Foel Fach Wind Farm Limited.

Foel Fach Wind Farm – Environmental Statement Volume III

Appendix 10.2: Wind Turbine Operational Noise Report

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Energy for generations

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Appendix 10.2

Wind Turbine Operational Noise Report

Foel Fach Wind Farm

Foel Fach Wind Farm Limited.

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Executive Summary

TNEI Services was commissioned by Foel Fach Wind Farm Limited to undertake an assessment of the potential impact of operational noise from the proposed Foel Fach Wind Farm (hereinafter referred to as 'the Proposed Development'), at the nearest noise sensitive receptors to the development.

The Welsh Government's approved guidance contained within ETSU-R-97 and current good practice has been used to assess the potential operational phase noise impact of the Proposed Development on the nearest noise sensitive receptors which are neighbouring residential properties.

This operational noise assessment has been undertaken in three stages:

1) Establish the Total ETSU-R-97 Noise Limits for each Noise Assessment Location (NAL) using the measured background noise levels to derive new limits.
2) Undertake noise modelling to determine whether noise predictions from the Proposed Development on its own are within 10 decibels (dB) of the noise predictions from other wind turbines within the area for each NAL. Where turbine predictions are within 10 dB then a cumulative noise assessment has been undertaken for that NAL.
3) Derive the Site Specific Noise Limits (SSNL) for the Proposed Development (through apportioning the Total ETSU-R-97 Noise Limits with other turbines which are within 10 dB) and compare against the noise predictions from the Proposed Development on its own.

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

A total of 12 noise sensitive receptors were chosen as Noise Assessment Locations (NALs). The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Development. Two of these NALs were further from the Proposed Development near to other wind turbines to the north and were included to appraise potential cumulative noise. For the NALs where no background noise measurements were undertaken, background noise data was used from the nearest noise monitoring location, or one which best represented the soundscape of the assessment location.

Wind speed data was measured using a LIDAR wind monitoring unit located within the proposed wind farm site. The wind data measured at 140 metres (m) and 120 m heights was used to calculate 135 m height wind speeds, which was then standardised to a height of 10 m in accordance with current good practice. Thus, the background data and limits are to consider wind turbines up to 135 m hub height, and would be worst-case for wind turbines with lower hub height.

Analysis of the measured wind and noise 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 ETSU-R-97 noise limits at each of the NALs. A 'Noise Limit' of 40 dB(A) fixed minimum or background plus 5 dB (whichever is the greater) daytime and 43 dB(A) fixed minimum or background plus 5 dB (whichever is the greater) night-time was used for this assessment. None of the NALs have been considered with a financial involvement with a fixed minimum limit of 45 dB(A) for both daytime and night-time.

Predictions of wind turbine noise for the Proposed Development were made, based upon the sound power level data for a candidate wind turbine, the Enercon E175-EP5 E2 7 megawatt

(MW), with serrated blades and with a hub height of either 112.5 m or 132.5 m, depending on the proposed turbine location (varying heights across the Proposed Development). The Enercon E175-EP5 E2 is considered to be representative of the type of turbine that could be installed at the proposed wind farm development. For the other cumulative schemes, predictions have been undertaken using sound power level data for the installed turbines or a suitable candidate. Modelling was undertaken using a noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment.

The likely cumulative assessment undertaken shows that the Proposed Development can operate concurrently with the consented and operational wind farms in the area, whilst still meeting the Total ETSU-R-97 Noise Limits at all receptors. The Proposed Development is sufficiently distant from the five operating turbines of 3.4 kilometres (km) to the north that it would not contribute at the NALs close to these turbines, and no cumulative noise impact is anticipated. One nearby wind development has a submitted planning application (Gaerwen) and one nearby wind development is at the scoping stage (Moel Chwa), both were also considered. No cumulative impact is anticipated with these developments either.

Site Specific Noise Limits have been derived based on an apportionment of the Total ETSU-R-97 Noise Limits, to suggest potential limit values that could be used to condition the operation of the Proposed Development on its own. The apportionment was undertaken in accordance with current good practice. Noise predictions for the Proposed Development on its own are below the Site Specific Noise Limits when considering the Enercon E175-EP5 E2 7 MW wind turbine in full mode. As such no noise mitigation measures would be required for that candidate turbine. A second slightly louder candidate wind turbine the Vestas V172 7.2 MW was also assessed and shown to meet the Site Specific Noise Limits.

There are a number of wind turbine makes and models that may be suitable for the proposed wind farm development. Should the Proposed Development receive consent the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would have to meet the noise limits determined and contained within any condition imposed. The use of Site Specific Noise Limits as presented in this report would ensure that the Proposed Development could operate concurrently with other wind turbines in the area and would also ensure that the Proposed Development's individual contribution could be measured and enforced if required.

Should consent be granted for the Proposed Development it would be appropriate to include a set of noise related planning conditions, which detail the noise limits applicable to the Proposed Development. The Site Specific Noise Limits contained in this report would be suitable for inclusion in a noise related planning condition.

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1 Introduction

1.1.1 TNEI was commissioned by Foel Fach Wind Farm Limited to undertake an operational noise assessment for the proposed Foel Fach Wind Farm (hereinafter referred to as 'the Proposed Development').

1.1.2 The following steps summarise the noise assessment process:

- Identify the nearby noise sensitive receptors;
- Measure the background noise levels at a sample of noise sensitive receptors;
- Determine the Total ETSU-R-97 Noise Limits applicable to all wind farms in the area, based on a background noise levels and fixed minimum limits;
- Undertake cumulative noise predictions, where required, to take account of other proposed, consented or operational schemes near to the Proposed Development;
- Compare the predicted cumulative noise levels against the Total ETSU-R-97 Noise Limits;
- Derive Site Specific Noise Limits for the Proposed Development, suitable for inclusion in noise related planning conditions should consent be granted for the Proposed Development;
- Compare the predicted noise levels from the Proposed Development operating on its own 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 Trade and Industry Noise Working Group on Noise from Wind Turbines, which are contained within the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* (ETSU for the DTI (Department of Trade and Industry, 1996) and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (Institute of Acoustics, 2013) (IOA GPG) which represents current good practice.

1.2 Background

1.1.1 The Site is located within a relatively remote area, north-east of the town of Bala, Gwynedd, within the administrative boundary of Gwynedd Council, and close to the border with Conwy Council area which is located to the north of the Site. The approximate UK eastings and northings of the centre of the Site is 293766, 341168.

1.2.1 The properties surrounding the Proposed Development are mainly single, rural dwellings, including farmhouses and holiday cottages which are scattered throughout the area.

1.2.2 The Proposed Development comprises of ten wind turbines with a maximum blade tip height of 220 metres (m). The proposed layout is shown on Figure A1.1a in **Annex 1**.

1.2.3 This noise assessment models a candidate turbine, the Enercon E175-EP5 E2 7 MW, with hub heights of either 112.5 m or 132.5 m depending on the proposed turbine location (varying heights across the Proposed Development). This turbine has been

selected as it is representative of the turbine type which could be installed at the Site within the maximum blade tip height parameter.

1.2.4 The noise assessment has considered schemes which are operational, consented, proposed (planning application submitted) and pre-application (scoping) within approximately 10 kilometres (km). The schemes found to be relevant and considered in this assessment are summarised in **Table 1.1** and are also shown in Figure A1.1b.

Table 1.1 Cumulative Wind Farm/ Turbine Development

Wind Farm/ Wind Turbine	Number of Turbines	Status and Bearing	Approximate distance from the Proposed Development wind turbines (km)	Modelled Turbine
Hafotty Uchaf	4	Operational, to the north	3.4	Vestas V52
Bryn Ffynnon	1	Operational, located to the north near Hafotty Uchaf.	3.4	Enercon E53
Gisgarth Uchaf & Ty'n Gwyn	2	Operational, located north-east.	5.7	Enercon E53
Gaerwen	9	Planning application submitted, scheme located to the east. Candidate turbine was suggested as the SG 6.0-155.	6.4	Siemens Gamesa SG 6.0-155
Moel Chwa	12	Scoping direction submitted, scheme located to the north-east. Candidate turbine was not specified but a 200 m tip height and 79.2 megawatts (MW) was specified.	5.7	Vestas V162

1.2.5 For the purposes of assessing the Proposed Development, the following terms have been referred to throughout the assessment:

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

1.2.6 Note that in this report, the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the received noise) at any receptor location due to the operation of the wind turbines. All references to decibels (dB) are referring to A weighted noise levels (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 are the main documents that have been considered:

- Future Wales: The national plan 2040 and Planning Policy Wales 2024 (Government, 2024);
- 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.

2.1.2 The Proposed Development is considered as a Development of National Significance (DNS) therefore the planning application will have due regard to all material considerations, especially National Planning Policy. Local Policies may also be relevant, albeit with a lower importance, and they are discussed below.

2.2 National Planning Policy

2.2.1 Future Wales: The National Plan 2040 was published in February 2021; it is the national development framework for Wales and has Development Plan status. Policies 17 and 18 confirm that proposals for renewable and low carbon energy projects will be permitted subject to certain criteria including no unacceptable adverse noise impacts.

2.2.2 Planning Policy Wales, Edition 12, published in 2024 details the land use planning policies of the Welsh Government. Section 6.7 Air Quality and Soundscape (Para 6.7.15) – Identifies the importance of creating appropriate soundscapes to enhance well-being, highlighting that planning authorities should consider both the positive and negative impacts of noise.

2.2.3 The guidance document Designing for Renewable Energy in Wales (Design Commission for Wales, December 2023) issued in December 2023 by the Design Commission for Wales sets out the key design objectives and considerations for the sensitive development of large-scale onshore wind and solar farms as well as ancillary development in Wales. This document updates and expands on the previous Designing Wind Farms in Wales 2014 good practice guidance. The guidance states that the Welsh Government has endorsed the current UK wind turbine assessment guidance as set out in ETSU-R-97 and the IOA GPG.

2.2.4 This same endorsement is also repeated in the Welsh Government Noise and Soundscape Action Plan 2023–2028 (NSAP) (Welsh Government, December 2023) also issued in December 2023, which outlines the Welsh public sector's strategic policy direction in relation to noise and soundscape management. Section 5.3 Onshore Wind Turbines states that ETSU-R-97 and the IOA GPG represent the most up-to-date professional guidance, and their use is endorsed by the Welsh Government. The document goes on to state that following the issue of the WSP BEIS (Department for Business, Energy & Industrial Strategy) Report, current UK guidance would benefit from being updated. However no actual alternative guidance

is proposed in the WSP BEIS Report and no final[1] guidance by the UK Government exists at the time of writing this assessment.

2.2.5 The NSAP indicate that the old 1997 Technical Advice 11 (TAN 11) on Noise is being updated to reflect the NSAP so at the time of writing the NSAP and endorsement of ETSU-R-97 and IOA GPG represent the most relevant technical planning guidance for noise from wind farms in Wales.

2.3 Local Policy

2.3.1 The Proposed Development and surrounding receptors are located within the administrative area of Gwynedd Council. There are also very few remote and distant receptors within Conway County Borough Council which have been considered in this noise assessment.

2.3.2 Gwynedd adopted their joint Local Development Plan (LDP) with Anglesey in July 2021. This plan covers parts of Conwy County Borough known as Plan Area which excludes the Eryri National Park area. The LDP sets out key issues for the council to address in Gwynedd and specifically states:
"*The Strategic Policy (PS 1) and Policies ADN 1 (Onshore Wind Energy), ADN 2 (Solar PV Energy) and ADN 3 (Other Renewable and Low Carbon Energy Technology) seek to ensure that the area fulfils its potential as a lead area for initiatives based on renewable or low carbon technologies as well as balancing the impact of renewable energy developments on the environment and communities*."

2.3.3 Section 2.23 of the LDP also states (under Natural Resources Policy):

"*In accordance with the Environment (Wales) Act 2016 the Welsh Government published a Natural Resources Policy (NRP) in August 2017. The focus of the NRP is the sustainable 8 management of Wales' natural resources, to increase their contribution to achieving the aims of the Well-being of Future Generations Act. The NRP identifies three National Priorities: Finding nature-based solutions; increasing renewable energy and more efficient use of resources; and adopting a place-based approach. The NRP also sets the context for Area Statements (which will be produced by Natural Resources Wales), ensuring that the national priorities for the sustainable management of natural resources inform local delivery. Local Planning Authorities will need to have regard to the relevant area statement when preparing an LDP. Both the North West Area Statement and Marine Area Statement are of relevance to the JLDP area. The implications of the relevant NRP and Area Statement will be considered in the preparation of the Revised Plan.*"

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

2.4.1 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

[1] It is acknowledged that the UK Government issued a consultation document on 4th July for new wind turbine noise guidance, however the document cover page clearly states *'This draft guidance update does not represent a final position from government. It should not be used by local planning authorities during or after the consultation period in relation to ongoing planning applications. '*

with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. This methodology was developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.4.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers (EHOs), 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."

