825812	113	2,044 (T5)	NML1

** 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 amenity area (usually the garden) on the wind farm side of the property and not the house.*

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 This assessment considers a candidate turbine for the Proposed Development with a rotor diameter of 170 m, serrated trailing edge blades and a hub height of 115 m.

6.2.2 For the cumulative assessment the turbines considered are summarised in Table 1.1 and Annex 7.

6.2.3 Due to the differences in the way in which levels are provided by different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG (2013). A 2 dB uncertainty was added to the manufacturers turbine noise data for all wind farms. Details of the sound power level and octave data used for each of the turbine types considered in this assessment have not been included within this report due to commercial sensitivities.

6.2.4 Manufacturer noise level data is usually supplied based on a turbine of a specific hub height although the noise levels are presented as standardised to 10 m height. Accordingly, the noise data used in this assessment corrects the published turbine noise data following the guidance detailed in Section 4.3 of IOA GPG Supplementary Guidance Note 4, where applicable. The hub heights considered for the cumulative wind farm/turbine developments are summarised in Annex 7.

6.2.5 The location of the wind turbines are shown on Figure A1.1a and grid references are included in Annex 7.

6.3 Stage 1 Assessment - Total WEDG Noise Limits

6.3.1 The Total WEDG Noise Limits have been established for each of the NALs as detailed in Table 6.2 and Table 6.3 below, based on a fixed minimum level of 40dB(A) (daytime) and 43 dB(A) (Night time).

Table 6.2 Total WEDG 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 (H18)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
NAL2 (H23)	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	47.7	50.7	53.9
NAL3 (H01)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
NAL4 (H03)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
NAL5 (H13)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
NAL6 (H16)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
NAL7 (H22)	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8

Table 6.3 Total WEDG 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 (H18)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
NAL2 (H23)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.0	48.8	51.8	55.1
NAL3 (H01)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
NAL4 (H03)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
NAL5 (H13)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
NAL6 (H16)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
NAL7 (H22)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0

6.4 Stage 2 Assessment – Likely Effects and Cumulative Assessment

6.4.1 A comparison has been undertaken of the predicted wind turbine noise immission levels from the Proposed Development operating alongside other wind farm developments to determine whether predictions are within 10 dB of each other. All turbines have been assumed to be operating in full mode.

6.4.2 Table 6.4 summarises the results and whether a cumulative noise assessment is required (as detailed in Section 4.4).

Table 6.4 Cumulative Assessment Requirement

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Is a cumulative assessment required?
NAL1 (H18)	YES	YES
NAL2 (H23)	YES	YES
NAL3 (H01)	YES	YES
NAL4 (H03)	YES	YES
NAL5 (H13)	YES	YES
NAL6 (H16)	YES	YES
NAL7 (H22)	YES	YES

6.4.3 A likely cumulative noise assessment was undertaken at NAL1 to NAL7 and the results are summarised in Table 6.5 and Table 6.6. The results show that the predicted cumulative wind turbine noise immission levels meet the 'Total WEDG Noise limits' under all conditions at NAL1 to NAL7. 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. For this assessment the uncertainty level added was 2 dB.

6.4.4 Figures A1.3a-g (Annex 1) show predictions at each NAL from the cumulative operation of all wind farms (including the Proposed Development) against the 'Total WEDG Noise Limits'. The individual contribution of all wind farms are also shown.

Table 6.5 WEDG 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 (H18)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.7	36.7	37.1	37.1	37.1	37.1	37.1	37.1
	Exceedance Level	-	-	-	-11.2	-6.3	-8.3	-7.9	-7.9	-7.9	-10.6	-14.2	-17.7
NAL2 (H23)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	47.7	50.7	53.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	29.4	32.6	33.3	33.3	33.3	33.3	33.3	33.3
	Exceedance Level	-	-	-	-15.4	-15.6	-12.4	-11.7	-11.7	-11.7	-14.4	-17.4	-20.6
NAL3 (H01)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-8.6	-3.2	-5.7	-5.2	-5.2	-5.2	-5.8	-8.4	-10.7
NAL4 (H03)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	36.2	38.8	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-	-9.2	-3.8	-6.2	-5.8	-5.7	-5.7	-6.3	-8.9	-11.2
NAL5 (H13)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.2	32.5	35.2	35.6	35.6	35.6	35.6	35.6	35.6
	Exceedance Level	-	-	-	-12.8	-7.5	-9.8	-9.4	-9.4	-9.4	-10.0	-12.6	-14.9
NAL6 (H16)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.6	28.7	31.6	32.0	32.0	32.0	32.0	32.0	32.0
	Exceedance Level	-	-	-	-16.4	-11.3	-13.4	-13.0	-13.0	-13.0	-13.6	-16.2	-18.5

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 (H22)	Total Noise Limit: WEDG 2006 L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.9	29.8	32.8	33.2	33.2	33.2	33.2	33.2	33.2
	Exceedance Level	-	-	-	-15.1	-10.2	-12.2	-11.8	-11.8	-11.8	-14.5	-18.1	-21.6

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}.

Table 6.6 WEDG 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 (H18)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.7	36.7	37.1	37.1	37.1	37.1	37.1	37.1
	Exceedance Level	-	-	-	-14.2	-9.3	-6.3	-5.9	-5.9	-7.0	-10.5	-14.2	-17.9
NAL2 (H23)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.0	48.8	51.8	55.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	29.4	32.6	33.3	33.3	33.3	33.3	33.3	33.3
	Exceedance Level	-	-	-	-18.4	-13.6	-10.4	-9.7	-10.1	-12.7	-15.5	-18.5	-21.8
NAL3 (H01)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-11.6	-6.2	-3.7	-3.2	-3.2	-3.2	-4.4	-7.6	-11.0
NAL4 (H03)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	36.2	38.8	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-	-12.2	-6.8	-4.2	-3.8	-3.7	-3.7	-4.9	-8.1	-11.5
NAL5 (H13)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.2	32.5	35.2	35.6	35.6	35.6	35.6	35.6	35.6
	Exceedance Level	-	-	-	-15.8	-10.5	-7.8	-7.4	-7.4	-7.4	-8.6	-11.8	-15.2
NAL6 (H16)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.6	28.7	31.6	32.0	32.0	32.0	32.0	32.0	32.0
	Exceedance Level	-	-	-	-19.4	-14.3	-11.4	-11.0	-11.0	-11.0	-12.2	-15.4	-18.8

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 (H22)	Total Noise Limit: WEDG 2006 L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.9	29.8	32.8	33.2	33.2	33.2	33.2	33.2	33.2
	Exceedance Level	-	-	-	-18.1	-13.2	-10.2	-9.8	-9.8	-10.9	-14.4	-18.1	-21.8

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}.

6.5 Stage 3 Assessment - Derivation of Site Specific Noise Limits

6.5.1 In order to protect residential amenity, the recommendations are that cumulatively, all wind farms (including the Proposed Development) operate within the Total WEDG Noise Limits.

6.5.2 To allow this to occur a set of Site Specific Noise limits for the Proposed Development are required and these have been derived for each NAL. Table 6.7 summarises the approach adopted at each NAL to derive the Site Specific Noise Limits.

6.5.3 The Site Specific Noise Limits have been derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments (operational or consented) in proximity to the Proposed Development. Extracts of the planning permissions are included within Annex and are summarised below.

6.5.4 For Oweninny, condition 7 states:

(ii)In all other areas noise levels emanating from the proposed development following commissioning, by itself or in combination with other existing or permitted wind energy development in the vicinity, when measured externally at third party noise-sensitive locations, shall not exceed the greater of 43dB(A)$L_{90,10\,min}$ or 5 dB(A) above background levels.

6.5.5 For ABO Sheskin the noise condition (Condition 46) refers back to the EIS which includes limits based on the WEDG 2006.

6.5.6 The cumulative noise model assumes that the consented turbines at Oweninny Phase 2 and ABO Sheskin are built, and that Oweninny Phase 1 continues to operate for the lifetime of its consent.

Table 6.7 Limit Derivation Strategy

NAL	Limit Derivation Strategy
NALs 1, 2, 6 and 7	The predicted likely cumulative noise levels from the other wind farm developments were found to be more than 10 dB below the Total WEDG Noise Limits and as such the entire noise limit has been allocated to the Proposed Development.
NALs 3 and 4	NAL3 is the closest property to Oweninny Wind Farm (Phases 1 and 2) and is considered to be a 'controlling property' for those schemes, i.e. noise budget cannot be fully used by Oweninny 1 and 2 at properties more distant than NAL3, without firstly exceeding the noise limits at NAL3. On that basis the predicted turbine noise levels for Oweninny (Phase 1 and 2) were increased by 4.1 dB at NAL3 to meet the noise limits at the property (set in the Oweninny Consent). The increase in level has been determined based on the minimum difference between the predicted level and the noise limits and that difference has been applied across all wind speeds (see Annex 1, Figure A1.4c). A 2 dB buffer was also added to the turbine noise predictions for the ABO Sheskin Wind Farm. The resulting 'cautious' predictions of cumulative wind turbine noise from the other wind farm developments were then logarithmically subtracted from the Total WEDG Noise Limits

NAL	Limit Derivation Strategy
	to determine the Site Specific Noise Limits for the Proposed Development at NAL3 and NAL4.
NAL5	There is significant headroom between the cumulative noise predictions from the other wind farm developments and the Total WEDG Noise Limit. A 2 dB buffer was added to the turbine noise predictions from the other wind farm developments (see Annex 1, Figure A1.4e). The resulting 'cautious' predictions of cumulative wind turbine noise from the other wind farms were then logarithmically subtracted from the Total WEDG Noise Limits to determine the Site Specific Noise Limits for the Proposed Development at NAL5.

6.5.7 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.

6.5.8 As summarised in Table 6.7 above, it is proposed that the full WEDG Noise Limits be allocated to the Proposed Development at a number of NALs, as the cumulative predictions from other wind farm developments do not need a portion of the limit (NALs 1, 2, 6 and 7). For the remaining noise assessment locations (NALs 3-5), apportionment was required in order to allow the Proposed Development and the other wind farm developments to co-exist within the Total WEDG Noise Limits.

6.5.9 Table 6.8 and Table 6.9 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.

6.5.10 Table 6.8 and Table 6.9 show that the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both the daytime and night time periods.

6.5.11 Without mitigation, at NAL3 a minor exceedance of 0.1 dB was predicted during the daytime period at a wind speed of 5 ms^{-1} and a 0.4 dB exceedance was predicted during the night time at wind speeds of 6-9 ms^{-1}. In order to meet the Site Specific Noise Limits, Turbine 18 would need to be operated in a lower noise mode for certain wind directions and wind speeds (north westerlies).

6.5.12 The predictions and assessment of noise for all identified NSRs is included in Annex 6. A similar exceedance can be seen for one property (H02), where an exceedance of 0.1 dB during the daytime and night time periods was predicted (for wind speeds of 5 ms^{-1}, and 7-9 ms^{-1} respectively). It should be noted, however, that application of the lower noise mode for Turbine 18 to mitigate the exceedance at NAL3 would also mitigate the minor exceedances at H02.

6.5.13 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 A1.5a - A1.5g (Annex 1).

6.5.14 In the event that planning permission is granted for the Proposed Development it would be appropriate to set noise limits equal to the Site Specific Noise Limits presented in Table 6.88 and Table 6.99.

Table 6.8 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 (H18)	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	23.4	28.3	33.2	36.2	36.5	36.5	36.5	36.5	36.5	36.5
	Exceedance Level	-	-	-16.6	-11.7	-6.8	-8.8	-8.5	-8.5	-8.5	-11.2	-14.8	-18.3
NAL2 (H23)	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	47.7	50.7	53.9
	Predicted Wind Turbine Noise L_{A90}	-	-	18.3	23.1	28.0	31.1	31.4	31.4	31.4	31.4	31.4	31.4
	Exceedance Level	-	-	-21.7	-16.9	-17.0	-13.9	-13.6	-13.6	-13.6	-16.3	-19.3	-22.5
NAL3 (H01)	Site Specific Noise Limit L_{A90}	38.6	38.6	38.6	38.6	30.0	41.4	40.7	40.7	40.7	42.1	46.6	49.6
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.2	**30.0***	33.1	33.4	33.4	33.4	33.4	33.4	33.4
	Exceedance Level	-	-	-18.2	-13.4	**0.0***	-8.3	-7.3	-7.3	-7.3	-8.7	-13.2	-16.2
NAL4 (H03)	Site Specific Noise Limit L_{A90}	38.8	38.8	38.8	38.8	31.7	42.3	41.8	41.8	41.8	42.9	46.9	49.8
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.2	30.1	33.1	33.4	33.4	33.4	33.4	33.4	33.4
	Exceedance Level	-	-	-18.4	-13.6	-1.6	-9.2	-8.4	-8.4	-8.4	-9.5	-13.5	-16.4
NAL5 (H13)	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	38.5	44.2	44.1	44.1	44.1	44.8	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	18.2	23.1	28.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-21.8	-16.9	-10.5	-13.2	-12.8	-12.8	-12.8	-13.5	-16.9	-19.2

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL6 (H16)	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	17.0	21.9	26.8	29.8	30.1	30.1	30.1	30.1	30.1	30.1
	Exceedance Level	-	-	-23.0	-18.1	-13.2	-15.2	-14.9	-14.9	-14.9	-15.5	-18.1	-20.4
NAL7 (H22)	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.2	24.1	29.0	32.0	32.3	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-20.8	-15.9	-11.0	-13.0	-12.7	-12.7	-12.7	-15.4	-19.0	-22.5

**a 0.1 dB exceedance was predicted. The values shown in the table include the application of turbine 18 in a reduced noise mode for a limited range of wind speeds and wind directions.*

Table 6.9 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 (H18)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	23.4	28.3	33.2	36.2	36.5	36.5	36.5	36.5	36.5	36.5
	Exceedance Level	-	-	-19.6	-14.7	-9.8	-6.8	-6.5	-6.5	-7.6	-11.1	-14.8	-18.5
NAL2 (H23)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.4	46.0	48.8	51.8	55.1
	Predicted Wind Turbine Noise L_{A90}	-	-	18.3	23.1	28.0	31.1	31.4	31.4	31.4	31.4	31.4	31.4
	Exceedance Level	-	-	-24.7	-19.9	-15.0	-11.9	-11.6	-12.0	-14.6	-17.4	-20.4	-23.7
NAL3 (H01)	Site Specific Noise Limit L_{A90}	42.3	42.3	42.3	42.3	39.9	33.4	33.0	33.0	33.0	38.0	45.4	50.0
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.2	30.1	33.1	**33.0***	**33.0***	**33.0***	33.4	33.4	33.4
	Exceedance Level	-	-	-21.9	-17.1	-9.8	-0.3	**0.0***	**0.0***	**0.0***	-4.6	-12.0	-16.6
NAL4 (H03)	Site Specific Noise Limit L_{A90}	42.5	42.5	42.5	42.5	40.6	37.1	35.3	35.3	35.3	39.9	45.8	50.2
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.2	30.1	33.1	33.4	33.4	33.4	33.4	33.4	33.4
	Exceedance Level	-	-	-22.1	-17.3	-10.5	-4.0	-1.9	-1.9	-1.9	-6.5	-12.4	-16.8
NAL5 (H13)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	41.7	41.5	41.5	41.5	43.1	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	18.2	23.1	28.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-24.8	-19.9	-15.0	-10.7	-10.2	-10.2	-10.2	-11.8	-16.1	-19.5

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL6 (H16)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	17.0	21.9	26.8	29.8	30.1	30.1	30.1	30.1	30.1	30.1
	Exceedance Level	-	-	-26.0	-21.1	-16.2	-13.2	-12.9	-12.9	-12.9	-14.1	-17.3	-20.7
NAL7 (H22)	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	19.2	24.1	29.0	32.0	32.3	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-23.8	-18.9	-14.0	-11.0	-10.7	-10.7	-11.8	-15.3	-19.0	-22.7

**a 0.4 dB exceedance was predicted. The values shown in the table include the application of turbine 18 in a reduced noise mode for a limited range of wind speeds and wind directions.*

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 using the guidance contained within the WEDG 2006, supplemented by ETSU-R-97 and current good practice (IOA GPG).

7.1.2 Background noise monitoring was undertaken by TNEI at three NSRs neighbouring the Proposed Development. A total of 23 NSRs were identified, of which seven were chosen as Noise Assessment Locations. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations considered representative of the 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 wind farm site. The data collected at 110 m and 123 m height, which were used to calculate hub height wind speeds (115 m), were then standardised to 10 m height in accordance with current good practice.

7.1.4 Analysis of the measured data was undertaken 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 WEDG Noise Limit' of 40 dB(A), where background noise levels are below 30 dB, and 45 dB or background noise plus 5 dB, whichever is the greater, where background noise levels are above 30 dB was set for the daytime. A limit of 43 dB(A) or background noise plus 5 dB, whichever is the greater, was used for night time.

7.1.5 There are a number of operational and consented wind farms 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 wind farm developments in the area. The results show that the predicted cumulative wind farm noise immission levels from all wind farms operating concurrently would meet the Total WEDG Noise Limits at all NALs (and all identified NSRs) during both the daytime and night time periods.

7.1.6 'Site Specific Noise Limits' were derived for the proposed Development. In deriving the Site Specific Noise Limits consideration was given to the noise limit already allocated to or could theoretically be used by other operational and consented wind farms in proximity to the Proposed Development. Where immissions from other wind farm developments were found to be at least 10 dB below the 'Total WEDG Noise Limit'; then the other wind farm developments 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. This was applicable at NALs 1-2 and 6-7.

7.1.7 For receptors where cumulative turbine predictions from the other wind farm developments were found to be within 10dB of the Total WEDG Noise Limits, apportionment of the Total WEDG Noise Limits was undertaken. This was required at NAL3, NAL4 and NAL5.

7.1.8 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 wind turbine noise immissions were below the Site Specific Noise Limits when considering a candidate turbine with a 170 m rotor diameter with serrated trailing edge blades. A minor exceedance of the Site Specific Noise Limit was predicted at receptors NAL3 (0.1 dB daytime

at 5 ms^{-1} and 0.4 dB at 7-9 ms^{-1} night time) and H02 (0.1 dB day at 5 ms^{-1} and 7-9 ms^{-1} night time), however, this can be mitigated by operating Turbine 18 in a lower noise mode for certain wind directions and wind speeds. This would need to be determined fully once final turbine specification is made.

7.1.9 There are a range of potential turbine models that could be installed on the site should consent be granted. The turbine is considered to be representative of the type of turbine that could be installed on the site.

7.1.10 Should the proposal receive planning permission, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would, however, would 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 Time 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.

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Annex 1 – Figures

N

0 250 500 1,000 Metres

NAL2 (H23) NML2

Loch na nGiúróg

Barr Ruscaí

Sliabh Fioch 331

Sheskin

Glencullin River

Glencullin Upper

NAL7 (H22)

H20 NML1

H21 H19 NAL1 (H18)

Sheskin Lodge (Ruin)

Lough Doo

Knockmoy Nature Rese

Lough Boleynagee

Foot Br.

Srahnakilly

Tawnaghmor

Largan

River Abhainn Mhór

H17 NAL6 (H16)

Graveyard

Megalithic Tomb

H15

NML3

NAL4 (H03)

NAL3 (H01)

H08 H02

NAL5 (H13)

H07 H06 H04

H14 H12 H11 H10 H05

H02 NAL3 (H01)

NAL4 (H03)

NML3

H08 H07

H09 H05

NAL5 (H13) H06 H04

H12 H11

H14 H10

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Legend

- Proposed Turbine Location
- Noise Monitoring Location (NML)
- Noise Assessment Location (NAL)
- Noise Sensitive Receptor

Rev.	Date	Amendment Details	Drw'n	Chk'd	App'd
00	11/10/2022	First Issue	GC	JB	JB

Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

tnei

Client: sse

Drawing Status: For Planning

Project Title: Sheskin South Wind Farm

Drawing Title: Figure A1.1 - Noise Monitoring and Assessment Locations

Scale	Designed	Drawn	Checked	Approved
1:30,000	GC	GC	JB	JB
Original Size	**Date**	**Date**	**Date**	**Date**
A3	11/10/2022	11/10/2022	11/10/2022	11/10/2022

Drawing Number: 14192-007

Revision: 0

N

NAL2 (H23)

NAL7 (H22)
H20
H19
NAL1 (H18)
H21

NAL3 (H01)
H02
NAL4 (H03)
H08
H07
H04
NAL5 (H13)
H09
H06
H05
H14
H11
H10
H15
NAL6 (H16)
H17
H12

0 375 750 1,500 Metres

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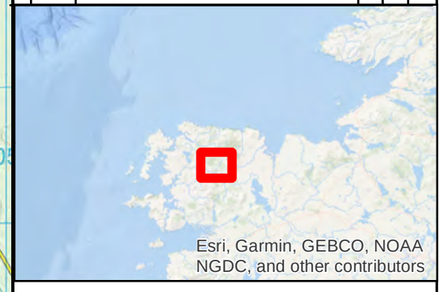
Legend

- Noise Assessment Location (NAL)
- Noise Sensitive Receptor

Wind Farm/ Turbine

- Sheskin South
- Oweninny 1
- Oweninny 2
- Oweninny 3
- ABO Sheskin

Rev.	Date	Amendment Details	Drw'n	Chk'd	App'd
01	21/11/2022	Removal of Corvoderry	GC	JB	JB
00	11/10/2022	First Issue	GC	JB	JB



tnei

Client: sse

Drawing Status: For Planning

Project Title: Sheskin South Wind Farm

Drawing Title: Figure A1.1a - Cumulative Turbine Locations

Scale	Designed	Drawn	Checked	Approved
1:45,000	GC	GC	JB	JB
Original Size	**Date**	**Date**	**Date**	**Date**
A3	11/10/2022	11/10/2022	11/10/2022	11/10/2022

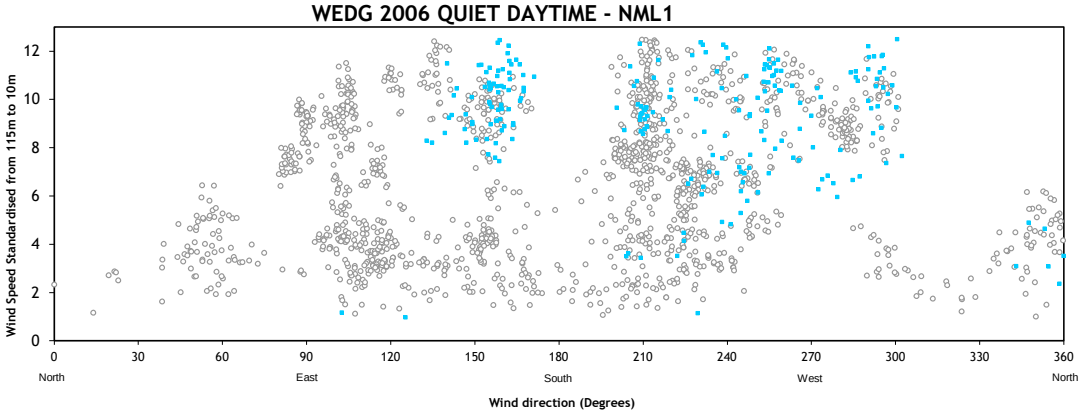
Drawing Number: 14192-010

Revision: 1

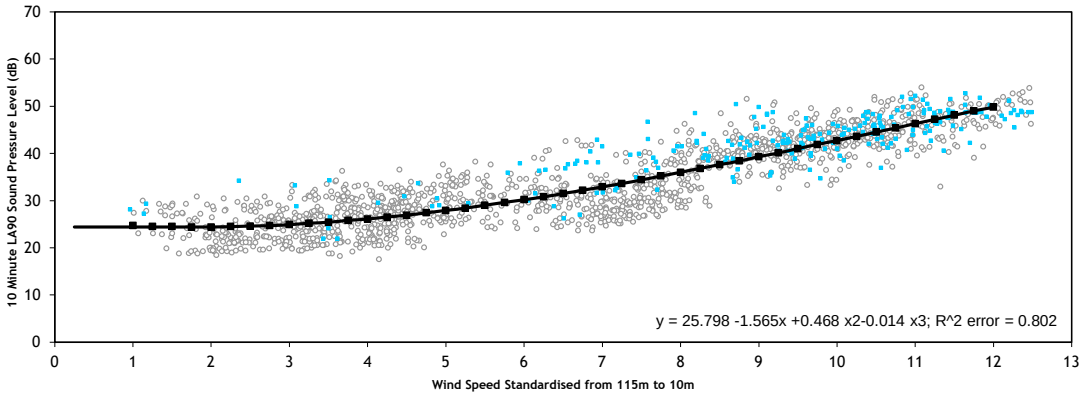
Figures A1.2 – Regression Analysis Graphs

WEDG 2006 QUIET DAYTIME - NML1

Wind Conditions Quiet Daytime



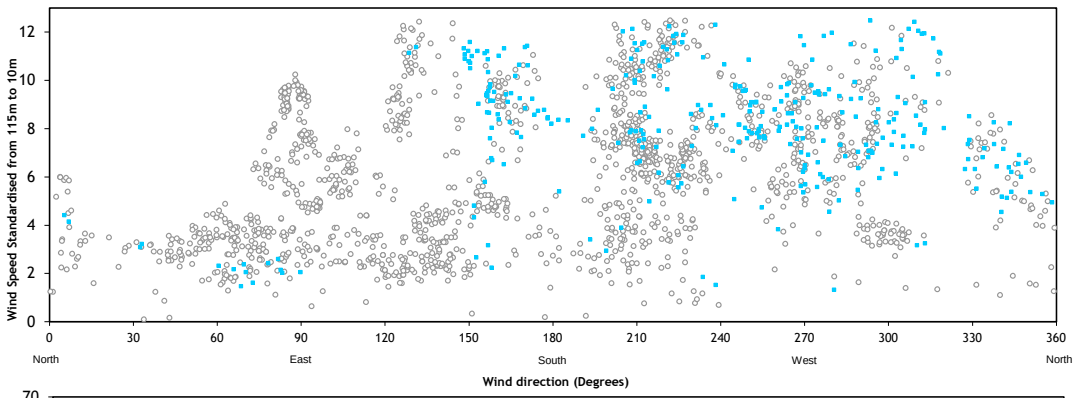
Regression Analysis Quiet Daytime



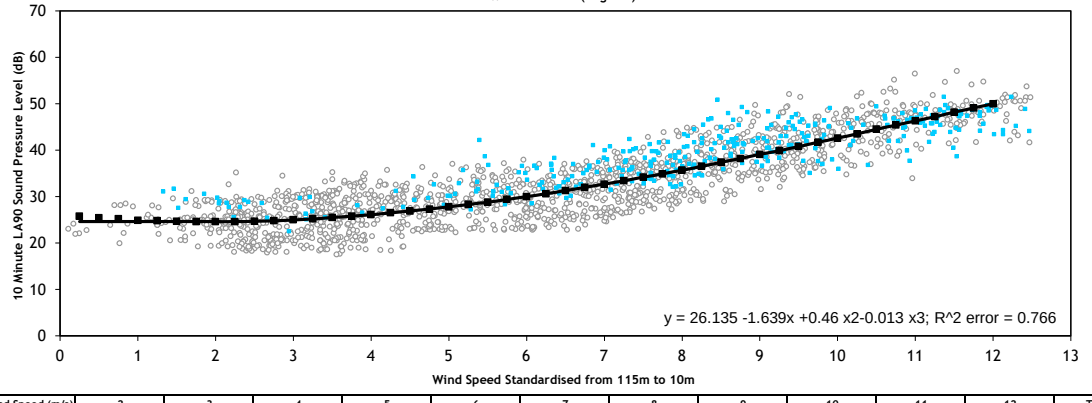
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	96	182	227	125	86	151	135	157	171	102	46	1478
Prevailing Background	24.4	24.9	26.1	27.9	30.2	32.9	36	39.3	42.7	46.3	49.8	

WEDG 2006 NIGHT-TIME - NML1

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	134	213	199	136	142	197	158	144	115	70	49	1557
Prevailing Background	24.6	25	26.1	27.8	30	32.7	35.7	39.1	42.6	46.3	50	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Drawn	JB
Checked	GC
Date	11/10/2022
Document Reference	14192-models

sse Renewables

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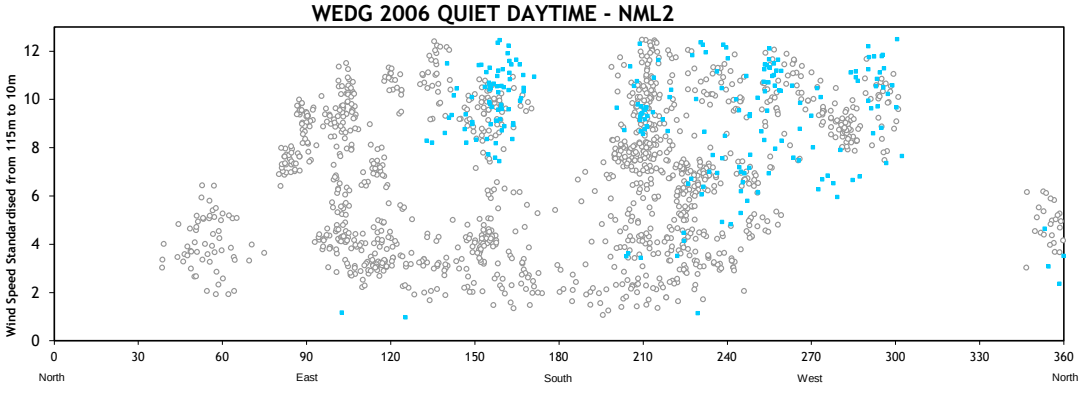
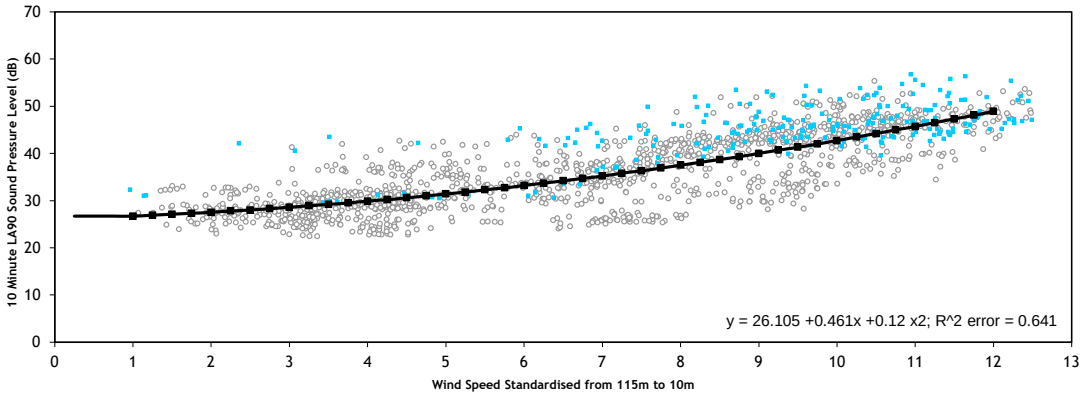
WEDG 2006 QUIET DAYTIME - NML2

Wind Conditions Quiet Daytime



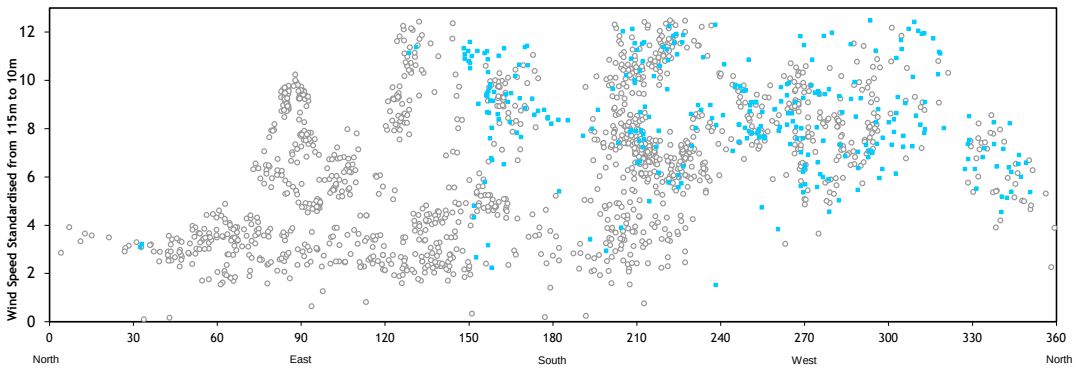
Regression Analysis Quiet Daytime



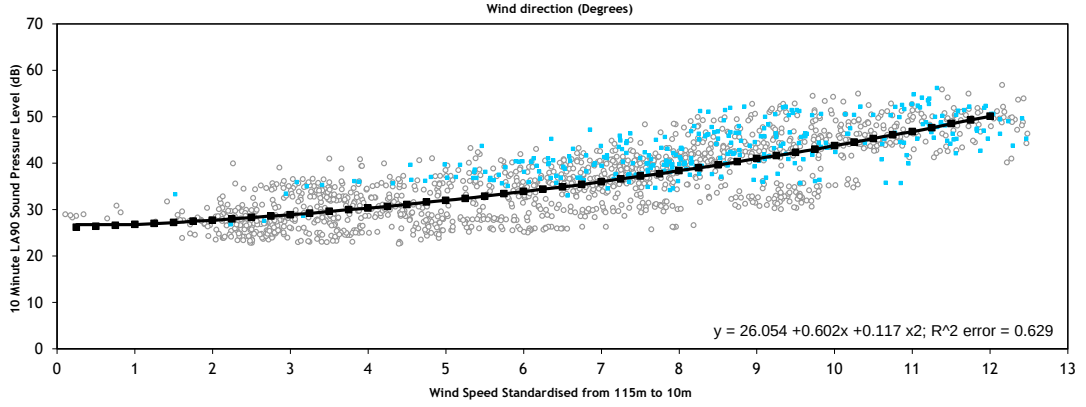
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	74	147	192	113	86	151	135	157	171	102	46	1374
Prevailing Background	27.5	28.6	29.9	31.4	33.2	35.2	37.5	40	42.7	45.7	48.9	

WEDG 2006 NIGHT-TIME - 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	102	171	148	119	128	194	158	144	115	70	49	1398
Prevailing Background	27.7	28.9	30.3	32	33.9	36	38.4	41	43.8	46.8	50.1	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2b
Drawn	JB
Checked	GC
Date	11/10/2022
Document Reference	14192-models

sse Renewables

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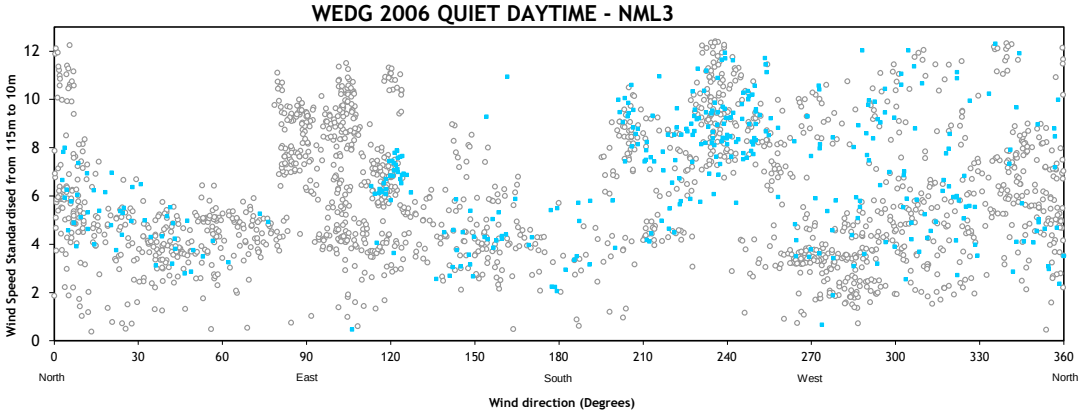
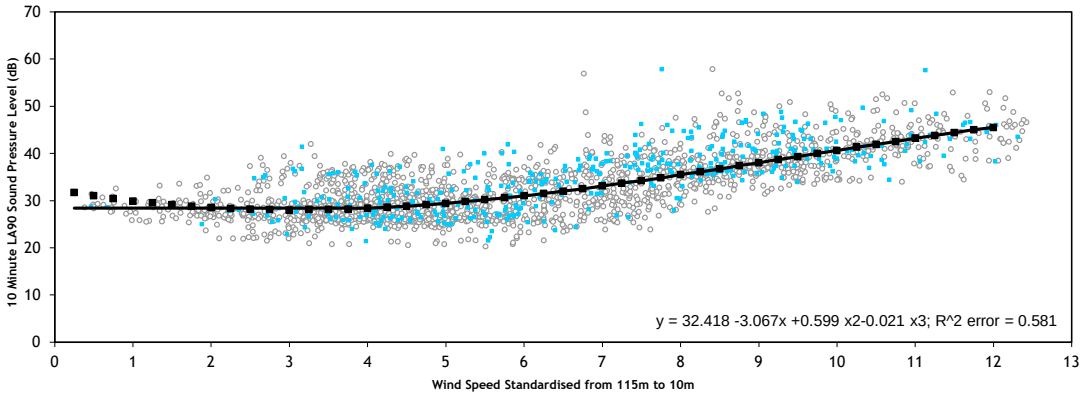
WEDG 2006 QUIET DAYTIME - NML3

Wind Conditions Quiet Daytime



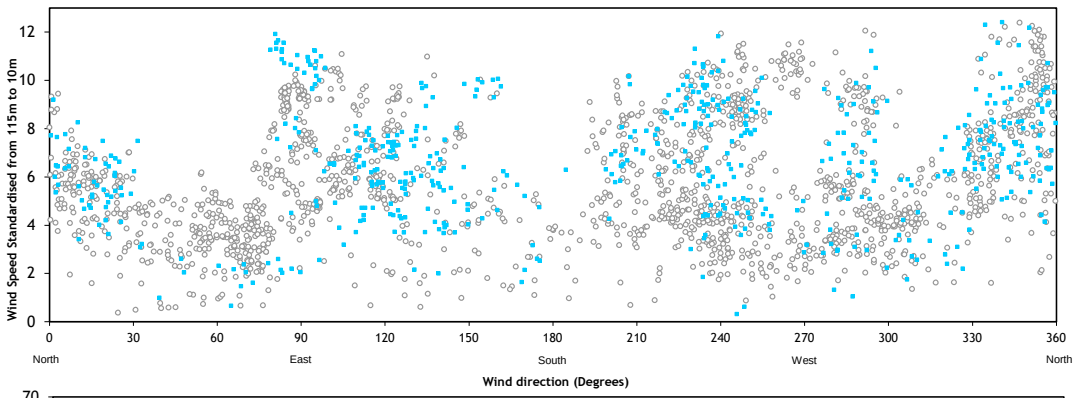
Regression Analysis Quiet Daytime



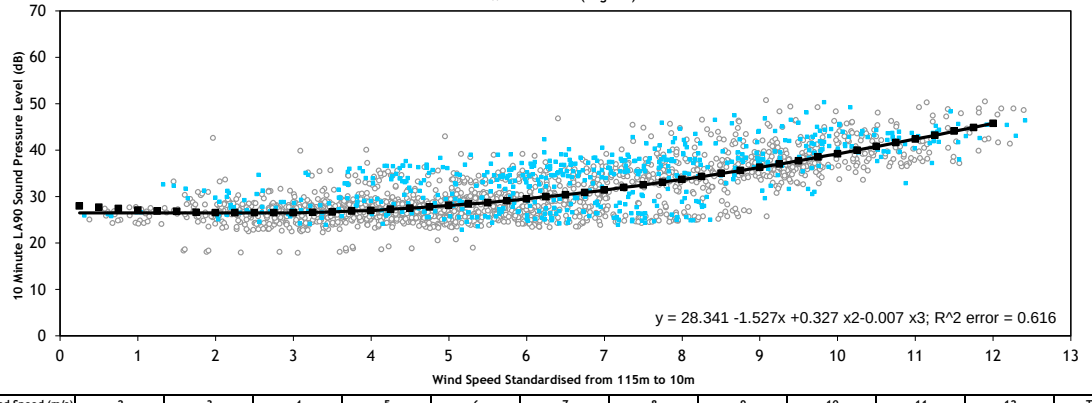
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	91	172	327	268	197	178	167	172	114	80	38	1804
Prevailing Background	28.4	28.4	28.4	29.4	31	33.1	35.5	38	40.6	43.2	45.5	