2.4.3 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).'*

2.4.4 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."

2.4.5 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."

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

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

2.4.7 The ETSU-R-97 assessment procedure specifies that where wind turbine noise is expected to be above the simplified limit of 35 dB L_{A90} noise limits should be set relative to existing background noise levels at the nearest receptors. These limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for daytime and night-time, are applied

where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2 to 3 m/s) and up to 12 m/s, where all wind speeds are referenced to a 10 m measurement height.

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

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

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

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

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

"The Noise Working Group recommends that both day and night-time lower fixed limits can be increased to 45 dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm."

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

2.5 Current Good Practice

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

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

2.5.2 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 kilowatts (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."

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

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

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

2.6 WSP BEIS Report

2.6.1 In February 2023, WSP published *'A review of noise guidance for onshore wind turbines'* (WSP, 2023)('WSP BEIS report'). The report, which was subsequently re-issued as version 4 in May 2023, was commissioned by (the former) UK Government Department for Business, Energy & Industrial Strategy (BEIS). The primary aim of the review was to make a recommendation on whether, in view of government policies on noise and Net Zero, and available evidence, the existing guidance requires updating.

2.6.2 The WSP BEIS report concluded that:

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

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

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

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

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

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

2.7 ETSU-R-97 Update

2.7.1 In June 2024, the UK Government Department for Energy Security and Net Zero (DESNZ) awarded a contract to Noise Consultants Limited to update ETSU-R-97. A draft update of new guidance 'Assessment and Rating of Wind Turbine Noise' (2025) was published for consultation on 4 July 2025. The closing date for consultation responses was 29 August 2025 and the document cover page states:

"*This draft guidance update does not represent a final position from government. It should not be used by local planning authorities during or after the consultation period in relation to ongoing planning applications…*".

2.7.2 As such this emerging new guidance has not been considered further in this assessment.

3 Potential Impacts

3.1 Operational Noise Sources

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

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low although at very low wind speeds the blades do not rotate, or rotate very slowly, and so negligible aerodynamic noise is generated. In higher winds aerodynamic noise may be masked by the normal sound of wind blowing through the trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines (Frits van den Berg et al, 2008).

3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound can be defined as the frequency range below 20 Hertz (Hz), while low frequency noise (LFN) is typically in the frequency range 20 – 200 Hz (HG, 2004). 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 (Berg, 2004), 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 (Department of Trade and Industry, n.d.). 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; and*
- *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 (Keele University Rejects Renewable Energy Foundation, n.d.) 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 (Institute of Acoustics Bulletin, 2009) 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 (Leventhall, 2013) 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 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 A report produced for the (former) UK Government Department for Business, Energy & Industrial Strategy (BEIS) (the WSP BEIS Report) noted on page 113 that:

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

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

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

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

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

3.2.12 Since the publication of the WSP BEIS report, the study that was granted funding by NHMRC (the National Health and Medical Research Council of Australia) was published in the Environmental Health Perspectives (EHP) journal which is published

by the United States National Institute of Environmental Health. The study (Anon., n.d.) aimed to test the effect of exposure to 72 hours of infrasound (designed to simulate a wind turbine infrasound signature) exposure on human physiology, particularly sleep. The study concluded that:

"Our findings did not support the idea that infrasound causes WTS[2]. High level, but inaudible, infrasound did not appear to perturb any physiological or psychological measure tested in these study participants."

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

3.3 Amplitude Modulation

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 (renewable UK, n.d.) on AM, which reflected the outcomes of research commissioned

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

over the previous three years, together with a template planning condition. Whilst this research undoubtedly improved understanding of 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 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.*
- *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 (Department of Energy & Climate Change, 2016) 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.*
- *An additional decibel penalty is proposed during the night-time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day."*

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

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

3.3.11 In the UK, the most recent notable document relating on how OAM is currently dealt in planning decision notices comes from the Scottish Government who has developed standard noise conditions for wind farms to ensure consistency in approach in planning decisions by the Scottish Ministers and Planning Authorities. On 25 February 2025, the final version of the document called 'Standard onshore wind conditions – section 36 consent and deemed planning permission: form and guidance' (Scottish Government, 2025) was issued following a consultation process and is available online on the Scottish Government website. The document mostly follows the standard conditions from the IOA GPG and no specific wording relating to OAM is included.

3.3.12 Until further studies are completed, and additional guidance is published, the approach set out in the IOA GPG section 7.2.1 remains valid:

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

3.3.13 In light of the latest research and evidence on OAM (also called Excess AM), there are no available method to assess the potential occurrence or significance of OAM at a specific site when at the planning stage and no wind turbines are operating.

4 Methodology

4.1 Assessing Operational Noise Impact

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

- Specify the location of the wind turbines for the Proposed Development and nearby relevant wind turbines / farms;
- Measure noise levels in the area in the absence of wind turbine noise, to establish representative background noise levels across a range of wind speeds;
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise dataset;
- Establish for each NAL the Total ETSU-R-97 Noise Limits, relative to background noise levels or fixed minimums;
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Development and all nearby cumulative wind turbines;
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total ETSU-R-97 Noise Limits;
- Determine the Site Specific Noise Limits which take account of the noise from other wind schemes in the area; and
- Calculate the likely noise immission levels due to the operation of the Proposed Development on its own and compare it to the Proposed Development's Site Specific Noise Limits.

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

- Stage 1 - establish the Total ETSU-R-97 Noise Limits for each Noise Assessment Location (NAL) using the measured background noise levels to derive new limits.

- Stage 2 - undertake noise modelling to determine whether noise predictions from the Proposed Development on its own are within 10 dB of the noise predictions from other wind turbines within the area for each NAL. Where turbine predictions are within 10 dB then a cumulative noise assessment has been undertaken for that NAL.

- Stage 3 - derive the Site Specific Noise Limits (SSNL) for the Proposed Development (through apportioning the Total ETSU-R-97 Noise Limits with other turbines which are within 10 dB) and compare against the noise predictions from the Proposed Development on its own.

4.2 Scoping Direction and Consultation

Scoping Direction

4.2.1 TNEI outlined a methodology for the operational wind turbine noise assessment in a Noise section of the Scoping Report submitted to Planning and Environment Decisions Wales (PEDW). In the Scoping Direction issued in December 2024, PEDW confirmed that the proposed outline noise methodology was appropriate but that on some specific noise topics, further consultation should be undertaken directly with the relevant Councils. Gwynedd Council and Conwy County Borough Council also provided some comments as consultees.

4.2.2 Gwynedd Council agreed with the methodology, specifically the use of ETSU-R-97 and the IOA GPG to assess operational noise. However, the Council did not agree with the assessment of amplitude modulation and low frequency noise being scoped out. As explained in detail in the **Section 3.3** of this report on OAM latest research and practice (and as already outlined in the Scoping Report), NAM is already considered within ETSU-R-97 and there are no method available to assess OAM (also called Excess AM) at the planning stage.

4.2.3 Conwy County Borough Council did not outline any discrepancy with the proposed methodology as a part of their limited response. However, Conwy County Borough Council highlighted two properties of interest that should be considered as receptors and as such these have been included in the noise assessment. The scoping response stated:

"Gellioedd Uchaf – this property should be added to the list of "noise sensitive receptors" and be considered as a monitoring location.

Castell – should be added to the list of "noise sensitive receptors".

Noise Consultation with Gwynedd Council and Conwy County Borough Council

4.2.4 Prior to the commencement of the noise survey, direct consultation was undertaken with the Environmental Health Department at both councils in order to agree the approach to the baseline noise monitoring methodology and locations.

4.2.5 A detailed consultation letter and associated figure was sent by email. An EHO from both councils responded agreeing with the proposed geographic spread of the monitoring locations, and methodology. Both the EHOs were also invited to the installation of noise equipment. As they did not attend, a copy of the noise equipment installation report was sent to both EHOs afterwards. A copy of the original consultation letter is included in **Annex 2**.

4.2.6 Further to Gwynedd Council's Scoping Direction consultation response on the topic of operational noise LFN and OAM, an update was sent in July 2025 to the EHO presenting the latest research regarding LFN and OAM. The information was identical to the sections in this report discussing these two topics and confirmed that it is not necessary or possible to assess LFN and OAM at the planning stage.

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

4.3.1 The baseline noise survey is described in detail in **Section 5** and has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise levels and in turn to establish, for each NAL, the daytime and night-time Total ETSU-R-97 Noise Limits, which would apply for the cumulative operation of all wind turbines in the area.

4.3.2 ETSU-R-97 suggests that the daytime fixed minimum limit criteria should be set somewhere in the range between 35(A) and 40 dB(A). The precise choice of criterion level within the range 35 - 40 dB(A) depends on mostly three factors: the number of dwellings in the neighbourhood of the wind farm, the effect of noise limits on the number of kWh generated and the duration and level of exposure to any noise. Section 3.2.4 of the IOA GPG notes that:

"*It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration and therefore are difficult for noise consultants to fully determine.*"

4.3.3 In order to assist with this choice, based on extensive experience of wind turbine noise environmental impacts in the UK, TNEI is able to provide relevant commentary as per the below **Table 4.1.**

Table 4.1 Choice of Daytime Fixed Minimum Limit

Factor	Guidance in ETSU-R-97	Guidance in IOA GPG	TNEI commentary
1) The number of noise affected properties	*"The planning process is trying to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate. Developers still have to consider the interests of individuals as protected under the Environmental Protection Act 1990."*	*"The number of neighbouring properties will depend on the nature of the area, (rural, semi-rural, urban) and is sometimes considered in relation to the size of the scheme and study area. The predicted 35 dB LA90 contour (at maximum noise output up to 12 m/s) can provide a guide to the dwellings to be considered in this respect."*	The wind turbines will be located in a rural area with a very low number of scattered dwellings surrounding the Site. It is estimated that there are only 3-4 properties near enough to the proposed wind turbines where it may be beneficial to have a value towards the upper end of the range 35-40. Consideration of this test alone suggests that a quiet daytime fixed minimum criteria towards the upper end of the 35-40 dB range permitted in ETSU-R-97 would be appropriate.
2) The effect of using tighter limits on the potential power output of	*"Similar arguments can be made when considering the effect of noise limits on uptake of wind energy. A single wind turbine causing noise levels of 40 dB(A) at several nearby residences would have less planning merit (noise considerations only) than 30 wind turbines also causing the*	*"A decision on the amenity lower fixed limit for the proposed wind farm cumulatively with any other wind farms in the locality should be agreed. Cumulatively, the power generation will have increased due to proposed*	The benefits arising out of the development of renewable is important in the current context of net-zero ambitions and climate change. The Gwynedd Council 'Climate and Nature Emergency Plan 2022/23 - 2029/30' is a response to the Council declaration of Climate Emergency in 2019. It

Factor	Guidance in ETSU-R-97	Guidance in IOA GPG	TNEI commentary
the wind farm:	*same amount of noise at several nearby residences."*	*additional wind turbines, as well as potential noise impact. …The consideration of the various wind farms as a single entity may result in the cumulative amenity lower fixed limit relating to the proposed wind farm in combination with the existing wind farms, differing from the existing individual wind farm's amenity lower fixed limit."*	indicated measures to reduce carbon emission and the need for more renewable electricity generation. The Proposed Development is a DNS and will have a significant renewable energy generating capacity, with a potential up to 72 MW (10 x 7.2 MW). Furthermore, this would be added to the other nearby wind turbines in the area also considered in the cumulative assessment. Consideration of this test alone suggests that a quiet daytime fixed minimum criteria towards the upper end of the 35-40 dB range permitted in ETSU-R-97 would be appropriate.
3) The duration of exposure of these properties.	*"The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35dB(A). This approach is difficult to formulate precisely and a degree of judgement should be exercised."*	*"This last test is more difficult to formulate. But ETSU-R-97 notes that the likely excess of turbine noise relative to background noise levels should be a relevant consideration. In rural areas, this will often be determined by the sheltering of the property relative to the wind farm site. Account can also be taken of the effects of wind directions (including prevailing ones at the Site) and likely directional effects. For cumulative developments, in some cases the effective duration of exposure may increase because of cumulative effects."*	Background noise levels in general are relatively low and are broadly consistent with levels measured at rural locations in the UK. The 3-4 receptors that are likely to benefit from a higher end of the range 35-40 are to the north-west of the Proposed Development wind turbines hence not downwind of prevailing south westerly winds (typical for the UK). Cumulatively, there are 5 x other existing wind turbines to the north (Hafotty and Bryn Fynnon) but when looking at predictions and distances these are relatively distant and not anticipated to contribute to a higher exposure. Consideration of this test alone suggests that a quiet daytime fixed minimum criteria towards the upper end of the 35-40 range permitted in ETSU-R-97 would be appropriate.

4.3.4 Given the low number of properties in the surroundings, the scale of the development as a DNS application with potential significant renewable energy generating capacity, the presence of cumulative wind turbines with additional renewable energy generating capacity in this area and TNEI's experience working on wind farms of this scale, this assessment uses the upper end of the day-time fixed minimum limit of 40 dB(A).

4.3.5 As a summary, the Total Noise Limits rely on the full ETSU criteria which is related to background levels or fixed minimums whichever is the greatest. The full criteria used in this assessment can be summarised as follows:

- Daytime Without Financial Involvement (FI): 40 dB or Background +5 Db;

- Night-time Without Financial Involvement: 43 dB or Background +5 dB; and
- Daytime & Night-time with Financial Involvement : 45 dB or Background +5 dB (not used here as no NAL assumed FI).

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

4.4 Consideration of Likely Effects and the Requirement for a Cumulative Assessment (Stage 2)

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

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

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

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

Noise Prediction / Propagation Model

4.4.3 The ISO 9613-2 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* (International Standards Organisation, 2024) model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors.

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

"ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from onshore 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."

4.4.5 There is currently no standard approach to specifying error bands on noise predictions. 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 onshore 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.

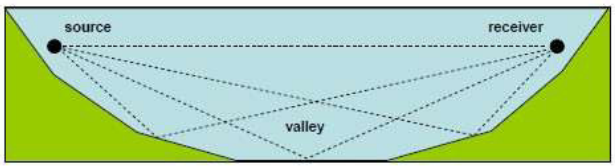
4.4.9 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, 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

4.4.10 to 4.4.13. Any differences in ground height Above Ordnance Datum (AOD) between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

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

Schematic 4.1 Multiple reflection paths for sound propagation across concave ground



Source: IOA GPG, page 21, Figure 5

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

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

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

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

4.4.14 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. 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.

4.4.15 The modelling parameters used in this assessment are detailed in **Section 6.2.1** below.

4.5 Setting the Site Specific Noise Limits (Stage 3)

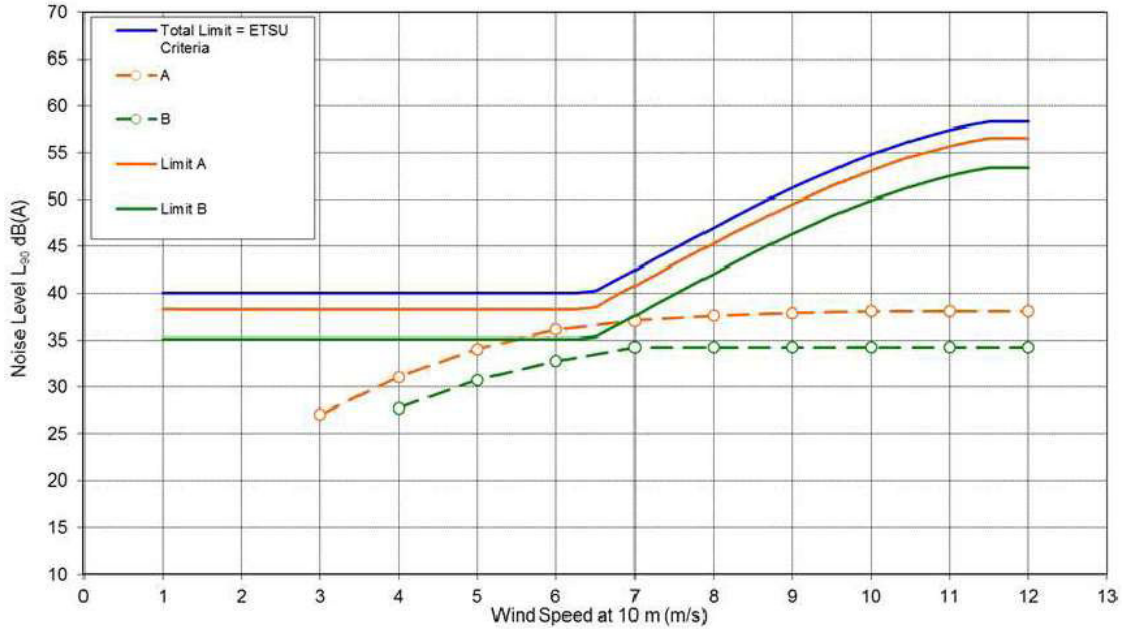
4.5.1 Summary Box 21 of the IOA GPG states:

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

4.5.2 In order to determine site specific noise limits at receptors in proximity to the Proposed Development, where required an apportionment of the Total ETSU-R-97 noise limits has been undertaken. The limit apportionment has considered the noise limit already allocated to other wind farms in the area.

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

Graph 4.1 Limit Apportionment Example



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

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

4.5.5 Information on the approach to apportionment for Site Specific Noise Limits is made on a receptor-by-receptor basis and specific detail of the chosen approach for each receptor is provided in **Section 6.6** below.

5 Baseline

5.1 Identification of Potential Noise Receptors

5.1.1 For the proposed Foel Fach Wind Farm, a background noise survey was undertaken by TNEI from 17/10/2024 – 16/12/2024 to inform the assessment. The survey was conducted in accordance with good practice for wind farm noise assessments and has been used in this assessment to represent existing background noise levels (and to set limits relative to it).

5.1.2 At the start of the noise assessment, preliminary desktop noise modelling was undertaken in order to locate noise sensitive receptors which may be affected and to identify suitable locations at which to monitor background noise levels. An initial wind turbine layout and candidate turbine sound power data at maximum noise output circa 10 m/s (standardised to 10 m height) was used to produce an initial noise contour plot. The noise contour plot was included in the Scoping Report and subsequently in the consultation letter sent to the Environmental Health Department at Gwynedd Council and Conwy County Borough Council. A copy of the consultation letter inclusive of the figure showing initial noise contours is included in **Annex 2**.

5.1.3 The initial noise contour plot predicted wind turbine noise levels at the noise sensitive receptors surrounding the Proposed Development with predicted turbine noise (measured in dB(A), L90) decreasing with distance from the Proposed Development. All properties or clusters of properties within the 35 dB(A) contour were identified and assessed to determine which properties to assess and monitor. Some receptors located marginally outside of the 35 dB contour were also included for completeness due to their proximity and the potential topographical effects which were not considered within the noise contour plot.

5.1.4 The IOA GPG notes that *"noise-sensitive receptors, [are] principally houses (existing or for which planning consent is being sought / has been given) and any building used for long-term residential purposes (such as a nursing home)"*. Following a detailed review of the initial noise contours and the area using aerial photography, the closest receptors were all found to be scattered residential properties most in relatively remote / isolated locations.

5.2 Background Noise Survey

5.2.1 Some sample locations for noise monitoring were selected amongst the identified receptors. Where possible, locations were selected which were subject to minimal influence from other noise sources such as local watercourses, operational wind turbines and vegetation.

5.2.2 Background noise monitoring was undertaken for the purposes of establishing existing noise levels in the area and setting the Total ETSU-R-97 Noise Limits. Noise monitoring equipment was installed at four Noise Monitoring Locations (NMLs) on the 17 October 2024. An installation report was sent to the EHOs at both councils afterwards. The NMLs were removed on 16 November at one location (at request of resident) and on 16 December 2024 at the other three locations.

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 Noise Monitoring Location (NML) 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	Easting	Northing	Comment / Observation
NML1 – Llaithgwm	292130	292130	Measurement period 17/10 to 16/12 but gap with no saved data between 23/10 (when card was full) and 14/11 (onsite maintenance of kit). The soundscape at this location consisted of noise from small watercourses, which were located all around the property, but in particular noise from a watercourse from a field to the north where it was judged too close to watercourse. The exact kit location was selected on the eastern edge of the field to move the kit away from watercourses and to remove the risk of damage from animals in the adjacent fields surrounding. The watercourses were faintly audible from this location and the dominant noise was the wind induced foliage noise. A number of farm animals such as sheep, goats, cows, and dogs were also audible on occasions.
NML2 – Greigwen	292970	342354	Measurement period 14/11 to 16/12, there was no gap but no saved data between 17/10 (installation day) and 14/11 (onsite maintenance of kit) due to equipment abnormal failure. The soundscape at this location consisted of wind-induced noise, which was dominant, followed by wind induced foliage rustle. No other aspects of the soundscape have been identified. Very quiet isolated rural location relatively elevated above the valley and exposed to south westerly winds (topography slope from south-west to north-east).
NML3 – Cwm Hwylfod	296940	341252	Measurement period 17/10 to 14/11. The equipment was removed on 14/11 at the request of the resident. The noise monitoring equipment was installed in a field immediately north of the dwelling at Cym Hwylfod, which is also immediately south of Pentre. The soundscape at this location consisted of sheep calls, some foliage rustle, and a small watercourse towards the north which was faintly audible.
NML4 – Penmaen Uchaf	292953	339133	Measurement period 17/10 to 16/12. The noise monitoring equipment was installed in a field along the track between Penmaen Ganol and Penmaen Uchaf, where it was agreed with the landowner that cattle could not access the equipment. Another location was considered with the landowner on the day, further south at the unoccupied dwelling of Penmaen Ganol, however this would have been within a few meters of another watercourse and may have required building fences to avoid cattle accessing the equipment so this location was not used. The soundscape at this location consisted of wind-induced foliage rustle, which was dominant, there was also a water course towards the east which was audible. Very remote and isolated derelict property.

5.3 Noise Monitoring Equipment

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

"Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 millimetres (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 0.2 dB as detailed in the FDS (included in **Annex 3**), therefore all recorded data is valid.

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 3**. All sound level meters conform to Class 1/ Type 1.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *"in an area frequently used for rest and relaxation"* (Section 2.5.1 of IOA GPG), where appropriate, away from obvious local sources of noise such as boiler flues, fans and running water. For NML1, NML3 and NML4 running water noise was noted and was unavoidable given the land where access was granted permission for monitoring and as noted in the observations efforts were made to locate equipment away from watercourses. The measured noise levels were also reviewed in detail, along with historical rainfall data, and some periods were discarded as explained later in **Section 5.4**.

5.3.5 All measurement systems were set to log the L_{A90} and L_{Aeq} noise levels over the required 10 minute intervals continuously over the deployment period.

5.4 Meteorological Data and Wind Shear Considerations

5.4.1 Wind shear can be defined as *"the change in the relationship between wind speed at different heights".* Due to wind shear, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4 m/s is recorded at 80 m height, 3.5 m/s may be recorded at 40 m and 2.5 m/s may be recorded at 10 m.

5.4.2 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 rotation speed of the blade hence 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.

5.4.3 During the noise survey, concurrent wind speed/direction were recorded using a LIDAR device which was located within the Site at approximate coordinates 293166, 341149. The meteorological data was collected and provided by Coriolis Energy /

ESB to TNEI. The installation report and calibration information for the LIDAR can be provided upon request.