WEDG 2006 NIGHT-TIME - 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	105	207	307	270	212	138	144	174	121	46	18	1742
Prevailing Background	26.5	26.5	27	28.1	29.5	31.4	33.7	36.3	39.2	42.4	45.8	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2c
Drawn	JB
Checked	GC
Date	11/10/2022
Document Reference	14192-models

sse Renewables

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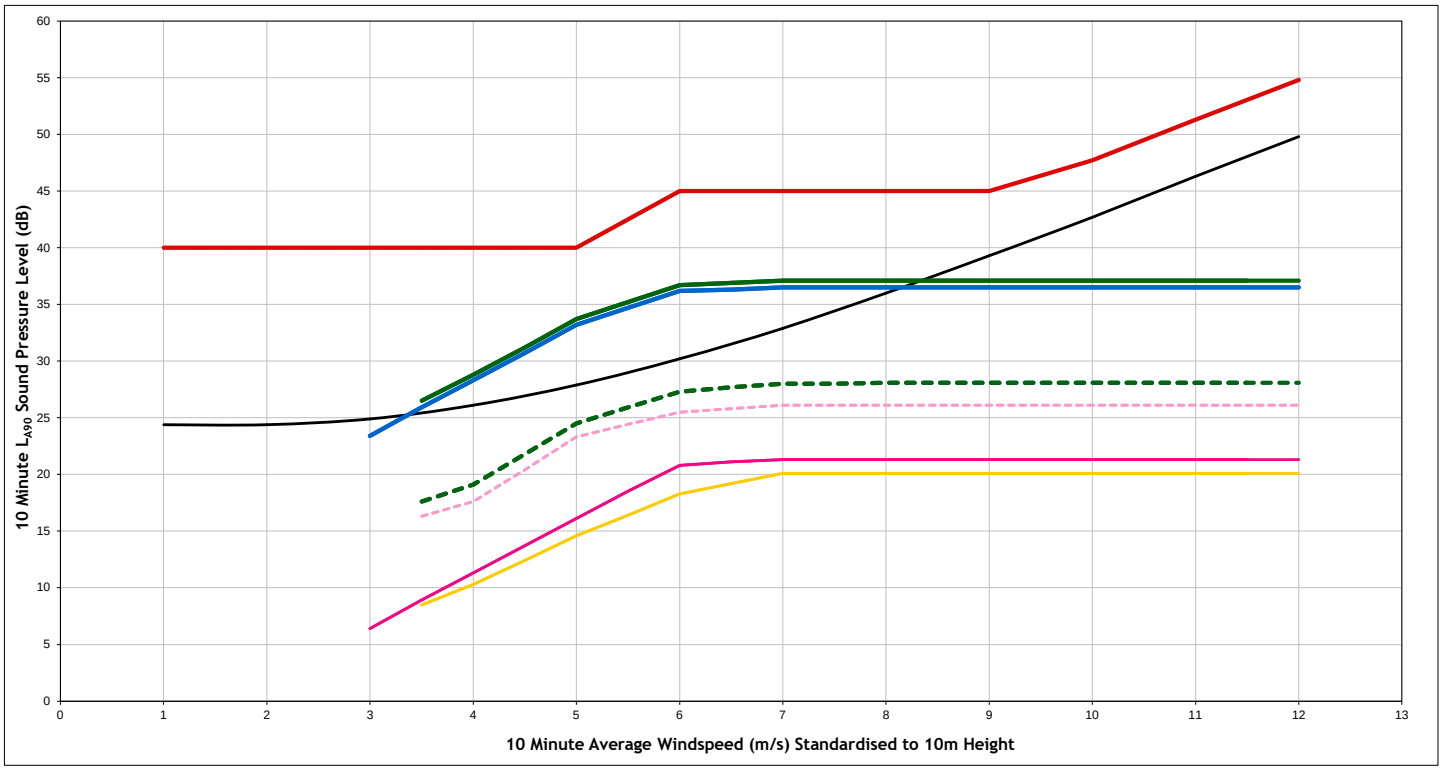
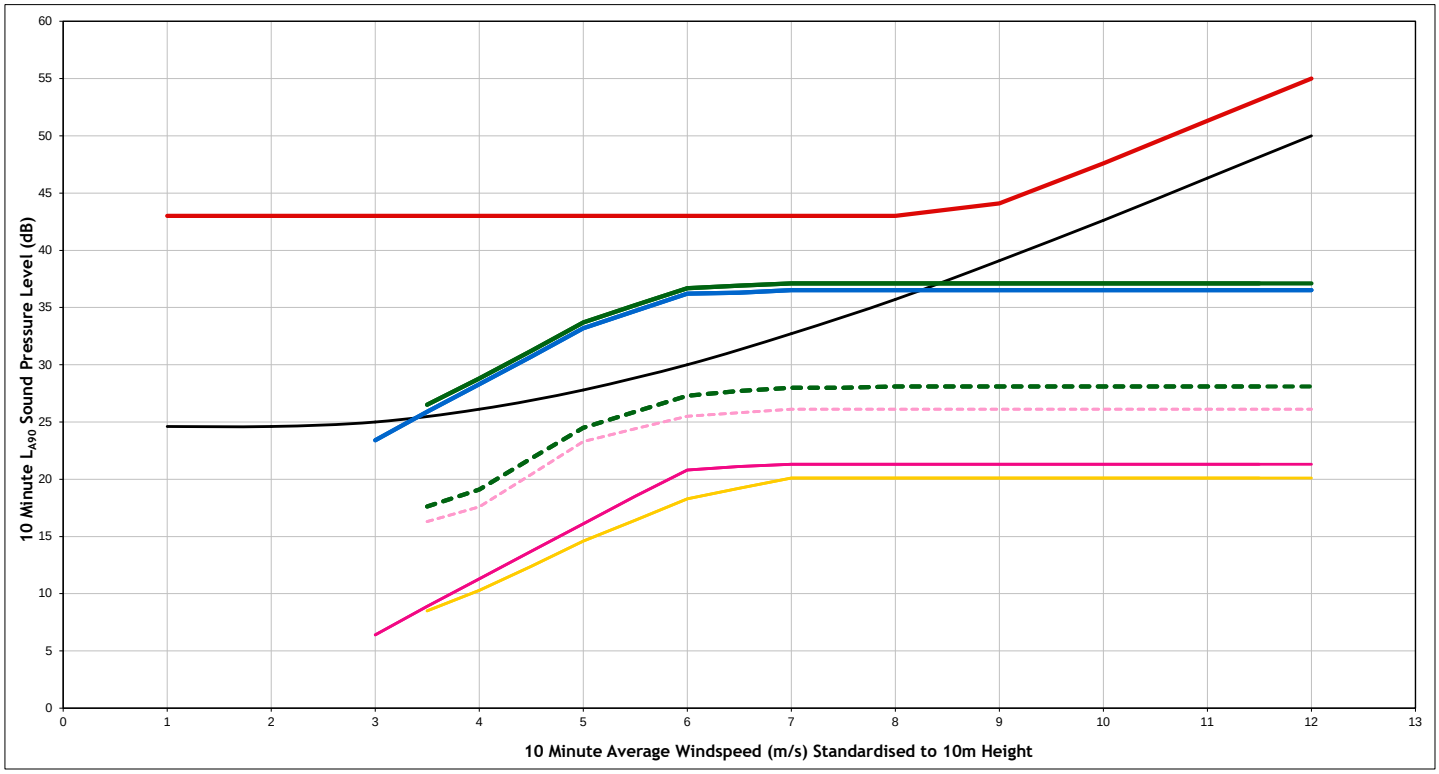
Figures A1.3 – Likely Noise Predictions

Daytime - NAL1 (H18)



Night Time - NAL1 (H18)

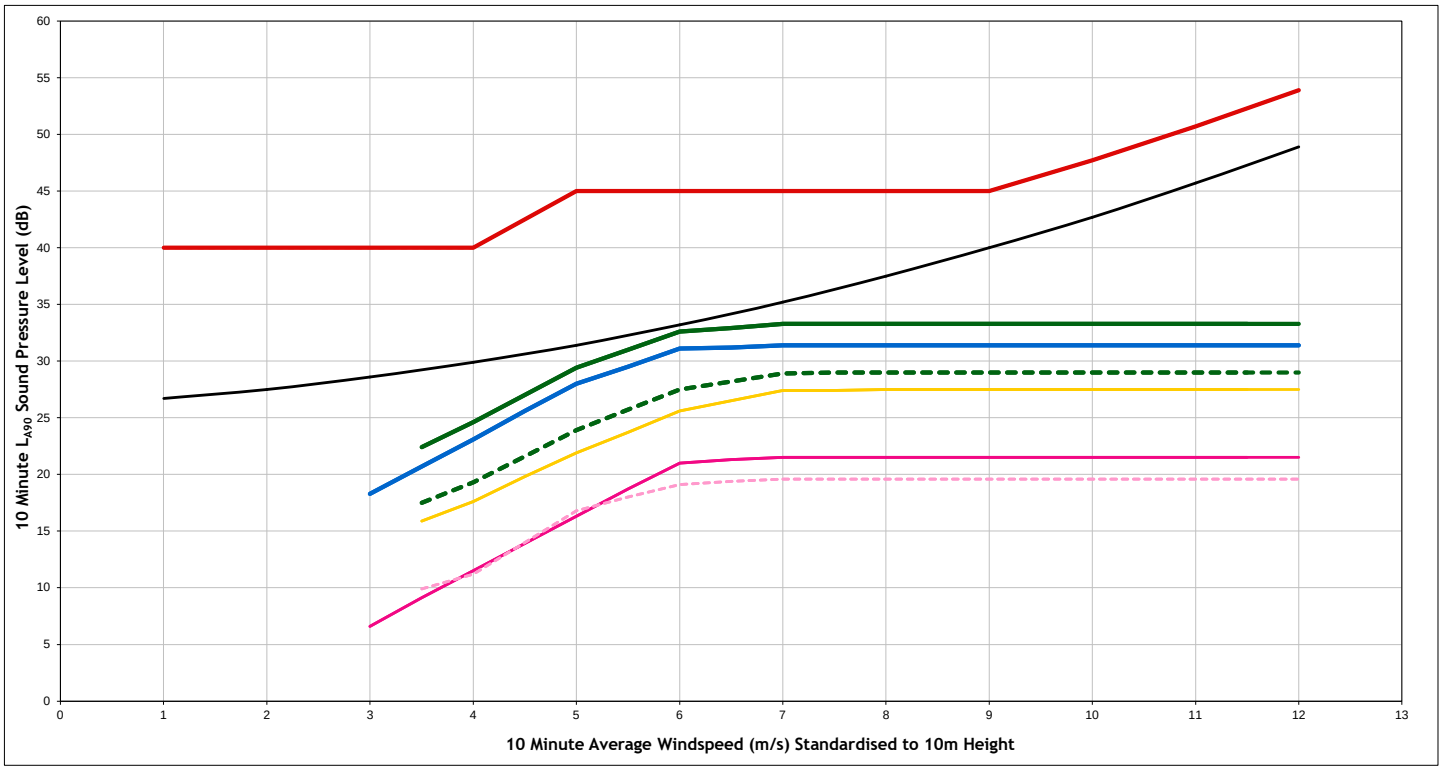


Legend:

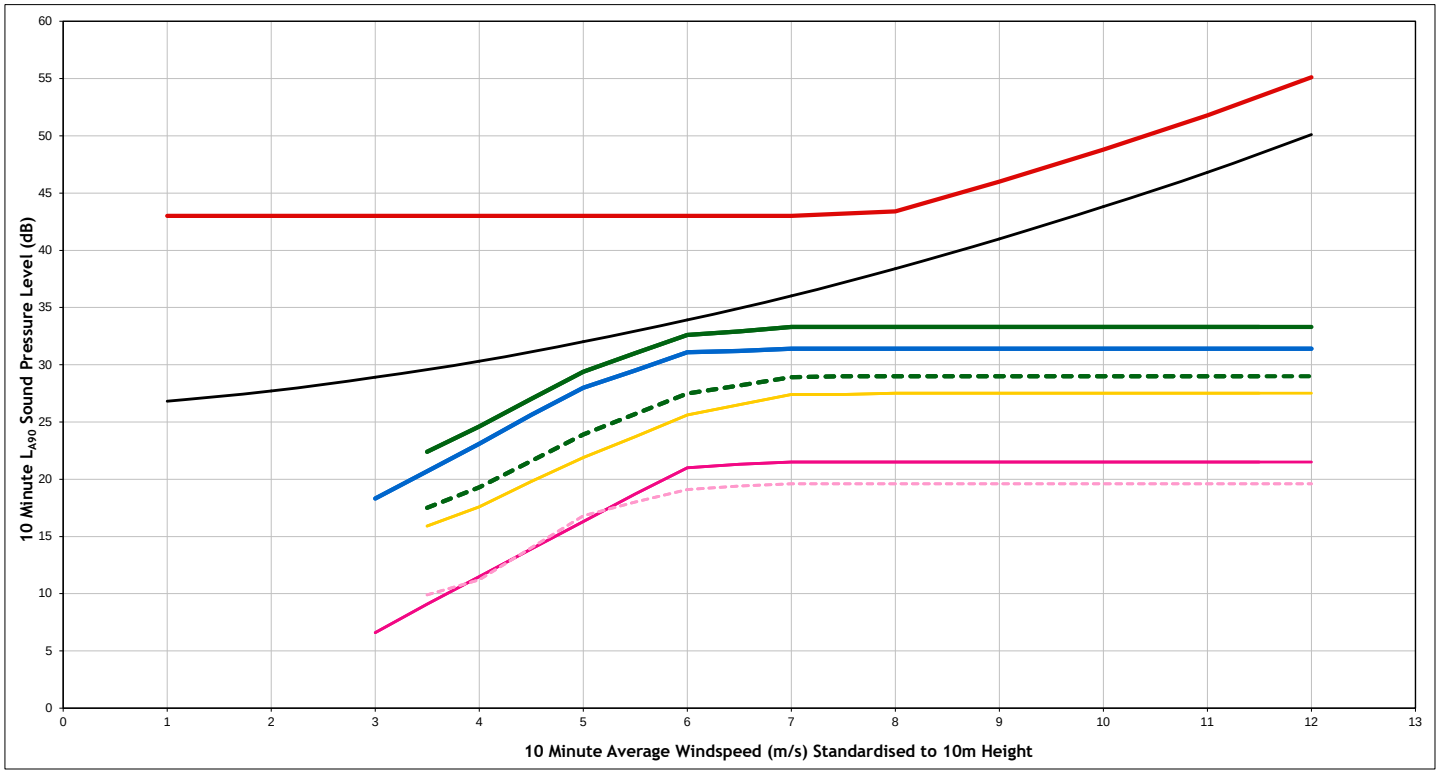
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions
	NAL1 (H18)
Figure Number	Figure A1.3a
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL2 (H23)



Night Time - NAL2 (H23)

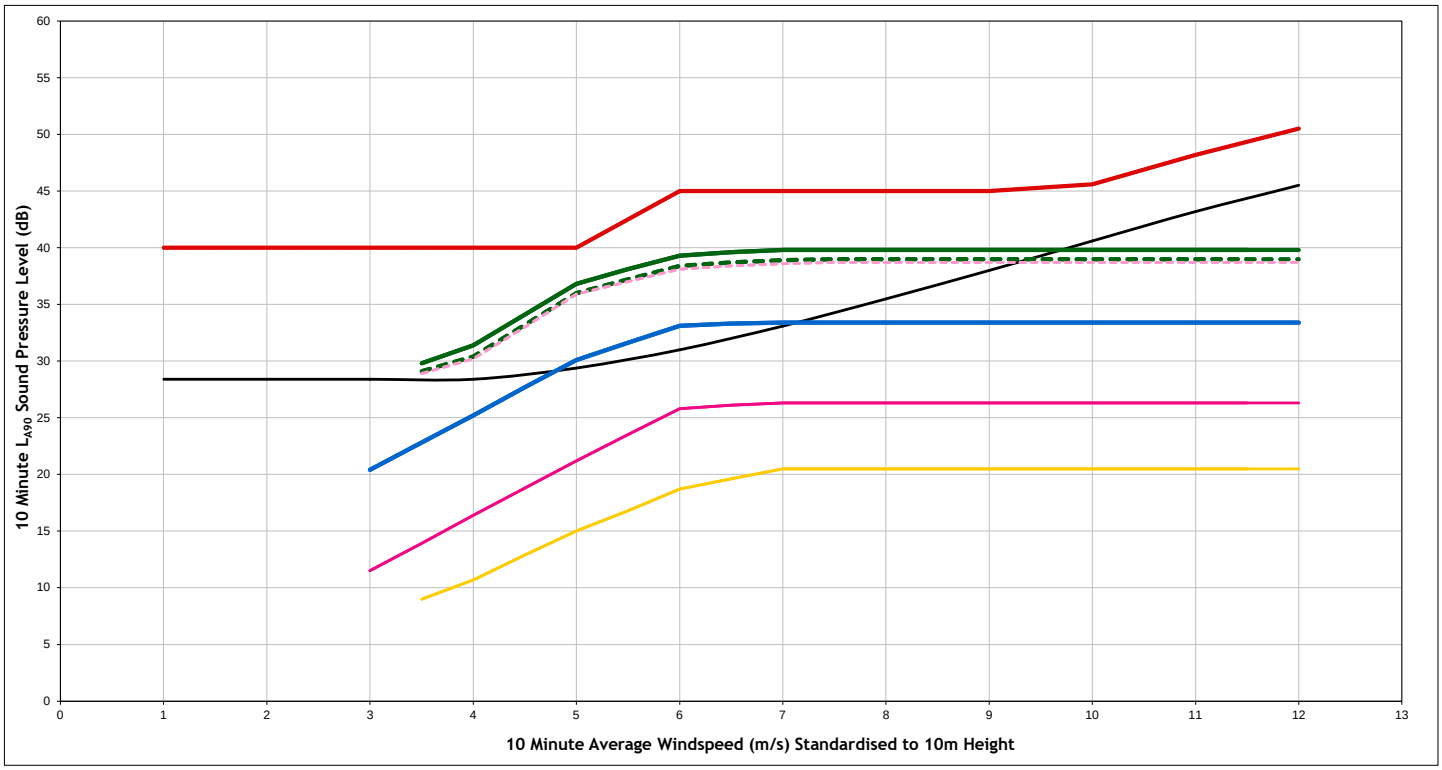


Legend:

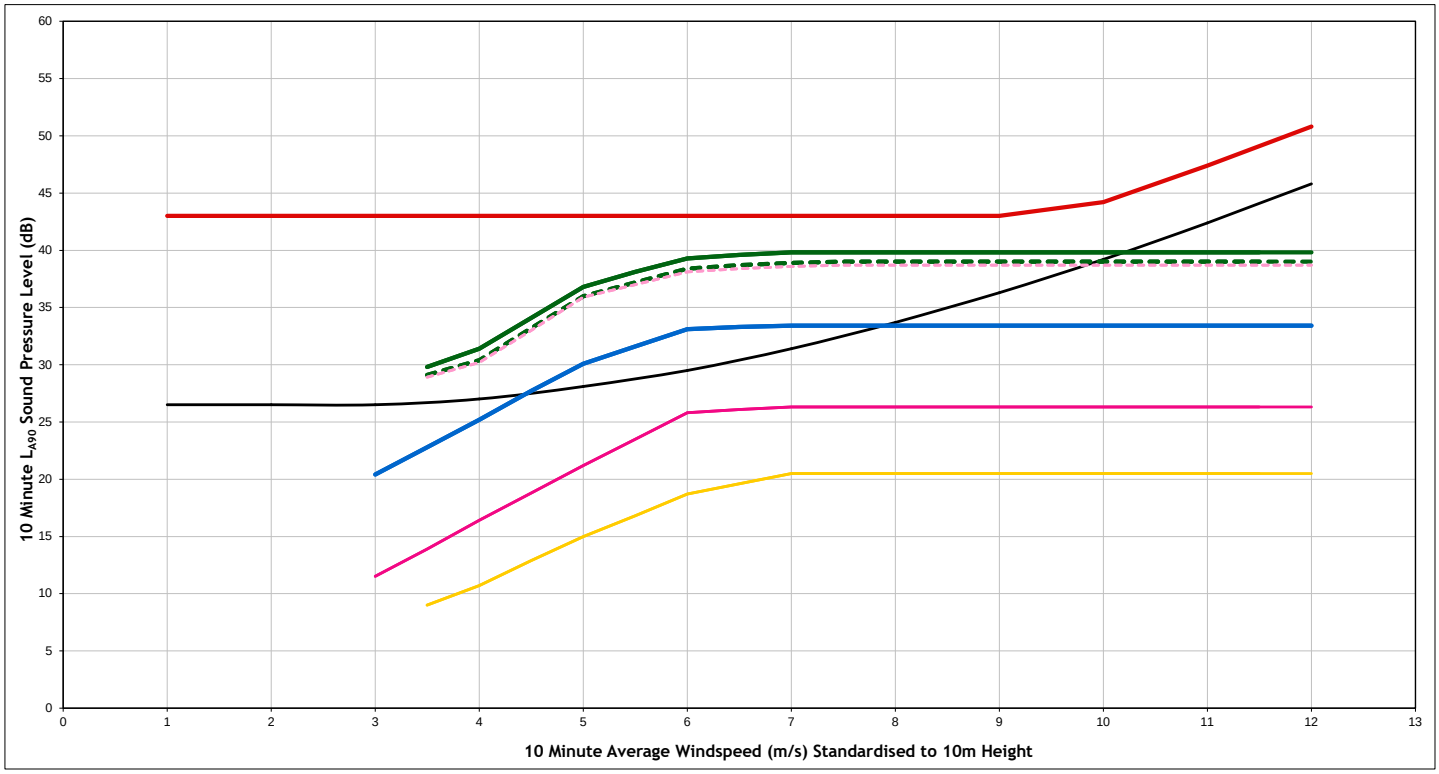
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL2 (H23)
Figure Number	Figure A1.3b
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL3 (H01)



Night Time - NAL3 (H01)

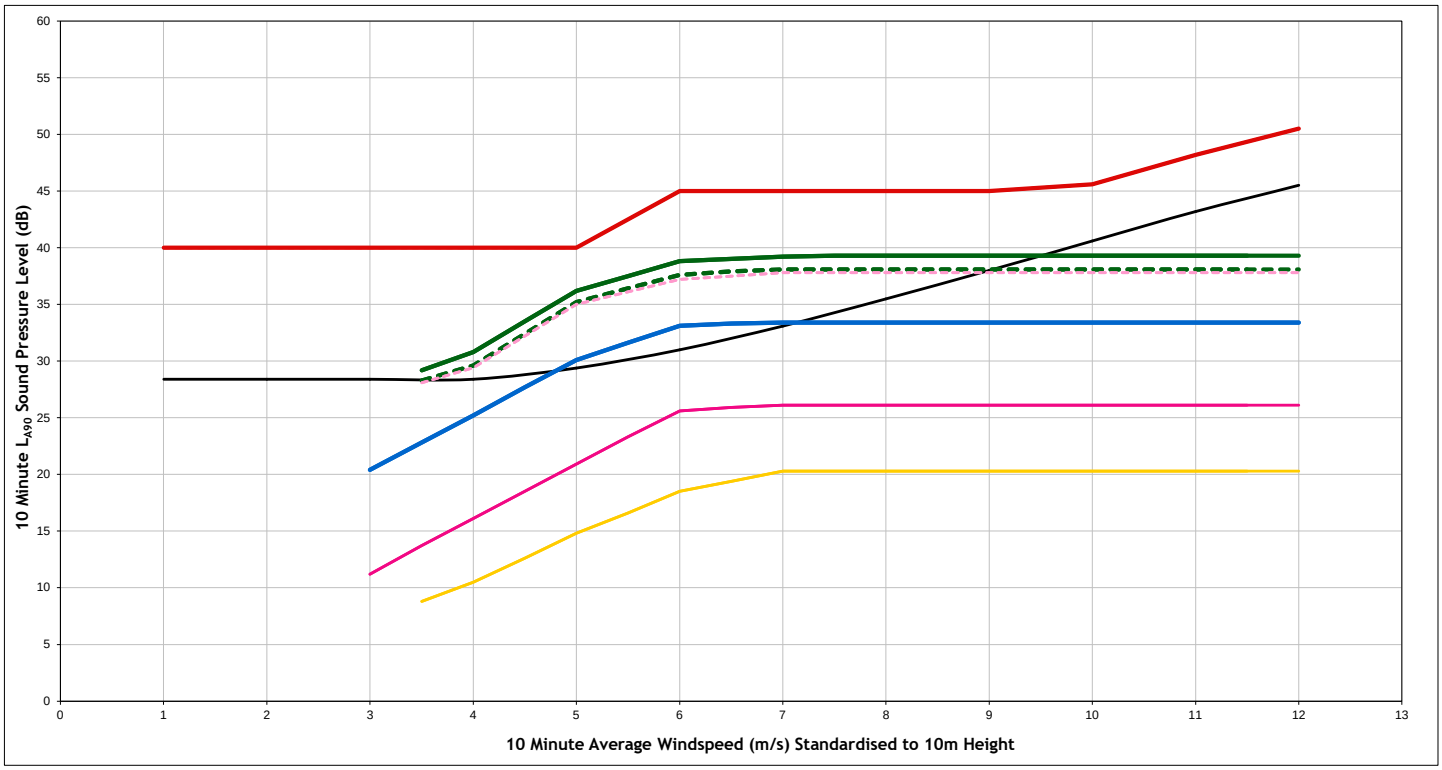


Legend:

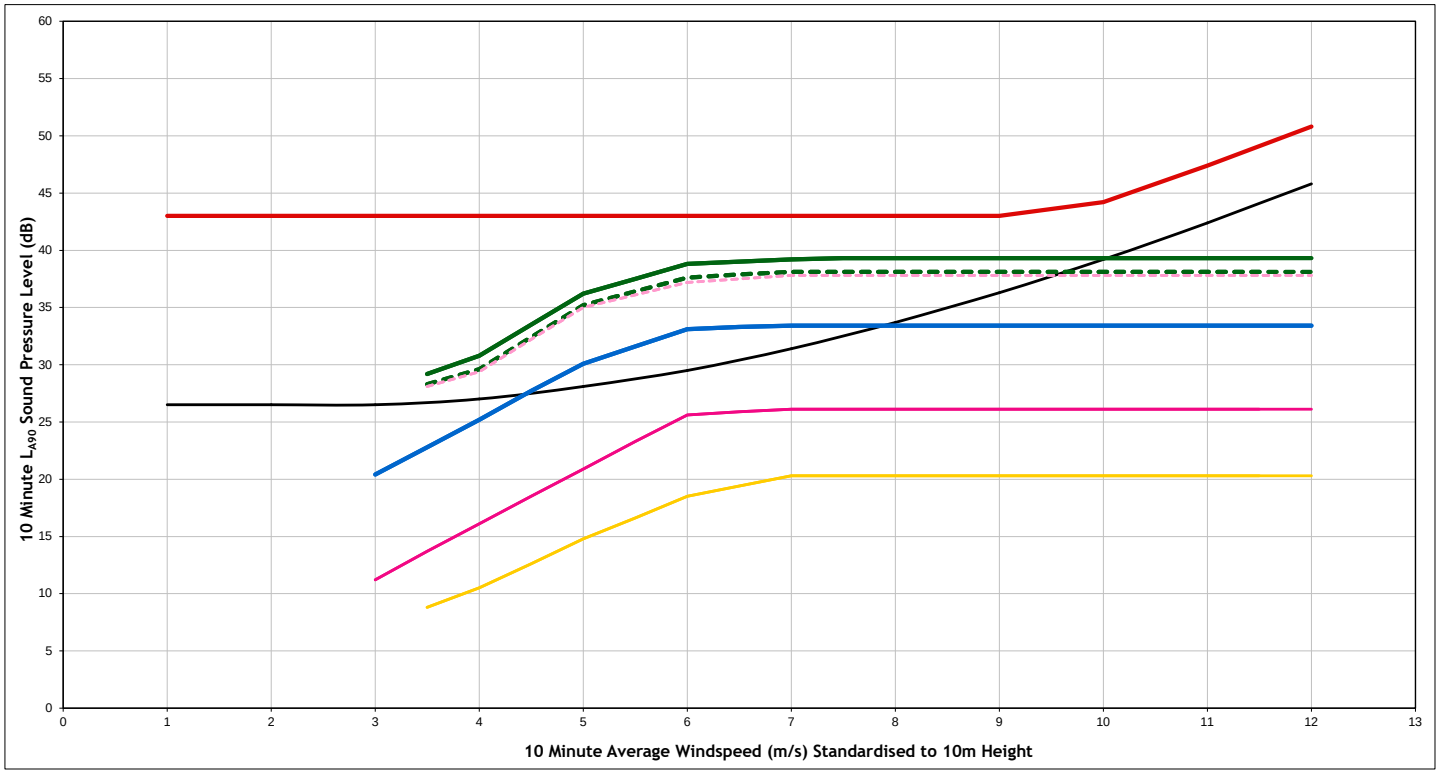
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL3 (H01)
Figure Number	Figure A1.3c
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL4 (H03)



Night Time - NAL4 (H03)

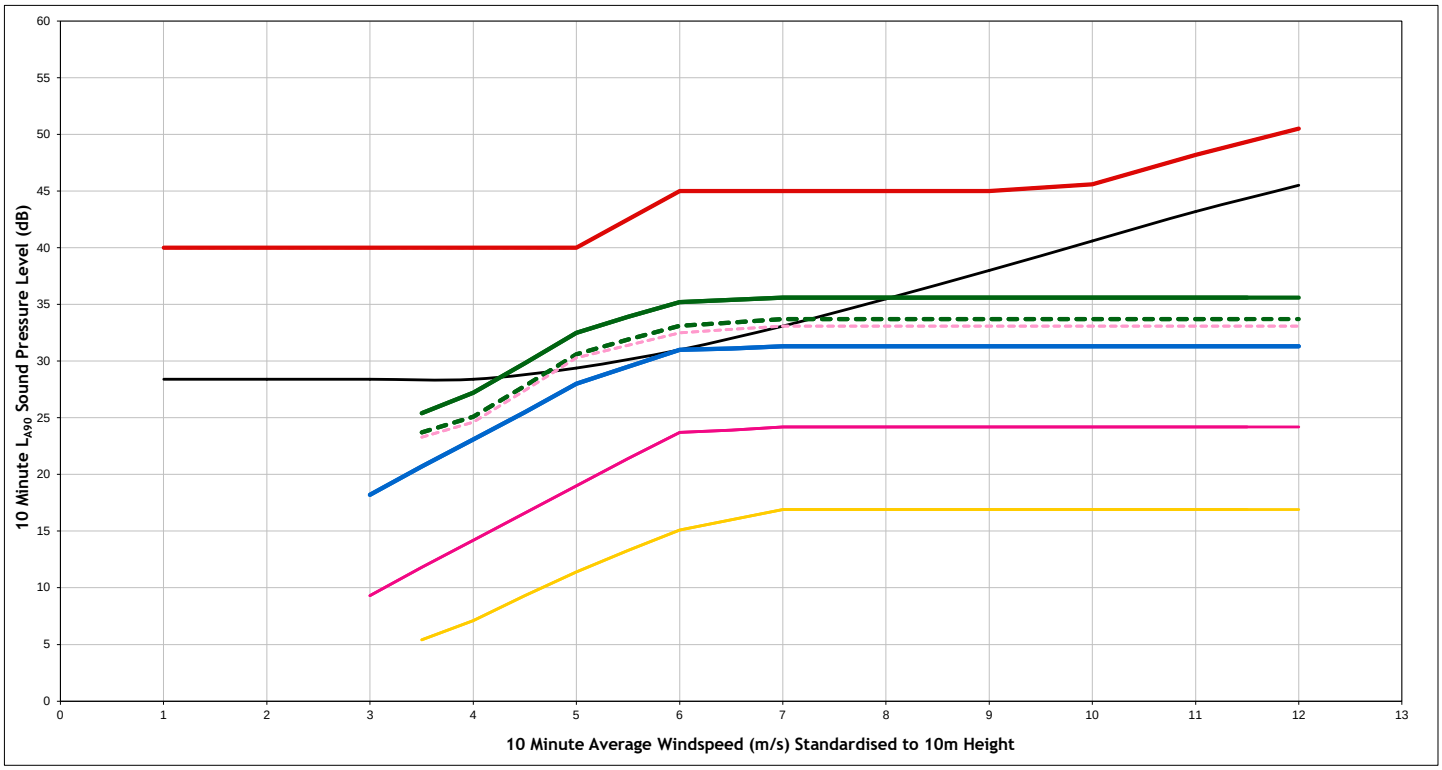


Legend:

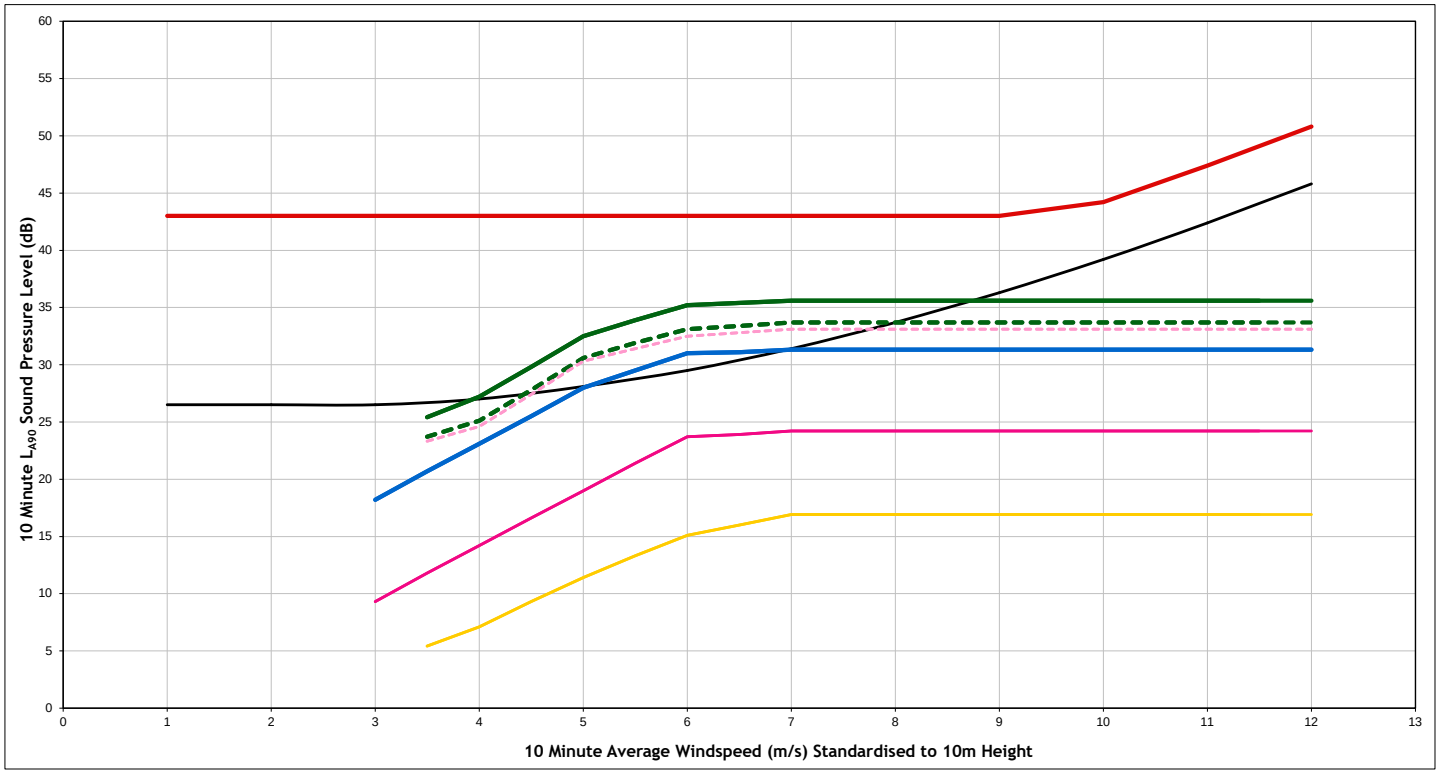
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL4 (H03)
Figure Number	Figure A1.3d
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL5 (H13)



Night Time - NAL5 (H13)

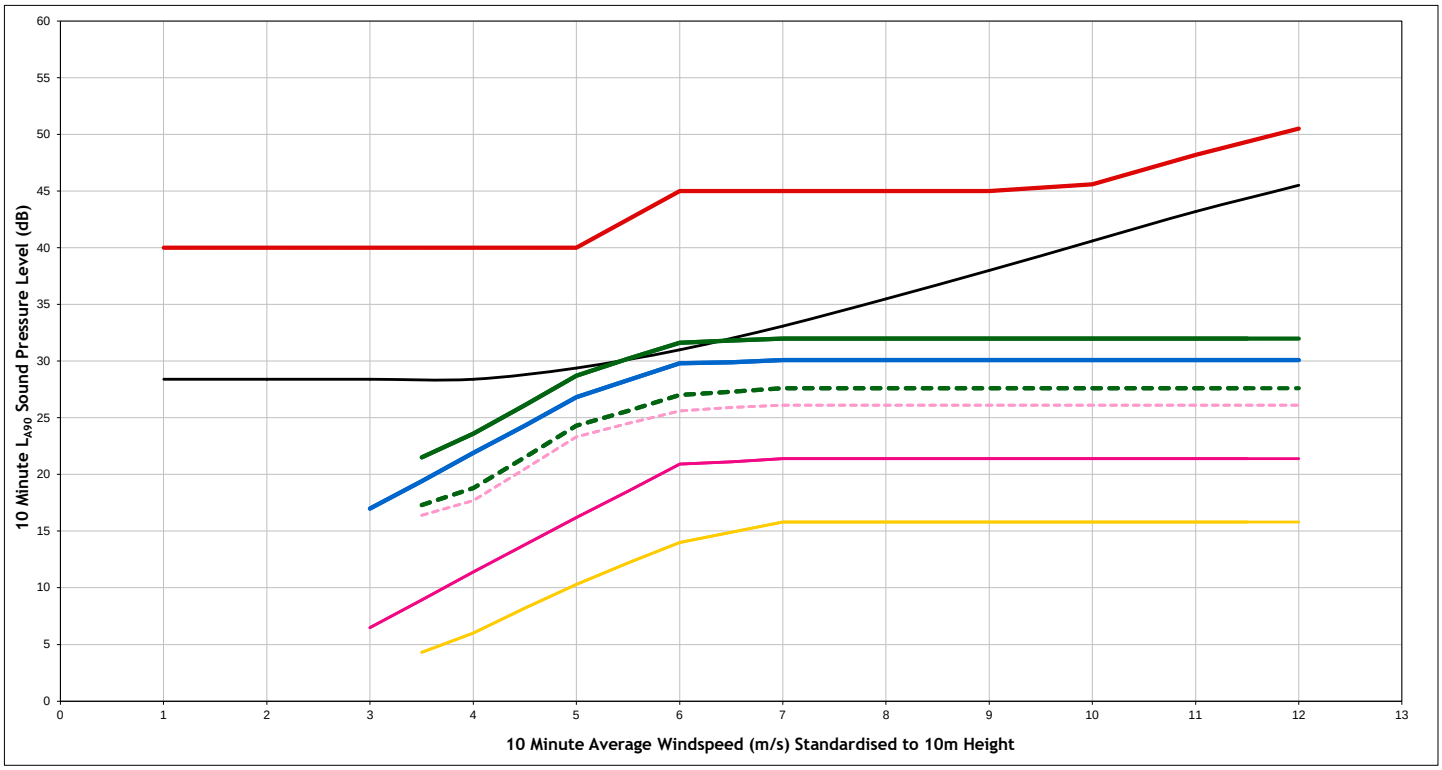


Legend:

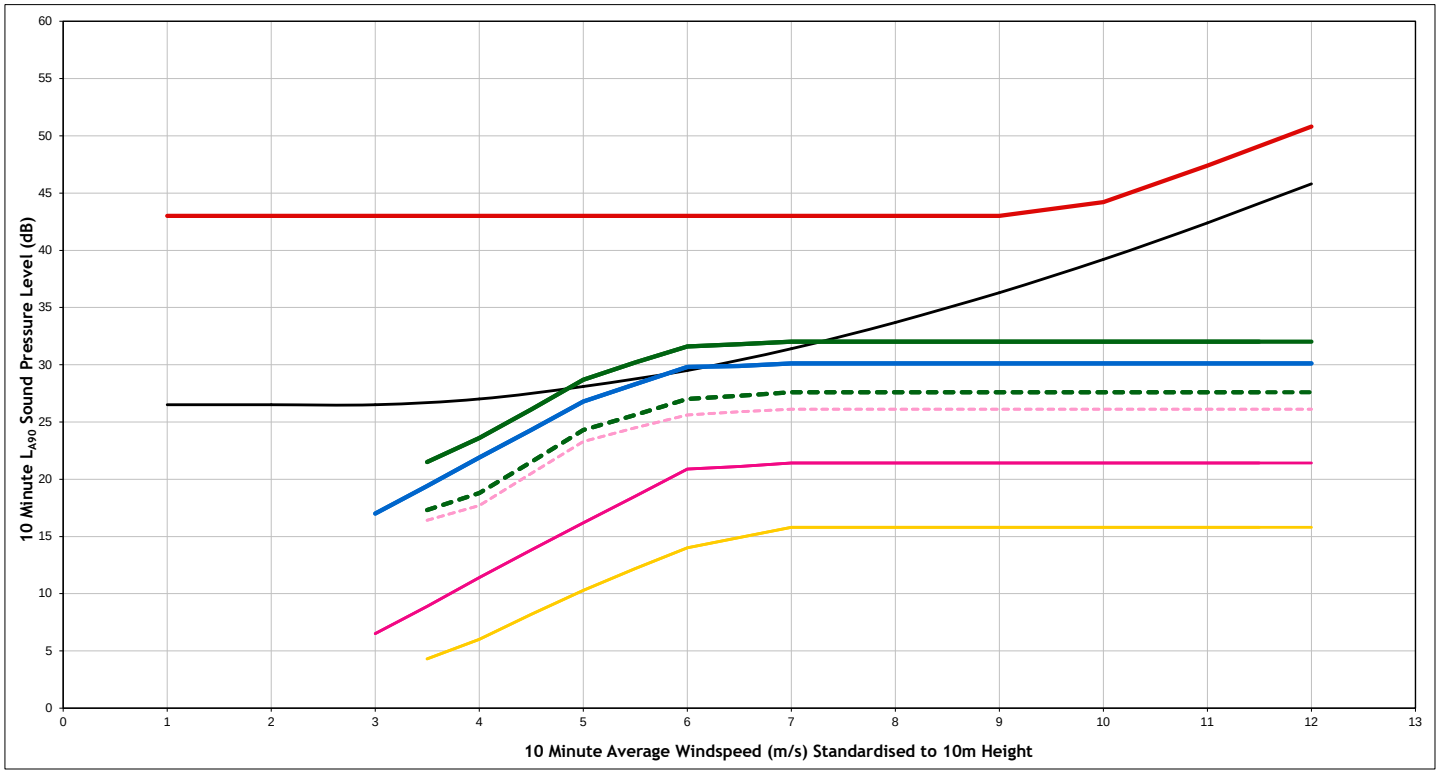
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL5 (H13)
Figure Number	Figure A1.3e
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL6 (H16)



Night Time - NAL6 (H16)

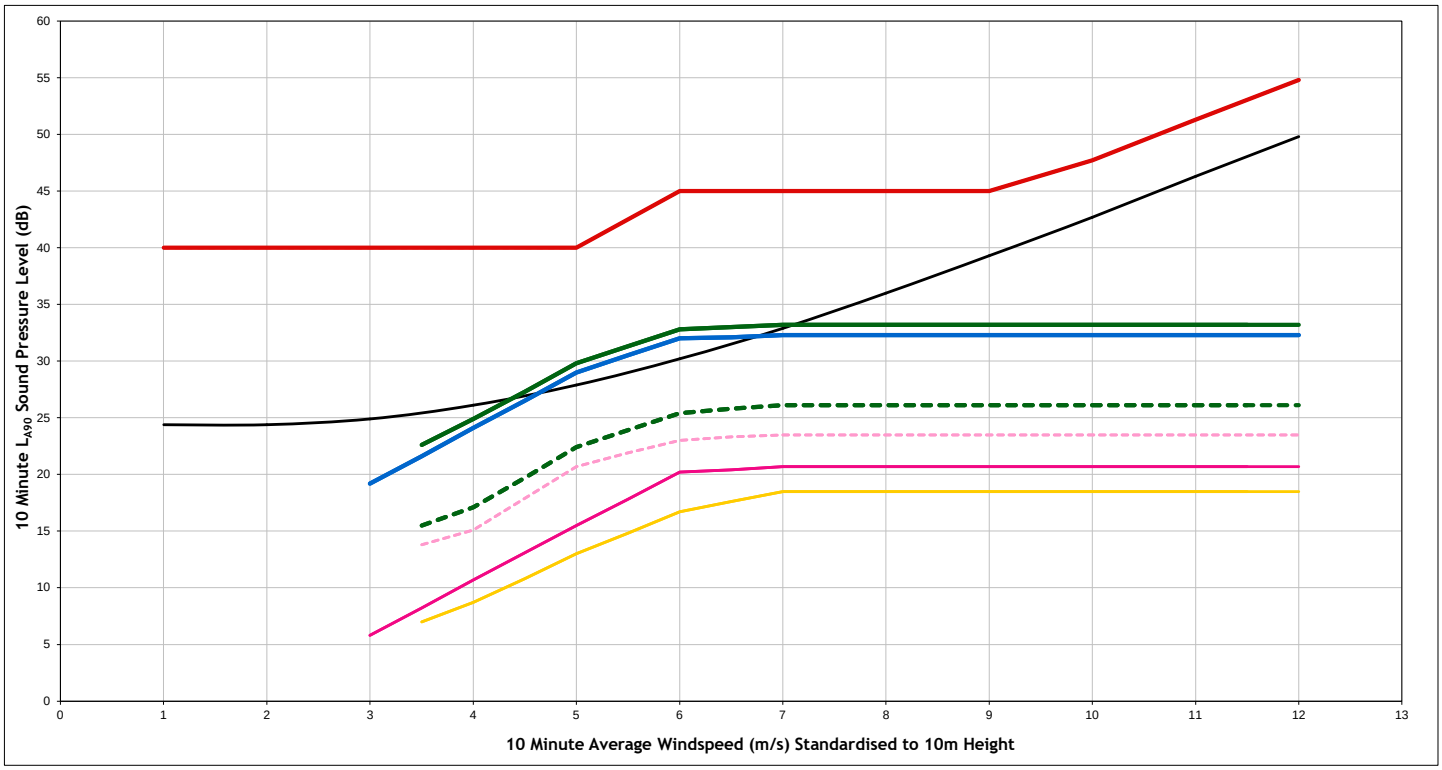


Legend:

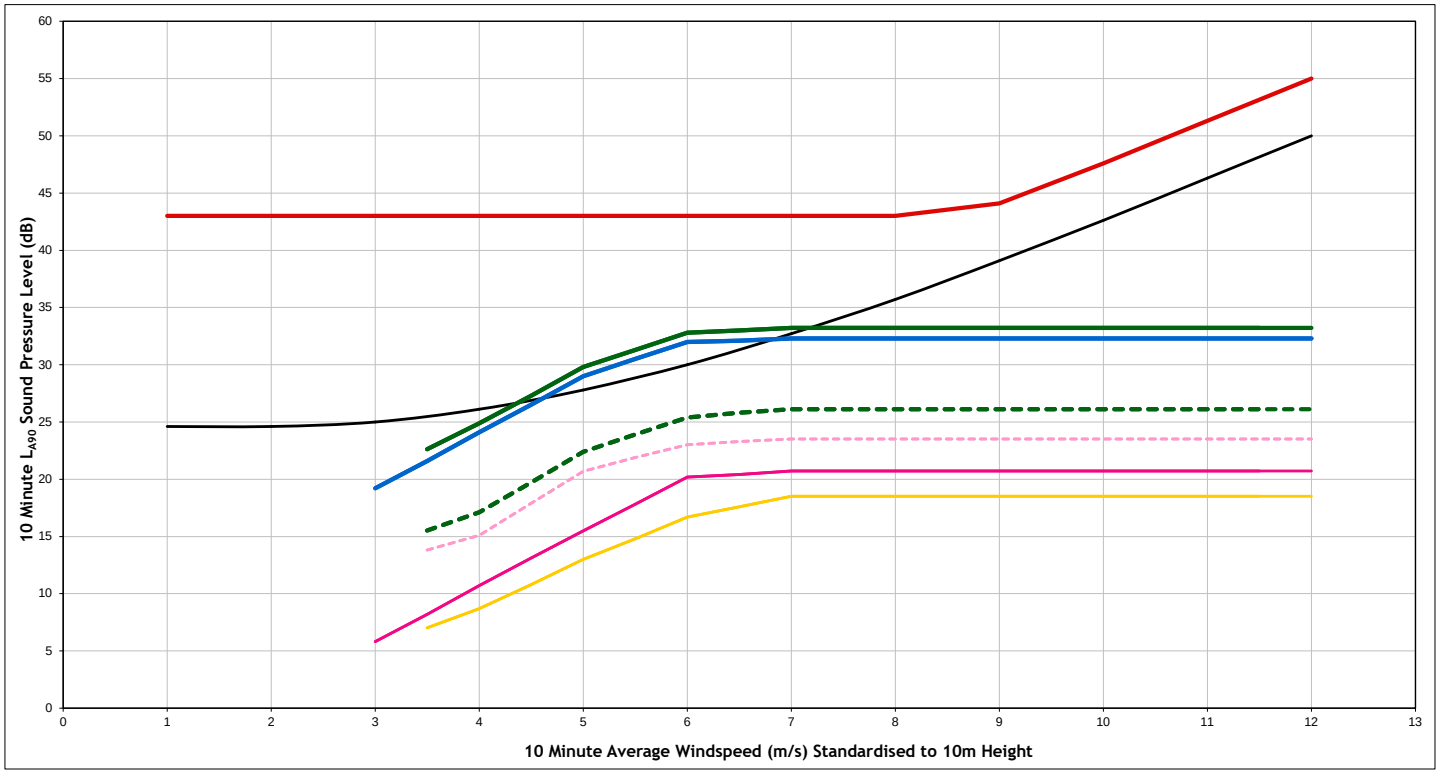
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL6 (H16)
Figure Number	Figure A1.3f
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL7 (H22)



Night Time - NAL7 (H22)



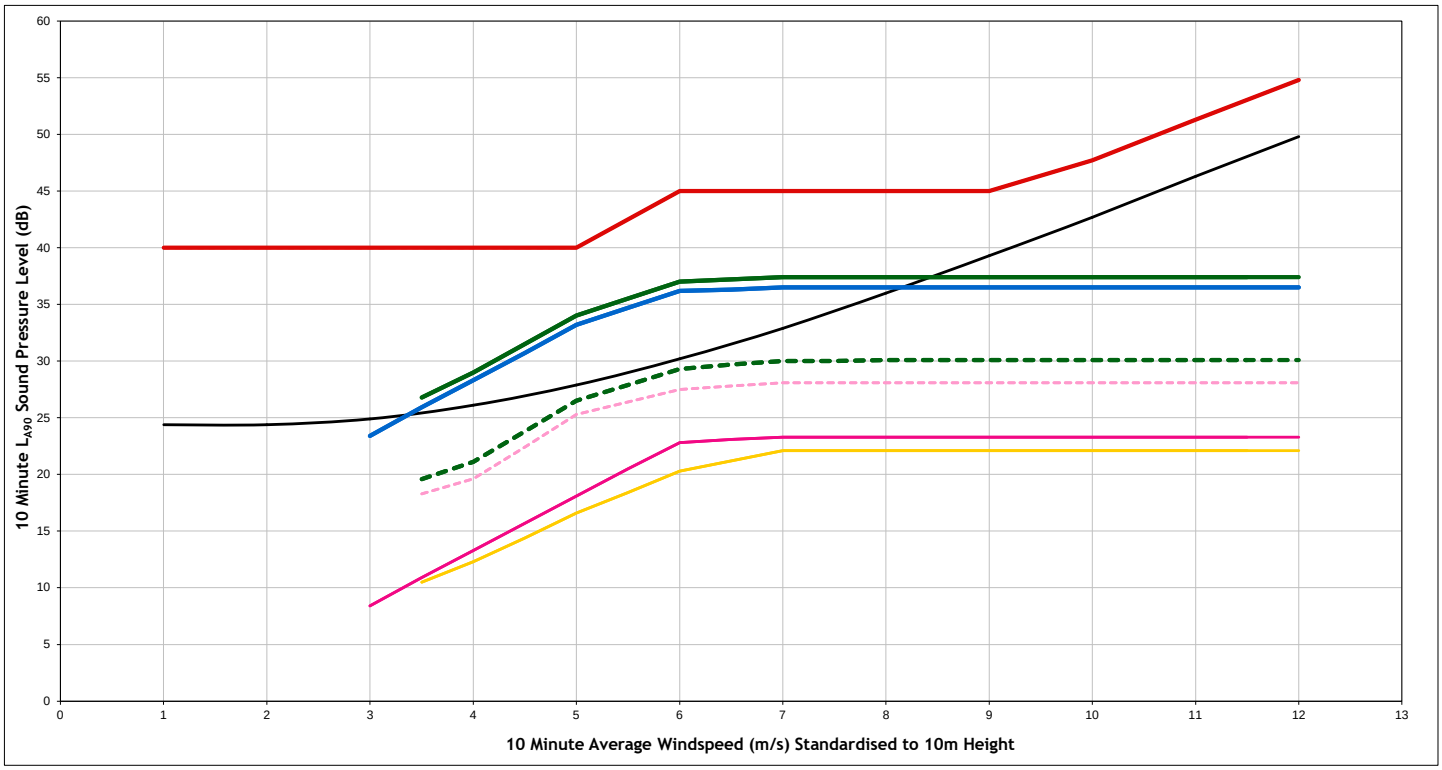
Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (excluding Sheskin South)
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

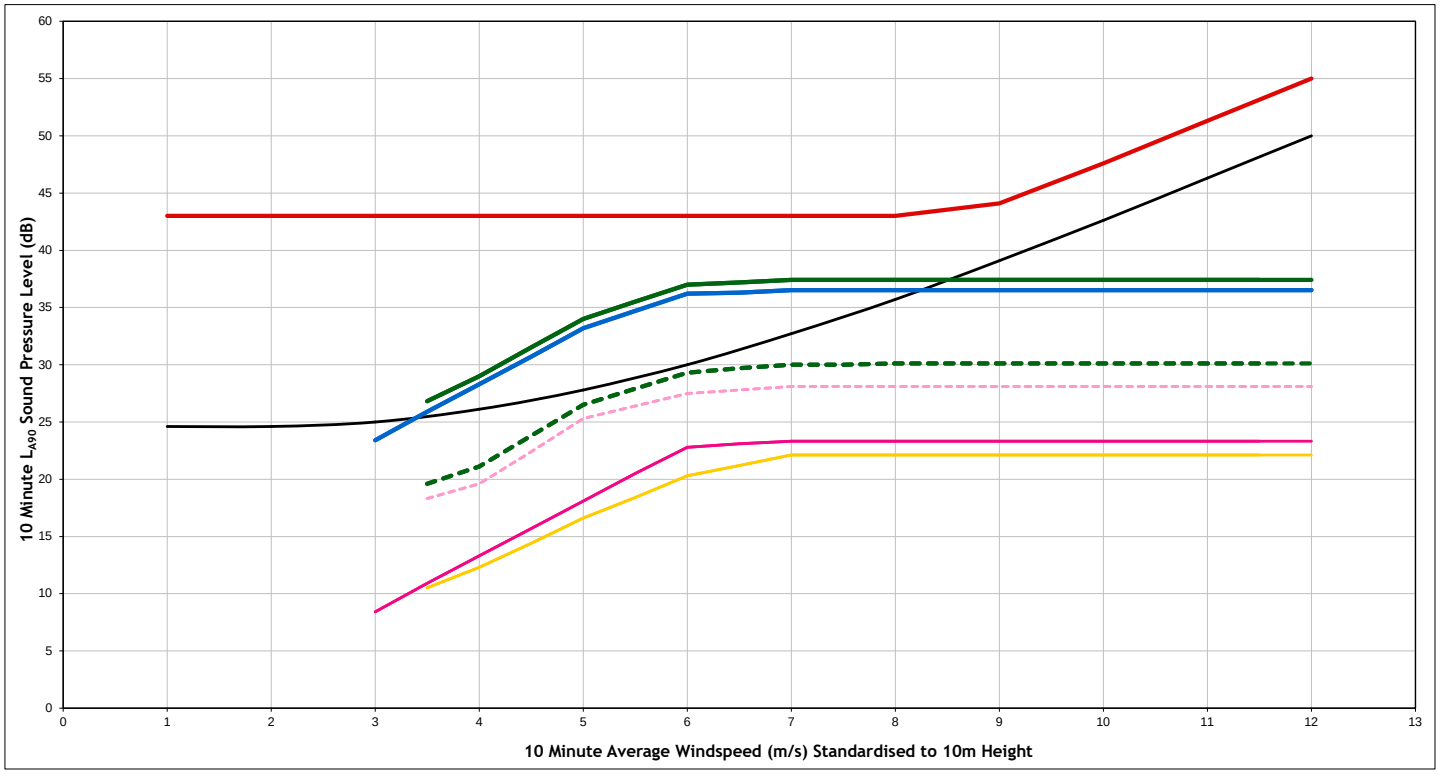
Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Likely Predictions NAL7 (H22)
Figure Number	Figure A1.3g
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Figures A1.4 – Cautious Noise Predictions

Daytime - NAL1 (H18)



Night Time - NAL1 (H18)

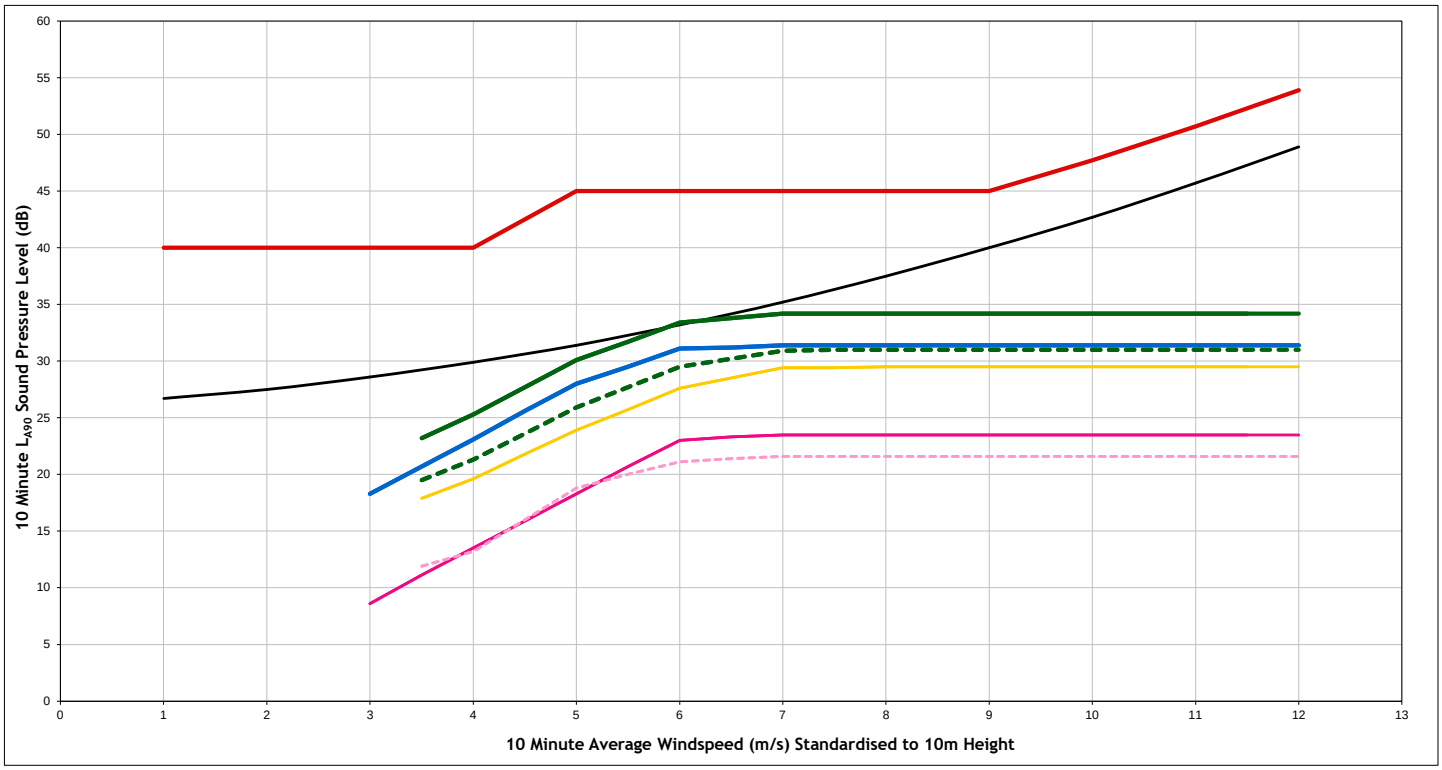


Legend:

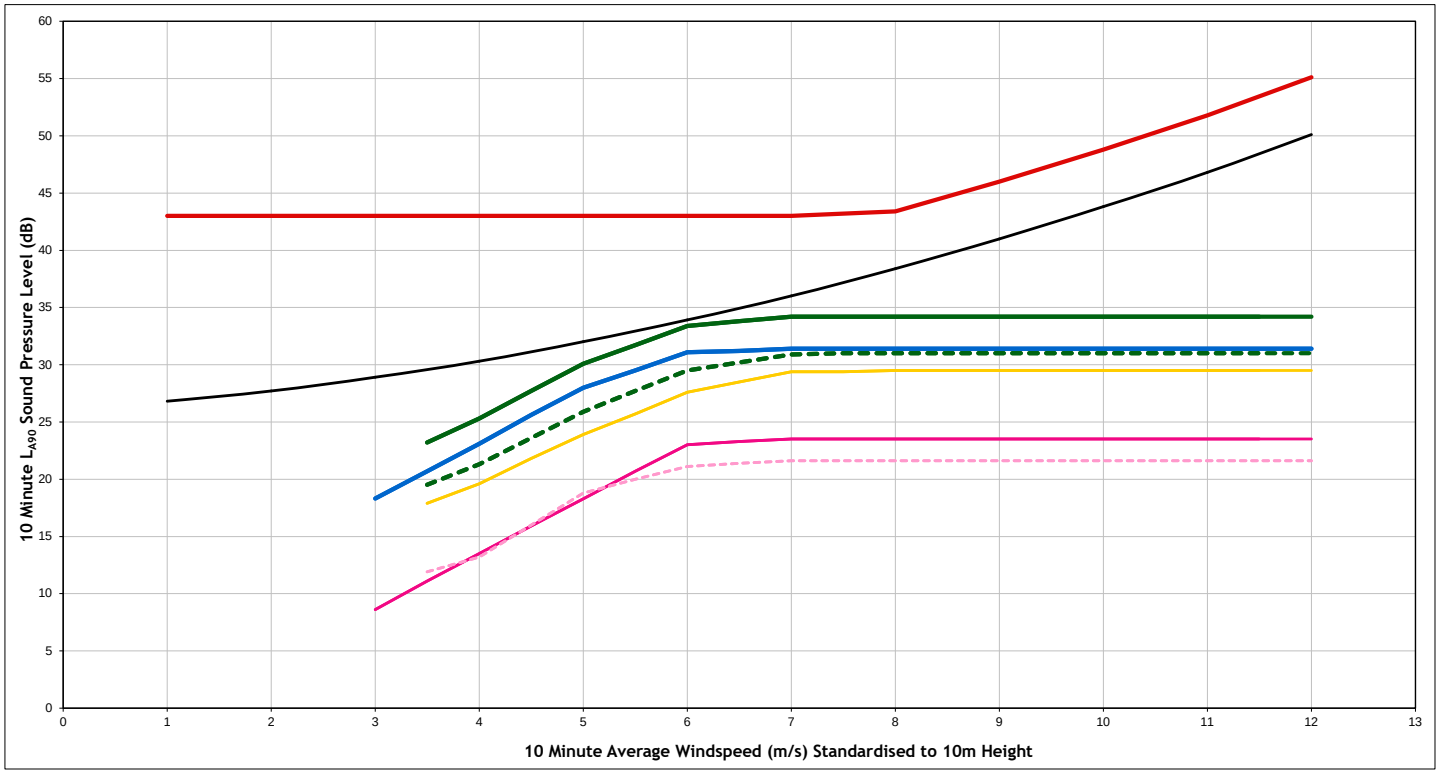
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL1 (H18)
Figure Number	Figure A1.4a
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL2 (H23)



Night Time - NAL2 (H23)

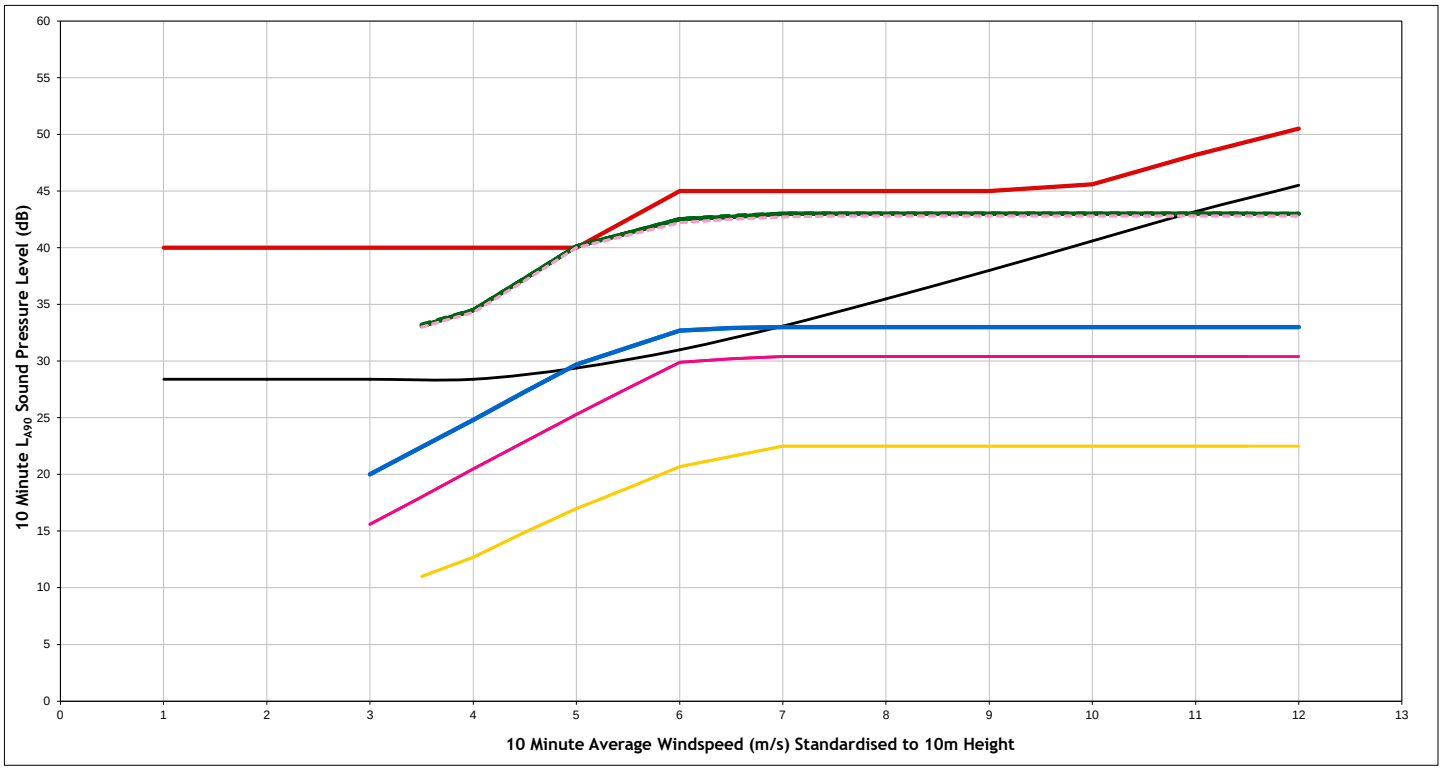


Legend:

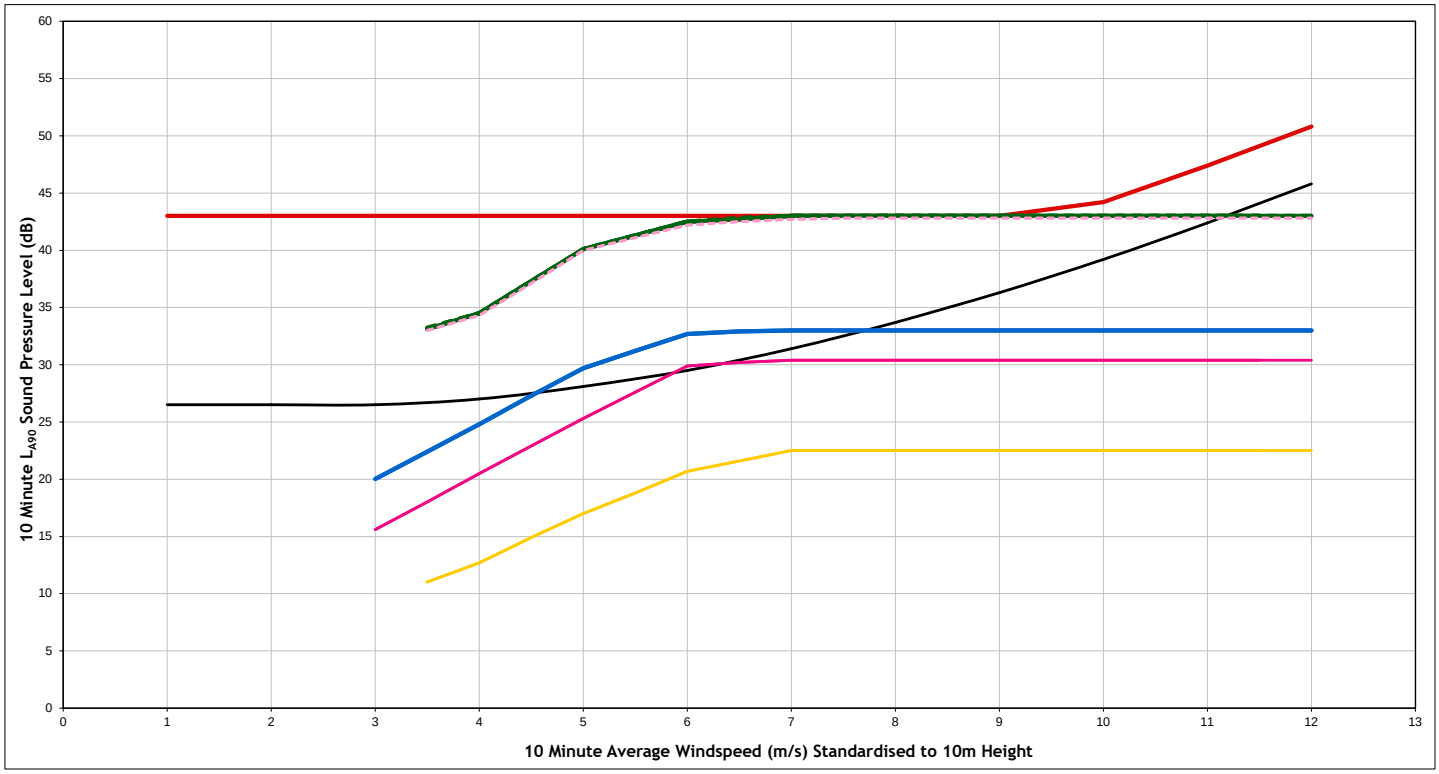
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL2 (H23)
Figure Number	Figure A1.4b
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL3 (H01)



Night Time - NAL3 (H01)

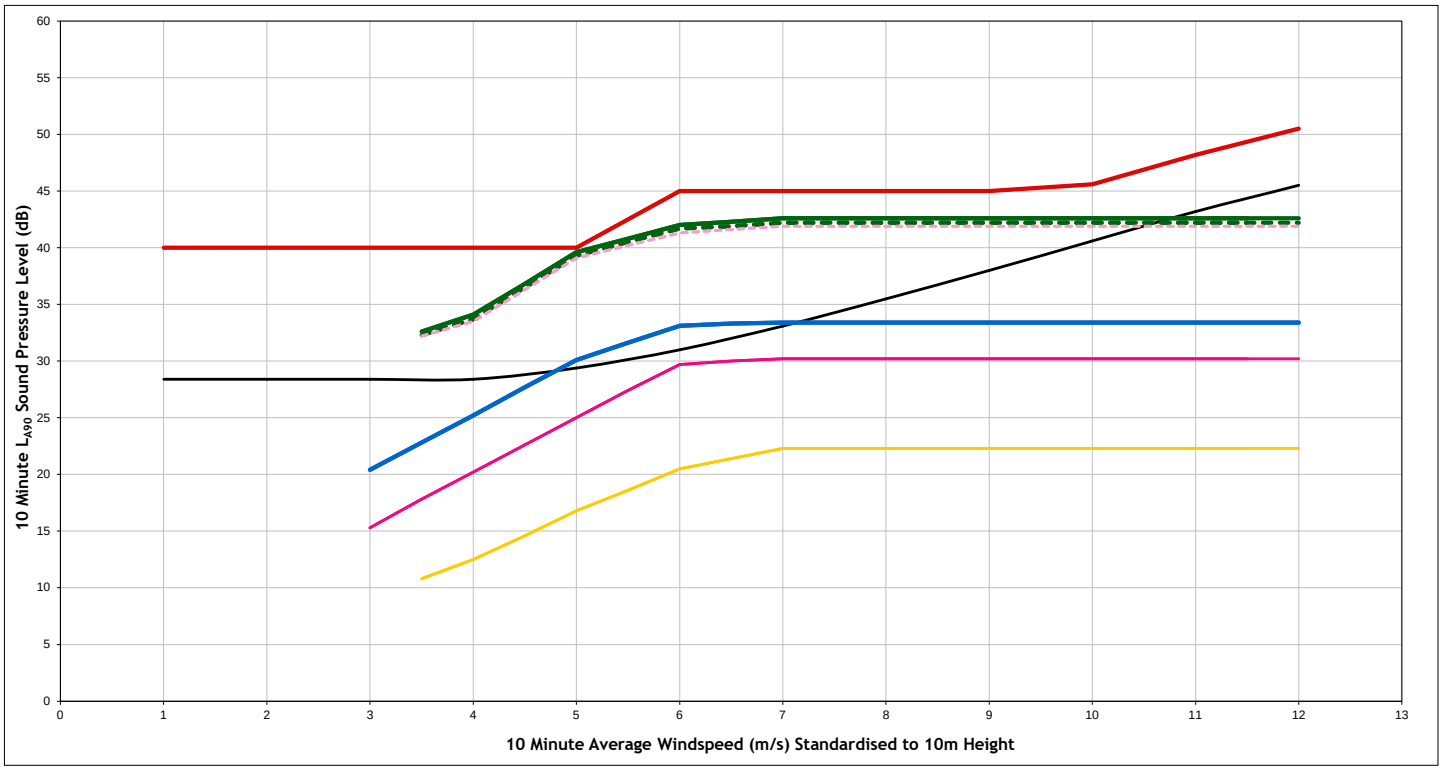


Legend:

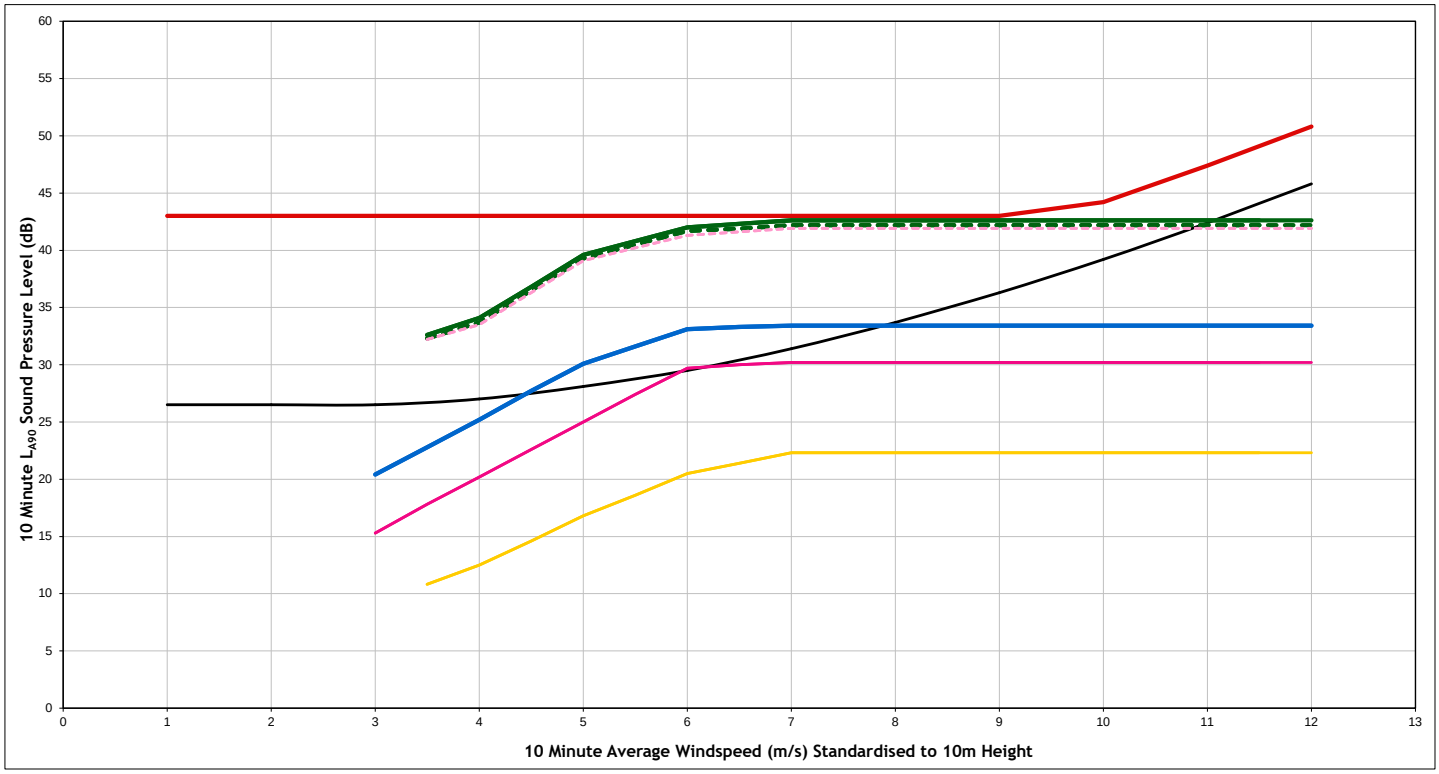
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL3 (H01)
Figure Number	Figure A1.4c
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL4 (H03)



Night Time - NAL4 (H03)

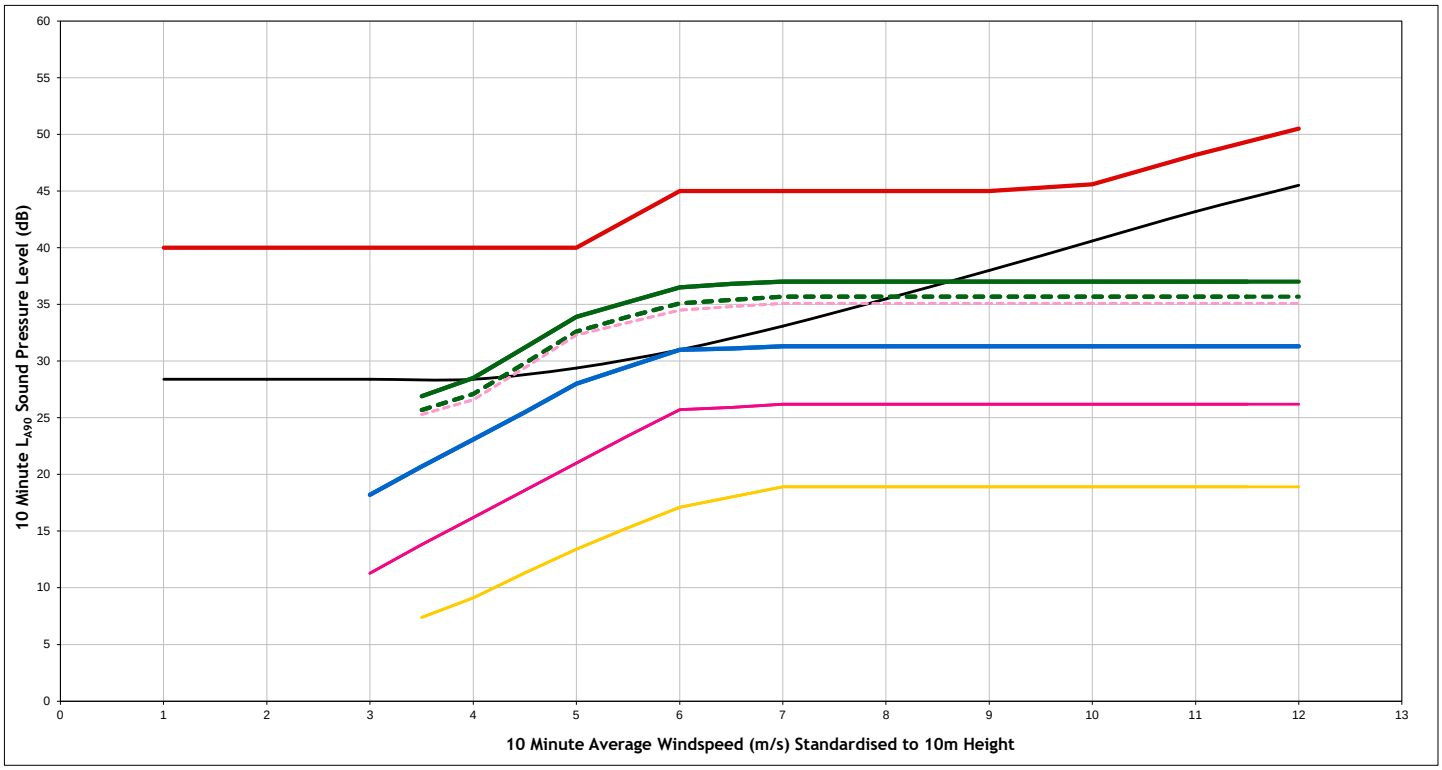


Legend:

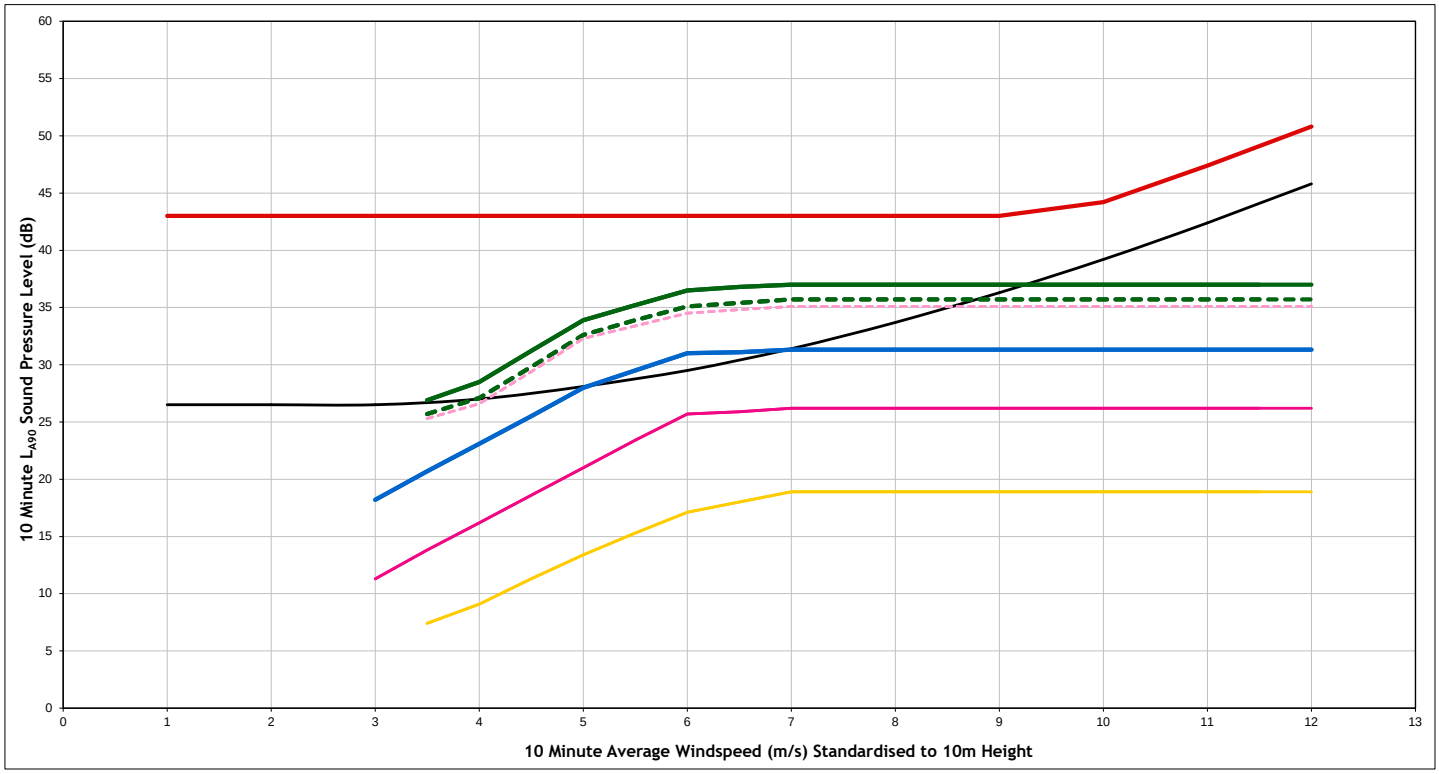
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL4 (H03)
Figure Number	Figure A1.4d
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL5 (H13)



Night Time - NAL5 (H13)



Legend:

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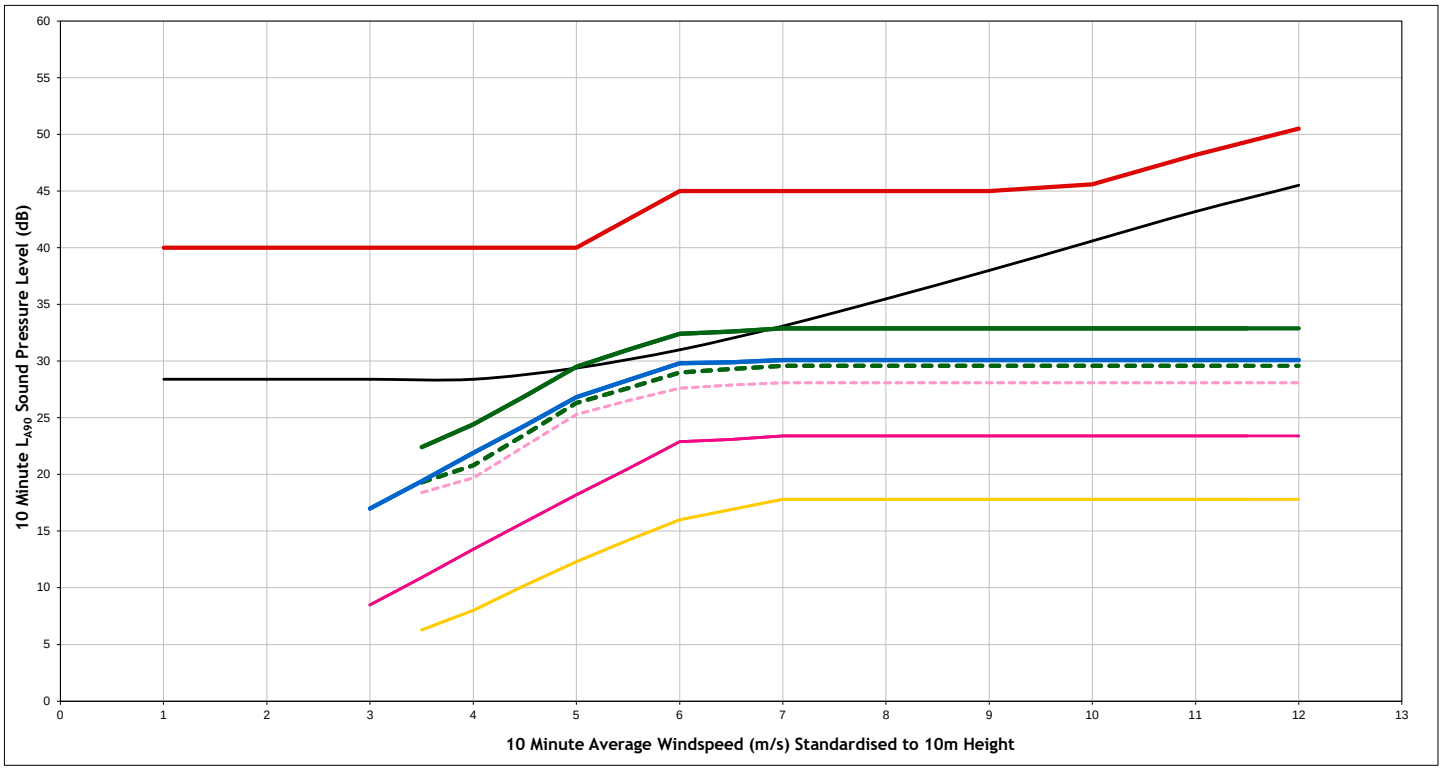
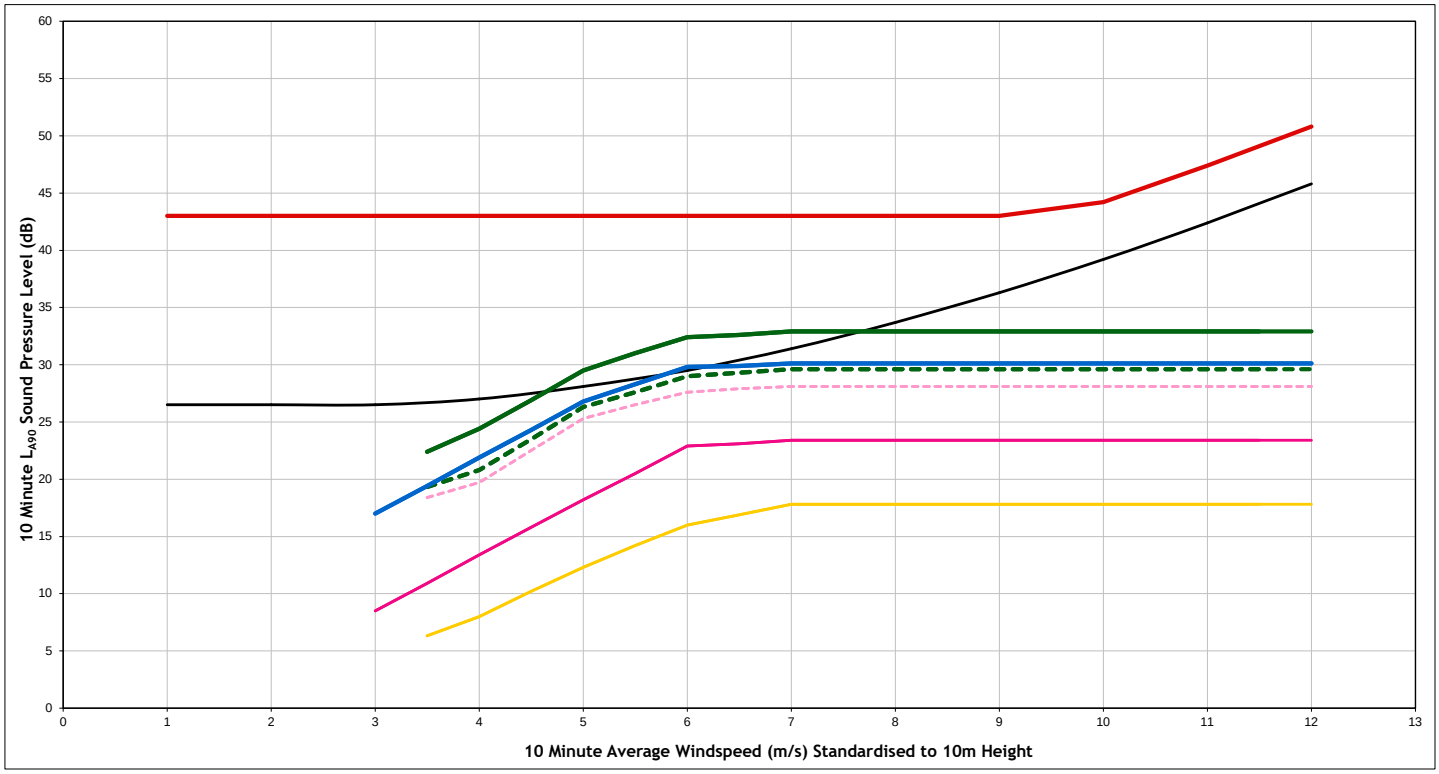
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL5 (H13)
Figure Number	Figure A1.4e
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL6 (H16)



Night Time - NAL6 (H16)

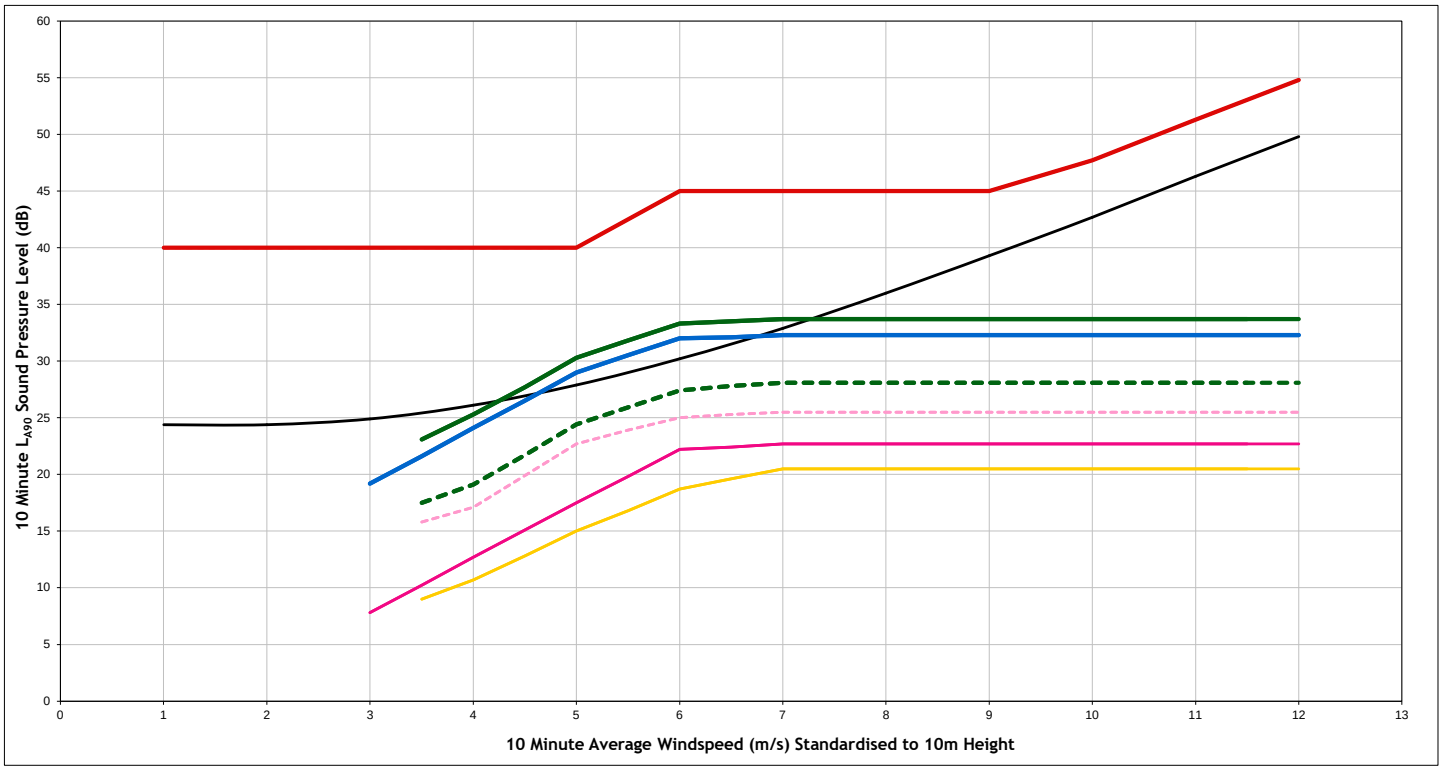


Legend:

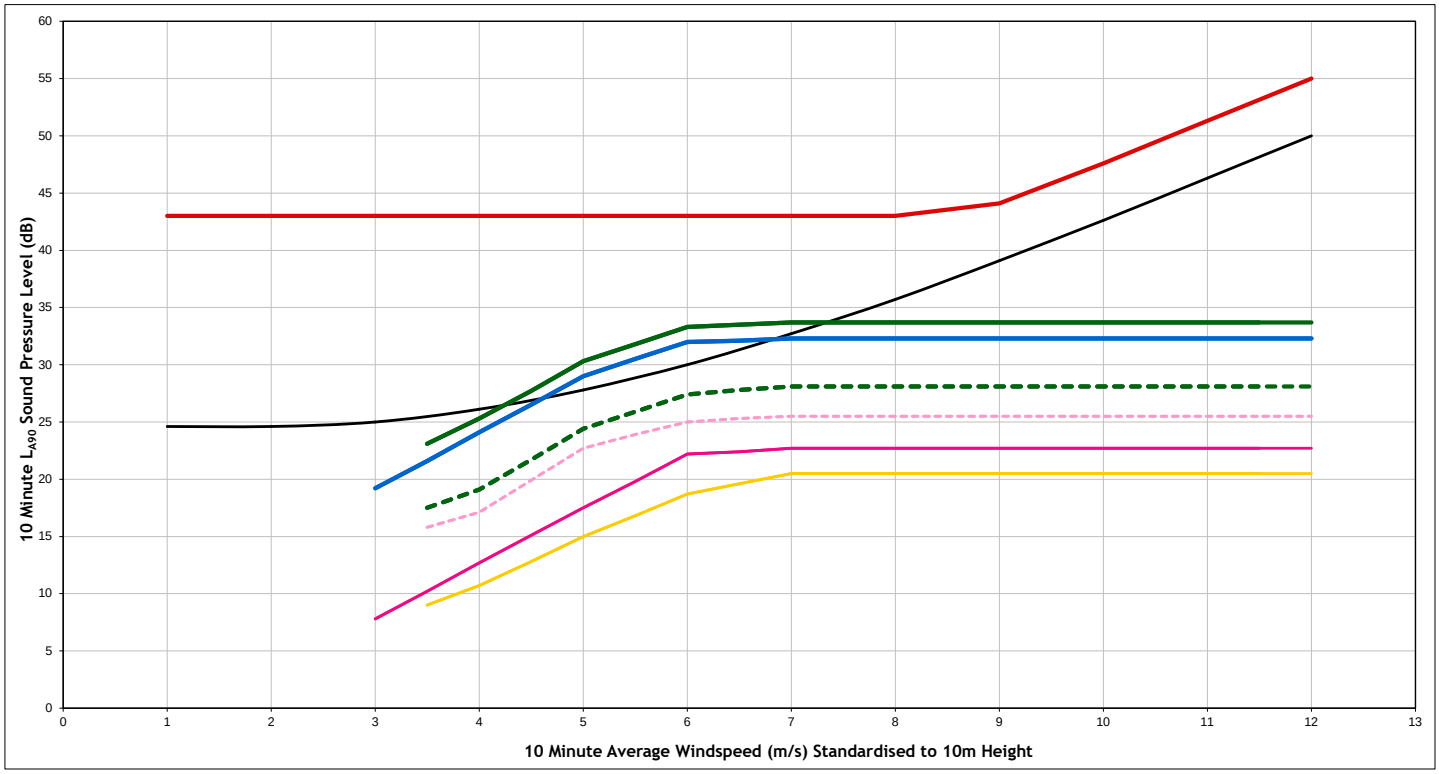
- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL6 (H16)
Figure Number	Figure A1.4f
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL7 (H22)



Night Time - NAL7 (H22)



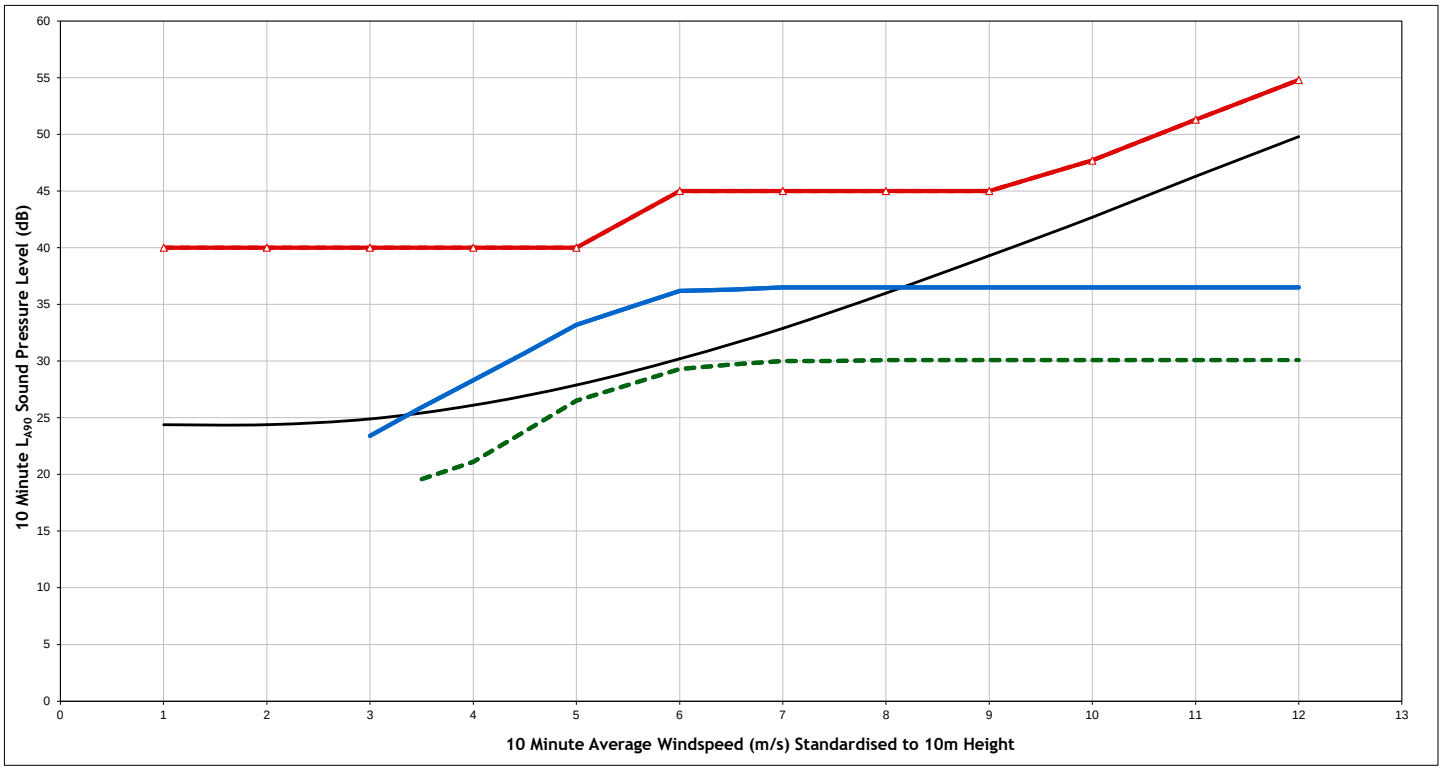
Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Cumulative (including Sheskin South)
- Cumulative (other wind farms excluding Sheskin South) - Cautious predictions
- Sheskin South
- ABO Sheskin
- Oweninny (Phase 1)
- Oweninny (Phase 2)

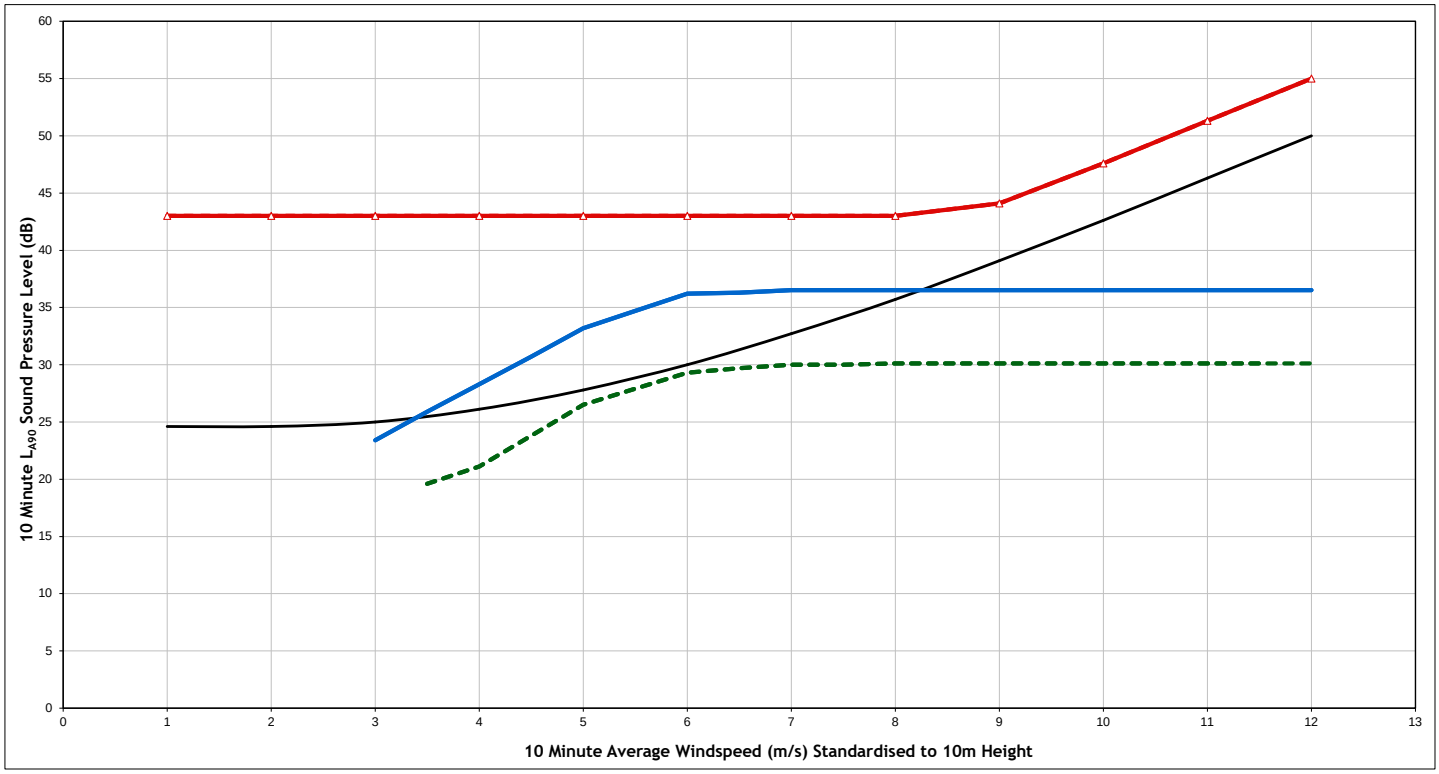
Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL7 (H22)
Figure Number	Figure A1.4g
Scale	NTS
Drawn	JB
Checked	GC
Date	16/12/2022
Document Reference	14192-004-Noise Models

Figures A1.5 – Site Specific Noise Predictions

Daytime - NAL1 (H18)



Night Time - NAL1 (H18)

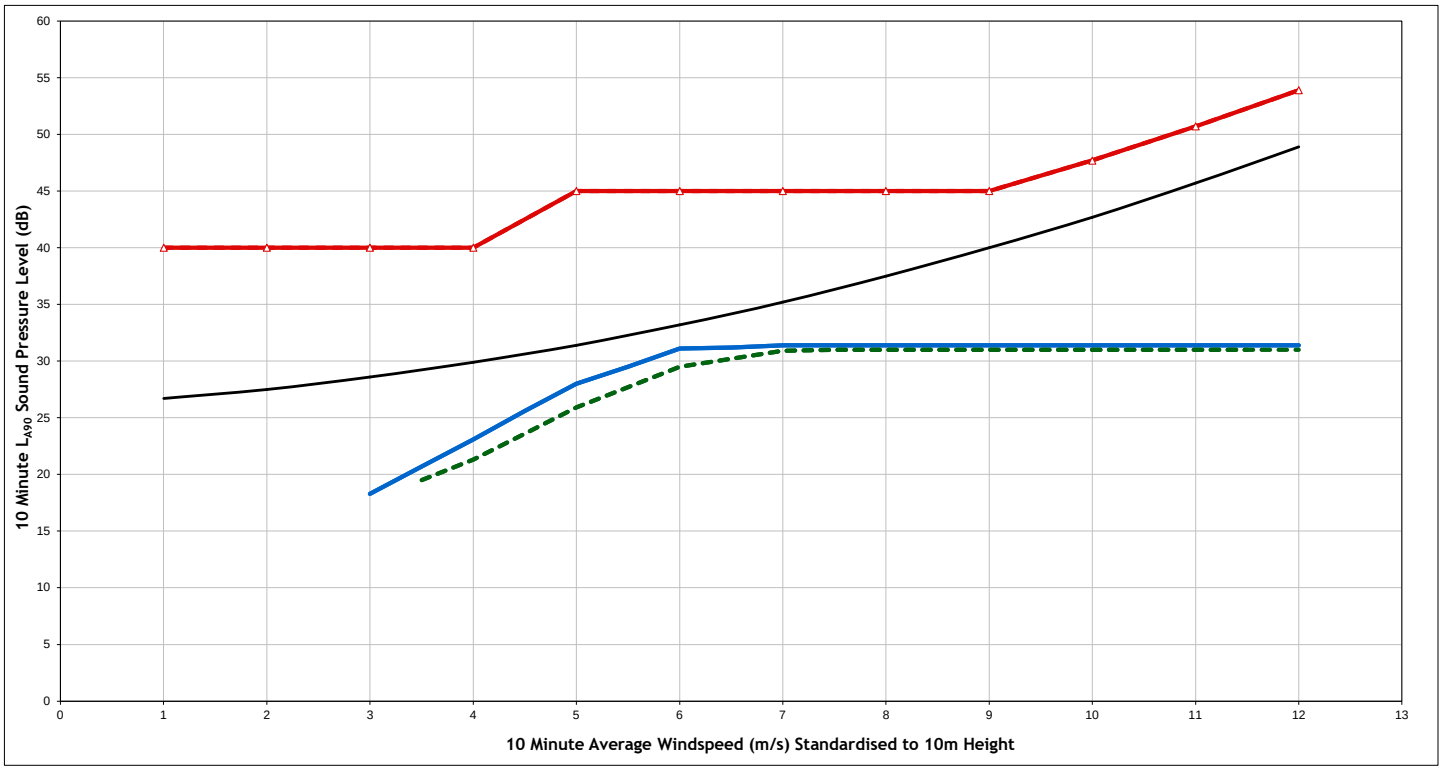


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL1 (H18)
Figure Number	Figure A1.5a
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL2 (H23)



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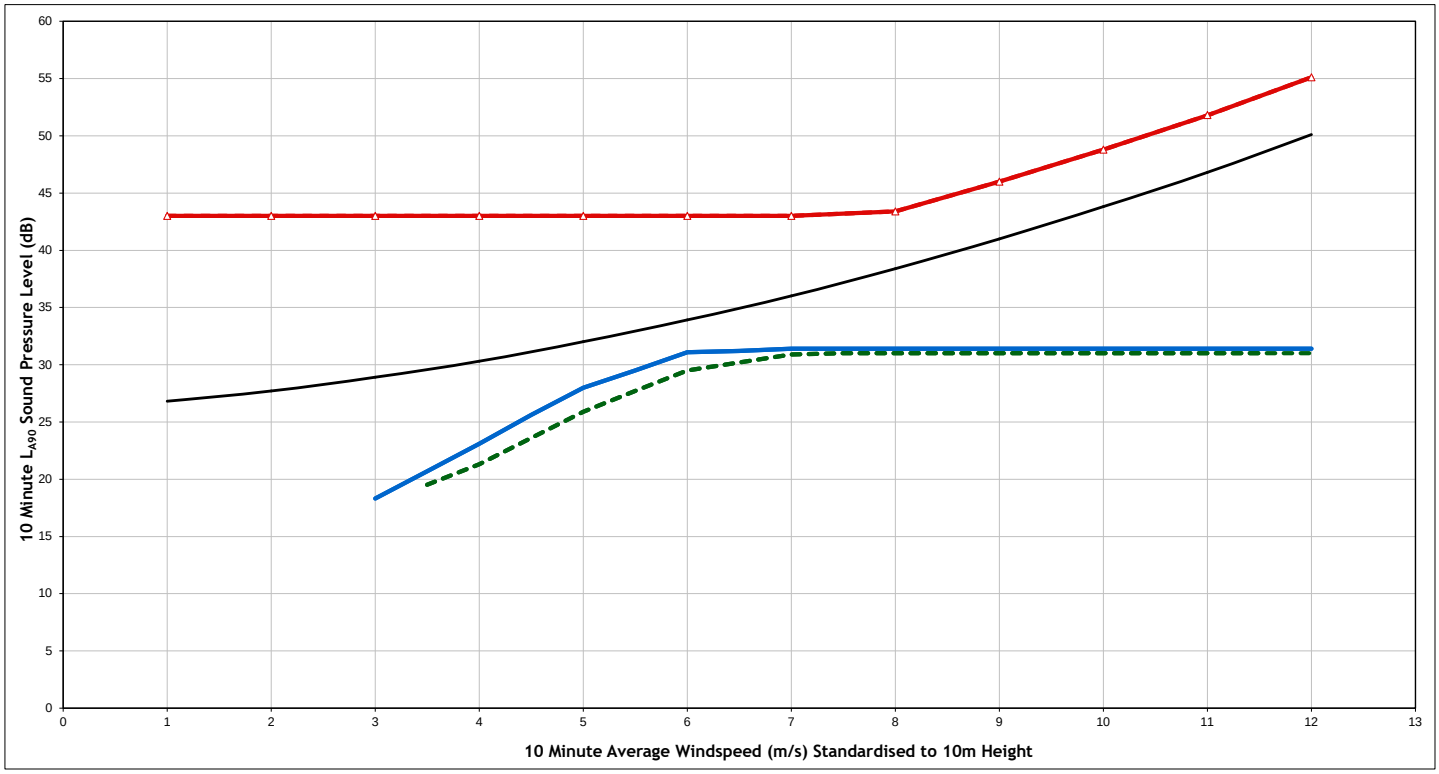
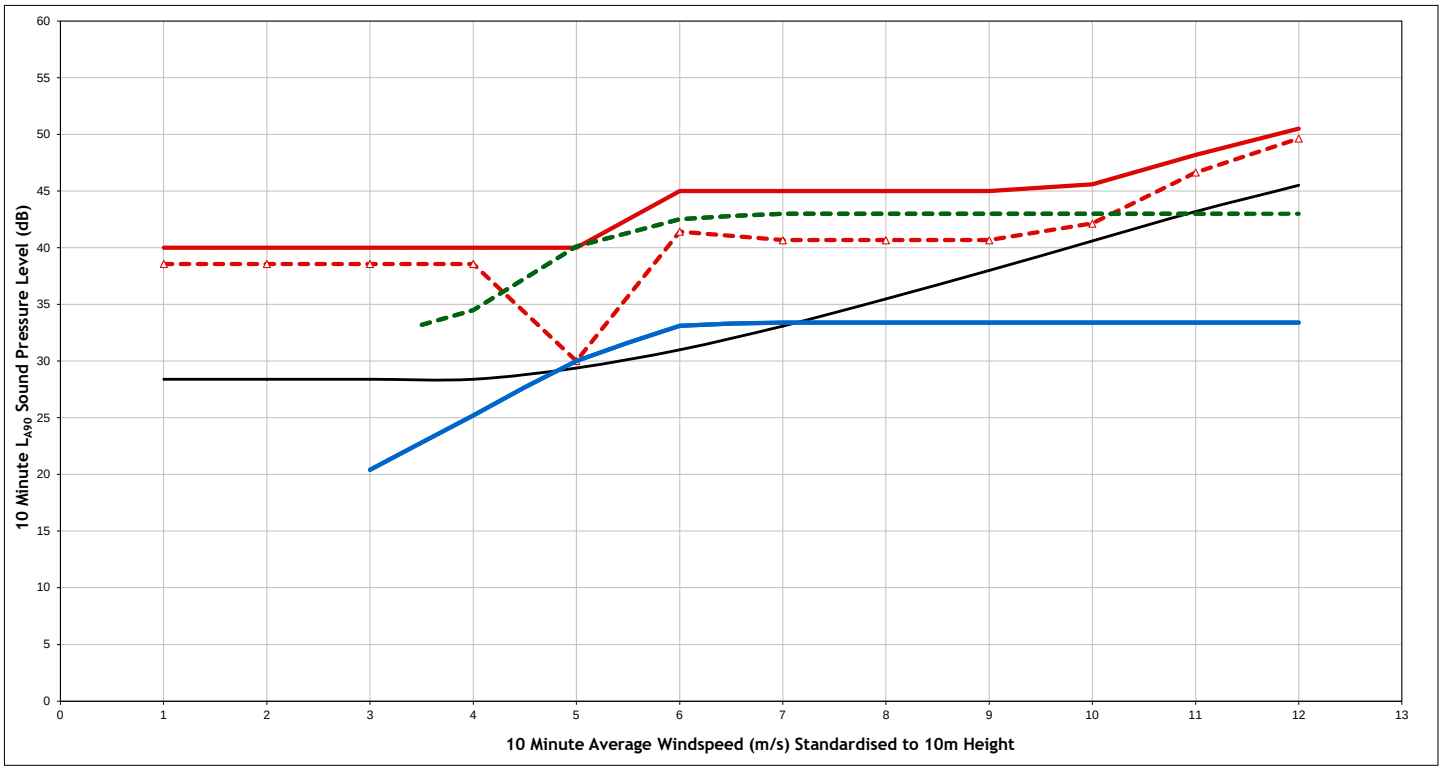


Legend:

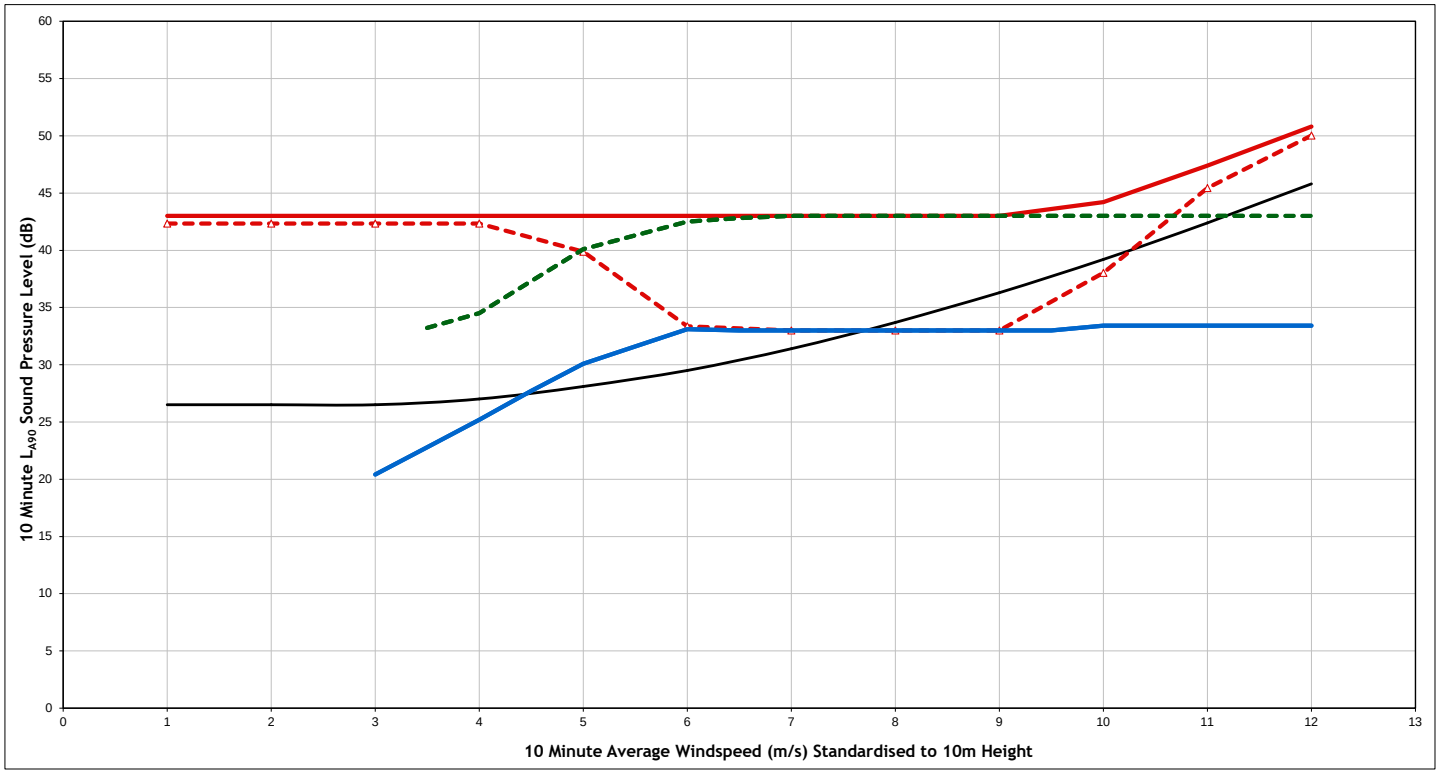
- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL2 (H23)
Figure Number	Figure A1.5b
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL3 (H01)



Night Time - NAL3 (H01)

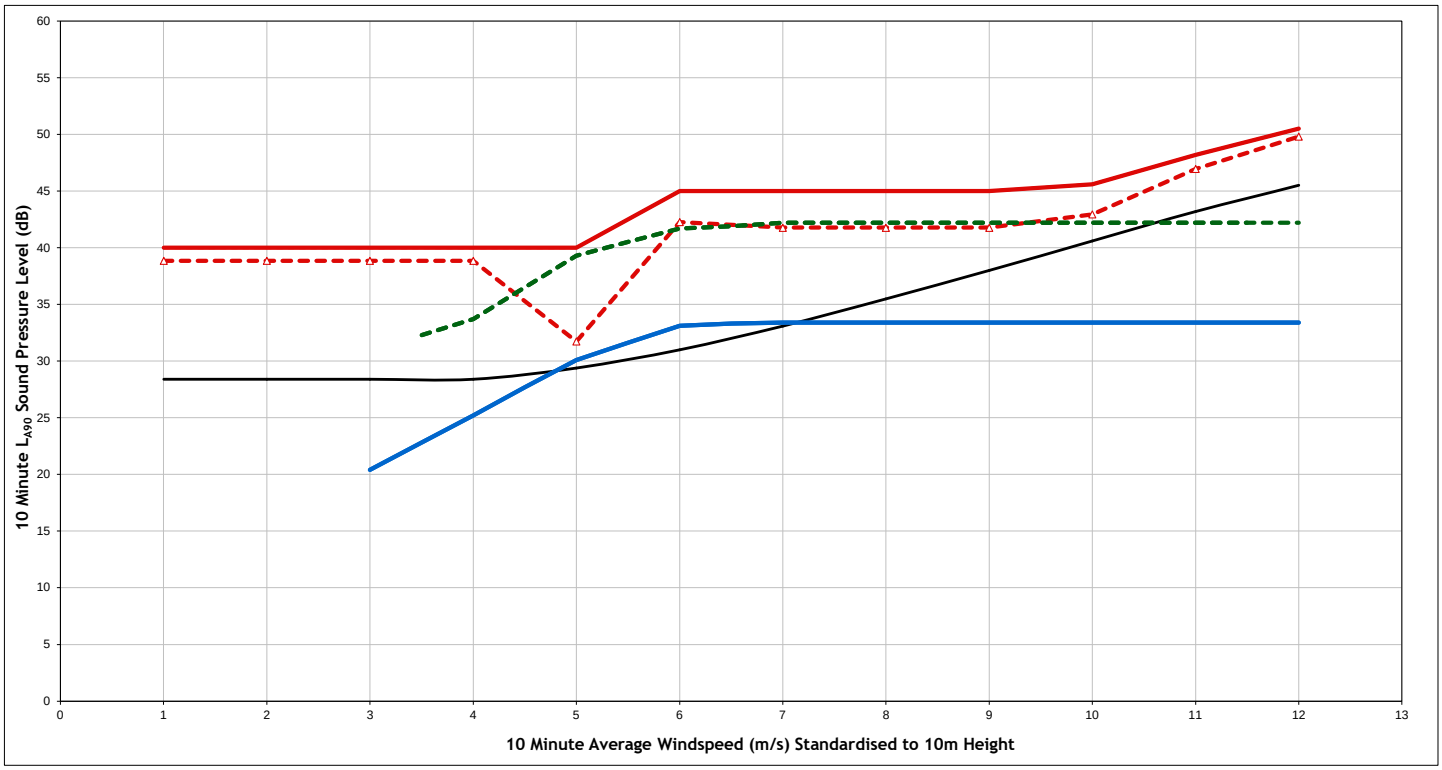


Legend:

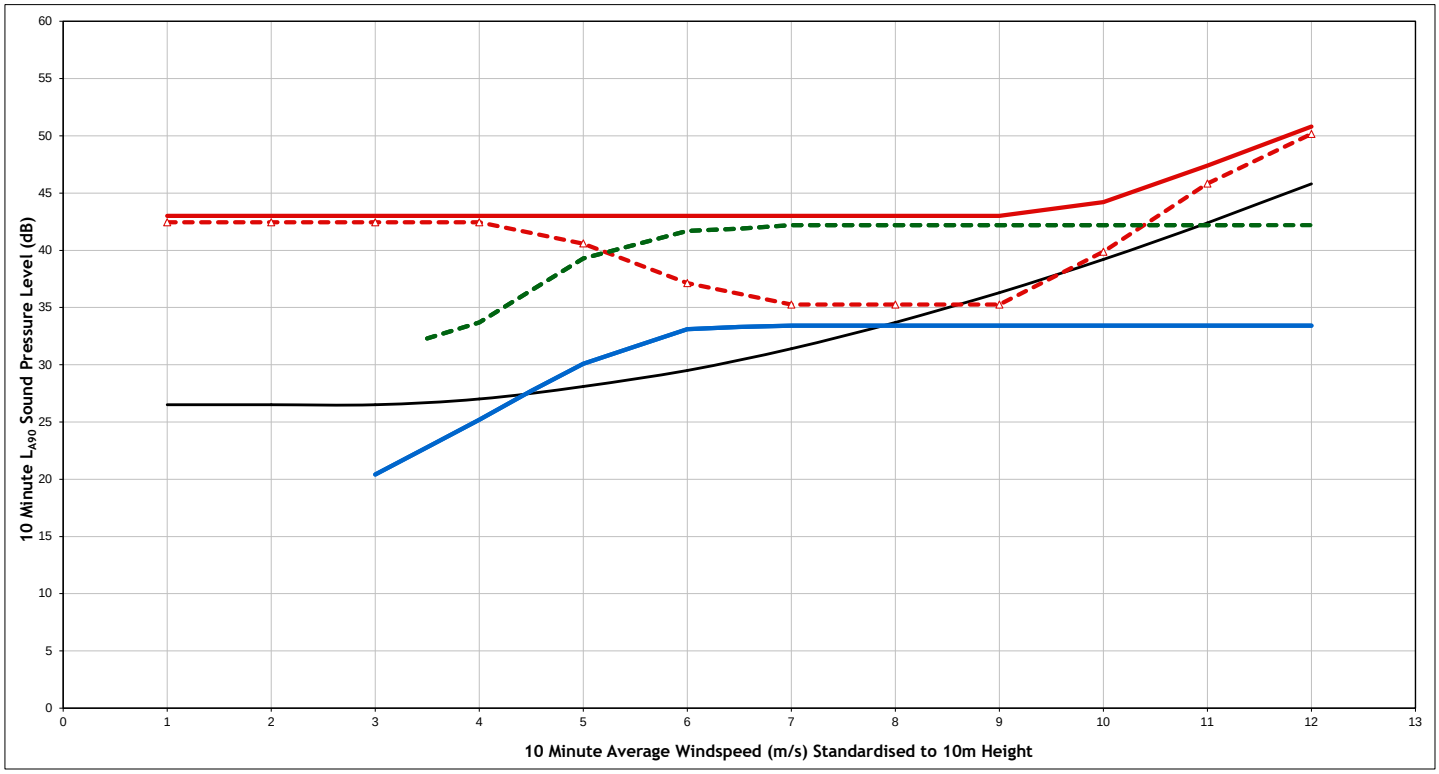
- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL3 (H01)
Figure Number	Figure A1.5c
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL4 (H03)



Night Time - NAL4 (H03)

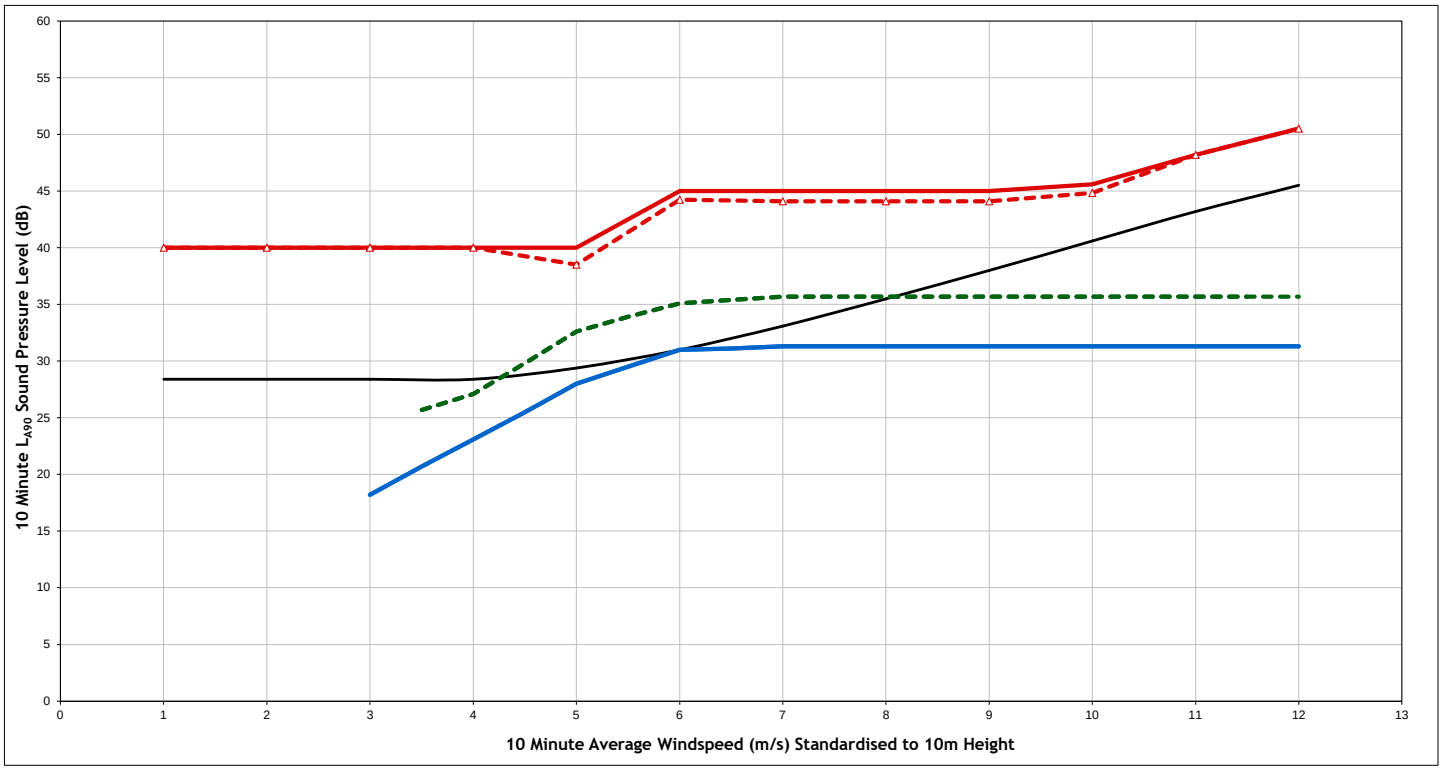


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL4 (H03)
Figure Number	Figure A1.5d
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL5 (H13)



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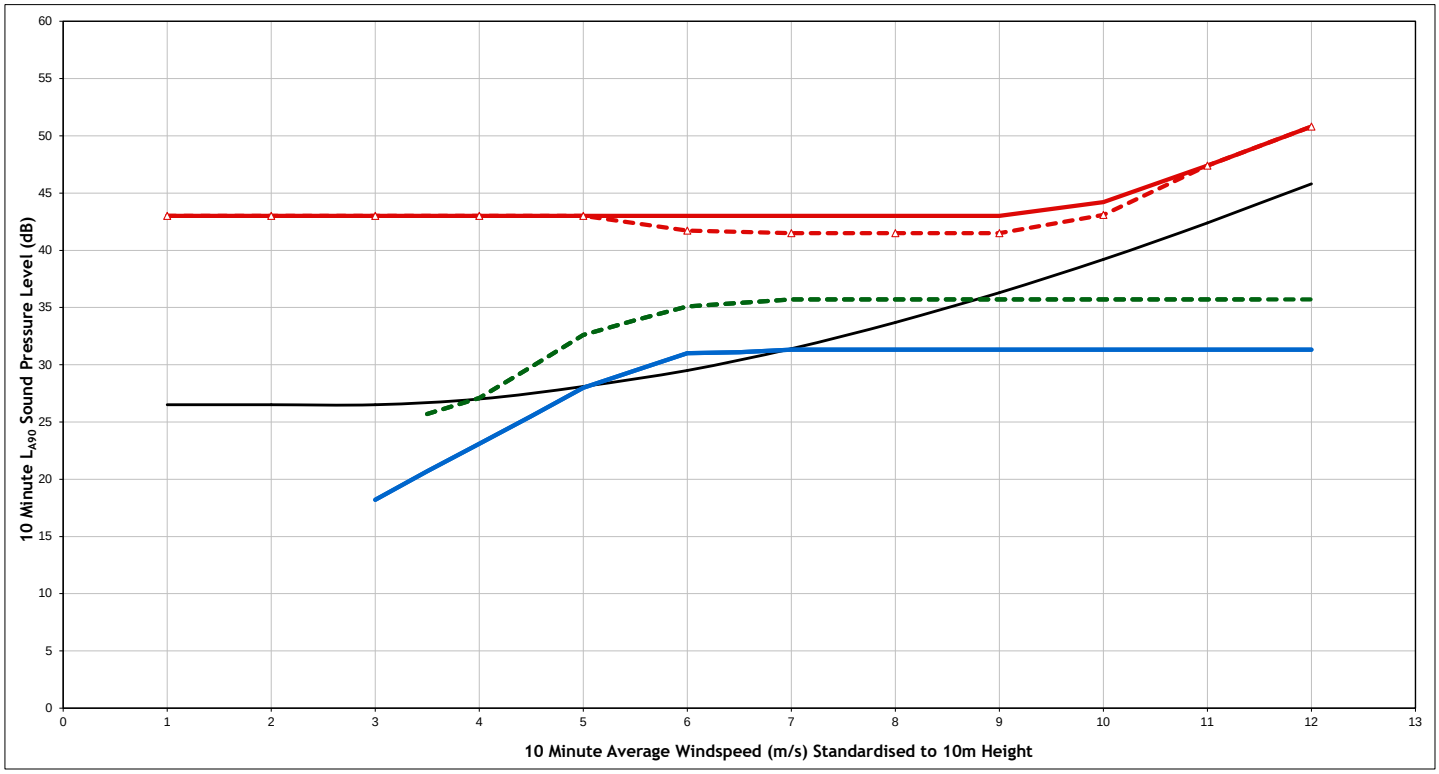
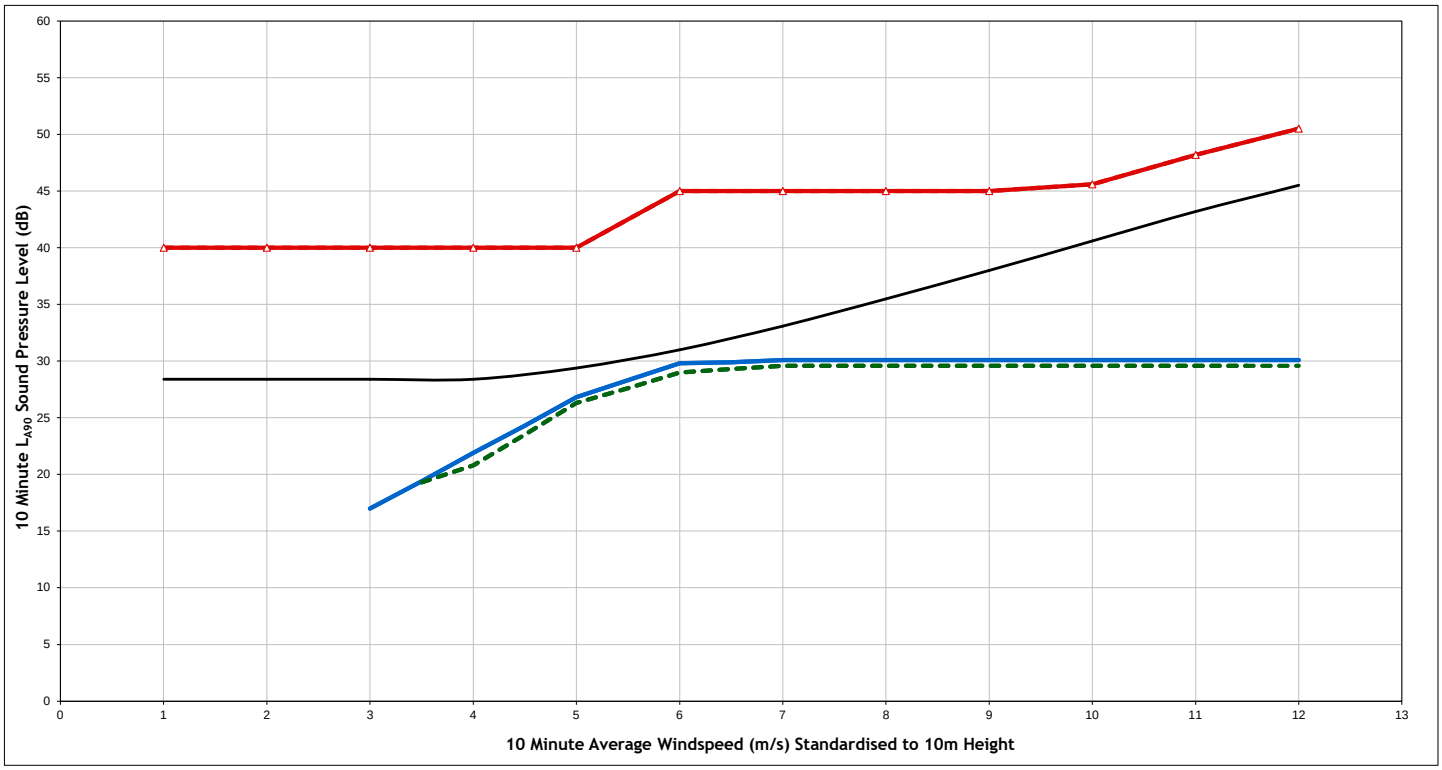


Legend:

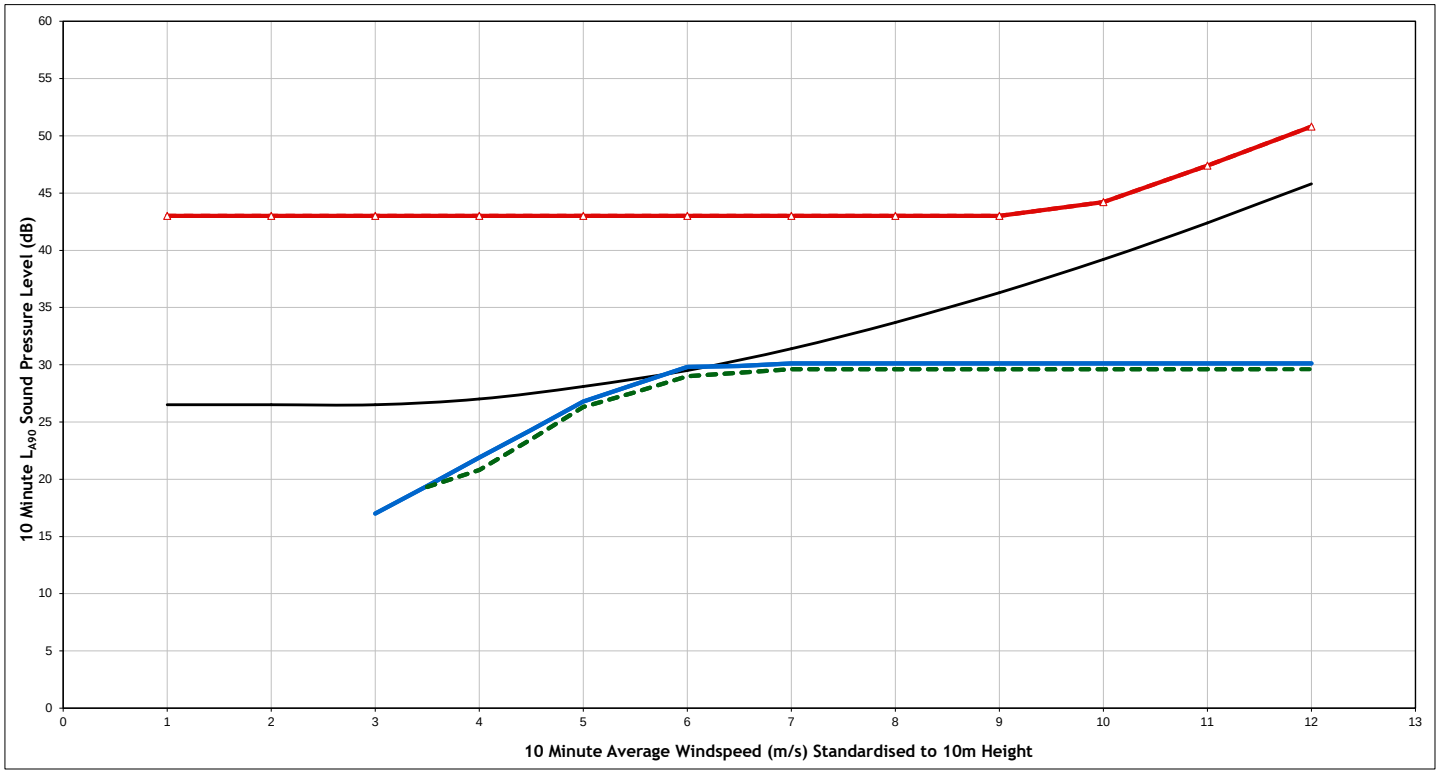
- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL5 (H13)
Figure Number	Figure A1.5e
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL6 (H16)



Night Time - NAL6 (H16)

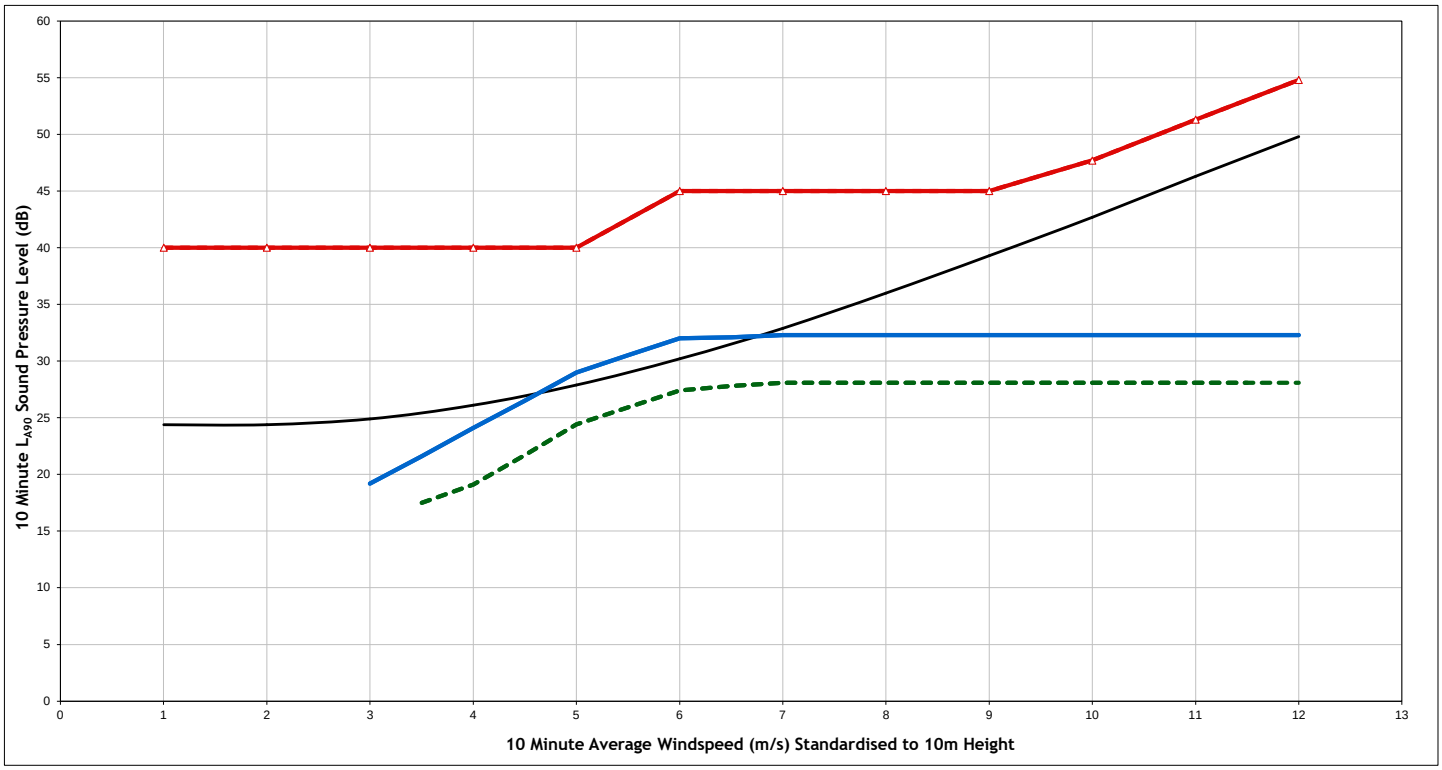


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL6 (H16)
Figure Number	Figure A1.5f
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Daytime - NAL7 (H22)



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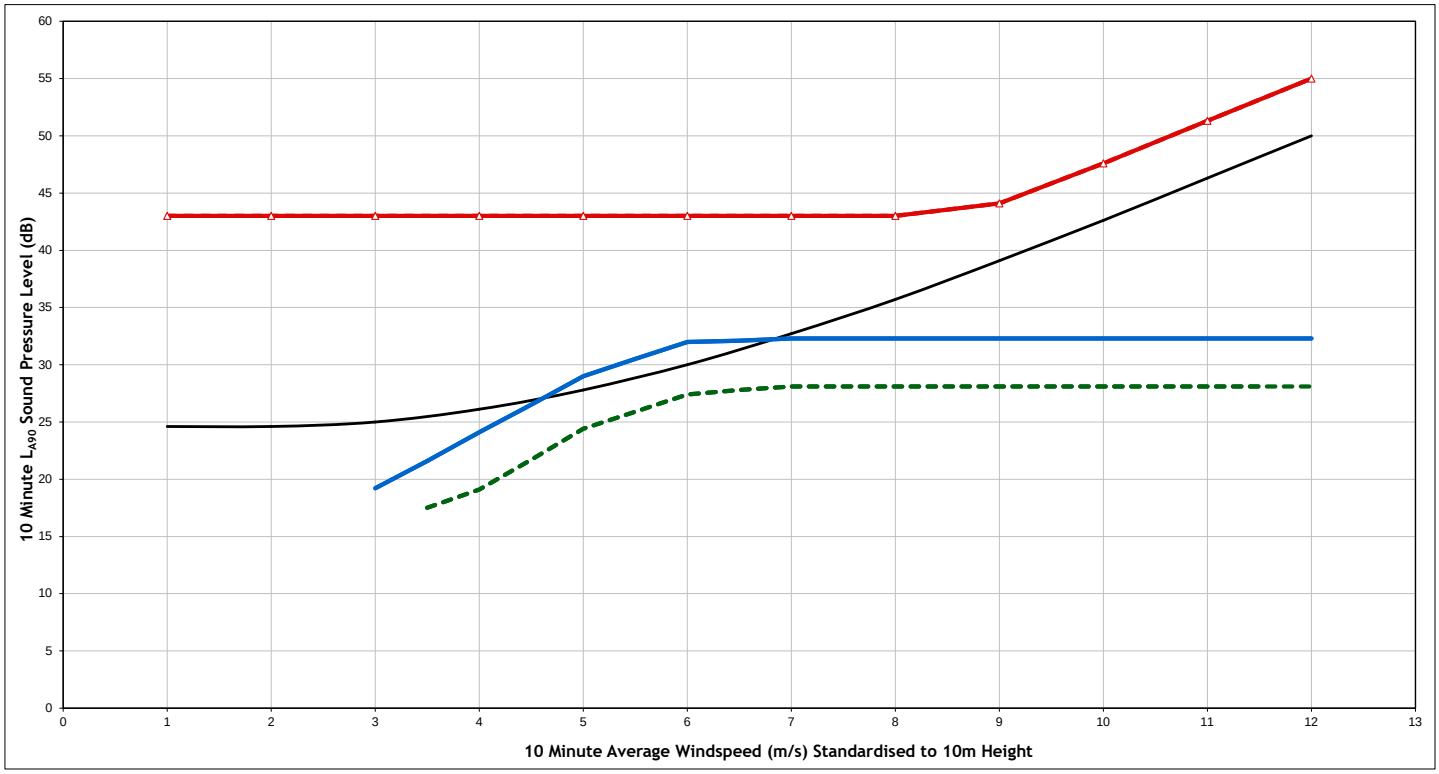


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Site Specific Noise Limit
- Sheskin South
- Cumulative (other wind farms excluding Sheskin South) - Cautious Predictions

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Noise Assessment - Cautious Predictions NAL7 (H22)
Figure Number	Figure A1.5g
Scale	NTS
Drawn	JB
Checked	GC
Date	19/12/2022
Document Reference	14192-004-Noise Models

Annex 2 – Extracts of Decision Notices

An Bord Pleanála

STRATEGIC INFRASTRUCTURE DEVELOPMENT

PLANNING AND DEVELOPMENT ACTS 2000 TO 2015

An Bord Pleanála Reference Number: 16.PA0029

(Planning Authority: Mayo County Council)

APPLICATION for permission under section 37E of the Planning and Development Act, 2000, as amended, in accordance with plans and particulars, including an environmental impact statement and a Natura impact statement, lodged with An Bord Pleanála on the 4th day of July, 2013 by Oweninny Power Limited of Stephen Court, 18/21 Saint Stephen's Green, Dublin.

PROPOSED DEVELOPMENT: Proposed wind farm development in the townlands of: Bellacorick, Corvoderry, Croaghaun West, Doobehy, Dooleeg More, Formoyle, Kilsallagh, Knockmoyle, Laghtanvack, Moneynierin, Shanvodinnaun, Shanvolahan, Sheskin, Srahnakilly and Tawnaghmore, County Mayo. (Bellacorick area is approximately 30 kilometres west of Ballina).

The proposed development will primarily consist of the following:

(i) Construction of a wind farm comprising 112 wind turbines with a maximum electricity generating capacity of approximately 370 megawatts. The wind turbines will have a hub height of up to 120 metres and a rotor diameter of up to 120 metres. The overall height of the structures (i.e. tip height) will be up to 176 metres.

(ii) Eight number permanent meteorological masts up to 120 metres in height.

(iii) Electrical requirements associated with the wind farm including: four number 110 kilovolts electrical substations each of which will include

(iii) The environmental management plan shall be subject to on-going independent audit (all costs of which shall be borne by the developer) in accordance with the requirements of the planning authority.

Reason: In the interest of protection of the environment and the amenities of the area.

6. Prior to the commencement of development an exclusion zone, suitably fenced to the satisfaction of the planning authority, enclosing at least an area extending 50 metres beyond the existing fenced boundary of the Bellacorick Iron Flush and including the elevated ground to the east of the Bellacorick Iron Flush referred to in the revised Natura impact statement as a source of shallow groundwater recharge to the Bellacorick Iron Flush, shall be created.

Reason: To protect the ecology of the area.

Noise

7. (i) The developer shall implement in full the proposals made in relation to mitigation measures for low noise environments as outlined in the environmental impact statement, as revised (section 7).

(ii) In all other areas noise levels emanating from the proposed development following commissioning, by itself or in combination with other existing or permitted wind energy development in the vicinity, when measured externally at third party noise-sensitive locations, shall not exceed the greater of 43dB(A)$L_{90,10\ min}$ or 5 dB(A) above background levels.

(iii) All noise measurements shall be made in accordance with I.S.O. Recommendations R1996/1, 2 and 3 “Acoustics – Description and Measurement of Environmental Noise”.

(iv) Prior to commencement of development the developer shall arrange for a noise compliance monitoring programme for the operational wind farm. Details on the nature and extent of the monitoring programme, including additional monitoring of baseline conditions or any mitigation measures such as the de-

rating of particular turbines, shall be submitted to, and agreed in writing with, the planning authority

Reason: In the interest of residential amenity.

Shadow Flicker

8. (i) Shadow flicker arising from the proposed development, by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed 30 hours per year or 30 minutes per day at existing or permitted dwellings or other sensitive receptors.

(ii) Turbine numbers 45, 51, 66, 67 and 68 shall be fitted with appropriate equipment and software to suitably control shadow flicker at nearby dwellings, in accordance with details which shall be submitted to, and agreed in writing with, the planning authority prior to the commencement of development.

(iii) Shadow flicker from the motion of overlapping blades shall not occur, at any time, at any existing house within ten rotor diameters of a turbine, as a result of the proposed development and appropriate equipment and software shall be fitted to the relevant turbines, to ensure compliance with this requirement.

(iv) A report shall be prepared by a suitably qualified person in accordance with the requirements of the planning authority, indicating compliance with the above shadow flicker requirements. Within 12 months of commissioning of the proposed wind farm, this report shall be submitted to, and agreed in writing with, the planning authority.

(v) Prior to the commencement of development the developer shall submit for the written agreement of the planning authority a shadow flicker compliance monitoring programme for the operational wind farm.

Reason: In the interest of residential amenity.

FIRST SCHEDULE

Having regard to:-

a) The Regional and National policy objectives in relation to renewable energy,

b) The provisions of the Mayo County Development Plan 2014 - 2020,

c) The Renewable Energy Strategy for County Mayo 2011-2020,

d) The nature and scale of the proposed development,

e) The previous grant of permission Ref. P15/825 and planning history in the wider area;

It is considered that, subject to compliance with the conditions set out below, the proposed development would not have a significant adverse impact on the landscape or upon its archaeological or cultural heritage of the area, would not give rise to any significant impacts on the natural heritage of the area or affect the integrity of any European site or any protected species, and would be acceptable in terms of traffic safety and convenience of road users. The proposed development would, therefore, be in accordance with the proper planning and sustainable development of the area.

SECOND SCHEDULE - SCHEDULE OF CONDITIONS – P19/457

1. The development shall be carried out in accordance with the site plans and particulars lodged with the application received by Mayo County Council on the 12/06/19 to include the Natura Impact Statement and Environmental Impact Assessment Report and the further information received on the 17/09/19 except as amended by Conditions hereunder.
   Reason: In the interests of proper planning and development.

2. This grant of permission for amendments to that previously granted under P15/825 shall expire on the expiry date of P15/825 which will be 06/12/26, unless before that date the windfarm has been erected.
   Reason: To avoid any confusion as to the expiry date of this grant of permission and to enable Mayo County Council to review the operation of the wind farm having regard to the circumstances then prevailing.

3. This permission shall be for a period of 25 years from the date of commissioning of the wind farm.
   Reason: To enable Mayo County Council to review the operation of the wind farm having regard to the circumstances then prevailing.

4. This permission shall not be construed as any form of consent or agreement to a connection to the national grid or to the routing or nature of any such connection.
   Reason: In the interest of clarity.

44. **(a)** The construction of the development shall be carried out only outside the breeding season of locally sensitive bird species, unless by the prior submission of written approval from the National Parks and Wildlife Service.

(b) No works or site preparation shall be carried out during the bird-nesting season in the first year of construction, unless by the prior submission of written approval from the National Parks and Wildlife Service.

(c) No re-commencement of construction works shall be permitted during the bird-nesting season in subsequent years after any significant periods of inactivity, unless by the prior submission of written approval from the National Parks and Wildlife Service.

(d) An annual monitoring program of birds in accordance with the methodology used to gather baseline data in the EIS to review interaction by birds with the wind farm, to survey species and to document bird casualties shall be submitted to Mayo County Council for written agreement prior to commencement of development. This program shall be developed in consultation with Mayo County Council and the Heritage Division of the Department of the Environment, Heritage and Local Government and shall cover the entire period of the operation of the wind farm and the program shall be forwarded to Mayo County Council.
Reason: To provide for the mitigation of effects of the development on avian species.

45. Prior to commencement of development, a detailed conservation plan for the rehabilitation of the site following completion of construction shall be submitted to Mayo County Council for written agreement. The conservation plan shall be prepared by a suitably qualified Ecologist. The conservation plan shall include for habitat management and enhancement measures on the site, the reinstatement of hedgerows and embankments removed to facilitate construction and an agreed monitoring period. The implementation of the conservation plan shall be monitored by a suitably qualified Ecologist, and a copy of this plan and monitoring reports shall be submitted to Mayo County Council and the National Parks & Wildlife Service.
Reason: To provide for the mitigation of effects of the development on the ecology of the area.

46. Noise and vibration levels shall be at the levels stipulated in Section 13 of the EIAR submitted to Mayo County Council on the 12/06/19.
Reason: In the interest of residential amenity.

Archaeological Conditions

47. The developer is required to employ a suitably qualified Archaeologist to monitor all ground disturbance in those areas which were not available for Pre-development testing. The monitoring should be undertaken in agreement with the National Monument Section of the Department of Arts, Heritage and the Gaeltacht. Should archaeological material be uncovered during the course of monitoring, the

Annex 3 – Field Data Sheets / Installation Report

Sheskin South Wind Farm Noise Survey - Installed Noise Monitoring Locations

Reproduced under Google Earth pro licence

Present during the course of the installation:

- Jason Baldwin, 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.

Noise Monitoring Location Latitude Longitudes

NML	Lat Long
NML01	54° 10'0.57"N, 9° 39'50.39"W
NML02	54° 12'28.69"N, 9° 37'15.44"W
NML03	54° 8'20.94"N, 9° 37'33.52"W

NML01

North

South

East

West

Description
The noise monitoring equipment was installed to the west of the property. The location was chosen due to its proximity to the west to the proposed development, and its further distance from the river compared to other properties in the area (the river is located to the north - running west to east). The kit was positioned within the amenity area, on the more sheltered side of the house with relation to the trees. The location was seen to be representative of the other properties in the area to the north east and west. The predominant sounds that were audible during the installation were from birdsong, and wind generated noise in the surrounding vegetation and trees. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

NML02

North

South-West

East

West

Description
The noise kit monitoring equipment was installed within the residents amenity area, to the west of the property. A boiler flue was noted to be at the rear of the property. The location was chosen due to its proximity to the north of the proposed development, and was also seen to be representative of properties further north of the location. The predominant sounds that were audible during the installation were from birdsong, and wind generated noise in the surrounding vegetation and trees. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. A rain gauge was installed at this location.

NML03

North West

South

East

West

Description
The noise monitoring equipment was installed within the residents amenity area, to the south of the property. A boiler flue was noted to be at the rear of the property. The location was chosen due to its proximity to the south of the proposed development, and was also seen to be representative of the other properties in the area to the east and west. The predominant sounds that were audible during the installation were from birdsong, and wind generated noise in the surrounding vegetation and trees. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. A rain gauge was installed at this location.

Noise Monitoring Field Data Sheet

Project Title	Sheskin South Wind Farm	**Project Number**	14192
Client	SSE Renewables	**Surveyor**	JB/ OC

MONITORING LOCATION

Location Name	NML01
Description	The noise monitoring equipment was installed to the west of the property.
Approximate National Grid Reference	91378, 325471
Noise sources noted during installation, weekly inspection and removal	Birdsong, distant traffic noise and wind induced noise from trees

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM006	NL-32	00482652	17/08/2020
Pre Amplifier	SLM006	NH-21	27756	17/08/2020
Microphone	SLM006	UC-53A	314027	17/08/2020
Calibrator	CAL003	Rion NC-74	35173441	06/03/2020/ 09/03/2021

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	02/12/20 13:20	20/01/21 10.13	94.0	94.0	0.0	02/12: Installation – birdsong, distant road traffic noise and wind induced noise through foliage. 20/01: Maintenance – distant traffic noise, boiler flue, birdsong and wind induced noise from trees.
0102	20/01/21 10:30	17/02/21 11:11	94.0	94.0	0.0	17/02: Maintenance – distant traffic noise, boiler flue, birdsong and wind induced noise from trees. wind induced noise dominant.
0103	17/02/21 11:20	19/03/21 09:00	94.0	94.1	+0.1	19/03: Decommissioning – birdsong, wind induced noise.

PHOTOGRAPHS

NML01 – N

NML01 – S

NML01 – E

NML01 – W

Noise Monitoring Field Data Sheet

Project Title	Sheskin South Wind Farm	**Project Number**	14192
Client	SSE Renewables	**Surveyor**	JB/ OC

MONITORING LOCATION

Location Name	NML02
Description	The noise monitoring equipment was installed to the west of the property.
Approximate National Grid Reference	94299, 329989
Noise sources noted during installation, weekly inspection and removal	Birdsong, noise from watercourse and wind induced noise.

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM012	NL-31	01273087	15/04/2019
Pre Amplifier	SLM012	NH-21	26006	15/04/2019
Microphone	SLM012	UC-53A	313365	15/04/2019
Calibrator	CAL003	Rion NC-74	35173441	06/03/2020/ 09/03/2021

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	02/12/20 15:20	20/01/21 11.11	94.0	94.0	0.0	02/12: Installation – birdsong. 20/01: Maintenance – birdsong and local watercourse to west.
0202	20/01/21 11:20	17/02/21 12:00	94.0	94.0	0.0	17/02: Maintenance – wind induced noise dominant.
0203	17/02/21 12:10	19/03/21 9:40	94.0	93.9	-0.1	19/03: Decommissioning – birdsong, wind induced noise.

PHOTOGRAPHS

NML02 – E

NML02 – W

NML02 – SW

NML02 – NW

Noise Monitoring Field Data Sheet

Project Title	Sheskin South Wind Farm	**Project Number**	14192
Client	SSE Renewables	**Surveyor**	JB/ OC

MONITORING LOCATION

Location Name	NML03
Description	The noise monitoring equipment was installed to the south of the property.
Approximate National Grid Reference	93792, 322330
Noise sources noted during installation, weekly inspection and removal	Birdsong and wind induced noise from surrounding vegetation.

NOISE MONITORING EQUIPMENT DETAILS

	Kit Number	**Model**	**Serial Number**	**Last Calibrated/ Conformance Checked**
Sound Level Meter	SLM009	NL-32	00972337	12/07/2019
Pre Amplifier	SLM009	NH-21	25122	12/07/2019
Microphone	SLM009	UC-55A	313228	12/07/2019
Calibrator	CAL003	Rion NC-74	35173441	06/03/2020/ 09/03/2021
	Kit Number	**Model**	**Serial Number**	**Last Calibrated/ Conformance Checked**
Sound Level Meter	SLM011	NL-31	01273082	12/04/2019
Pre Amplifier	SLM011	NH-21	26001	12/04/2019
Microphone	SLM011	UC-53A	313385	12/04/2019

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	02/12/20 14:10	16/01/21 17.00	94.0	94.1	+0.1	02/12: Installation – birdsong and wind induced noise through foliage. 20/01: Maintenance – birdsong, distant traffic noise, birdsong and wind induced noise from trees. The meter stopped recording on 16/01 due to lack of battery power.
0302	20/01/21 09:30	17/02/21 09:11	94.0	94.0	0.0	17/02: Maintenance - wind induced noise dominant. Technical issue with SLM (would not re-start) and therefore replaced with SLM011.
0303	17/02/21 15:30	19/03/21 08:20	94.0	94.0	0.0	19/03: Decommissioning – wind induced noise, birdsong.

PHOTOGRAPHS

NML03 – NE

NML03 – S

NML03 – SW

1

NML03 – W

Annex 4 – Calibration/ Conformance Certificates for Sound Level Meters and Calibrator

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 09 March 2020 **Certificate Number: UCRT20/1290**

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

B. Bogdan

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA			
Order No.	5001			
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators			
Description	Acoustic Calibrator			
Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-74	35173441

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) 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 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS20/03178	
Date Received	06 March 2020	
Date Calibrated	09 March 2020	
Previous Certificate	*Dated*	07 March 2019
	Certificate No.	UCRT19/1292
	Laboratory	0653

Measurements

The sound pressure level generated by the calibrator in its WS2 configuration was measured five times by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below. It is corrected to the standard atmospheric pressure of 101.3 kPa (1013 mBar) using original manufacturers information.

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

Results

The level of the calibrator output under the conditions outlined above was

94.04 ± 0.10 dB rel 20 µPa

Functional Tests and Observations

The frequency of the sound produced was	1001.65 Hz	±	0.13 Hz
The total distortion was	1.25 %	±	6.7 % of Reading

During the measurements environmental conditions were

Temperature	23	to	24	°C
Relative Humidity	36	to	43	%
Barometric Pressure	100.2	to	100.3	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.