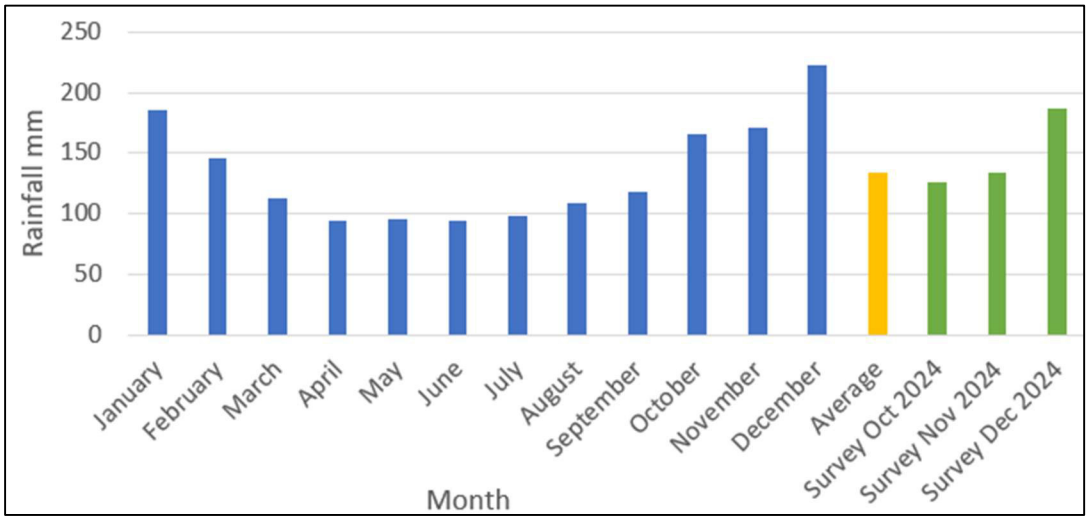
5.4.4 The wind data measured at 140 m and 120 m heights was used to calculate 135 m height wind speeds, which was then standardised to a height of 10 m in accordance with current good practice. Thus, the background data and limits are to consider wind turbines up to 135 m hub height and would be worst-case for wind turbines with lower hub height.

5.4.5 Wind speed and direction data were collected over the same time-scale, and averaged over the same 10 minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

5.4.6 Tipping bucket rain gauges were installed by TNEI at NML1 and NML4 to record periods of rainfall, and time synchronised to the noise measurements. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were analysed and the 10 minute periods which contain the registered rainfall events and the preceding 10 minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2d (**Annex 1**) as blue squares.

5.4.7 The **Graph 5.1** below presents a review of historical rain data (sourced from Met Office, for 10 year average) with the monthly rainfall during the survey in October to December 2024 (sourced from Met Office historical data for Wales). It shows that all months were below historical averages per individual month, and October and November were also below the yearly average.

Graph 5.1 Comparison of Long Term Rain Data and Rain Data recorded during Background Noise Survey



5.4.8 Upon review of the observations and data, it was noted that the running water noise was part of the environment at NML1, NML3 and NML4. At NML1, the influence was minimal as this was a minor unnamed stream of water through the courtyard near to where the outdoor residential amenity is found.

5.4.9 At NML3, the stream Nant Cefn-coch was approximately 35 m from the monitoring location and approximately 25 m from the nearby house of Pentre and 55 m from

Cwn Hwylfod (both houses are intended to be represented by NML3). These distances are also presented in a graphic in the Field Data Sheet found in **Annex 3**. Given these relative distances and the fact that the survey at NML3 was only in October and November (not in December for this location) where historical rainfall was below average, it was judged that the measured data at NML3 should be representative of Pentre and Cwn Hwylfod.

5.4.10 At NML4, review of the time series indicated some unexpected changes in noise levels which could not be associated with a constant flow of water over the nearby local stream. The noise was a at a certain level for a few days and suddenly would drop to much lower levels for several days and then suddenly raise again to much higher levels for several days, as if a generator of plant would come on at certain times and then switch off. This was investigated but the location is very remote (derelict property which is hard to access) and no human activities or plant was noted onsite. After a thorough investigation, it was found that ahydro-electric scheme operated on this stream, there is a reservoir above and pipeline underground not visible from the kit location. It is assumed that on some days the waterflow in the stream would be much higher when the water is not being released via the pipelines sending water to the generator station in the bottom of the valley. As can be seen on the time series and regression analysis graphics, a large amount of data (shown in red) was removed for all the days with elevated noise levels.

Influence of Existing Turbines on Background Measurements

5.4.11 The IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise, some steps must be taken to try remove wind turbine noise, with the aim of setting background noise levels in the absence of any wind turbine noise. No operational wind turbines were seen or heard at the four monitoring locations, so the background noise levels are accordingly in the absence of any wind turbine noise.

5.5 Directional Filtering of Background Noise

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

5.5.2 For this Site there are no such dominant local noise sources, so no directional filtering was undertaken.

5.6 Prevailing Background Noise Level

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

5.6.2 Time series graphs are provided in **Annex 5**, which show the variation in measured wind speed/direction and noise level over the monitoring period. These graphs also

show where data was excluded, either due to rainfall, birdsong or manual exclusions due to atypical data.

5.6.3 A series of graphs are presented for each of the NMLs to illustrate the data points collected for the regression analysis, these are included as Figures A1.2a - A1.2d (**Annex 1**). There is a set of graphs for each of the NMLs, which show the range of wind speeds and directions recorded during the survey at the nearest meteorological mast and the 10 minute average wind speeds plotted against the recorded $L_{A90,\ 10min}$ noise levels at the NML along with a calculated 'best fit' polynomial regression line for the quiet daytime and night time periods.

5.6.4 The figures A1.2a - A1.2d also includes a table with the count of recorded data points per integer wind speed bin and the prevailing measured background noise levels. For all NMLs, there is significantly more than the minimum criteria of 200 data points overall for both day and night. The minimum criteria of 5 data points per bin is achieved in the range 2-12 m/s day and night.

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

5.6.6 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. The same has been applied at higher wind speeds if required, taking a conservative approach by assuming that noise would not increase as wind speed increase. These minor adjustments are 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 through the data is shown as a dashed black line.

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

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

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 - Llaithgwm	36.2	36.2	36.5	36.9	37.5	38.2	39.2	40.3	41.5	43.0	44.6	46.4
NML2 – Greigwen	27.3	27.3	27.7	28.3	29.3	30.5	32.0	33.8	35.9	38.3	41.0	43.9
NML3 – Cwm Hwylfod	40.9	41.6	42.2	42.8	43.5	44.1	44.7	45.4	46.0	46.7	47.3	47.9
NML4 – Penmaen Uchaf	28.8	29.7	30.7	31.6	32.5	33.4	34.3	35.2	36.1	37.0	37.9	38.8

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12

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 - Llaithgwm	35.2	35.6	36.0	36.7	37.4	38.3	39.3	40.4	41.6	43.0	44.5	46.1
NML2 – Greigwen	28.0	28.0	28.2	28.7	29.6	30.7	32.1	33.8	35.9	38.2	40.8	43.7
NML3 – Cwm Hwylfod	40.9	41.4	41.9	42.4	42.9	43.5	44.0	44.5	45.0	45.5	46.1	46.6
NML4 – Penmaen Uchaf	29.5	30.1	30.6	31.1	31.7	32.2	32.7	33.3	33.8	34.3	34.8	35.4

6 Noise Assessment Results

6.1 Noise Assessment Locations

6.1.1 Noise Assessment Locations (NAL) refer to the position where a detailed assessment was undertaken, denoted by the blue house symbol on Figure A1.1 (**Annex 1**). A total of twelve noise sensitive receptors were chosen as NALs. The NALs chosen were the closest receptors to the Proposed Development in any direction and with the inclusion of two receptors further away near the five operating wind turbines of Hafotty Uchaf and Bryn Ffynnon to the north. Predictions of wind turbine noise have been made at each of the NALs detailed in **Table 6.1**, where coordinates are intended to be the closest edge of the amenity area (usually the garden) to the wind turbines.

6.1.2 This approach ensures that the report models the worst case (highest) noise immission level expected at each group of noise sensitive receptors, as, generally speaking, sound levels decrease due to the attenuating factors described in **Section 6.3** and thus the closer to a noise source, the higher the noise level.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance to Nearest Foel Fach Turbine* (m)	Background Noise Data used
NAL01 Greigwenr	292970	342354	316	1032 (T02)	NML02
NAL02 Ty'n Y Ddol Uchaf	292439	342182	360	1291 (T02)	NML02
NAL03 Maespyllan	292377	341785	383	1074 (T01)	NML02
NAL04 Llaithgwm	292130	341006	385	928 (T01)	NML01
NAL05 Penmaen Uchaf	292953	339133	310	1793 (T04)	NML04
NAL06 Creigiau Uchaf	294675	339377	366	1264 (T04)	NML04
NAL07 Pentre	295563	340272	361	957 (T10)	NML03
NAL08 Cwm Cywen	296940	341252	359	1876 (T10)	NML02
NAL09 Cwm Llan	296104	343009	414	1801 (T05)	NML02
NAL10 Rhyd Yr Ewig	293355	343343	382	1637 (T06)	NML02
NAL11 Gellioedd Uchaf	293067	344924	328	3120 (T05)	N/A- see **Section 6.5**
NAL12 Castell	292538	345169	376	3600 (T05)	

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

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the Proposed Development. This assessment considers the Enercon E175-EP5 E2 7 MW with hub heights of either 112.5 m or 132.5 m, the coordinates of which are provided in **Annex 6**. The wind turbines considered for the other nearby wind farms considered are also detailed in **Annex 6** and all wind turbines are shown on Figure A1.1b in **Annex 1**.

6.2.2 Details of the sound power level, octave data and measurement uncertainty used for all the turbines considered in this assessment are included in **Annex 7**. Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG.

6.2.3 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 source data as per Section 4.2 of the IOA GPG. The uncertainty level added by TNEI when interpreting manufacturer data is generally +2 dB but this can vary depending on the turbine manufacturer data available for each turbine.

6.2.4 Manufacturer data is usually supplied based on a specific hub height whilst values are presented as standardised to 10 m height. The noise model used in this assessment alters turbine noise data to account for different hub heights, where applicable. The hub height considered for each individual wind turbine is detailed in **Annex 6**.

6.3 Noise Propagation Parameters

6.3.1 The full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors. For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4 m above local ground level, mixed ground (G=0.5) and air absorption co-efficients based on a temperature of 10 °C and 70 % relative humidity to provide a realistic impact assessment. The modelling parameters reflect current good practice as detailed within the IOA GPG.

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

6.3.3 A topographical assessment has been undertaken between each noise sensitive receptor and wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA (DataKustik Gmbh, n.d.) 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 5**.

6.3.4 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 noise sensitive receptor, it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors as detailed in **Annex 5.** 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 in all of the Tables and Graphs in this report.

6.3.5 The noise predictions have 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 foot (ft) above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

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

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

6.3.8 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 **Table 6.2**. These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required, and adopting a single attenuation value for receptors located more than 5 tip heights from a turbine.

Table 6.2 Wind Directivity Attenuation Factors used in Modelling

Direction (°)	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 (°)	180	195	210	225	240	255	270	285	300	315	330	345
Attenuation (dB(A))	0	0	0	0	0	0	-2	-4.6	-6.7	-8.3	-9.3	-9.9

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

6.4.1 The Total ETSU-R-97 Noise Limits assumed for each of the NALs selected for the cumulative assessment (further detail of which is presented in **Section 6.5**) are detailed in **Table 6.3** below.

Table 6.3 Total ETSU-R-97 Noise Limits Quiet Daytime

Location	Wind Speed (m/s) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
NAL02-Ty'n Y Ddol Uchaf	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
NAL03-Maespyllan	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
NAL04-Llaithgwm	41.2	41.2	41.5	41.9	42.5	43.2	44.2	45.3	46.5	48	49.6	51.4
NAL05-Penmaen Uchaf	40	40	40	40	40	40	40	40.2	41.1	42	42.9	43.8
NAL06-Creigiau Uchaf	40	40	40	40	40	40	40	40.2	41.1	42	42.9	43.8
NAL07-Pentre	45.9	46.6	47.2	47.8	48.5	49.1	49.7	50.4	51	51.7	52.3	52.9
NAL08-Cwm Cywen	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
NAL09-Cwm Llan	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
NAL10-Rhyd Yr Ewig	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9

Location	Wind Speed (m/s) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL11-Gellioedd Uchaf and NAL12 - Castell	N/A – see **Section 6.5**											

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

Location	Wind Speed (m/s) as standardised to 10 m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL02-Ty'n Y Ddol Uchaf	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL03-Maespyllan	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL04-Llaithgwm	43	43	43	43	43	43.3	44.3	45.4	46.6	48	49.5	51.1
NAL05-Penmaen Uchaf	43	43	43	43	43	43	43	43	43	43	43	43
NAL06-Creigiau Uchaf	43	43	43	43	43	43	43	43	43	43	43	43
NAL07-Pentre	45.9	46.4	46.9	47.4	47.9	48.5	49	49.5	50	50.5	51.1	51.6
NAL08-Cwm Cywen	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL09-Cwm Llan	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL10-Rhyd Yr Ewig	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
NAL11-Gellioedd Uchaf and NAL 12 Castell	N/A – see **Section 6.5**											

6.5 Cumulative Assessment and the Likely Effects (Stage 2)

6.5.1 A cumulative noise assessment was undertaken at all NALs. Figures A1.3a-l (**Annex 1**) show likely cumulative noise predictions against the Total ETSU-R-97 Noise Limits. The individual contributions of all the individual wind farms considered are also shown.

6.5.2 At locations NAL01-10 (nearest to the Proposed Development), the cumulative assessment provided in these Figures A1.3a-j show that the Proposed Development is as expected the main wind farm contributing to the cumulative predictions and Total ETSU-R-97 noise limits are met by cumulative predictions.

6.5.3 The figures also show that at NAL01-07 the cumulative predictions are equal to the Proposed Development predictions, therefore other nearby wind development considered are at least 10 dB below and not contributing so **no significant cumulative impact** is predicted at NAL01-07.

6.5.4 At NAL08-10, the cumulative predictions are slightly higher than the Proposed Development predictions, therefore other nearby wind development considered are within 10 dB and have a small contribution. However, it should be noted that this finding for NAL08-10 assumes some developments are at scoping and as stated in 6.5.2 the cumulative predictions remain well below the Total ETSU-R-97 limits, as such no significant cumulative impact is predicted at NAL08-10.

6.5.5 At NAL11-12 which are very distant from the Proposed Development, the figures show that predictions for the Proposed Development are low and more than 10 dB below the wind turbine noise from the five operational wind turbines of Hafotty Uchaf and Bryn Ffynnon. As such, based on the 10 dB rule, the Proposed Development would not contribute to cumulative noise at these two receptors and **no significant cumulative noise** is predicted at NAL11-12. These two receptors NAL11 and 12 do not require to be considered further and are excluded from the next part of this assessment.

6.5.6 **Table 6.5** below summarises the results of the cumulative noise assessment.

Table 6.5 Cumulative Assessment Summary

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Cumulative Assessment
NAL01-07	NO	No contribution from any other nearby wind turbines / farms considered, only the Proposed Development contributes to the overall noise level. The Total ETSU-R-97 limits are met. No significant cumulative effects are predicted and the Proposed Development can be allocated the Total ETSU-R-97 Noise Limits for the Site Specific Noise Limits.
NAL08-10	YES	Small contribution from other nearby wind turbines / farms considered but this includes some wind farms at still at the scoping stage. The Total ETSU-R-97 limits are met. **No significant cumulative effects**

Noise Assessment Location (NAL)	Are predicted wind turbine noise levels within 10 dB?	Cumulative Assessment
		are predicted and a minor apportionment of the Total ETSU-R-97 Noise Limits may be required for the Site Specific Noise Limits.
NAL11-12	NO	No contribution from the Proposed Development as it is 10 dB below Hafotty Uchaf and Bryn Ffynnon predicted noise levels. No requirement to assess these two receptors further and no requirement to set noise limits (Total and Site Specific).

6.5.7 **Table 6.6** and **Table 6.7** detail the results of the cumulative noise assessment and show that the predicted cumulative wind turbine noise immission levels meet the Total ETSU-R-97 Noise limits under all conditions at all relevant NAL01 to NAL10.

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

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30	34.9	38.4	39	39	39	39	39	39
	Exceedance Level	-	-	-	-10	-5.1	-1.6	-1	-1	-1.9	-4.3	-7	-9.9
NAL02-Ty'n Y Ddol Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.2	33.1	36.7	37.3	37.3	37.3	37.3	37.3	37.3
	Exceedance Level	-	-	-	-11.8	-6.9	-3.3	-2.7	-2.7	-3.6	-6	-8.7	-11.6
NAL03-Maespyllan	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.2	34.2	37.8	38.3	38.3	38.3	38.3	38.3	38.3
	Exceedance Level	-	-	-	-10.8	-5.8	-2.2	-1.7	-1.7	-2.6	-5	-7.7	-10.6
NAL04-Llaithgwm	Total Noise Limit: ETSU-R-97 L_{A90}	41.2	41.2	41.5	41.9	42.5	43.2	44.2	45.3	46.5	48	49.6	51.4
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.8	37.4	37.9	37.9	37.9	37.9	37.9	37.9
	Exceedance Level	-	-	-	-13.1	-8.7	-5.8	-6.3	-7.4	-8.6	-10.1	-11.7	-13.5
NAL05-Penmaen Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40.2	41.1	42	42.9	43.8

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.9	29.8	33.3	33.8	33.8	33.9	33.9	33.9	33.9
	Exceedance Level	-	-	-	-15.1	-10.2	-6.7	-6.2	-6.4	-7.2	-8.1	-9	-9.9
NAL06-Creigiau Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40.2	41.1	42	42.9	43.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	32.3	35.9	36.4	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-	-12.6	-7.7	-4.1	-3.6	-3.8	-4.7	-5.6	-6.5	-7.4
NAL07-Pentre	Total Noise Limit: ETSU-R-97 L_{A90}	45.9	46.6	47.2	47.8	48.5	49.1	49.7	50.4	51	51.7	52.3	52.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.7	34.6	38.2	38.6	38.6	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-18.1	-13.9	-10.9	-11.1	-11.8	-12.3	-13	-13.6	-14.2
NAL08-Cwm Cywen	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.1	29.7	33.1	33.6	33.6	33.7	33.7	33.7	33.7
	Exceedance Level	-	-	-	-14.9	-10.3	-6.9	-6.4	-6.4	-7.2	-9.6	-12.3	-15.2
NAL09-Cwm Llan	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.8	28.5	32	32.7	32.8	32.9	32.9	32.9	32.9
	Exceedance Level	-	-	-	-16.2	-11.5	-8	-7.3	-7.2	-8	-10.4	-13.1	-16

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL10-Rhyd Yr Ewig	Total Noise Limit: ETSU-R-97 L_{A90}	40	40	40	40	40	40	40	40	40.9	43.3	46	48.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27	31.7	35.2	36.1	36.3	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-	-13	-8.3	-4.8	-3.9	-3.7	-4.5	-6.9	-9.6	-12.5

Note: For the noise predictions, the noise model considers the range of noise data available for each turbine type modelled. Noise data is usually not available for very low wind speeds therefore no predictions are included for some low wind speeds.

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

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30	34.9	38.4	39	39	39	39	39	39
	Exceedance Level	-	-	-	-13	-8.1	-4.6	-4	-4	-4	-4.2	-6.8	-9.7
NAL02-Ty'n Y Ddol Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.2	33.1	36.7	37.3	37.3	37.3	37.3	37.3	37.3
	Exceedance Level	-	-	-	-14.8	-9.9	-6.3	-5.7	-5.7	-5.7	-5.9	-8.5	-11.4
NAL03-Maespyllan	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.2	34.2	37.8	38.3	38.3	38.3	38.3	38.3	38.3
	Exceedance Level	-	-	-	-13.8	-8.8	-5.2	-4.7	-4.7	-4.7	-4.9	-7.5	-10.4
NAL04-Llaithgwm	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43.3	44.3	45.4	46.6	48	49.5	51.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.8	37.4	37.9	37.9	37.9	37.9	37.9	37.9
	Exceedance Level	-	-	-	-14.2	-9.2	-5.9	-6.4	-7.5	-8.7	-10.1	-11.6	-13.2

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL05-Penmaen Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43	43	43
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.9	29.8	33.3	33.8	33.8	33.9	33.9	33.9	33.9
	Exceedance Level	-	-	-	-18.1	-13.2	-9.7	-9.2	-9.2	-9.1	-9.1	-9.1	-9.1
NAL06-Creigiau Uchaf	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43	43	43
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	32.3	35.9	36.4	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-	-15.6	-10.7	-7.1	-6.6	-6.6	-6.6	-6.6	-6.6	-6.6
NAL07-Pentre	Total Noise Limit: ETSU-R-97 L_{A90}	45.9	46.4	46.9	47.4	47.9	48.5	49	49.5	50	50.5	51.1	51.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.7	34.6	38.2	38.6	38.6	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-17.7	-13.3	-10.3	-10.4	-10.9	-11.3	-11.8	-12.4	-12.9
NAL08-Cwm Cywen	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.1	29.7	33.1	33.6	33.6	33.7	33.7	33.7	33.7
	Exceedance Level	-	-	-	-17.9	-13.3	-9.9	-9.4	-9.4	-9.3	-9.5	-12.1	-15
NAL09-Cwm Llan	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	23.8	28.5	32	32.7	32.8	32.9	32.9	32.9	32.9
	Exceedance Level	-	-	-	-19.2	-14.5	-11	-10.3	-10.2	-10.1	-10.3	-12.9	-15.8
NAL10-Rhyd Yr Ewig	Total Noise Limit: ETSU-R-97 L_{A90}	43	43	43	43	43	43	43	43	43	43.2	45.8	48.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27	31.7	35.2	36.1	36.3	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-	-16	-11.3	-7.8	-6.9	-6.7	-6.6	-6.8	-9.4	-12.3

Note: For the noise predictions, the noise model considers the range of noise data available for each turbine type modelled. Noise data is usually not available for very low wind speeds therefore no predictions are included for some low wind speeds.

6.6 Derivation of Site Specific Noise Limits (Stage 3)

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

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

6.6.2 The stage 2 has demonstrated that there would be no cumulative excess of the Total ETSU-R-97 noise limit. This stage 3 is a further step to consider the fact nearby wind farms may have the right to operate at higher levels than 'likely' predictions and also to consider potential noise conditions applicable to the Proposed Development on its own.

6.6.3 Site Specific Noise Limits have been calculated as an apportionment of the Total ETSU-R-97 noise limits where required. The modelling done for any apportionment assumes that all nearby wind turbines considered are operating and with wind blowing in the worst-case direction (highest predictions without the Proposed Development), which can lead to an assumed situation were at the same time a NAL will be in upwind conditions from the Proposed Development. Because the SSNL are intended to be tested in downwind (not upwind), these are very much worst-case assumptions when setting the SSNLs.

6.6.4 The apportionment options provided in the IOA GPG were considered to determine the most appropriate option for each NAL, as detailed in **Table 6.8.**

Table 6.8 Limit Derivation Strategy

NAL	Limit Derivation Strategy
NALs 01-07	The likely predictions level from other schemes were found to be more than 10 dB below the Total ETSU-R-97 Noise Limits and as such the entire noise limits has been allocated to the Proposed Development.
NALs 08-10	At some wind speeds the likely predictions level from the nearby wind turbines were found to be within 5 - 10 dB of the TNL. As such, a 2 dB cautious buffer has been added to the nearby turbines noise predictions (to assume they could have the right to be louder) and the resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the Site Specific Noise Limit.

6.6.5 A series of graphs to show the predicted wind turbine noise from the Proposed Development compared to the Site Specific Noise Limits are included as Figures A1.4a - A1.4j (**Annex 1**). These graphs show the Total ETSU-R-97 Noise Limit (solid red line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the Proposed Development on its own in full mode for the candidate turbine (solid blue line). Predictions for a second candidate turbine the Vestas V172 7.2 MW are also shown on these graphs.

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

6.6.7 The tables show that the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods. The candidate turbine was chosen as it is considered to be representative of the type of turbine that could be installed at the Site. The graphs show a second candidate turbine that is slightly noisier and also meet the Site Specific Noise Limits. There are a number of wind turbine makes and models that may be suitable for the Proposed Development, 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 have to meet the noise limits.