…… END ……

Note:

Calibrator adjusted prior to calibration?	NO	
Initial Level	N/A	dB
Initial Frequency	N/A	Hz

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

None

Calibrated by: BB / CH

NSAI
National Metrology Laboratory

Certificate of Calibration

Issued to

TNEI Group
Floor 7
West One
Forth Banks
Newcastle Upon Tyne
England
NE1 3PA

Attention of Ewan Watson

Certificate Number	**210913**
Item Calibrated	RION NC-74 Sound Level Calibrator
Serial Number	35173441
ID Number	None
Order Number	1679
Date Received	09 Mar 2021
NML Procedure Number	AP-NM-13
Method	The above calibrator was allowed to stabilize for a suitable period in laboratory conditions. It was then calibrated by measuring the sound pressure level generated in its measuring cavity. The calibrator's operating frequency was also measured.
Calibration Standards	Norsonic 1504A Calibration System incorporating: Agilent 34401A Digital Multimeter, File No. 0736 [Cal Due: 24 Apr 2021] B & K 4134 Measuring Microphone, File No. 0743 [Cal Due: 27 May 2022] B & K 4228 Pistonphone, File No. 0741 [Cal Due: 26 May 2022]

Calibrated by	David Fleming	**Approved by**	Paul Hetherington
Date of Calibration	10 Mar 2021	**Date of Issue**	10 Mar 2021

CIPM MRA

This certificate is consistent with Calibration and Measurement Capabilities (CMC's) that are included in Appendix C of the Mutual Recognition Arrangement (MRA) drawn up by the International Committee for Weights and Measures. Under the MRA, all participating institutes recognize the validity of each other's calibration certificates and measurement reports for quantities, ranges and measurement uncertainties specified in Appendix C (for details see www.bipm.org)

Standard Terms & Conditions for Calibration, Testing and Consultancy Assignments

1. Reports issued by the National Metrology Laboratory Division of NSAI are copyright to NSAI and shall not be used, either in whole or in part, for the purposes of advertising, publicity or litigation without the written consent of the Chief Executive or his nominee.
2. No action or legal proceeding shall be taken (except in the case of wilful neglect or default) against NSAI or the Board or any member of the Board or any committee appointed by the Board or any officer or servant of NSAI, by reason of or arising out of the carrying out of any research, investigation, test or analysis or the publication of the results thereof in the name of NSAI.
3. NSAI will not release any information received from or provided to the client in relation to this report except as may be required by law, including the Freedom of Information Act 1997, or as specified by the client.
4. This certificate relates only to the item(s) described on the front page and shall not be reproduced, except in full.
5. This contract is governed by the laws of Ireland whose courts shall have exclusive jurisdiction.

Decision Rule and Compliance Statement

The rule that describes how measurement uncertainty is accounted for when stating conformity with a specified requirement is known as a decision rule. The rule used by NSAI NML follows the guidelines set out in the document ILAC-G8:09/2019 published by the International Laboratory Accreditation Co-operation. Further information on the decision rule is available on the NSAI website:
(https://www.nsai.ie/images/uploads/metrology/Decision_Rule.pdf).

The symbols used to indicate the state of compliance of the instrument calibration and their meanings are given in the following table.

Statement of compliance and associated symbol	Description
PASS	The absence of a symbol indicates that the measurement result is inside the specification limit by a margin greater than its associated expanded uncertainty; the instrument meets its accuracy specification.
Conditional PASS Symbol: £	The measurement result is inside the specification limit by a margin less than or equal to its associated expanded measurement uncertainty; it is therefore not possible to state compliance. There is a risk that the instrument fails to meet its specification.
Conditional FAIL Symbol: &	The measurement result is on the specification limit or is outside the specification limit by a margin less than or equal to its associated expanded measurement uncertainty; it is therefore not possible to state non-compliance.
FAIL Symbol: $	The measurement result is outside the specification limit by a margin greater than its associated measurement uncertainty; the instrument fails to meet its accuracy specification.
Unc. > Spec Symbol: #	The expanded measurement uncertainty is greater than the instrument's accuracy specification. It is not possible to determine compliance or otherwise with the specification. The user should expand the in-use accuracy specification to make allowance for the calibration uncertainty.
Outside CIPM MRA Symbol: ¢	Indicates that the calibration result is traceable to SI units but is not currently included in the table of NSAI NML's calibration and measurement capabilities approved under the CIPM MRA.

Where no specification exists, and none is prescribed by the client, the Decision Rule policy of the NSAI NML does not apply and results are provided without a statement of compliance.

Measuring Conditions:

Ambient Pressure:	(99.3 ± 0.5) kPa
Ambient Temperature:	(20.5 ± 1.0) °C
Ambient Rel. Humidity:	(38 ± 5) %RH

Results:

The measured sound pressure levels (SPL) reported below refer to the ambient laboratory conditions at the time of calibration.

Calibrator Setting	Measured Parameter	Measured Value (1)		Tolerance (3) (±)	Meas. Uncertainty (±)
		Before Adj.	After Adj.		
94 dB	Sound Pressure Level(2)	94.00 dB	*	0.40 dB	0.15 dB
	Frequency	1001.8 Hz	*	10 Hz	0.25 Hz

Notes: (1) * indicates that no calibration adjustment was made.
(2) The measured sound pressure level was that generated in the calibrator's cavity when loaded by the microphone specified on page 1 of this certificate (including protection grid).
(3) Tolerance limits set out in IEC 60942:2003, Sound Calibrators, Class 1.

Comments:

Where used in the results table, further information on the meaning of symbols is given in the table on page 2 of this certificate.

The instrument was found to comply with the requirements of IEC 60942 (2003), Class 1, for the sound pressure level and frequency outputs measured at the time of calibration.

Note that for acoustic calibrators which meet IEC 60942 (2003), the instrument is considered out of tolerance if the measured deviation from the set level, extended by it associated uncertainty, exceeds the specified tolerance limits.

Note that the measured values refer to the ambient conditions given above.

When using the calibrator with a sound level meter any manufacturer's guidelines regarding free-field corrections should be observed.

The reported measurement results are traceable, via national standards maintained by NSAI National Metrology Laboratory (NML) or by other national metrology institutes, to internationally accepted realisations of the SI units.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ which, for a normal probability distribution, corresponds to a coverage probability of approximately 95%. It has been determined in accordance with the "Guide to the Expression of Uncertainty in Measurement (GUM)". These uncertainties apply only to the measured values and do not carry any implication regarding the long-term stability of the instrument.

CERTIFICATE OF CALIBRATION

Date of Issue: 17 August 2020

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

Certificate Number: TCRT20/1460

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One, Forth Banks Newcastle Upon Tyne NE1 3PA
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	00482652
Rion	Firmware		1.009AN1002
Rion	Pre Amplifier	NH-21	27756
Rion	Microphone	UC-53A	314027
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 13 August 2020 ANV Job No. TRAC20/08266

Date Calibrated 17 August 2020

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*
	12 July 2019	TCRT19/1563	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT20/1460

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	15 July 2020		
Calibrator cert. number	UCRT20/1634		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.00	dB	Calibration reference sound pressure level
Calibrator frequency	1001.92	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	23.45	23.93	± 0.30 °C
Humidity	64.0	55.0	± 3.00 %RH
Ambient Pressure	99.74	99.72	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	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		
	11.8	dB	UR	19.7	dB	UR	24.8	dB	UR
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: C. Hirlav

R 2

..... END .....

Additional Comments
None

SLM 11

CERTIFICATE OF CALIBRATION

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

Date of Issue: 12 April 2019

Issued by:

Certificate Number: TCRT19/1291

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA			
Order No.	5001			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-31	01273082
	Rion	Firmware		1.400
	Rion	Pre Amplifier	NH-21	26001
	Rion	Microphone	UC-53A	313385
	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	11 April 2019	ANV Job No.	TRAC19/04158	
Date Calibrated	12 April 2019			

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*
	01 December 2017	TCRT17/1794	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT19/1291

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

SLM instruction manual title	NL-21 NL-31 Instruction Manual		
SLM instruction manual ref / issue	32006 09-04		
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	29 March 2019		
Calibrator cert. number	UCRT19/1384		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	93.98	dB	Calibration reference sound pressure level
Calibrator frequency	1001.93	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	22.92	22.66	± 0.30 °C
Humidity	33.0	31.4	± 3.00 %RH
Ambient Pressure	101.71	101.70	± 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		
	9.8	dB	UR	15.6	dB	UR	22.6	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: B. Bogdan

R 2

..... END .....

Additional Comments
None

SLM12

CERTIFICATE OF CALIBRATION

Date of Issue: 15 April 2019

Certificate Number: TCRT19/1306

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

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-31	01273087
Rion	Firmware		1.050
Rion	Pre Amplifier	NH-21	26006
Rion	Microphone	UC-53A	313365
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 11 April 2019 ANV Job No. TRAC19/04158

Date Calibrated 15 April 2019

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*
	02 January 2018	TCRT18/1005	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT19/1306

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

SLM instruction manual title	NL-21 NL-31 Instruction Manual		
SLM instruction manual ref / issue	32006 09-04		
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	29 March 2019		
Calibrator cert. number	UCRT19/1384		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	93.98	dB	Calibration reference sound pressure level
Calibrator frequency	1001.93	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	22.98	22.99	± 0.40 °C
Humidity	33.4	33.6	± 3.00 %RH
Ambient Pressure	101.03	100.86	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	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		
	10.5	dB	UR	16.9	dB	UR	22.7	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: A Patel

R 1

..... END .....

Additional Comments
None

SLM9

CERTIFICATE OF CALIBRATION

Date of Issue: 12 July 2019

Certificate Number: TCRT19/1561

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

Customer	TNEI Services Ltd 7th Floor West One, Forth Banks Newcastle Upon Tyne NE1 3PA
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	00972337
Rion	Firmware		1.0009
Rion	Pre Amplifier	NH-21	25122
Rion	Microphone	UC-53A	313228
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 11 July 2019 ANV Job No. TRAC19/07303

Date Calibrated 12 July 2019

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*
	16 February 2018	TCRT18/1165	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT19/1561

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	27 June 2019		
Calibrator cert. number	UCRT19/1727		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.94	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	22.66	22.57	± 0.30 °C
Humidity	51.8	52.3	± 3.00 %RH
Ambient Pressure	100.47	100.49	± 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		
	12.0	dB	UR	17.9	dB	UR	23.3	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: B. Giles

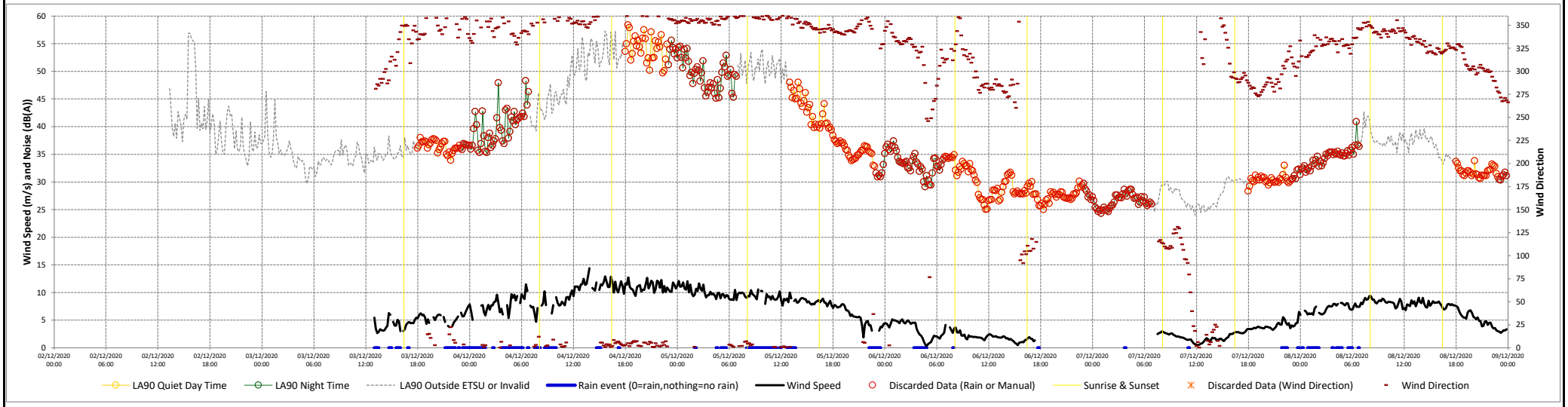
R 2

..... END .....

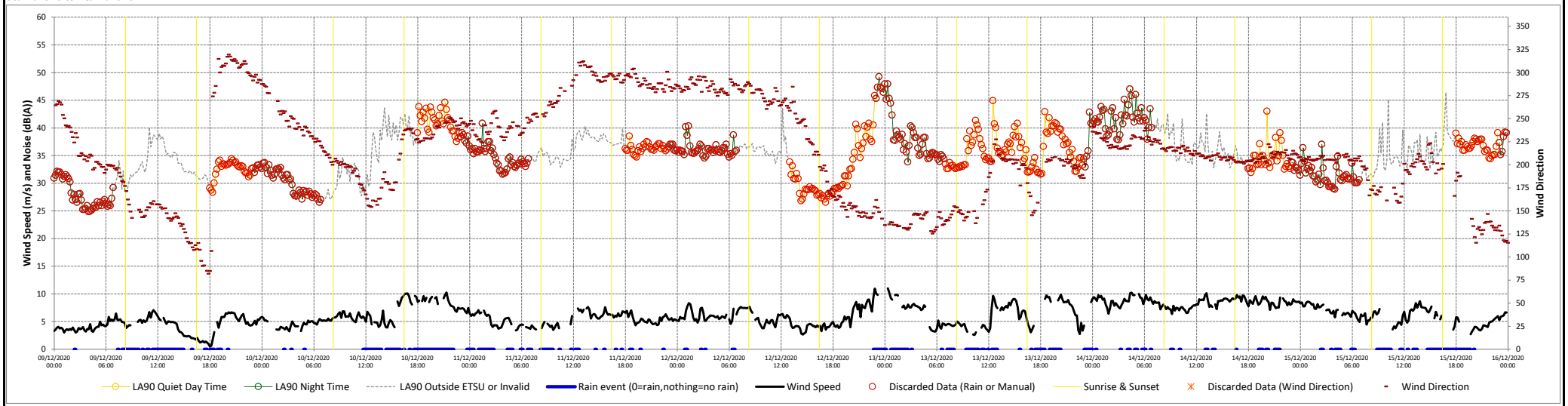
Additional Comments
None

Annex 5 – Time Series Graphs / Regression Analysis Graphs showing Exclusions

02/12/2020 to 09/12/2020

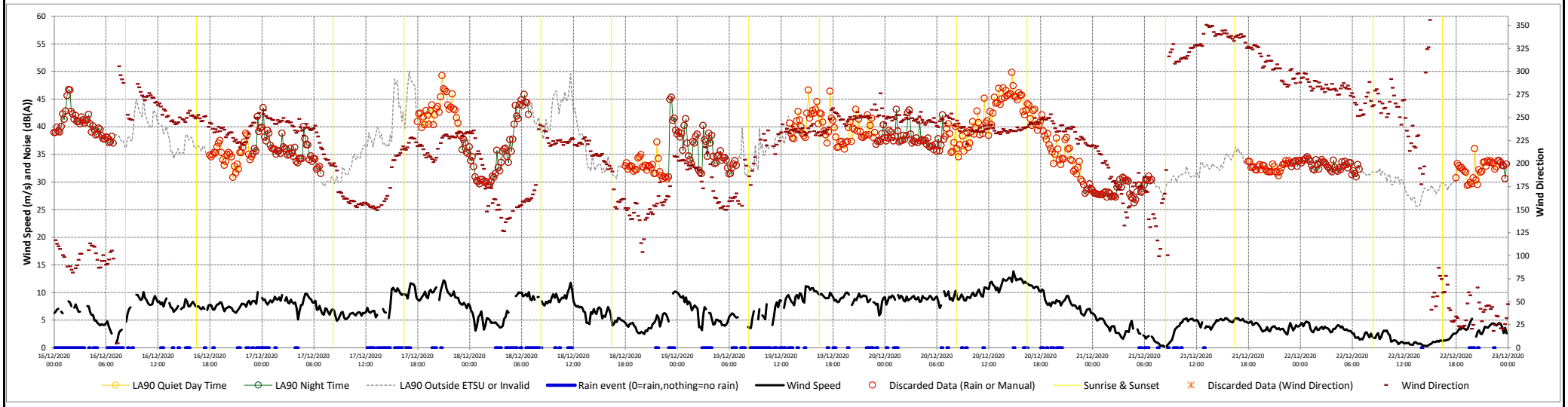


09/12/2020 to 16/12/2020

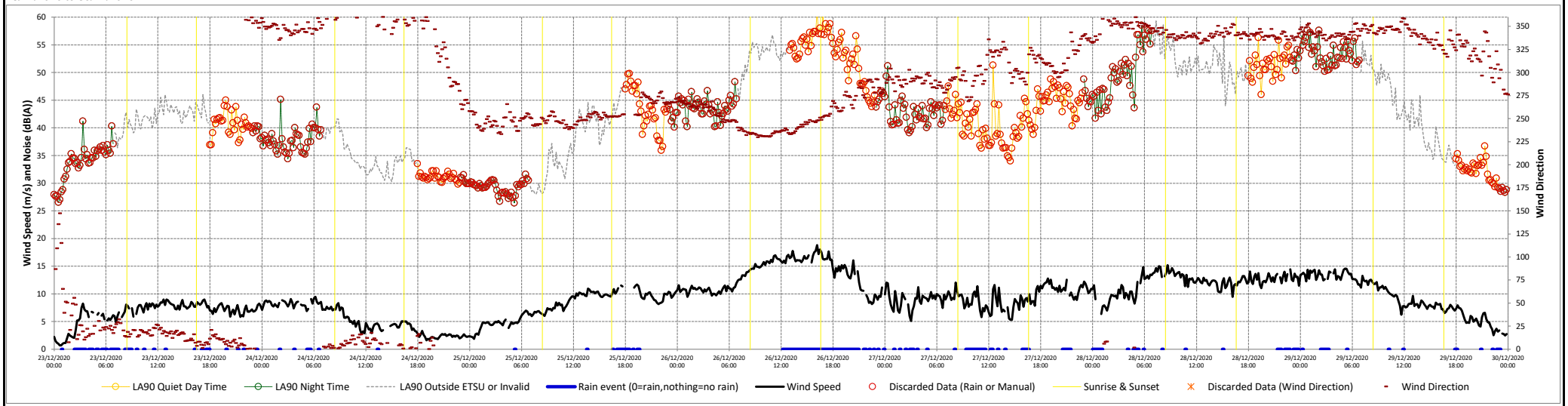


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 1 of 8)
Date	12/10/2022

16/12/2020 to 23/12/2020

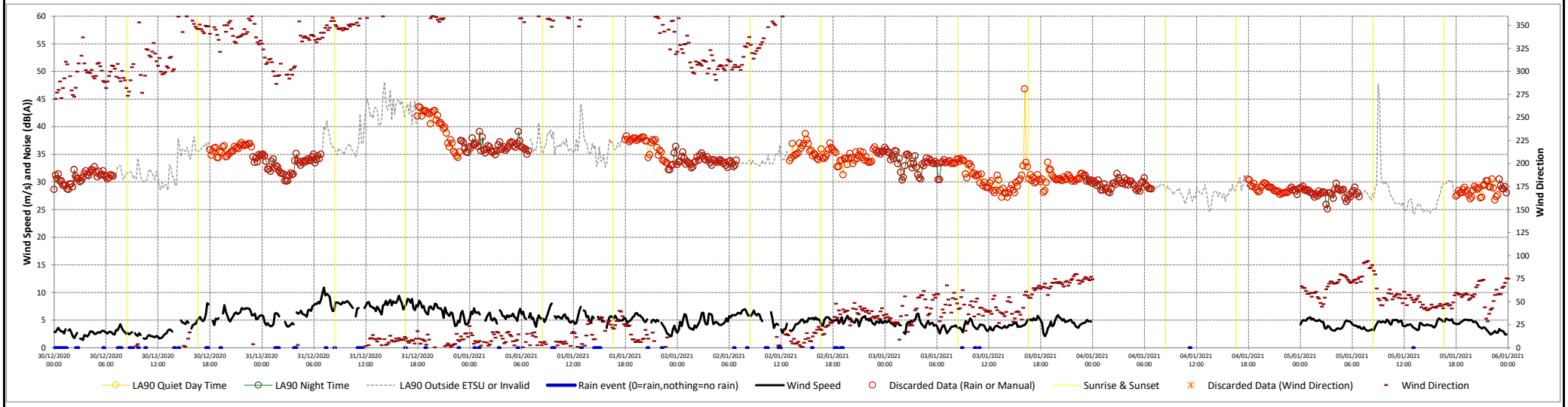


23/12/2020 to 30/12/2020

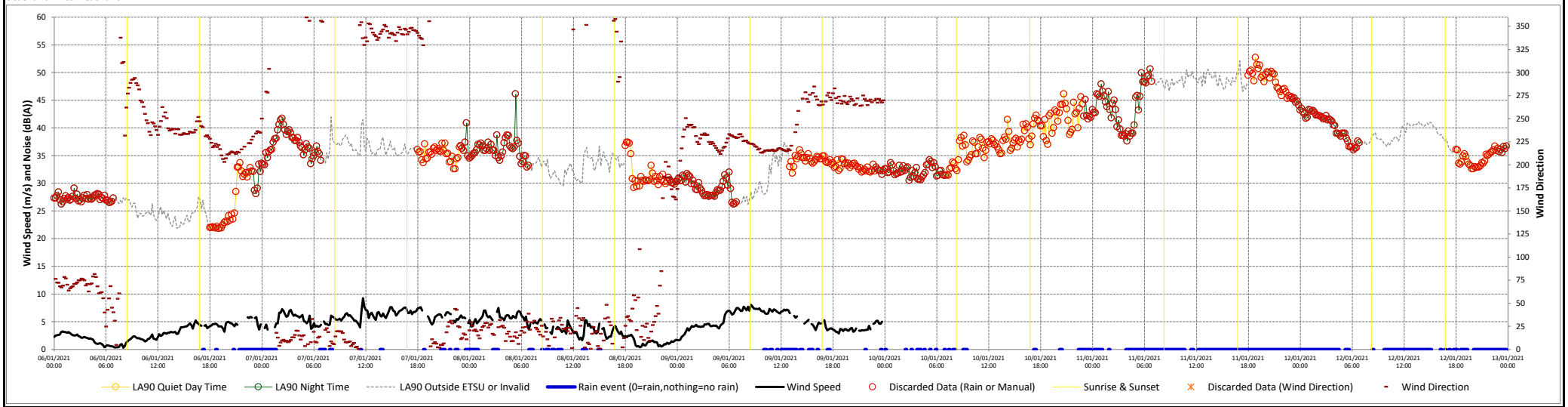


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 2 of 8)
Date	12/10/2022

30/12/2020 to 06/01/2021

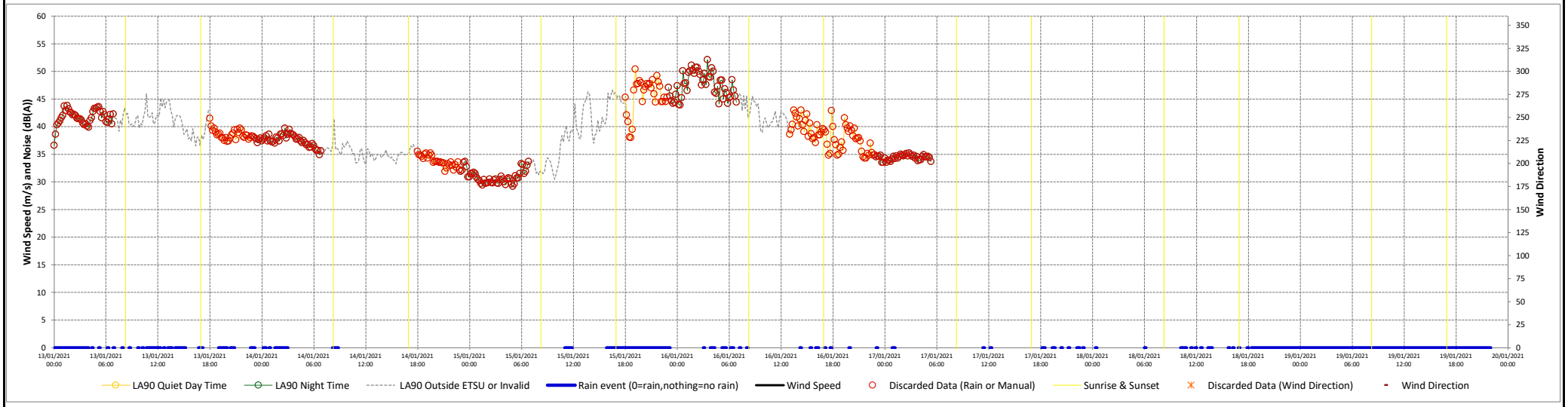


06/01/2021 to 13/01/2021

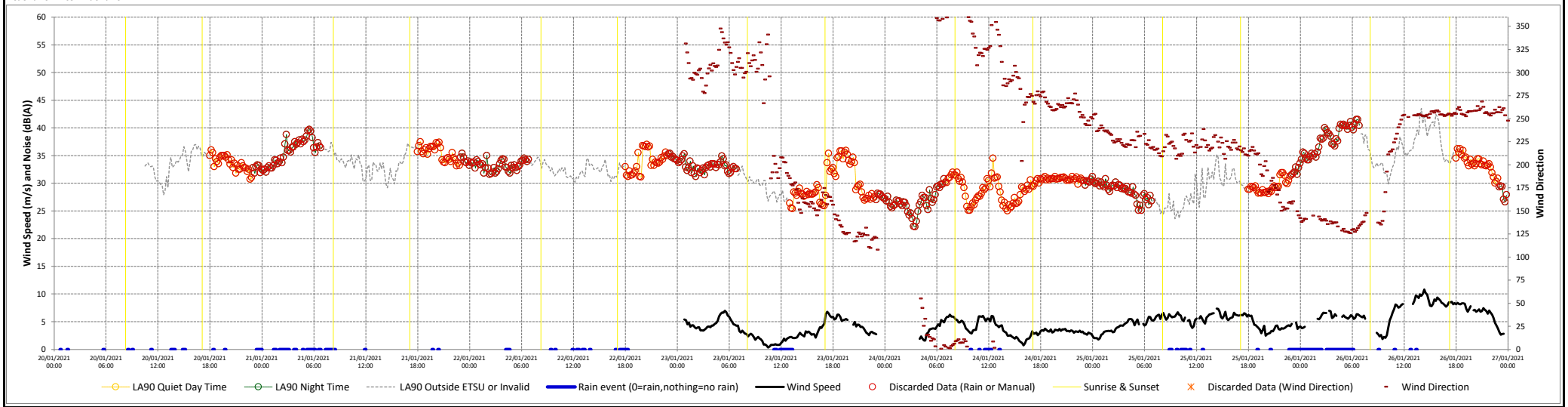


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 3 of 8)
Date	12/10/2022

13/01/2021 to 20/01/2021

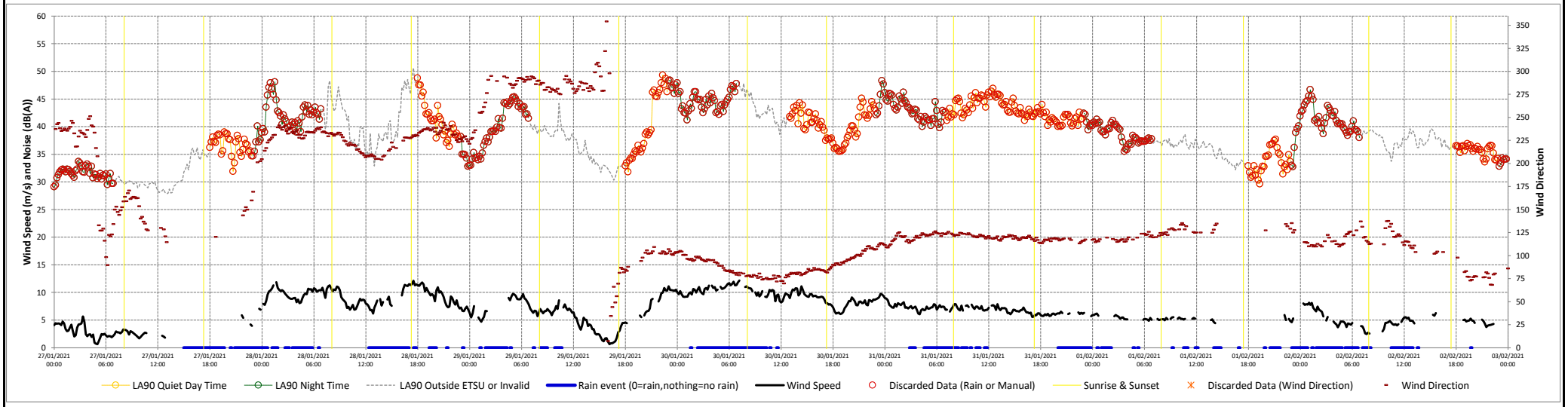


20/01/2021 to 27/01/2021

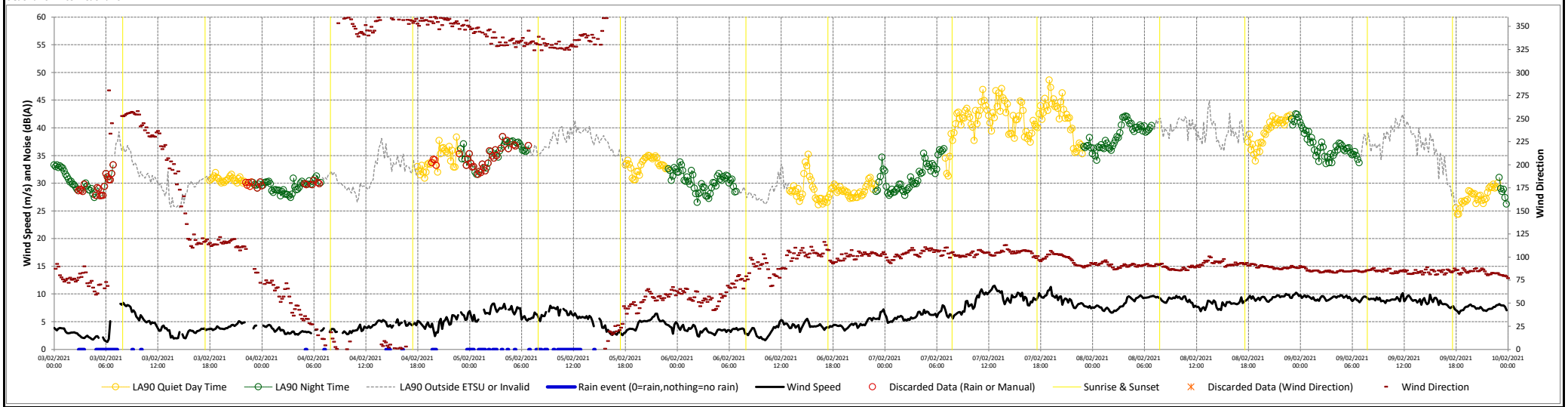


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 4 of 8)
Date	12/10/2022

27/01/2021 to 03/02/2021

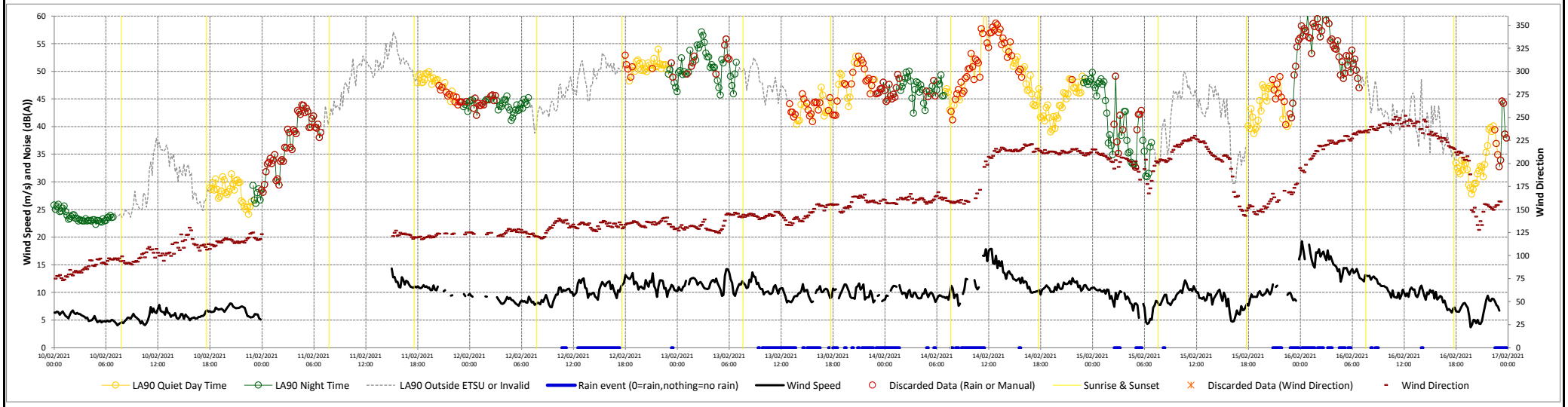


03/02/2021 to 10/02/2021

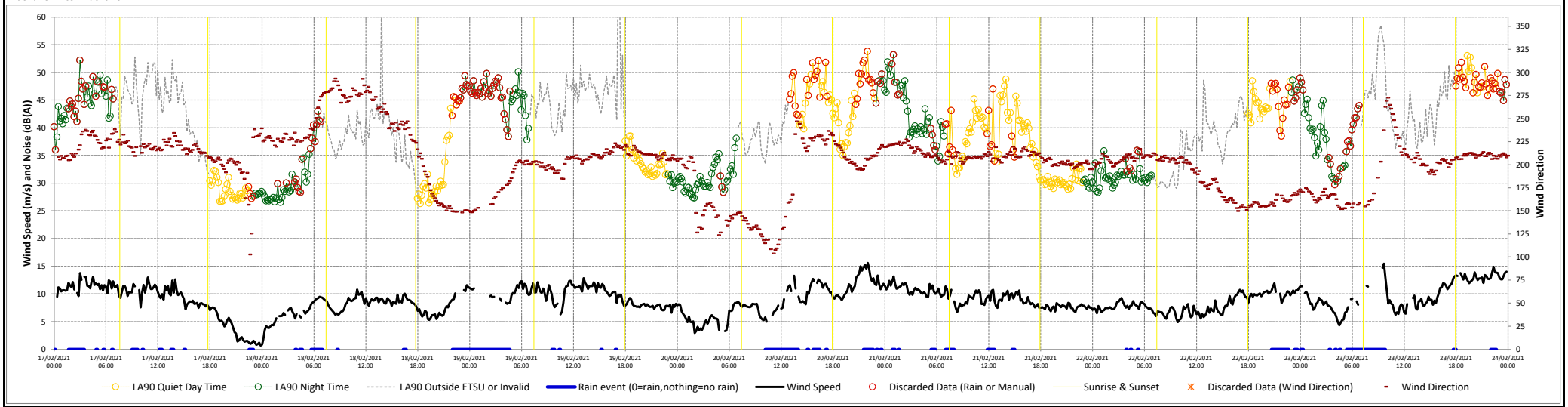


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 5 of 8)
Date	12/10/2022

10/02/2021 to 17/02/2021

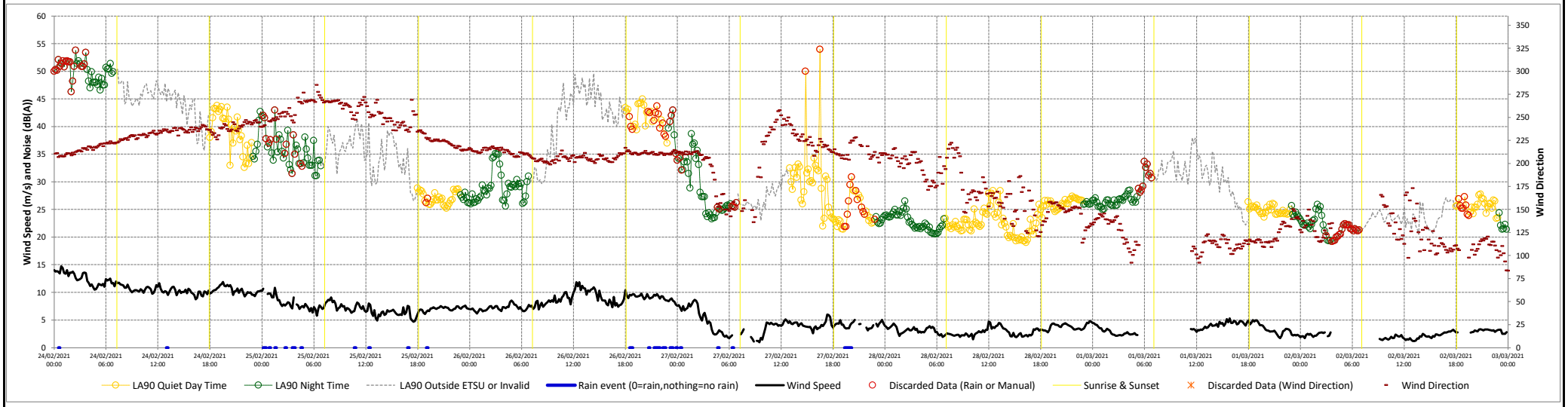


17/02/2021 to 24/02/2021

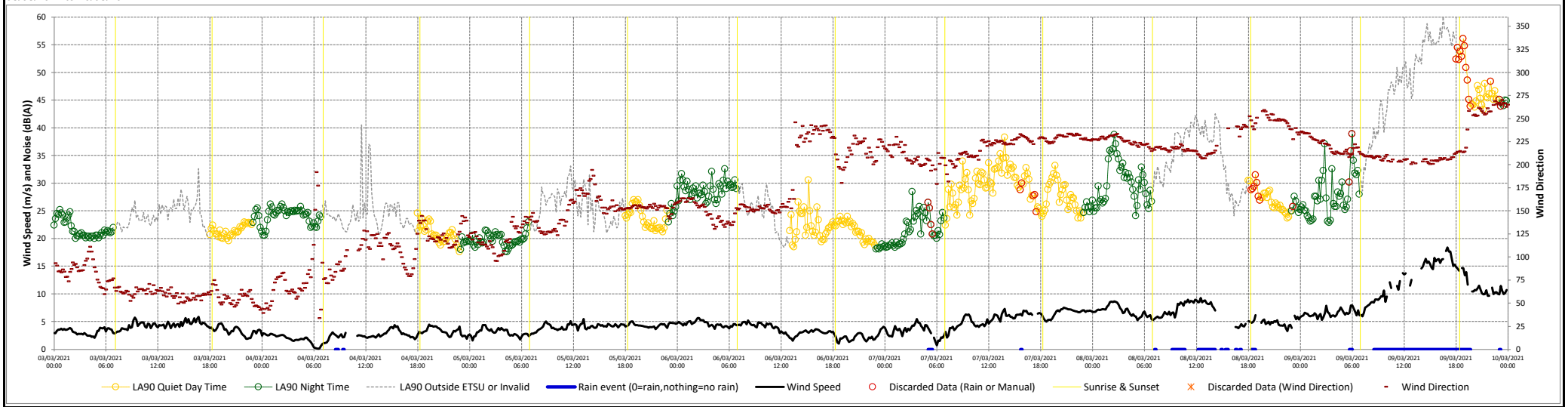


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 6 of 8)
Date	12/10/2022

24/02/2021 to 03/03/2021

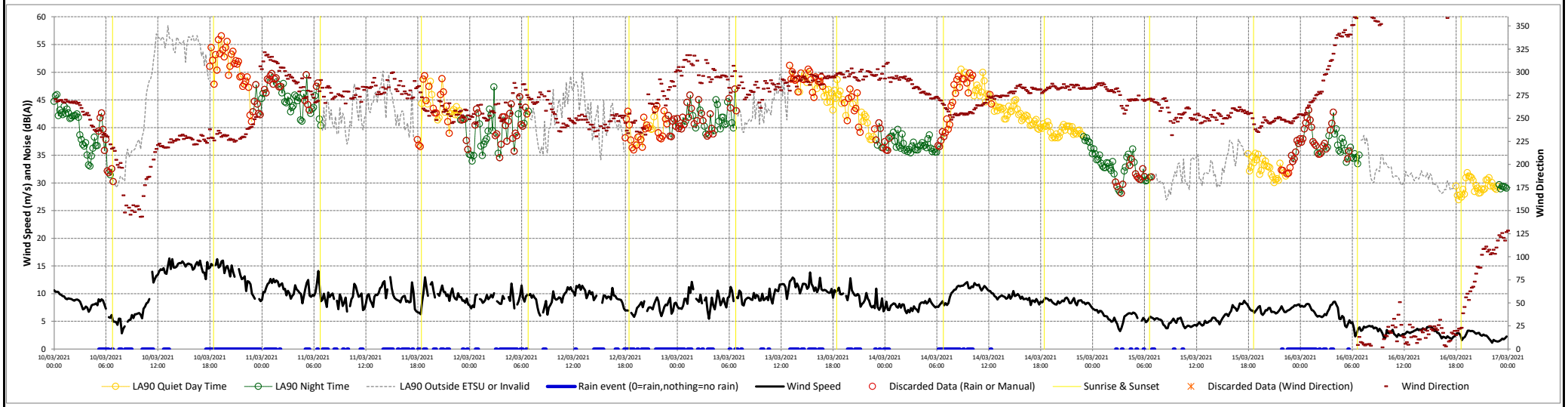


03/03/2021 to 10/03/2021

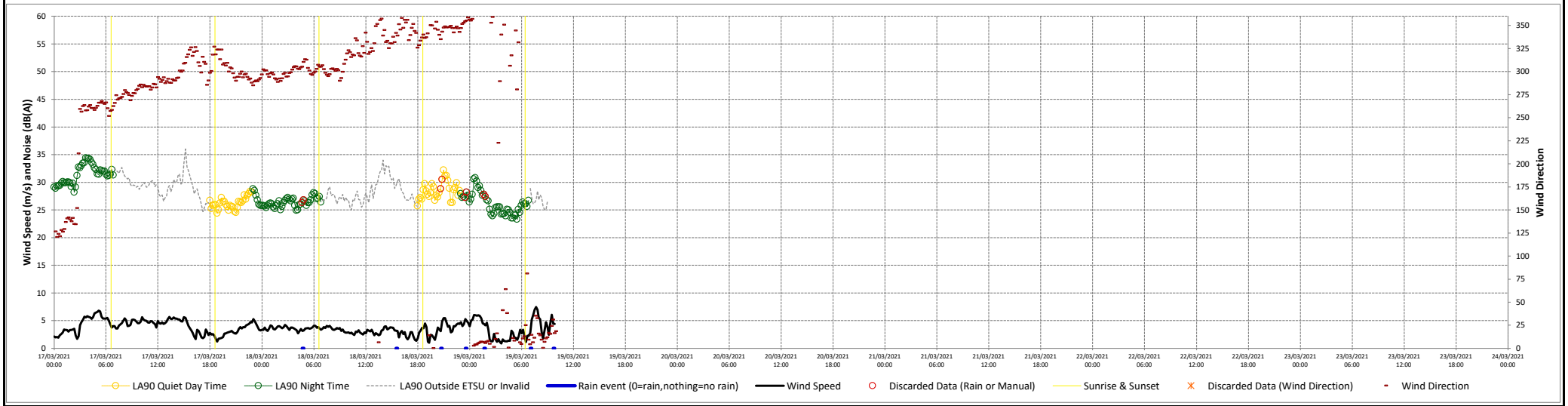


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 7 of 8)
Date	12/10/2022

10/03/2021 to 17/03/2021

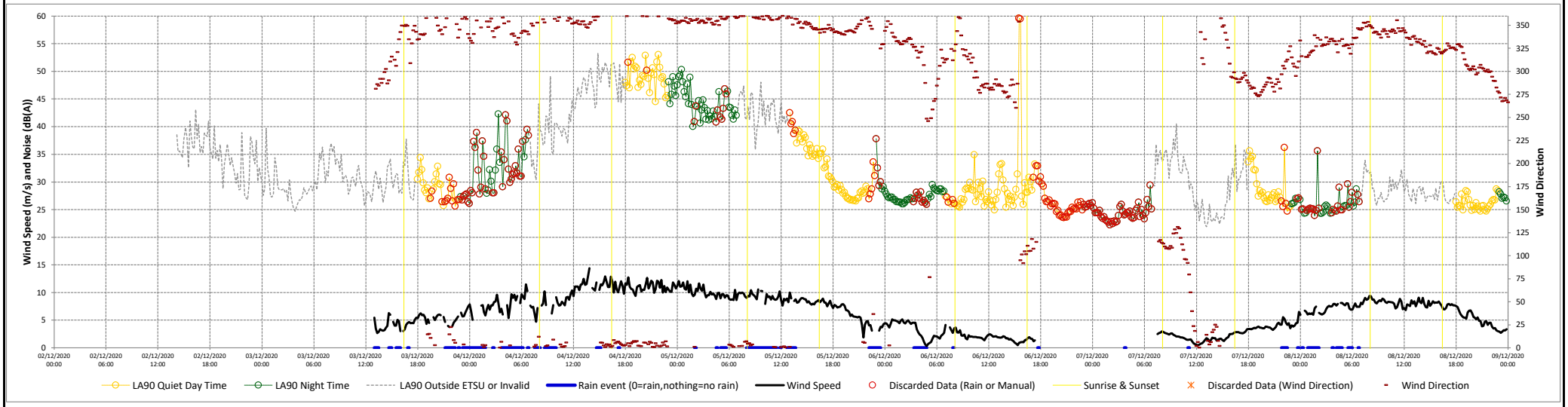


17/03/2021 to 24/03/2021

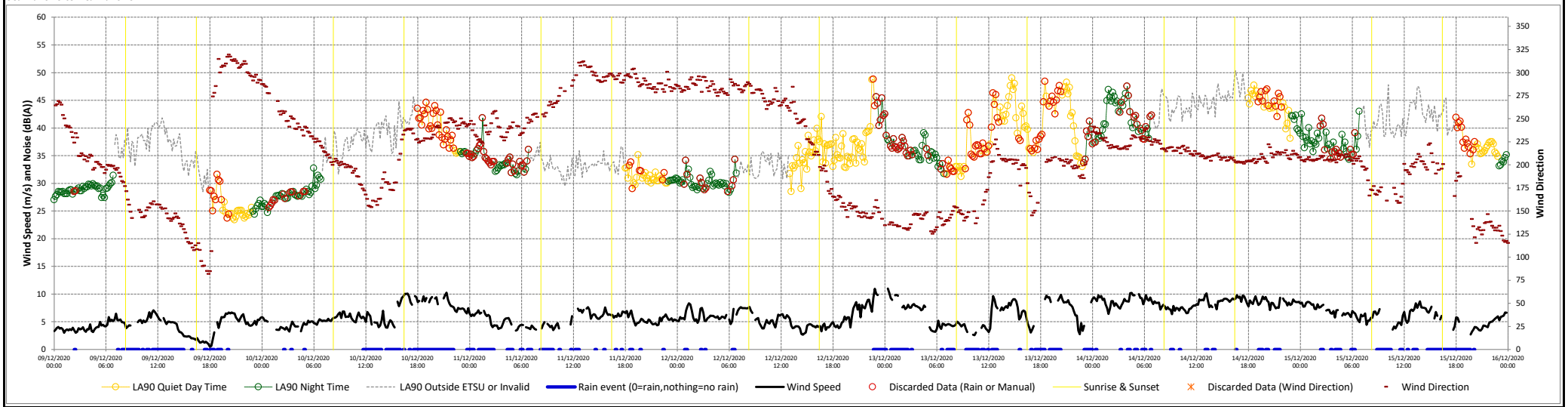


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML1 (Page 8 of 8)
Date	12/10/2022