Table 6.9 Site Specific Noise Limits Compliance Table – Daytime

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	29.8	34.8	38.3	38.8	38.8	38.8	38.8	38.8	38.8
	Exceedance Level	-	-	-	-10.2	-5.2	-1.7	-1.2	-1.2	-2.1	-4.5	-7.2	-10.1
NAL02-Ty'n Y Ddol Uchaf	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	27.8	32.7	36.4	36.8	36.8	36.8	36.8	36.8	36.8
	Exceedance Level	-	-	-	-12.2	-7.3	-3.6	-3.2	-3.2	-4.1	-6.5	-9.2	-12.1
NAL03-Maespyllan	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.9	43.3	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	28.9	33.9	37.5	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-11.1	-6.1	-2.5	-2.0	-2.0	-2.9	-5.3	-8.0	-10.9
NAL04-Llaithgwm	Site Specific Noise Limit L_{A90}	41.2	41.2	41.5	41.9	42.5	43.2	44.2	45.3	46.5	48.0	49.6	51.4
	Predicted Proposed Development Noise L_{A90}	-	-	-	28.6	33.6	37.2	37.7	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-	-13.3	-8.9	-6.0	-6.5	-7.6	-8.8	-10.3	-11.9	-13.7
NAL05-Penmaen Uchaf	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.2	41.1	42.0	42.9	43.8
	Predicted Proposed Development Noise L_{A90}	-	-	-	24.4	29.4	33.0	33.5	33.5	33.5	33.5	33.5	33.5
	Exceedance Level	-	-	-	-15.6	-10.6	-7.0	-6.5	-6.7	-7.6	-8.5	-9.4	-10.3
NAL06-Creigiau Uchaf	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.2	41.1	42.0	42.9	43.8
	Predicted Proposed Development Noise L_{A90}	-	-	-	27.1	32.1	35.7	36.1	36.1	36.1	36.1	36.1	36.1

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Exceedance Level	-	-	-	-12.9	-7.9	-4.3	-3.9	-4.1	-5.0	-5.9	-6.8	-7.7
NAL07-Pentre	Site Specific Noise Limit L_{A90}	45.9	46.6	47.2	47.8	48.5	49.1	49.7	50.4	51.0	51.7	52.3	52.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.4	34.4	38.0	38.5	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-	-18.4	-14.1	-11.1	-11.2	-11.9	-12.5	-13.2	-13.8	-14.4
NAL08-Cwm Cywen	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	40.0	39.5	39.5	40.9	43.3	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	23.7	28.7	32.2	32.7	32.7	32.7	32.7	32.7	32.7
	Exceedance Level	-	-	-	-16.3	-11.3	-7.8	-6.8	-6.8	-8.2	-10.6	-13.3	-16.2
NAL09-Cwm Llan	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	39.5	39.4	39.3	40.3	43.3	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	22.8	27.8	31.3	31.7	31.7	31.7	31.7	31.7	31.7
	Exceedance Level	-	-	-	-17.2	-12.2	-8.2	-7.7	-7.6	-8.6	-11.6	-14.3	-17.2
NAL10-Rhyd Yr Ewig	Site Specific Noise Limit L_{A90}	40.0	40.0	40.0	40.0	40.0	39.3	38.8	38.6	39.7	42.7	46.0	48.9
	Predicted Proposed Development Noise L_{A90}	-	-	-	25.9	30.9	34.4	34.9	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-14.1	-9.1	-4.9	-3.9	-3.7	-4.8	-7.8	-11.1	-14.0

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

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL01-Greigwen	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	29.8	34.8	38.3	38.8	38.8	38.8	38.8	38.8	38.8
	Exceedance Level	-	-	-	-13.2	-8.2	-4.7	-4.2	-4.2	-4.2	-4.4	-7.0	-9.9
NAL02-Ty'n Y Ddol Uchaf	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	27.8	32.7	36.4	36.8	36.8	36.8	36.8	36.8	36.8
	Exceedance Level	-	-	-	-15.2	-10.3	-6.6	-6.2	-6.2	-6.2	-6.4	-9.0	-11.9
NAL03-Maespyllan	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	28.9	33.9	37.5	38.0	38.0	38.0	38.0	38.0	38.0
	Exceedance Level	-	-	-	-14.1	-9.1	-5.5	-5.0	-5.0	-5.0	-5.2	-7.8	-10.7
NAL04-Llaithgwm	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.3	44.3	45.4	46.6	48.0	49.5	51.1
	Predicted Proposed Development Noise L_{A90}	-	-	-	28.6	33.6	37.2	37.7	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-	-14.4	-9.4	-6.1	-6.6	-7.7	-8.9	-10.3	-11.8	-13.4
NAL05-Penmaen Uchaf	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Proposed Development Noise L_{A90}	-	-	-	24.4	29.4	33.0	33.5	33.5	33.5	33.5	33.5	33.5
	Exceedance Level	-	-	-	-18.6	-13.6	-10.0	-9.5	-9.5	-9.5	-9.5	-9.5	-9.5
NAL06-Creigiau Uchaf	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Proposed Development Noise L_{A90}	-	-	-	27.1	32.1	35.7	36.1	36.1	36.1	36.1	36.1	36.1
	Exceedance Level	-	-	-	-15.9	-10.9	-7.3	-6.9	-6.9	-6.9	-6.9	-6.9	-6.9

Location		Wind Speed (m/s) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL07-Pentre	Site Specific Noise Limit L_{A90}	45.9	46.4	46.9	47.4	47.9	48.5	49.0	49.5	50.0	50.5	51.1	51.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	29.4	34.4	38.0	38.5	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-	-18.0	-13.5	-10.5	-10.5	-11.0	-11.5	-12.0	-12.6	-13.1
NAL08-Cwm Cywen	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	23.7	28.7	32.2	32.7	32.7	32.7	32.7	32.7	32.7
	Exceedance Level	-	-	-	-19.3	-14.3	-10.8	-10.3	-10.3	-10.3	-10.5	-13.1	-16.0
NAL09-Cwm Llan	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	22.8	27.8	31.3	31.7	31.7	31.7	31.7	31.7	31.7
	Exceedance Level	-	-	-	-20.2	-15.2	-11.7	-11.3	-11.3	-11.3	-11.5	-14.1	-17.0
NAL10-Rhyd Yr Ewig	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.4	42.4	42.3	42.5	45.8	48.7
	Predicted Proposed Development Noise L_{A90}	-	-	-	25.9	30.9	34.4	34.9	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-17.1	-12.1	-8.6	-7.5	-7.5	-7.4	-7.6	-10.9	-13.8

7 Summary and Conclusions

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

7.1.2 Background noise monitoring was undertaken by TNEI at four noise monitoring locations neighbouring the Proposed Development. The measured wind and noise data was analysed in accordance with guidance from the IOA GPG to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits for each of the assessment locations.

7.1.3 A total of 12 noise sensitive receptors were chosen as Noise Assessment Locations (NALs). The assessment locations were chosen to represent the noise sensitive receptors located closest to the Proposed Development and other nearby wind farms. Two of these NALs were further from the Proposed Development near to other wind turbines to the north and were included to appraise potential cumulative noise.

7.1.4 Wind speed data was measured using a LIDAR wind monitoring unit located within the proposed wind farm site. The wind data measured at 140 m and 120 m heights was used to calculate 135 m height wind speeds, which was then standardised to a height of 10 m in accordance with current good practice. Thus, the background data and limits are to consider wind turbines up to 135 m hub height and would be worst-case for wind turbines with lower hub height.

7.1.5 A Total ETSU-R-97 Noise Limit of 40 dB(A) daytime or background plus 5 dB (whichever is the greater) and 43 dB(A) night-time or background plus 5 dB (whichever is the greater) was used in this assessment. None of the NALs have been considered with a financial involvement with a fixed minimum limit of 45 dB(A) for both daytime and night-time.

7.1.6 Predictions of wind turbine noise for the proposed wind farm development were made, based upon the sound power level data for a candidate wind turbine, the Enercon E175-EP5 E2 7 MW, with serrated blades and with a hub height of either 112.5 m or 132.5 m, depending on the proposed turbine location (varying heights across the Proposed Development).

7.1.7 There are a number of wind farm schemes in proximity to the Proposed Development found to be relevant for considering potential cumulative operational wind turbine noise, so a cumulative assessment was undertaken. The cumulative assessment undertaken shows that the proposed wind farm development can operate concurrently with the consented and operational wind farms in the area, whilst still meeting the Total ETSU-R-97 Noise Limits at all receptors. The Proposed Development is sufficiently distant from the five operating turbines which are located 3.4 km to the north, that it would not contribute at the NALs close to these turbines, and no cumulative noise impact is anticipated. Two nearby wind developments at various stages, Gaerwen in-planning and Moel Chwa at the scoping stage, were also considered and no cumulative impact is anticipated with these either.

7.1.8 An apportionment of the Total ETSU-R-97 Noise Limits was undertaken where required to calculate ‘Site Specific Noise Limits’ for the Proposed Development at the

NALs. This step is necessary to consider potential conditioning of the Proposed Development operating on its own and to also assume that some of the nearby wind farms could in practice be allowed to operate at higher levels than typical 'likely' noise predictions assumed in the cumulative assessment. The results show that the predicted wind turbine noise immission levels for the Proposed Development on its own meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods.

7.1.9 The Enercon E175-EP5 E2 7 MW candidate turbine was chosen as it is considered to be representative of the type of turbine that could be installed at the Site. The predictions shown in this report for a second candidate turbine that is slightly noisier also meet the Site Specific Noise Limits. There are a number of wind turbine makes and models that may be suitable for the Proposed Development. 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 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 ms^{-1}. 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, and
- 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 % 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 10 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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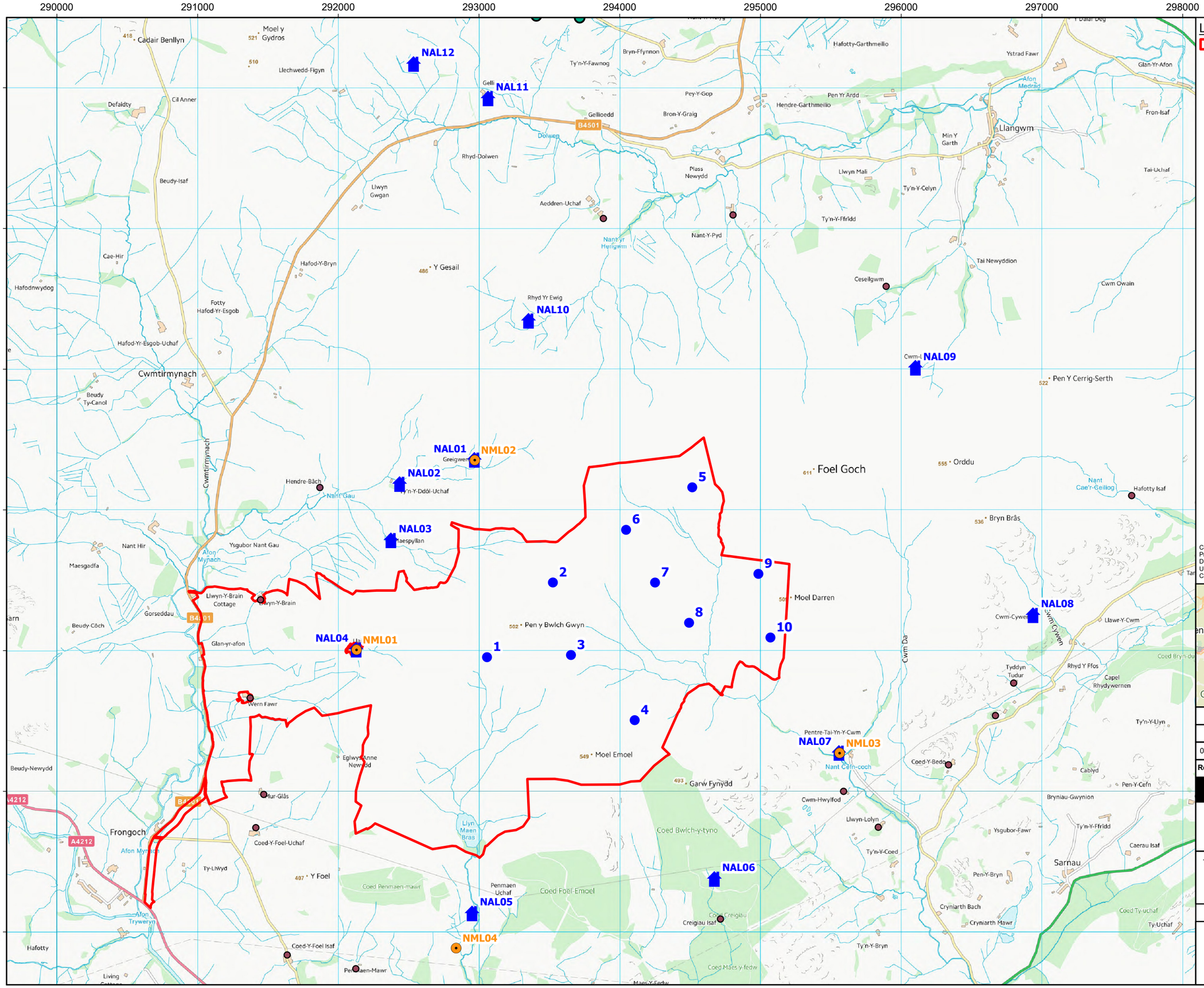
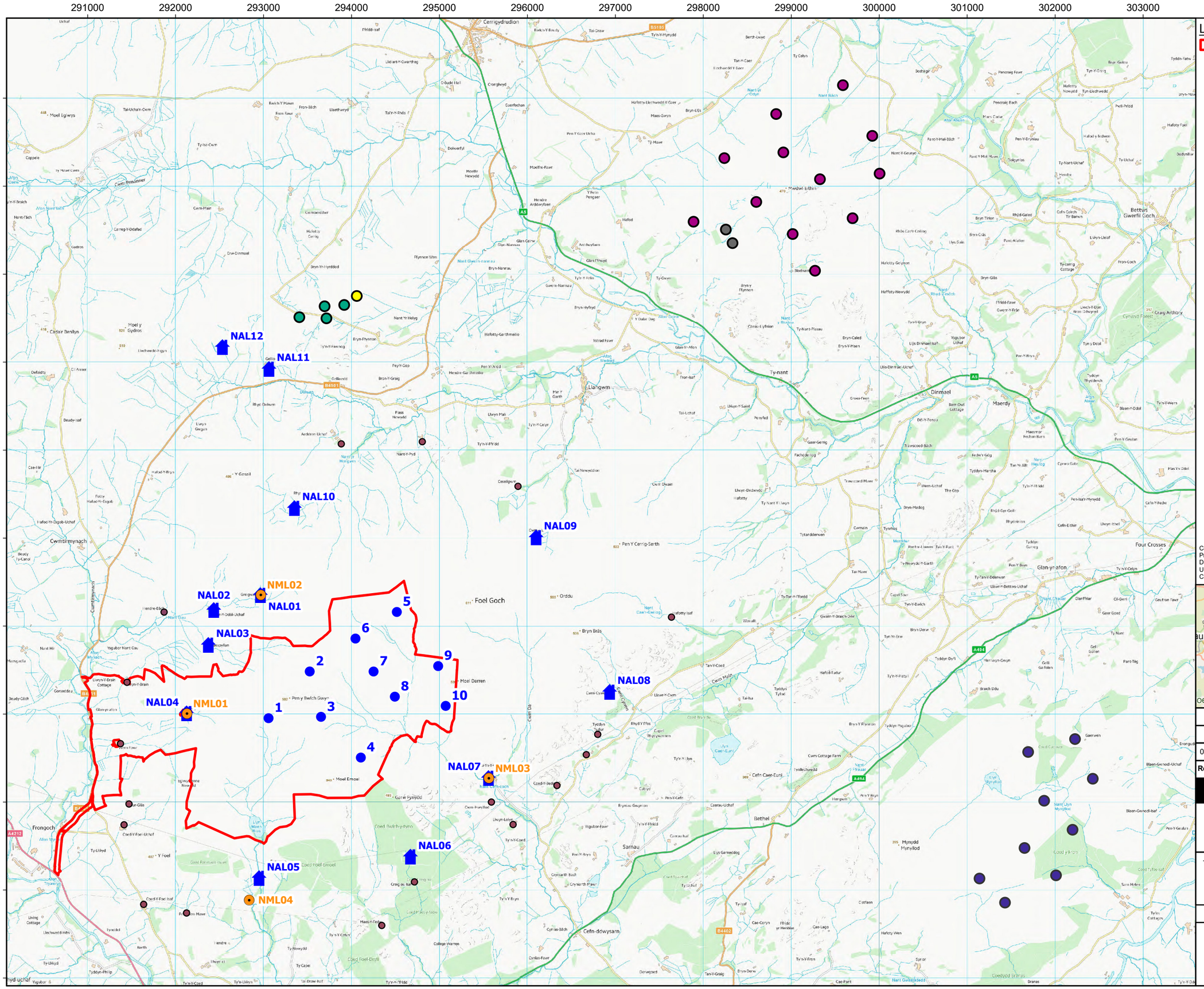
Annex 1 – Figures





LEGEND:

- Site Boundary
- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Noise Sensitive Receptors (NSRs)
- Foel Fach Wind Turbines
- Hafotty Wind Turbines (Operational 4 x Vestas V52)
- Gaerwen Wind Turbines (In Planning 9 x SG 155)
- Moel Chwa Turbines (Scoping 12 x Vestas V162)
- Disgarth Ucha & Ty'n Gwyn Turbines (Operational 2 x Enercon E53)
- Bryn Ffynnon Turbine (Operational 1 x Enercon E53)
- Hendre Bach

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter
Client: ESB/Coriolis Energy

Rev	Date	Description	Drn	Chk	App
00	25/11/2025	First Issue	MR	MC	MC

Foel Fach Wind Farm

Coriolis Energy | RSK environment | ESB Energy for generations

TITLE: Annex 1 - Figure A1.1b - Operational Noise Assessment Cumulative Wind Turbine Locations

ID: 16513 - Figure 1.1b

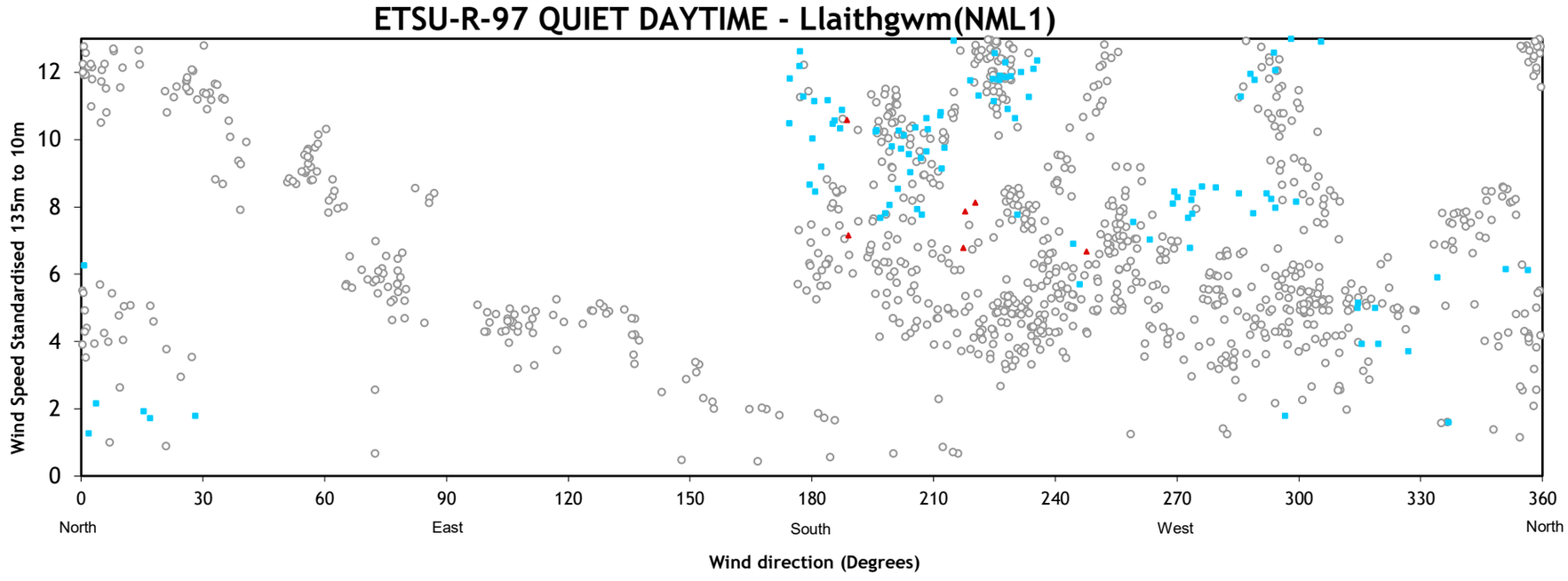
0 0.8 1.6
Kilometres

Scale: 1:40,000 @ A3

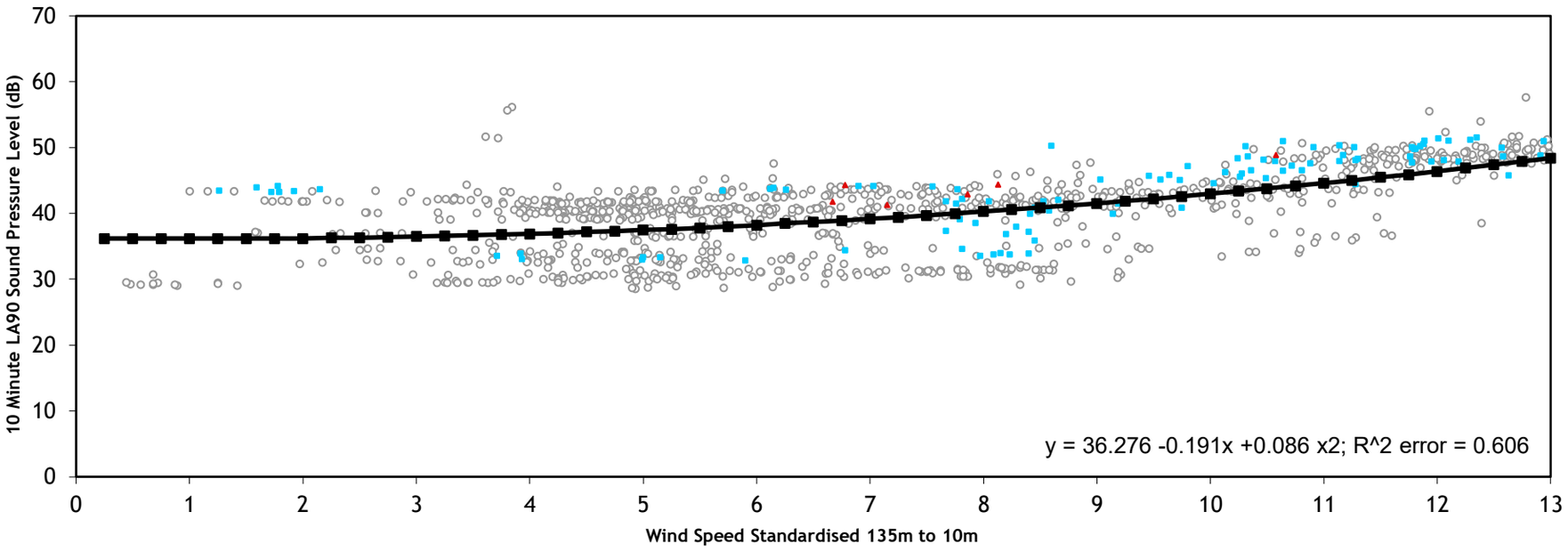
REV 00

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

Wind Conditions Quiet Daytime