02/12/2020 to 09/12/2020

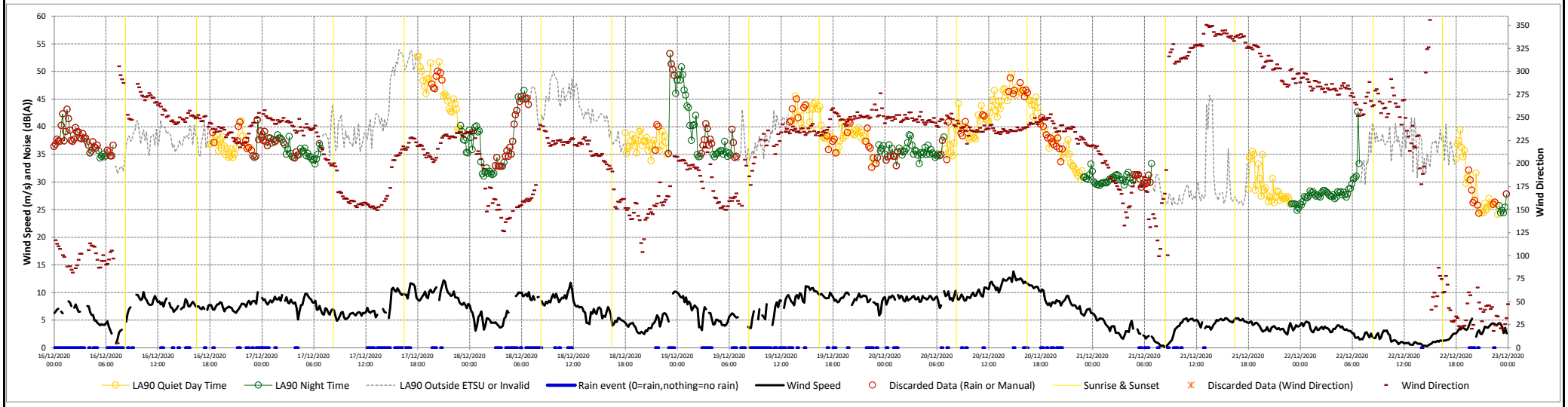


09/12/2020 to 16/12/2020

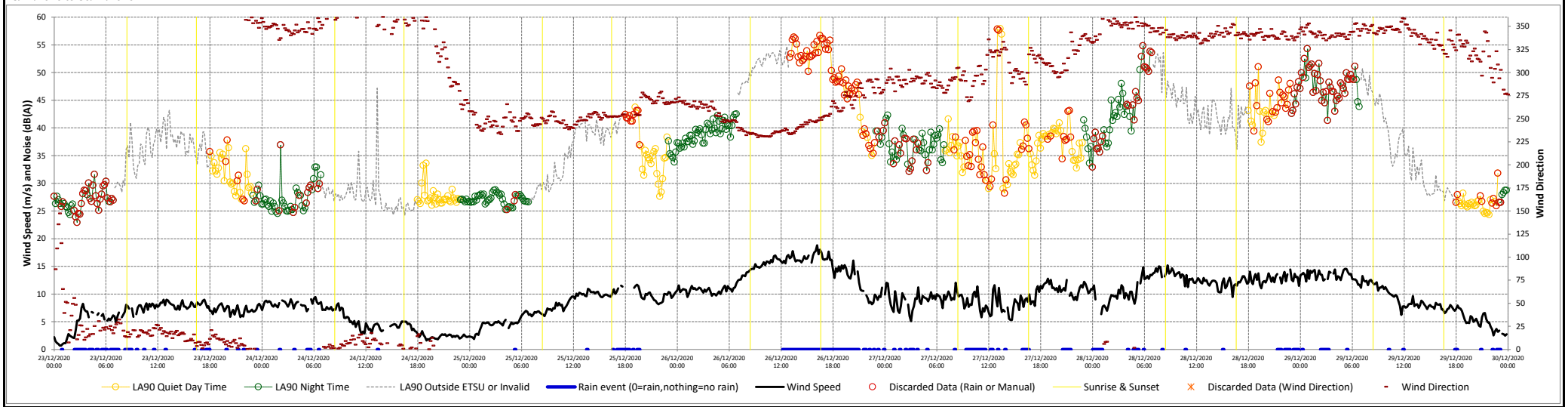


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 1 of 8)
Date	12/10/2022

16/12/2020 to 23/12/2020

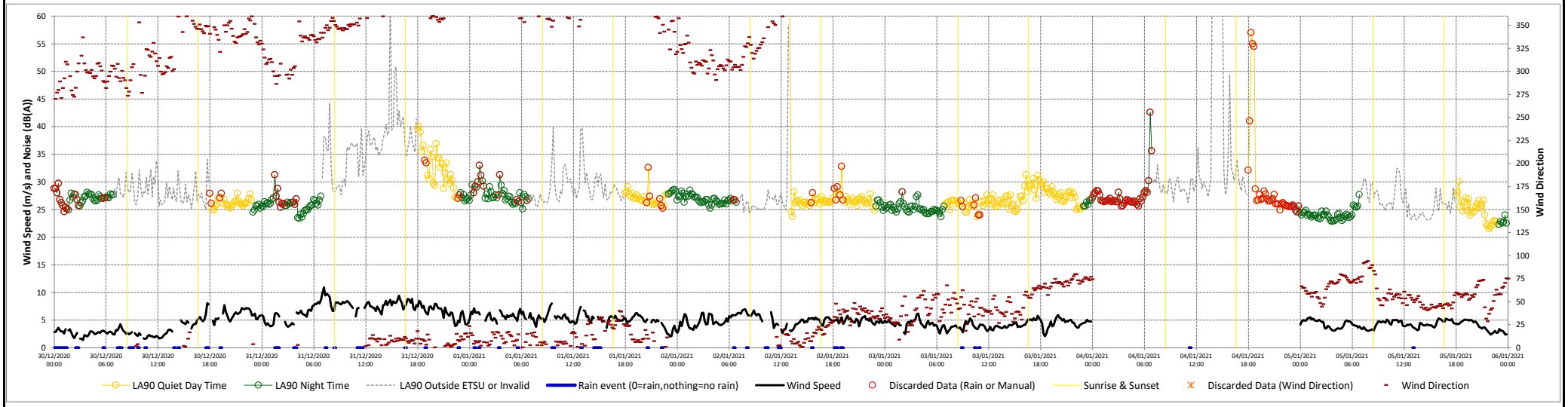


23/12/2020 to 30/12/2020

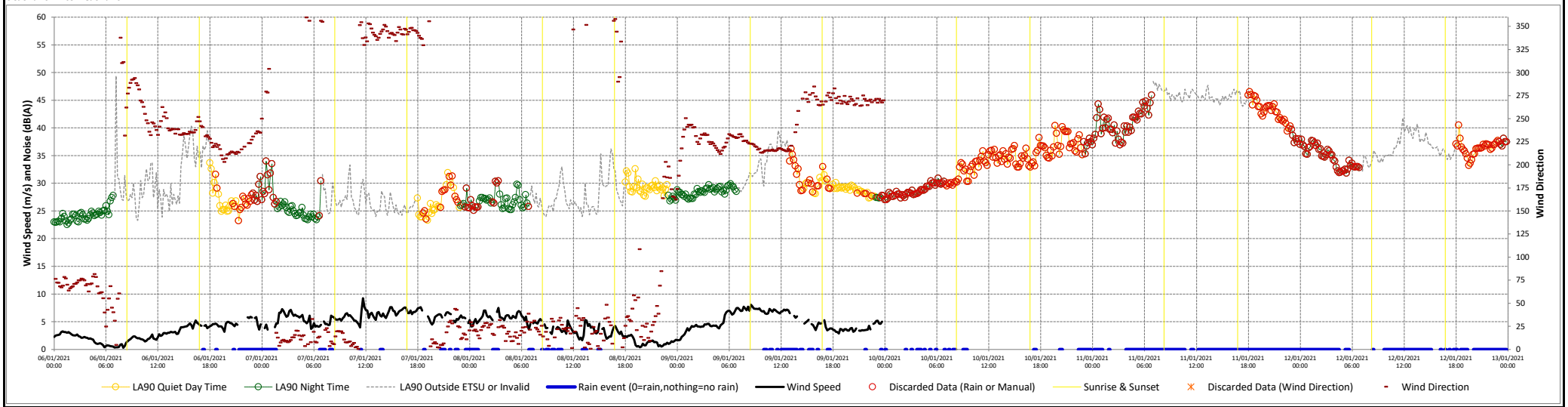


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 2 of 8)
Date	12/10/2022

30/12/2020 to 06/01/2021

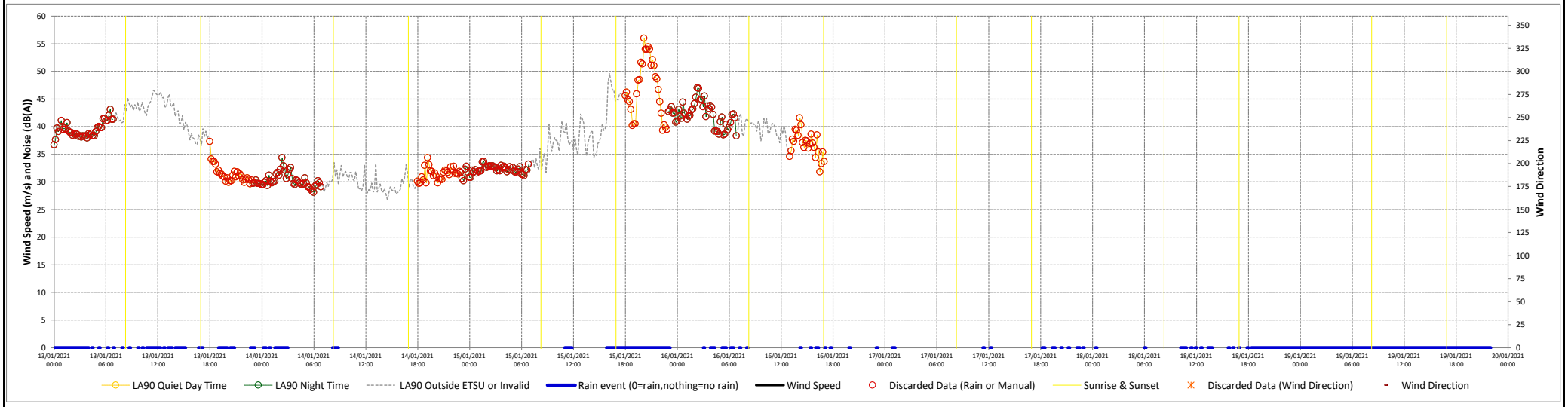


06/01/2021 to 13/01/2021

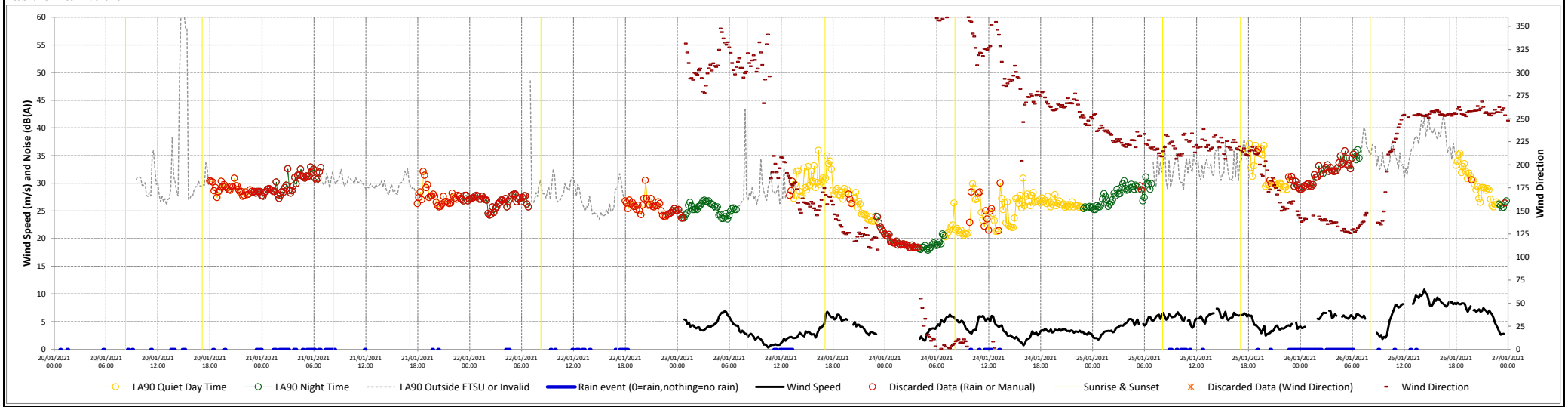


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 3 of 8)
Date	12/10/2022

13/01/2021 to 20/01/2021

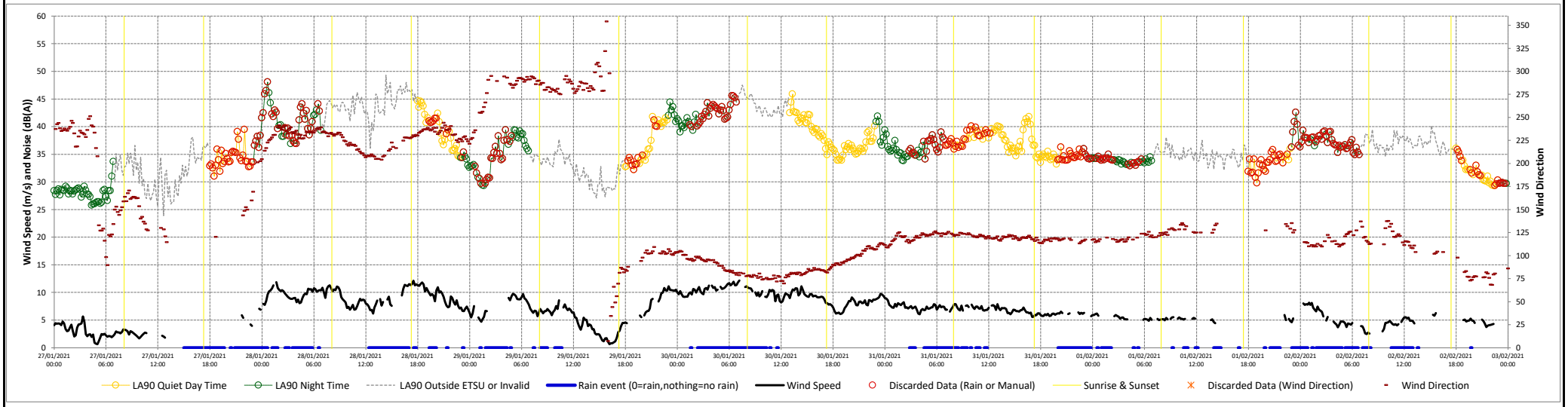


20/01/2021 to 27/01/2021

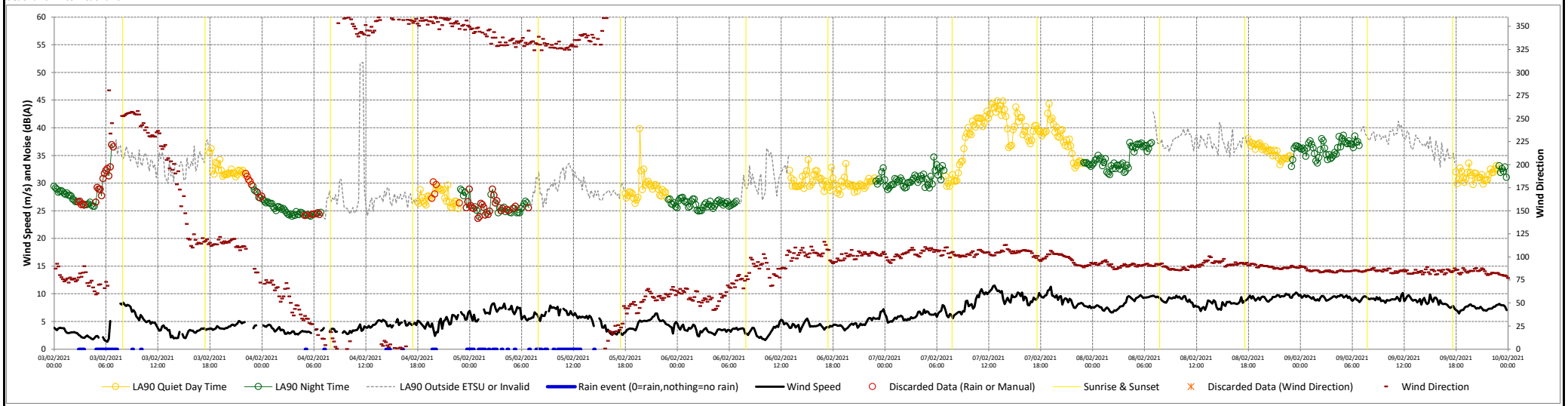


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 4 of 8)
Date	12/10/2022

27/01/2021 to 03/02/2021

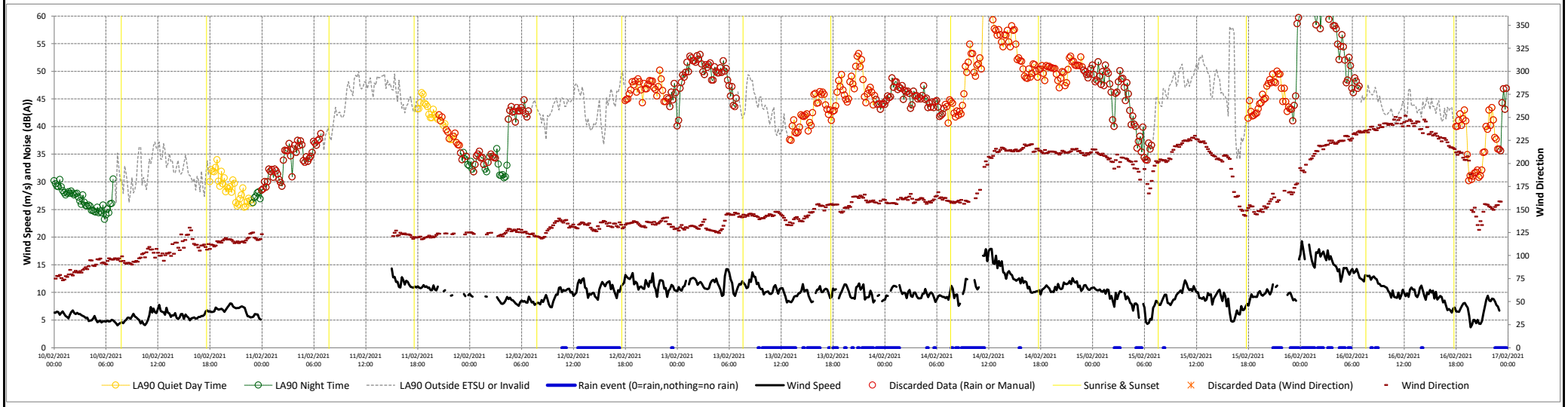


03/02/2021 to 10/02/2021

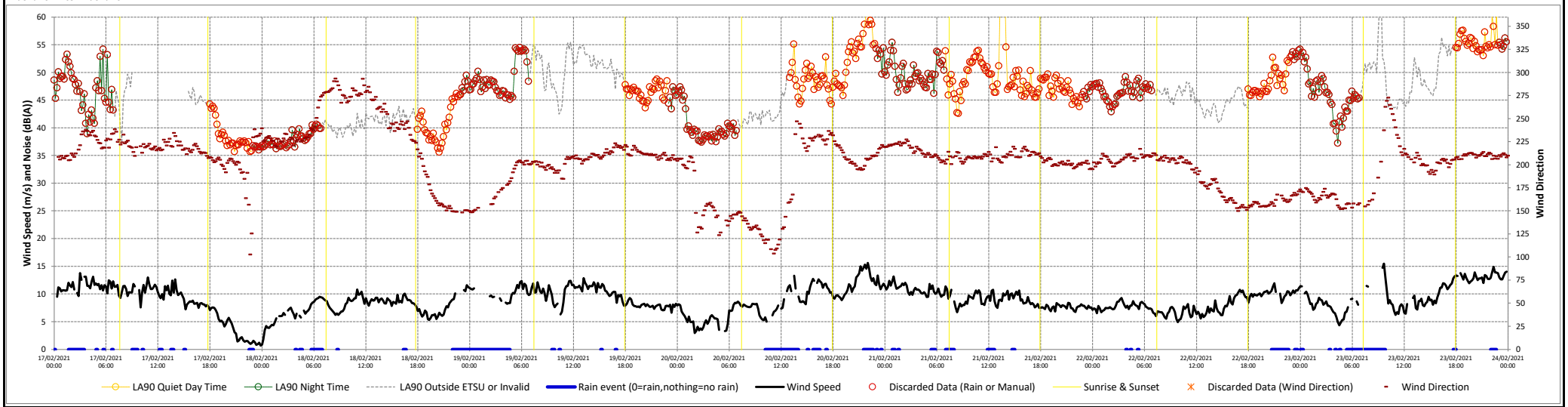


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 5 of 8)
Date	12/10/2022

10/02/2021 to 17/02/2021

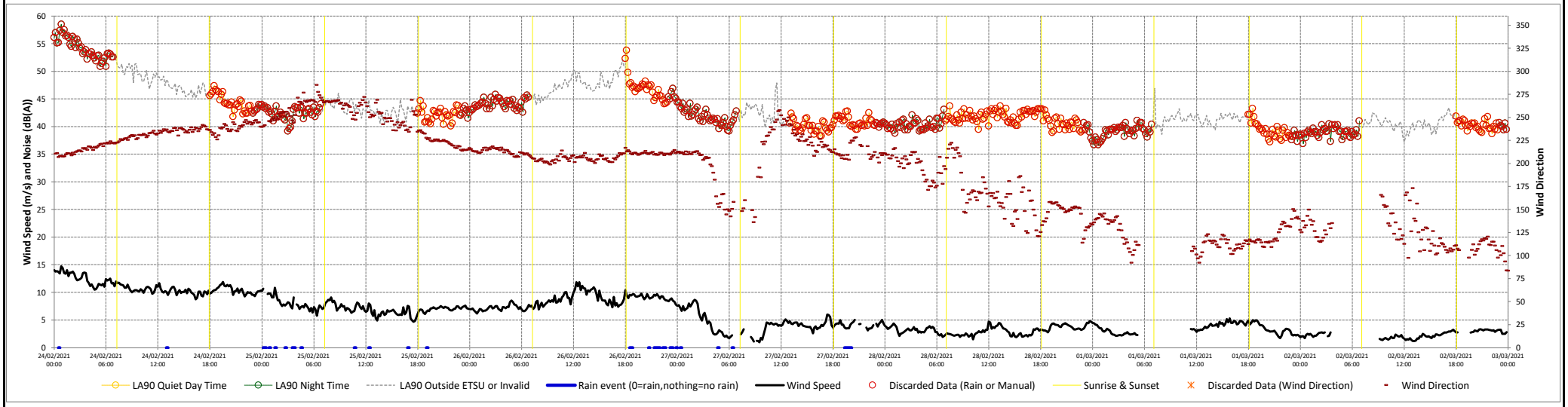


17/02/2021 to 24/02/2021

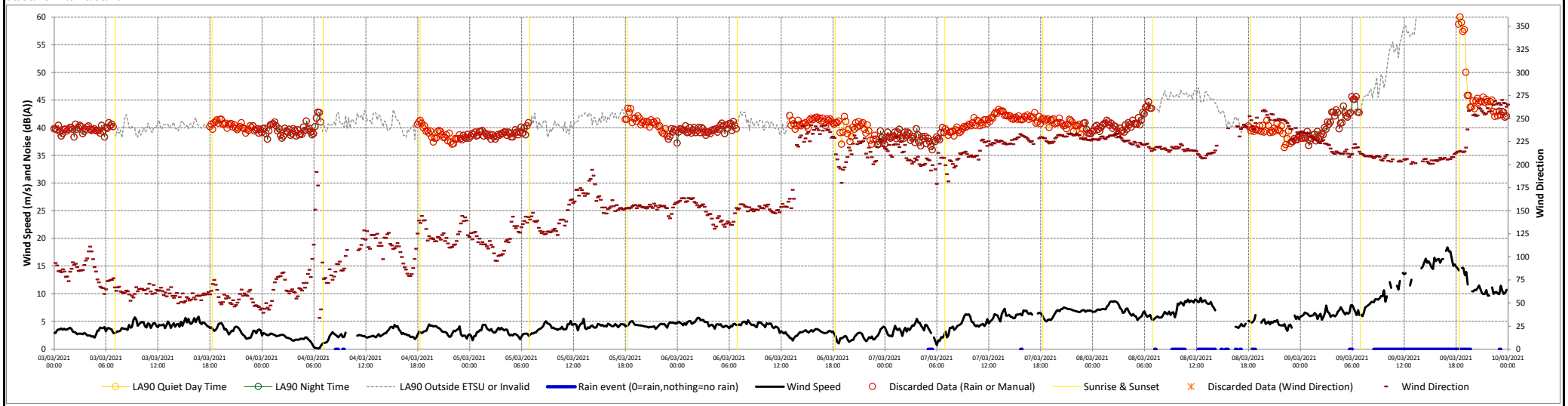


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 6 of 8)
Date	12/10/2022

24/02/2021 to 03/03/2021

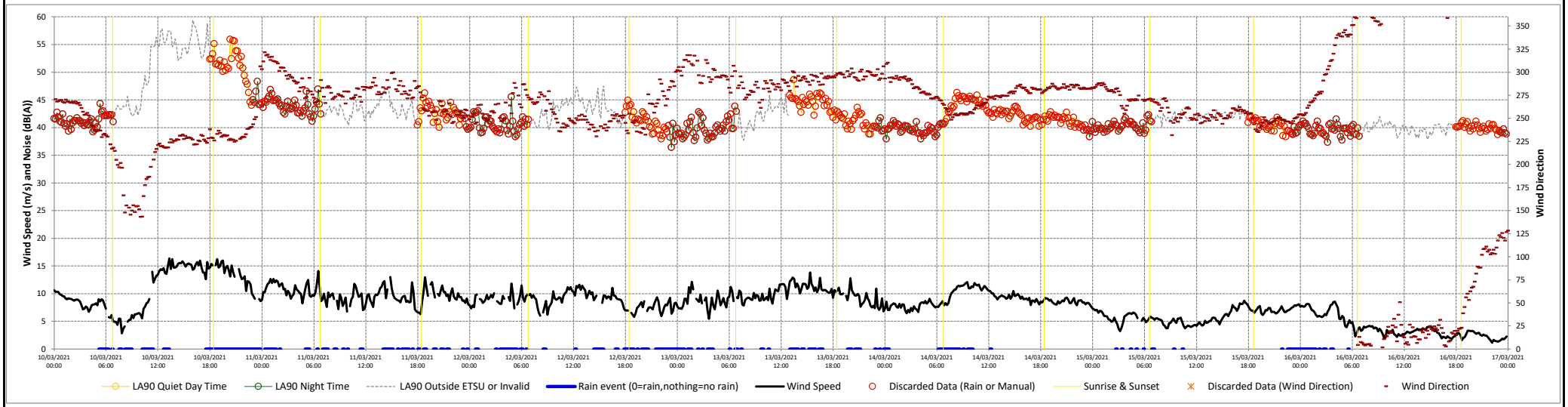


03/03/2021 to 10/03/2021

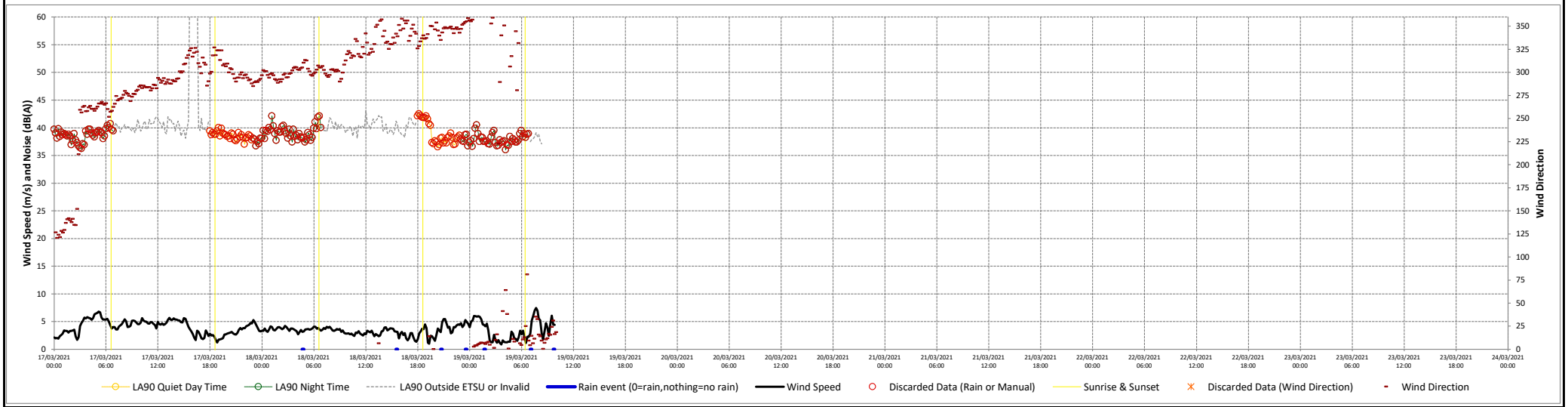


Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 7 of 8)
Date	12/10/2022

10/03/2021 to 17/03/2021



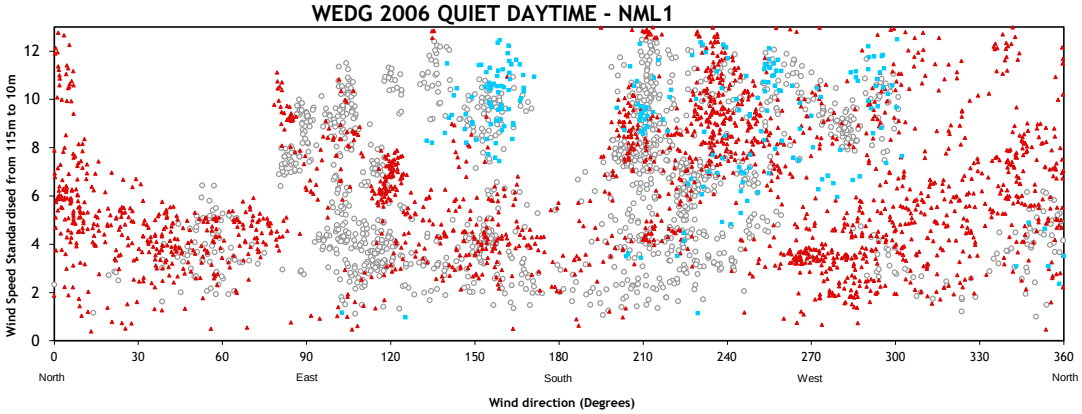
17/03/2021 to 24/03/2021



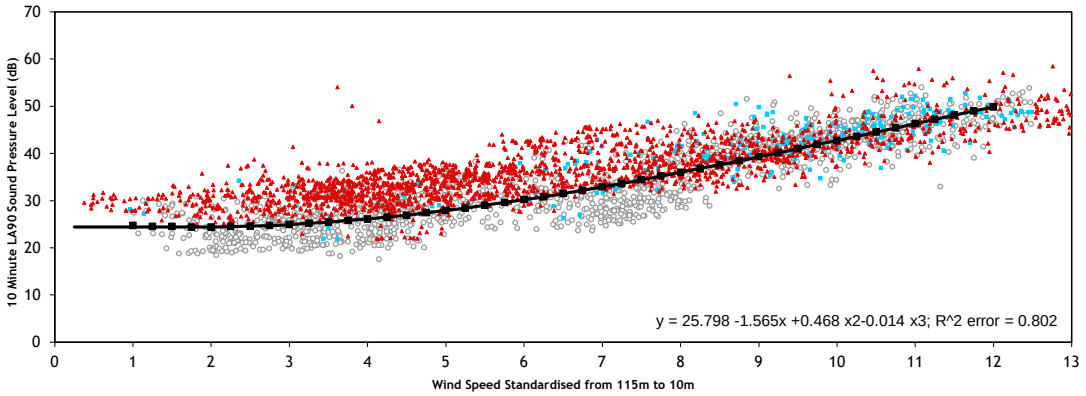
Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Time Series for NML3 (Page 8 of 8)
Date	12/10/2022

WEDG 2006 QUIET DAYTIME - NML1

Wind Conditions Quiet Daytime



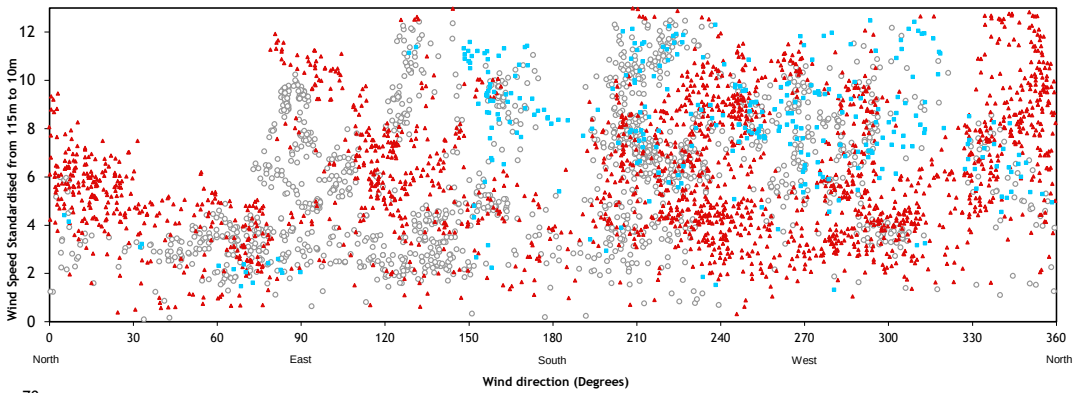
Regression Analysis Quiet Daytime



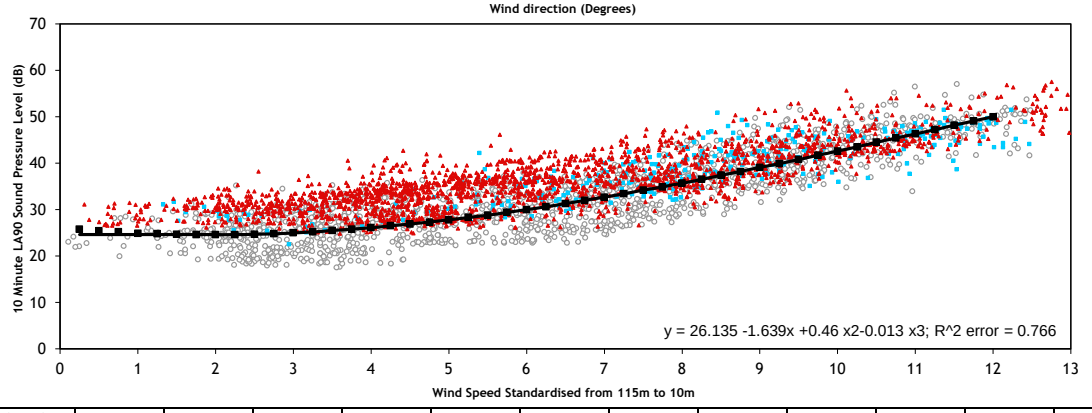
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	96	182	227	125	86	151	135	157	171	102	46	1478
Prevailing Background	24.4	24.9	26.1	27.9	30.2	32.9	36	39.3	42.7	46.3	49.8	

WEDG 2006 NIGHT-TIME - NML1

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	134	213	199	136	142	197	158	144	115	70	49	1557
Prevailing Background	24.6	25	26.1	27.8	30	32.7	35.7	39.1	42.6	46.3	50	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Drawn	JB
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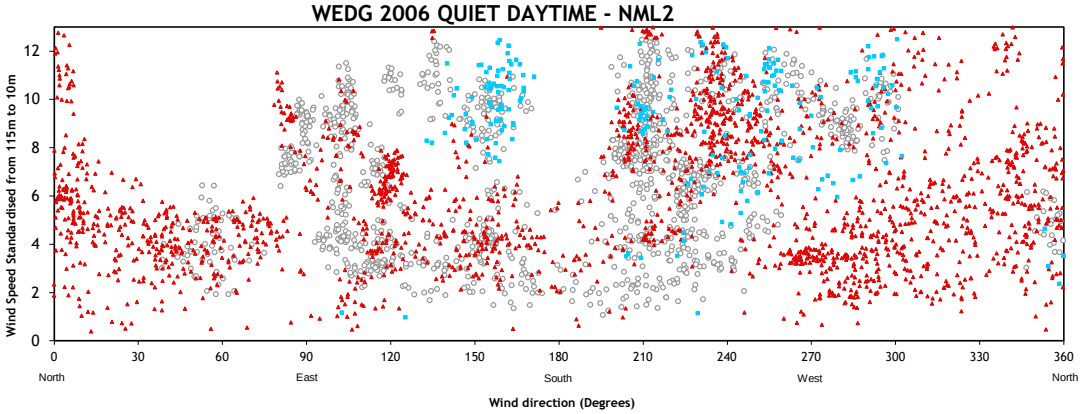
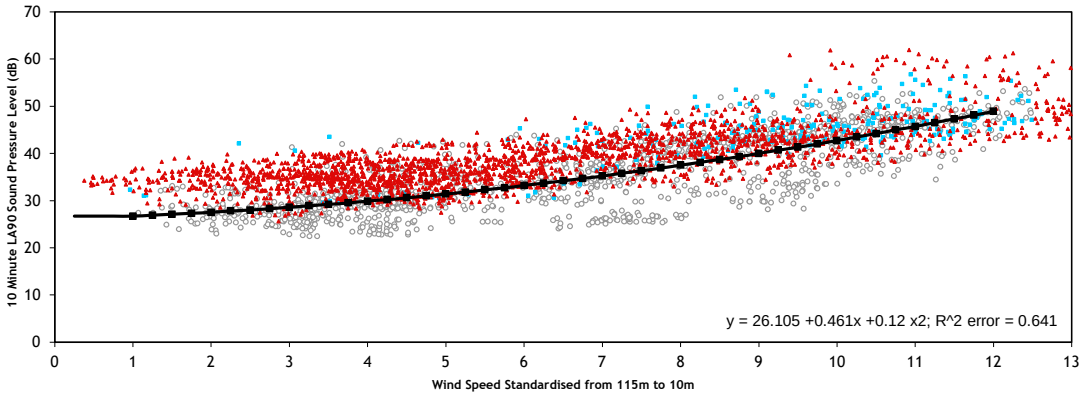
WEDG 2006 QUIET DAYTIME - NML2

Wind Conditions Quiet Daytime



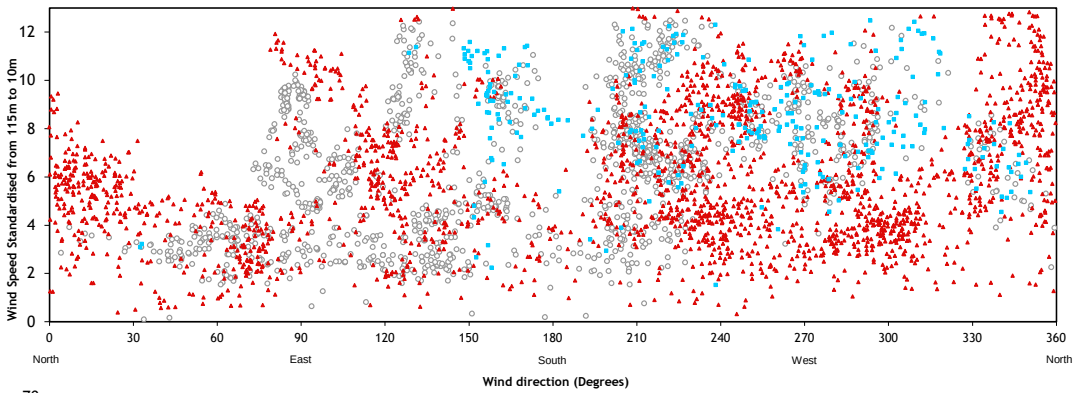
Regression Analysis Quiet Daytime



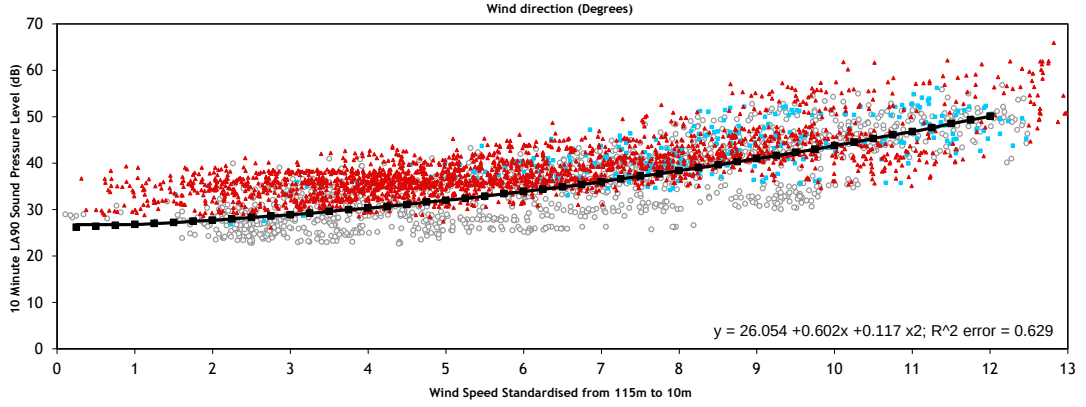
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	74	147	192	113	86	151	135	157	171	102	46	1374
Prevailing Background	27.5	28.6	29.9	31.4	33.2	35.2	37.5	40	42.7	45.7	48.9	

WEDG 2006 NIGHT-TIME - 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	102	171	148	119	128	194	158	144	115	70	49	1398
Prevailing Background	27.7	28.9	30.3	32	33.9	36	38.4	41	43.8	46.8	50.1	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2b
Drawn	JB
Checked	GC
Date	11/10/2022
Document Reference	14192-models

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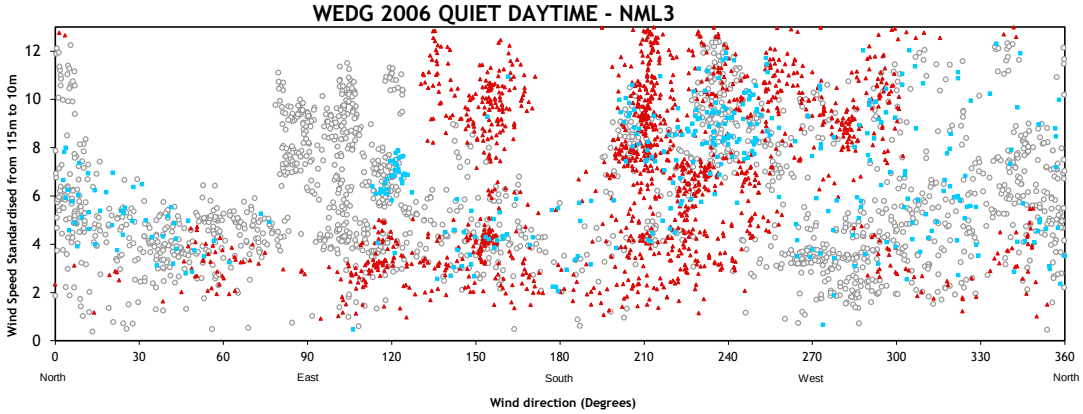
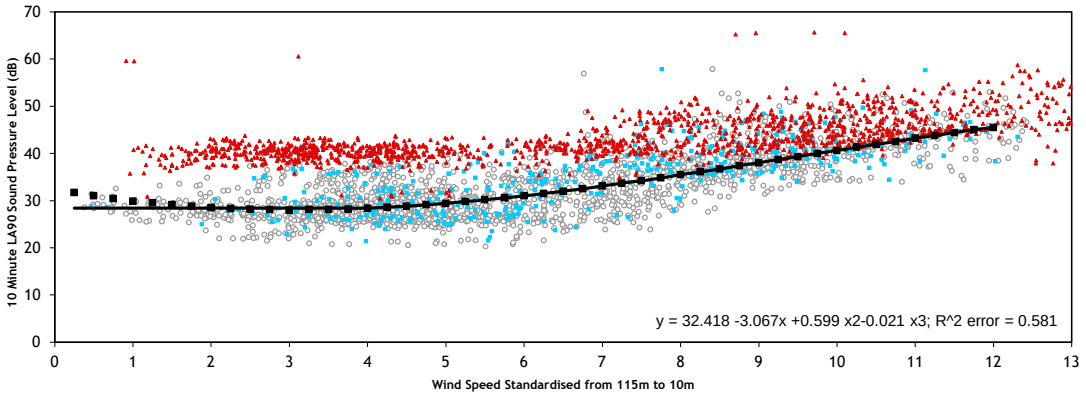
WEDG 2006 QUIET DAYTIME - NML3

Wind Conditions Quiet Daytime



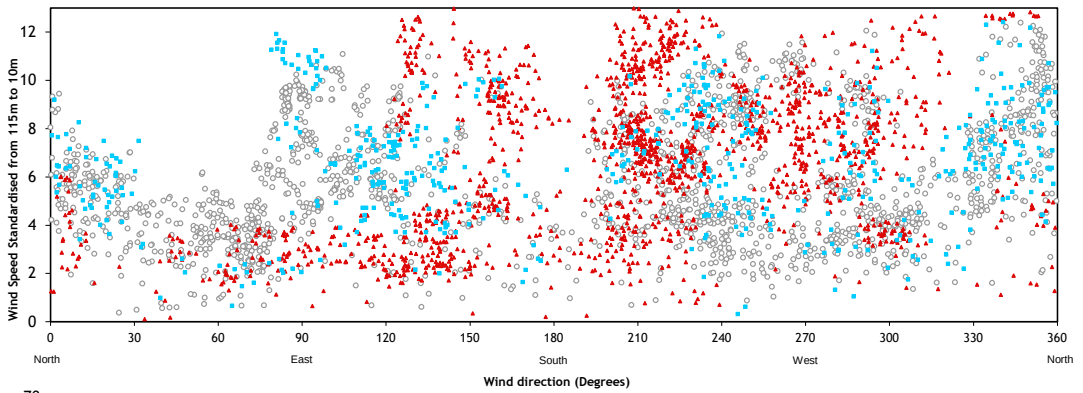
Regression Analysis Quiet Daytime



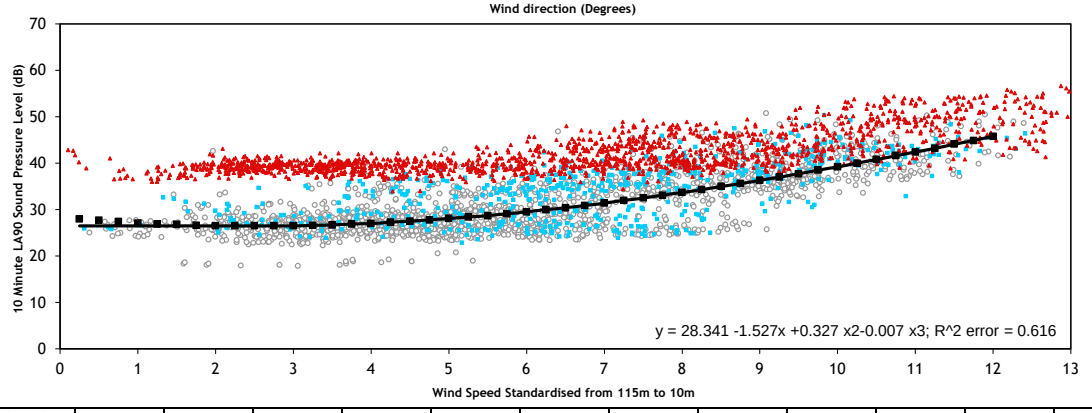
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	91	172	327	268	197	178	167	172	114	80	38	1804
Prevailing Background	28.4	28.4	28.4	29.4	31	33.1	35.5	38	40.6	43.2	45.5	

WEDG 2006 NIGHT-TIME - 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	105	207	307	270	212	138	144	174	121	46	18	1742
Prevailing Background	26.5	26.5	27	28.1	29.5	31.4	33.7	36.3	39.2	42.4	45.8	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Sheskin South Wind Farm
Client	SSE Renewables
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2c
Drawn	JB
Checked	GC
Date	11/10/2022
Document Reference	14192-models

Annex 6 – NSR Coordinates and Prediction Modelling Results

Table A6.1: Noise Sensitive Receptors

Noise Sensitive Receptor (H)	Easting (m)	Northing (m)	Elevation (m AOD)	Background Noise Data Used **	Is this NSR also an NAL?
H01	493866	822407	115	NML3	Yes - NAL3*
H02	493785	822376	117	NML3	No
H03	493743	822357	118	NML3	Yes - NAL4*
H04	493862	822004	93	NML3	No
H05	493697	822070	99	NML3	No
H06	493662	822026	96	NML3	No
H07	493503	822198	110	NML3	No
H08	493468	822203	110	NML3	No
H09	493365	822162	108	NML3	No
H10	493365	821844	88	NML3	No
H11	493114	822026	98	NML3	No
H12	493053	821995	96	NML3	No
H13	493014	822026	100	NML3	Yes - NAL5*
H14	492794	821881	88	NML3	No
H15	492121	822047	89	NML3	No
H16	491561	822376	89	NML3	Yes - NAL6*
H17	491346	822405	72	NML3	No
H18	491517	825521	134	NML3	Yes - NAL2*
H19	491351	825484	135	NML1	No
H20	491073	825672	122	NML1	No
H21	490918	825617	126	NML1	No
H22	490697	825812	113	NML3	YES - NAL7*
H23	494271	830004	134	NML2	Yes - NAL2*

* The assessment results for these receptors are included within Tables 6.6 and 6.7 (Cumulative) and Tables 6.9 and 6.10 (Site Specific) of the main report.

** shown on Figure A1.1, Annex 1

Table A6.2 WEDG 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
H02	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	36.4	39.0	39.4	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-9.0	-3.6	-6.0	-5.6	-5.6	-5.6	-6.2	-8.8	-11.1
H04	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.8	38.3	38.8	38.8	38.8	38.8	38.8	38.8
	Exceedance Level	-	-	-	-9.7	-4.2	-6.7	-6.2	-6.2	-6.2	-6.8	-9.4	-11.7
H05	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.8	35.3	37.8	38.3	38.3	38.3	38.3	38.3	38.3
	Exceedance Level	-	-	-	-10.2	-4.7	-7.2	-6.7	-6.7	-6.7	-7.3	-9.9	-12.2
H06	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.6	35.0	37.5	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-10.4	-5.0	-7.5	-7.0	-7.0	-7.0	-7.6	-10.2	-12.5
H07	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.4	34.8	37.4	37.8	37.8	37.8	37.8	37.8	37.8
	Exceedance Level	-	-	-	-10.6	-5.2	-7.6	-7.2	-7.2	-7.2	-7.8	-10.4	-12.7
H08	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.2	34.6	37.2	37.6	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-10.8	-5.4	-7.8	-7.4	-7.4	-7.4	-8.0	-10.6	-12.9
H09	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	34.2	36.8	37.2	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-	-11.2	-5.8	-8.2	-7.8	-7.8	-7.8	-8.4	-11.0	-13.3
H10	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.1	33.5	36.1	36.6	36.6	36.6	36.6	36.6	36.6
	Exceedance Level	-	-	-	-11.9	-6.5	-8.9	-8.4	-8.4	-8.4	-9.0	-11.6	-13.9

H11	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	32.9	35.5	36.0	36.0	36.0	36.0	36.0	36.0
	Exceedance Level	-	-	-	-12.4	-7.1	-9.5	-9.0	-9.0	-9.0	-9.6	-12.2	-14.5
H12	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.3	32.6	35.3	35.8	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-12.7	-7.4	-9.7	-9.2	-9.2	-9.2	-9.8	-12.4	-14.7
H14	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.2	31.5	34.2	34.7	34.7	34.7	34.7	34.7	34.7
	Exceedance Level	-	-	-	-13.8	-8.5	-10.8	-10.3	-10.3	-10.3	-10.9	-13.5	-15.8
H15	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.2	29.3	32.2	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-	-15.8	-10.7	-12.8	-12.4	-12.4	-12.4	-13.0	-15.6	-17.9
H17	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.1	28.1	31.1	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-	-16.9	-11.9	-13.9	-13.5	-13.5	-13.5	-16.2	-19.8	-23.3
H19	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.0	32.9	35.9	36.3	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-12.0	-7.1	-9.1	-8.7	-8.7	-8.7	-11.4	-15.0	-18.5
H20	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.5	34.5	34.9	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-13.4	-8.5	-10.5	-10.1	-10.1	-10.1	-12.8	-16.4	-19.9
H21	Total Noise Limit: WEDG L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.0	30.9	33.9	34.3	34.3	34.3	34.3	34.3	34.3
	Exceedance Level	-	-	-	-14.0	-9.1	-11.1	-10.7	-10.7	-10.7	-13.4	-17.0	-20.5

Table A6.3 WEDG 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
H02	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	36.4	39.0	39.4	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.0	-6.6	-4.0	-3.6	-3.6	-3.6	-4.8	-8.0	-11.4
H04	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.8	38.3	38.8	38.8	38.8	38.8	38.8	38.8
	Exceedance Level	-	-	-	-12.7	-7.2	-4.7	-4.2	-4.2	-4.2	-5.4	-8.6	-12.0
H05	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.8	35.3	37.8	38.3	38.3	38.3	38.3	38.3	38.3
	Exceedance Level	-	-	-	-13.2	-7.7	-5.2	-4.7	-4.7	-4.7	-5.9	-9.1	-12.5
H06	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.6	35.0	37.5	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-13.4	-8.0	-5.5	-5.0	-5.0	-5.0	-6.2	-9.4	-12.8
H07	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.4	34.8	37.4	37.8	37.8	37.8	37.8	37.8	37.8
	Exceedance Level	-	-	-	-13.6	-8.2	-5.6	-5.2	-5.2	-5.2	-6.4	-9.6	-13.0
H08	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.2	34.6	37.2	37.6	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-13.8	-8.4	-5.8	-5.4	-5.4	-5.4	-6.6	-9.8	-13.2
H09	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	34.2	36.8	37.2	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-	-14.2	-8.8	-6.2	-5.8	-5.8	-5.8	-7.0	-10.2	-13.6
H10	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.1	33.5	36.1	36.6	36.6	36.6	36.6	36.6	36.6
	Exceedance Level	-	-	-	-14.9	-9.5	-6.9	-6.4	-6.4	-6.4	-7.6	-10.8	-14.2

H11	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	32.9	35.5	36.0	36.0	36.0	36.0	36.0	36.0
	Exceedance Level	-	-	-	-15.4	-10.1	-7.5	-7.0	-7.0	-7.0	-8.2	-11.4	-14.8
H12	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.3	32.6	35.3	35.8	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-15.7	-10.4	-7.7	-7.2	-7.2	-7.2	-8.4	-11.6	-15.0
H14	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.2	31.5	34.2	34.7	34.7	34.7	34.7	34.7	34.7
	Exceedance Level	-	-	-	-16.8	-11.5	-8.8	-8.3	-8.3	-8.3	-9.5	-12.7	-16.1
H15	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.2	29.3	32.2	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-	-18.8	-13.7	-10.8	-10.4	-10.4	-10.4	-11.6	-14.8	-18.2
H17	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.1	28.1	31.1	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-	-19.9	-14.9	-11.9	-11.5	-11.5	-12.6	-16.1	-19.8	-23.5
H19	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.0	32.9	35.9	36.3	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-15.0	-10.1	-7.1	-6.7	-6.7	-7.8	-11.3	-15.0	-18.7
H20	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.5	34.5	34.9	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-16.4	-11.5	-8.5	-8.1	-8.1	-9.2	-12.7	-16.4	-20.1
H21	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.0	30.9	33.9	34.3	34.3	34.3	34.3	34.3	34.3
	Exceedance Level	-	-	-	-17.0	-12.1	-9.1	-8.7	-8.7	-9.8	-13.3	-17.0	-20.7

Table A6.4 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
H02	Site Specific Noise Limit L_{A90}	38.7	38.7	38.7	38.7	30.0	42.1	41.4	41.4	41.4	42.7	46.8	49.8
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.3	**30.0***	33.2	33.5	33.5	33.5	33.5	33.5	33.5
	Exceedance Level	-	-	-18.3	-13.4	**0.0***	-8.9	-7.9	-7.9	-7.9	-9.2	-13.3	-16.3
H04	Site Specific Noise Limit L_{A90}	38.9	38.9	38.9	38.9	32.3	42.3	41.9	41.9	41.9	43.0	47.0	49.8
	Predicted Wind Turbine Noise L_{A90}	-	-	18.4	23.2	28.1	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-20.5	-15.7	-4.2	-11.1	-10.4	-10.4	-10.4	-11.5	-15.5	-18.3
H05	Site Specific Noise Limit L_{A90}	39.1	39.1	39.1	39.1	34.9	42.9	42.5	42.5	42.5	43.5	47.2	49.9
	Predicted Wind Turbine Noise L_{A90}	-	-	18.8	23.7	28.5	31.6	31.9	31.9	31.9	31.9	31.9	31.9
	Exceedance Level	-	-	-20.3	-15.4	-6.4	-11.3	-10.6	-10.6	-10.6	-11.6	-15.3	-18.0
H06	Site Specific Noise Limit L_{A90}	39.1	39.1	39.1	39.1	35.5	43.1	42.7	42.7	42.7	43.7	47.3	50.0
	Predicted Wind Turbine Noise L_{A90}	-	-	18.5	23.3	28.2	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-20.6	-15.8	-7.3	-11.9	-11.2	-11.2	-11.2	-12.2	-15.8	-18.5
H07	Site Specific Noise Limit L_{A90}	39.3	39.3	39.3	39.3	36.4	43.4	43.1	43.1	43.1	44.0	47.4	50.0
	Predicted Wind Turbine Noise L_{A90}	-	-	19.5	24.4	29.3	32.3	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-19.8	-14.9	-7.1	-11.1	-10.5	-10.5	-10.5	-11.4	-14.8	-17.4
H08	Site Specific Noise Limit L_{A90}	39.3	39.3	39.3	39.3	36.7	43.5	43.3	43.3	43.3	44.1	47.5	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	19.5	24.4	29.2	32.3	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-19.8	-14.9	-7.5	-11.2	-10.7	-10.7	-10.7	-11.5	-14.9	-17.9
H09	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	37.3	43.7	43.5	43.5	43.5	44.3	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	19.3	24.2	29.1	32.1	32.4	32.4	32.4	32.4	32.4	32.4
	Exceedance Level	-	-	-20.7	-15.8	-8.2	-11.6	-11.1	-11.1	-11.1	-11.9	-15.8	-18.1
H10	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	37.7	43.9	43.7	43.7	43.7	44.5	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	17.9	22.8	27.7	30.7	31.0	31.0	31.0	31.0	31.0	31.0
	Exceedance Level	-	-	-22.1	-17.2	-10.0	-13.2	-12.7	-12.7	-12.7	-13.5	-17.2	-19.5

H11	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	38.3	44.1	44.0	44.0	44.0	44.7	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	18.4	23.3	28.2	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-21.6	-16.7	-10.1	-12.9	-12.5	-12.5	-12.5	-13.2	-16.7	-19.0
H12	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	38.4	44.2	44.1	44.1	44.1	44.8	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	18.3	23.1	28.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-21.7	-16.9	-10.4	-13.2	-12.8	-12.8	-12.8	-13.5	-16.9	-19.2
H14	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	38.9	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	17.5	22.3	27.2	30.2	30.5	30.5	30.5	30.5	30.5	30.5
	Exceedance Level	-	-	-22.5	-17.7	-11.7	-14.8	-14.5	-14.5	-14.5	-15.1	-17.7	-20.0
H15	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.6	48.2	50.5
	Predicted Wind Turbine Noise L_{A90}	-	-	16.8	21.6	26.5	29.5	29.8	29.8	29.8	29.8	29.8	29.8
	Exceedance Level	-	-	-23.2	-18.4	-13.5	-15.5	-15.2	-15.2	-15.2	-15.8	-18.4	-20.7
H17	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	16.5	21.3	26.2	29.2	29.5	29.5	29.5	29.5	29.5	29.5
	Exceedance Level	-	-	-23.5	-18.7	-13.8	-15.8	-15.5	-15.5	-15.5	-18.2	-21.8	-25.3
H19	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	22.6	27.4	32.3	35.3	35.6	35.6	35.6	35.6	35.6	35.6
	Exceedance Level	-	-	-17.4	-12.6	-7.7	-9.7	-9.4	-9.4	-9.4	-12.1	-15.7	-19.2
H20	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	21.1	25.9	30.8	33.8	34.1	34.1	34.1	34.1	34.1	34.1
	Exceedance Level	-	-	-18.9	-14.1	-9.2	-11.2	-10.9	-10.9	-10.9	-13.6	-17.2	-20.7
H21	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	47.7	51.3	54.8
	Predicted Wind Turbine Noise L_{A90}	-	-	20.3	25.2	30.1	33.1	33.4	33.4	33.4	33.4	33.4	33.4
	Exceedance Level	-	-	-19.7	-14.8	-9.9	-11.9	-11.6	-11.6	-11.6	-14.3	-17.9	-21.4

Table A6.5 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
H02	Site Specific Noise Limit L_{A90}	42.4	42.4	42.4	42.4	40.3	36.5	33.4	33.4	33.4	39.3	45.7	50.1
	Predicted Wind Turbine Noise L_{A90}	-	-	20.4	25.3	30.1	33.2	**33.4***	**33.4***	**33.4***	33.5	33.5	33.5
	Exceedance Level	-	-	-22.0	-17.1	-10.2	-3.3	**0.0***	**0.0***	**0.0***	-5.8	-12.2	-16.6
H04	Site Specific Noise Limit L_{A90}	42.5	42.5	42.5	42.5	40.7	37.4	35.7	35.7	35.7	40.0	45.9	50.2
	Predicted Wind Turbine Noise L_{A90}	-	-	18.4	23.2	28.1	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-24.1	-19.3	-12.6	-6.2	-4.2	-4.2	-4.2	-8.5	-14.4	-18.7
H05	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.2	39.0	37.9	37.9	37.9	41.0	46.1	50.3
	Predicted Wind Turbine Noise L_{A90}	-	-	18.8	23.7	28.5	31.6	31.9	31.9	31.9	31.9	31.9	31.9
	Exceedance Level	-	-	-24.2	-19.3	-12.7	-7.4	-6.0	-6.0	-6.0	-9.1	-14.2	-18.4
H06	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.3	39.4	38.5	38.5	38.5	41.3	46.2	50.3
	Predicted Wind Turbine Noise L_{A90}	-	-	18.5	23.3	28.2	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-24.5	-19.7	-13.1	-8.2	-7.0	-7.0	-7.0	-9.8	-14.7	-18.8
H07	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.6	40.1	39.4	39.4	39.4	41.8	46.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.5	24.4	29.3	32.3	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-23.5	-18.6	-12.3	-7.8	-6.8	-6.8	-6.8	-9.2	-13.8	-18.2
H08	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.6	40.3	39.8	39.8	39.8	42.0	46.5	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.5	24.4	29.2	32.3	32.6	32.6	32.6	32.6	32.6	32.6
	Exceedance Level	-	-	-23.5	-18.6	-12.4	-8.0	-7.2	-7.2	-7.2	-9.4	-13.9	-18.2
H09	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.9	40.8	40.3	40.3	40.3	42.4	46.6	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.3	24.2	29.1	32.1	32.4	32.4	32.4	32.4	32.4	32.4
	Exceedance Level	-	-	-23.7	-18.8	-12.8	-8.7	-7.9	-7.9	-7.9	-10.0	-14.2	-18.4
H10	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.0	41.0	40.7	40.7	40.7	42.5	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	17.9	22.8	27.7	30.7	31.0	31.0	31.0	31.0	31.0	31.0
	Exceedance Level	-	-	-25.1	-20.2	-14.3	-10.3	-9.7	-9.7	-9.7	-11.5	-16.4	-19.8

H11	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.2	41.5	41.3	41.3	41.3	43.0	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	18.4	23.3	28.2	31.2	31.5	31.5	31.5	31.5	31.5	31.5
	Exceedance Level	-	-	-24.6	-19.7	-14.0	-10.3	-9.8	-9.8	-9.8	-11.5	-15.9	-19.3
H12	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	41.6	41.4	41.4	41.4	43.1	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	18.3	23.1	28.0	31.0	31.3	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-24.7	-19.9	-15.0	-10.6	-10.1	-10.1	-10.1	-11.8	-16.1	-19.5
H14	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.0	41.9	41.9	41.9	43.4	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	17.5	22.3	27.2	30.2	30.5	30.5	30.5	30.5	30.5	30.5
	Exceedance Level	-	-	-25.5	-20.7	-15.8	-11.8	-11.4	-11.4	-11.4	-12.9	-16.9	-20.3
H15	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.4	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	16.8	21.6	26.5	29.5	29.8	29.8	29.8	29.8	29.8	29.8
	Exceedance Level	-	-	-26.2	-21.4	-16.5	-13.5	-13.2	-13.2	-13.2	-14.4	-17.6	-21.0
H17	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	16.5	21.3	26.2	29.2	29.5	29.5	29.5	29.5	29.5	29.5
	Exceedance Level	-	-	-26.5	-21.7	-16.8	-13.8	-13.5	-13.5	-14.6	-18.1	-21.8	-25.5
H19	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	22.6	27.4	32.3	35.3	35.6	35.6	35.6	35.6	35.6	35.6
	Exceedance Level	-	-	-20.4	-15.6	-10.7	-7.7	-7.4	-7.4	-8.5	-12.0	-15.7	-19.4
H20	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	21.1	25.9	30.8	33.8	34.1	34.1	34.1	34.1	34.1	34.1
	Exceedance Level	-	-	-21.9	-17.1	-12.2	-9.2	-8.9	-8.9	-10.0	-13.5	-17.2	-20.9
H21	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.1	47.6	51.3	55.0
	Predicted Wind Turbine Noise L_{A90}	-	-	20.3	25.2	30.1	33.1	33.4	33.4	33.4	33.4	33.4	33.4
	Exceedance Level	-	-	-22.7	-17.8	-12.9	-9.9	-9.6	-9.6	-10.7	-14.2	-17.9	-21.6

* A minor exceedence of 0.1 dB was predicted. Any mode management applied at NAL3 would mitigate the exceedence at H02. The mode management has been applied to these calculations.

Annex 7 – Topographical Corrections/ Turbine Coordinates

Table 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

			Noise Assessment Locations																						
Wind Farm	**Hub**	**T ID**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
ABO Sheskin T1	106	1	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T2	106	2	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T3	106	3	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T4	95	4	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T5	95	5	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T6	95	6	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T7	95	7	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
ABO Sheskin T8	95	8	-2	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T1	120	30	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T2	120	31	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T3	120	32	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T4	120	33	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T5	120	34	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T6	120	35	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T7	120	36	-2	-2	0	0	-2	-2	-2	0	-2	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2
Oweninny 1 T8	120	37	-2	-2	0	0	0	-2	-2	0	-2	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T9	120	38	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T10	120	39	-2	-2	0	0	-2	-2	-2	0	-2	0	0	0	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T11	120	40	-2	-2	0	0	-2	-2	-2	0	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T12	120	41	-2	-2	0	0	-2	-2	-2	0	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T13	120	42	-2	-2	0	0	-2	-2	0	0	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	0	-2	-2	-2
Oweninny 1 T14	120	43	-2	-2	0	0	-2	-2	-2	0	-2	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2
Oweninny 1 T15	120	44	-2	-2	0	0	-2	-2	-2	0	-2	0	0	0	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T16	120	45	-2	-2	0	0	-2	-2	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 1 T17	120	46	-2	-2	0	0	-2	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	0	-2	0	0
Oweninny 1 T18	120	47	-2	-2	0	0	0	-2	0	0	-2	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 1 T19	120	48	-2	-2	0	0	-2	-2	0	0	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	0	-2	-2	0
Oweninny 1 T20	120	49	0	-2	0	0	-2	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	-2	0	0	0	0	0
Oweninny 1 T21	120	50	0	-2	0	0	-2	0	0	0	-2	0	0	-2	-2	-2	-2	-2	-2	0	0	0	0	0	0
Oweninny 1 T22	120	51	0	-2	0	0	-2	0	0	0	-2	0	0	0	-2	-2	-2	-2	-2	0	0	0	0	0	0
Oweninny 1 T23	120	52	0	-2	0	0	0	0	0	0	-2	0	-2	0	-2	-2	-2	0	0	0	0	0	0	0	0

Oweninny 1 T24	120	53	0	-2	0	0	0	0	0	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0
Oweninny 1 T25	120	54	0	-2	0	0	-2	0	0	0	-2	0	0	0	-2	-2	-2	-2	-2	-2	0	0	0	0	0
Oweninny 1 T26	120	55	0	-2	0	0	0	0	0	0	-2	0	0	0	-2	-2	0	0	0	0	-2	0	0	0	0
Oweninny 1 T27	120	56	-2	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0	0
Oweninny 1 T28	120	57	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oweninny 1 T29	120	58	0	-2	0	0	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oweninny 1 T30	120	59	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T1	117	60	-2	-2	0	0	-2	-2	-2	0	0	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	0	-2	0
Oweninny 2 T2	117	61	0	-2	0	0	-2	-2	0	0	0	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	0	0	0
Oweninny 2 T3	117	62	0	-2	0	0	-2	-2	0	0	0	0	0	0	-2	0	0	-2	-2	-2	-2	-2	0	0	0
Oweninny 2 T4	117	63	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2	0	0	0
Oweninny 2 T5	117	64	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T6	117	65	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T7	117	66	0	-2	0	0	-2	-2	0	0	0	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	0	0	0
Oweninny 2 T8	117	67	-2	-2	0	0	-2	-2	-2	0	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	0	-2	0
Oweninny 2 T9	117	68	-2	-2	0	0	-2	-2	-2	0	-2	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	0	-2	0
Oweninny 2 T10	117	69	-2	-2	0	0	-2	-2	-2	0	-2	0	0	0	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2
Oweninny 2 T11	117	70	0	-2	0	0	-2	-2	0	0	0	0	0	0	-2	-2	0	0	0	-2	-2	-2	0	0	0
Oweninny 2 T12	117	71	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	-2	0
Oweninny 2 T13	117	72	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	-2	0
Oweninny 2 T14	117	73	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T15	117	74	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T16	117	75	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T17	117	76	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Oweninny 2 T18	117	77	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	-2	-2
Oweninny 2 T19	117	78	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T20	117	79	0	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	-2	-2
Oweninny 2 T21	117	80	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T22	117	81	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T23	117	82	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T24	117	83	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T25	117	84	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T26	117	85	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T27	117	86	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2
Oweninny 2 T28	117	87	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T29	117	88	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T30	117	89	-2	-2	0	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2
Oweninny 2 T31	117	90	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Sheskin South T1	115	120	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	0	0	-2	-2	-2	0	0	0
Sheskin South T2	115	121	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2	0	0	0
Sheskin South T3	115	122	0	-2	0	0	-2	-2	0	0	0	0	-2	-2	-2	-2	0	-2	-2	-2	-2	-2	0	0	0
Sheskin South T4	115	123	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	-2	0	-2	-2	-2	-2	-2	0	0	0

Sheskin South T5	115	124	0	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T6	115	125	0	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T7	115	126	0	0	3	3	-2	-2	0	3	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T8	115	127	0	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T9	115	128	0	0	0	0	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T10	115	129	0	-2	0	0	-2	-2	0	0	0	0	0	0	-2	-2	0	-2	-2	-2	-2	-2	0	0	0
Sheskin South T11	115	130	0	0	0	0	-2	-2	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T12	115	131	-2	0	0	0	-2	-2	-2	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sheskin South T13	115	132	0	0	3	3	-2	-2	-2	3	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T14	115	133	0	0	0	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T15	115	134	-2	0	0	0	-2	-2	-2	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Sheskin South T16	115	135	0	-2	0	0	-2	-2	0	0	0	0	0	0	0	0	0	-2	-2	-2	-2	-2	0	0	0
Sheskin South T17	115	136	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Sheskin South T18	115	137	0	-2	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Sheskin South T19	115	138	0	0	0	0	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T20	115	139	0	0	0	0	-2	-2	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0
Sheskin South T21	115	140	0	-2	0	0	-2	-2	0	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	0	0	0

Table 2: Wind Farms/ Turbines Modelled

Wind Farm	Easting	Northing	Height	Hub Height Modelled
ABO Sheskin Wind Farm T1	495805	827410	119	106
ABO Sheskin Wind Farm T2	495975	827161	111	106
ABO Sheskin Wind Farm T3	496385	827571	115	106
ABO Sheskin Wind Farm T4	495946	827893	129	95
ABO Sheskin Wind Farm T5	496420	828058	124	95
ABO Sheskin Wind Farm T6	496812	828197	125	95
ABO Sheskin Wind Farm T7	496232	828303	133	95
ABO Sheskin Wind Farm T8	496677	828564	134	95
Oweninny 1 T1	498691	822157	87	120
Oweninny 1 T2	498302	822490	86	120
Oweninny 1 T3	499389	822180	85	120
Oweninny 1 T4	498953	822720	87	120
Oweninny 1 T5	498548	823165	85	120
Oweninny 1 T6	499318	823284	90	120
Oweninny 1 T7	499500	824514	92	120
Oweninny 1 T8	499794	824173	91	120
Oweninny 1 T9	500080	823744	93	120
Oweninny 1 T10	499643	824966	92	120
Oweninny 1 T11	499746	825379	93	120
Oweninny 1 T12	500231	825744	94	120
Oweninny 1 T13	500707	825927	96	120
Oweninny 1 T14	500064	824601	92	120
Oweninny 1 T15	500286	824998	91	120
Oweninny 1 T16	500715	825387	96	120
Oweninny 1 T17	501120	825760	97	120
Oweninny 1 T18	500723	824236	92	120
Oweninny 1 T19	501016	825006	97	120
Oweninny 1 T20	501516	825522	100	120
Oweninny 1 T21	501905	826022	103	120
Oweninny 1 T22	502309	825665	112	120
Oweninny 1 T23	502714	825332	112	120
Oweninny 1 T24	502317	824943	108	120
Oweninny 1 T25	501905	825236	101	120
Oweninny 1 T26	501707	824601	100	120
Oweninny 1 T27	501389	824030	97	120
Oweninny 1 T28	502031	823728	105	120
Oweninny 1 T29	502333	824339	106	120
Oweninny 1 T30	498992	823593	87	120
Oweninny 2 T1	495507	824986	97	117
Oweninny 2 T2	495086	824597	100	117
Oweninny 2 T3	494832	824168	103	117
Oweninny 2 T4	494380	823890	114	117
Oweninny 2 T5	494729	823731	103	117
Oweninny 2 T6	495284	823898	102	117

Oweninny 2 T7	495538	824398	96	117
Oweninny 2 T8	495912	824835	93	117
Oweninny 2 T9	496285	824597	92	117
Oweninny 2 T10	496801	824366	84	117
Oweninny 2 T11	495959	824192	96	117
Oweninny 2 T12	496459	823874	93	117
Oweninny 2 T13	496213	823311	97	117
Oweninny 2 T14	495650	823557	100	117
Oweninny 2 T15	495181	823287	99	117
Oweninny 2 T16	494721	823033	105	117
Oweninny 2 T17	495419	822946	104	117
Oweninny 2 T18	496134	822747	97	117
Oweninny 2 T19	496634	822533	90	117
Oweninny 2 T20	495269	822509	98	117
Oweninny 2 T21	495054	822058	96	117
Oweninny 2 T22	494991	821621	95	117
Oweninny 2 T23	495443	821399	96	117
Oweninny 2 T24	495467	821788	97	117
Oweninny 2 T25	495650	822207	103	117
Oweninny 2 T26	496158	822097	96	117
Oweninny 2 T27	496602	821843	89	117
Oweninny 2 T28	495912	821677	95	117
Oweninny 2 T29	495983	821264	93	117
Oweninny 2 T30	496483	821288	88	117
Oweninny 2 T31	494332	823470	110	117
Sheskin South T1	493541	824049	136	115
Sheskin South T2	492484	824313	162	115
Sheskin South T3	493171	825359	151	115
Sheskin South T4	493318	824924	151	115
Sheskin South T5	492715	826139	196	115
Sheskin South T6	493000	825783	171	115
Sheskin South T7	493158	826709	240	115
Sheskin South T8	493355	827503	236	115
Sheskin South T9	493535	826353	204	115
Sheskin South T10	493769	824835	132	115
Sheskin South T11	493661	827239	199	115
Sheskin South T12	494691	828349	186	115
Sheskin South T13	494085	827802	224	115
Sheskin South T14	494563	827383	181	115
Sheskin South T15	494848	827929	165	115
Sheskin South T16	493115	824241	144	115
Sheskin South T17	492366	823822	178	115
Sheskin South T18	492870	823674	165	115
Sheskin South T19	493729	825892	159	115
Sheskin South T20	494796	826712	155	115
Sheskin South T21	493929	825397	126	115