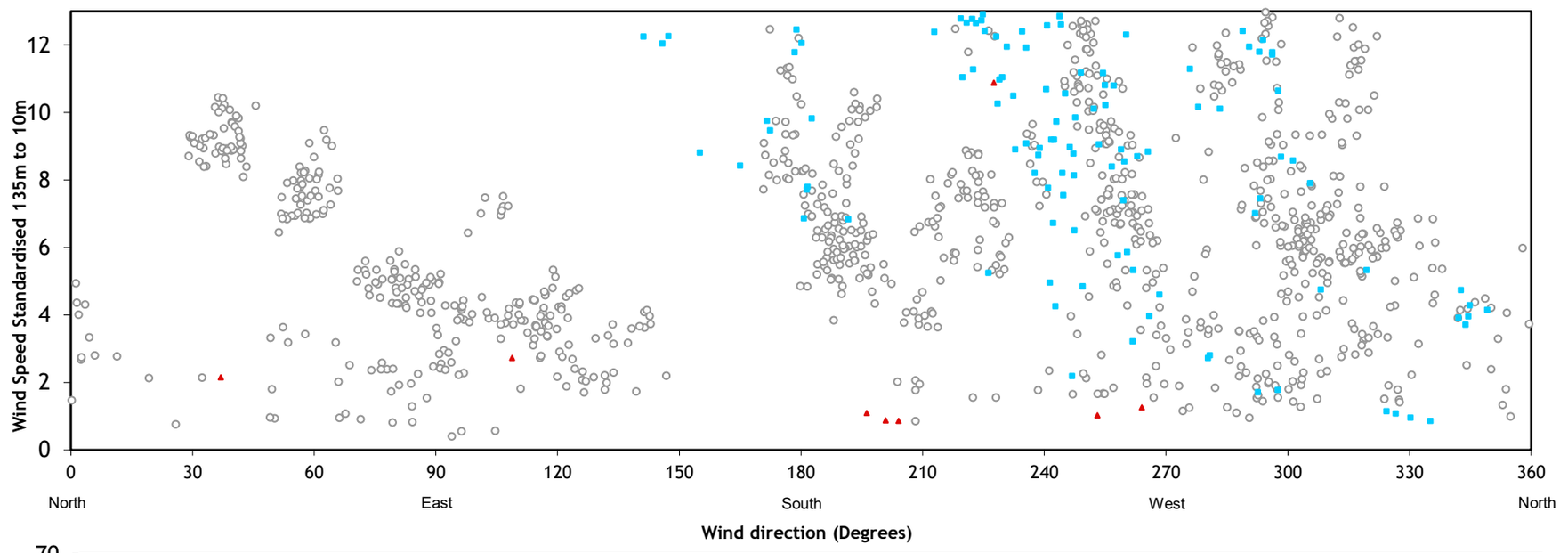
Regression Analysis Quiet Daytime



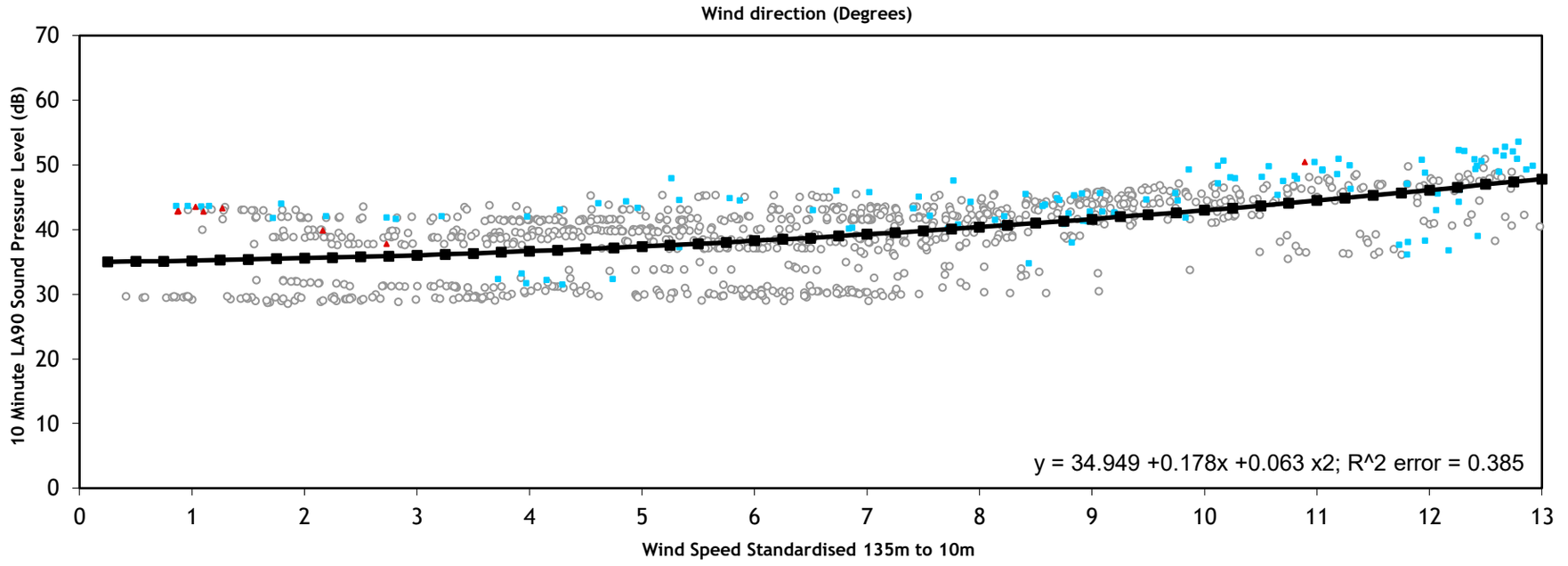
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	18	41	119	196	120	88	89	66	41	68	74	920
Prevailing Background	36.2	36.5	36.9	37.5	38.2	39.2	40.3	41.5	43	44.6	46.4	

ETSU-R-97 NIGHT-TIME - Llaithgwm(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	81	68	114	107	125	130	101	85	53	38	37	939
Prevailing Background	35.6	36	36.7	37.4	38.3	39.3	40.4	41.6	43	44.5	46.1	

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	Foel Fach
Client	Coriolis
Title	Wind Conditions&Regression Analysis Llaithgwm(NML1)
Figure Number	A1.2a
Drawn	MR
Checked	MC
Date	18/06/2025
Document Reference	16513-BG Model

Coriolis Energy

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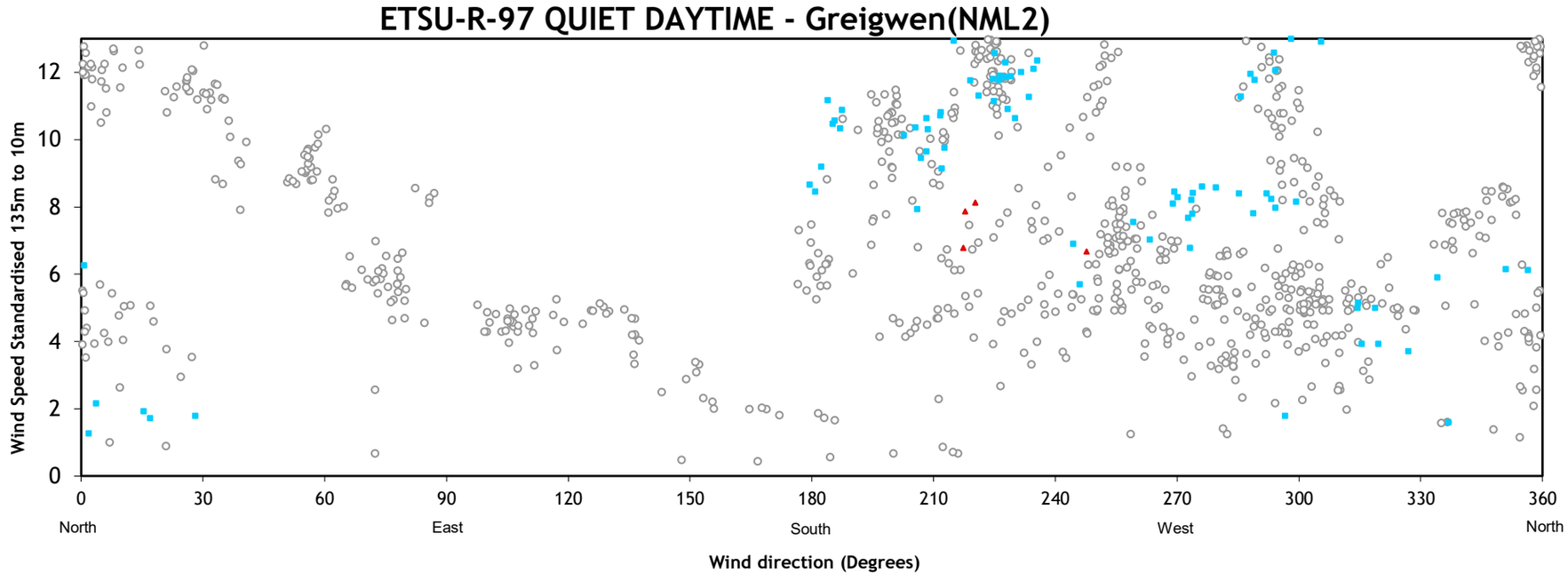
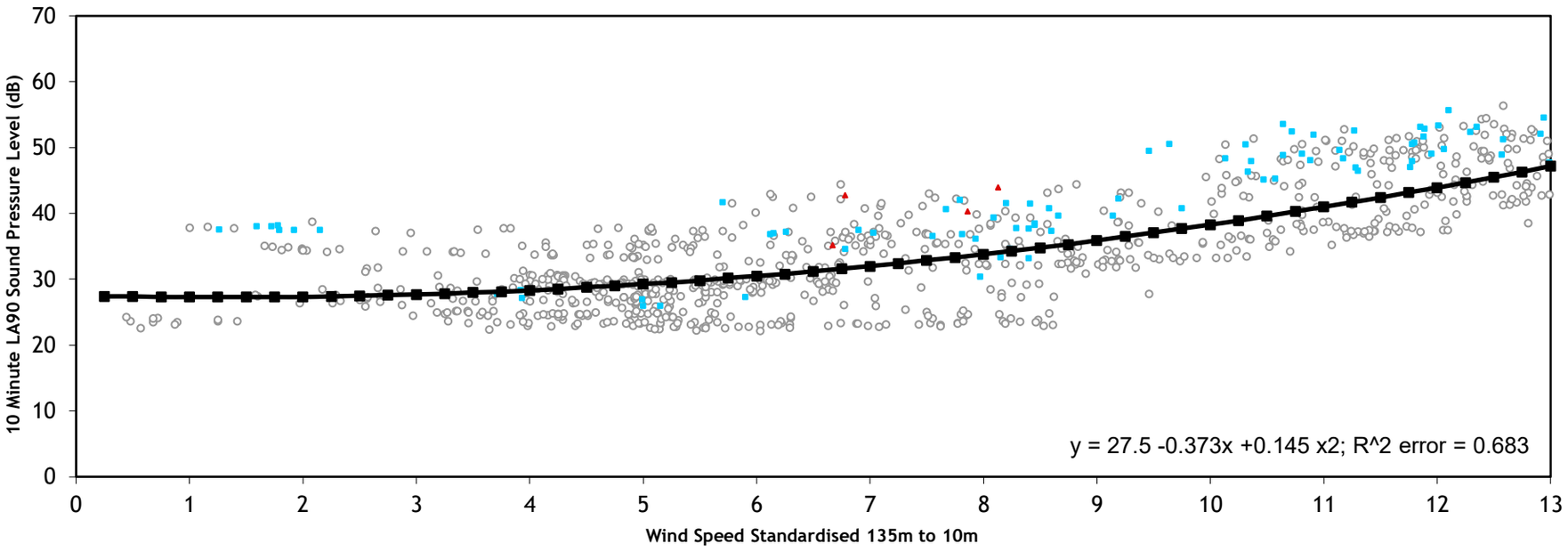
ETSU-R-97 QUIET DAYTIME - Greigwen(NML2)

Wind Conditions Quiet Daytime



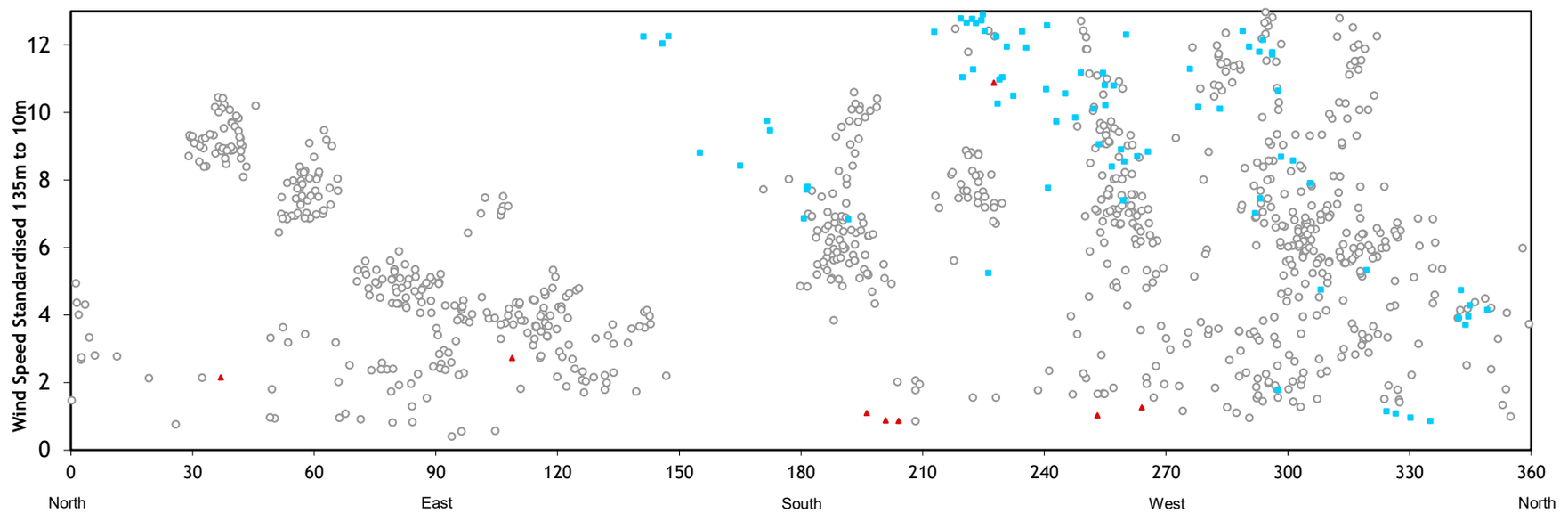
Regression Analysis Quiet Daytime



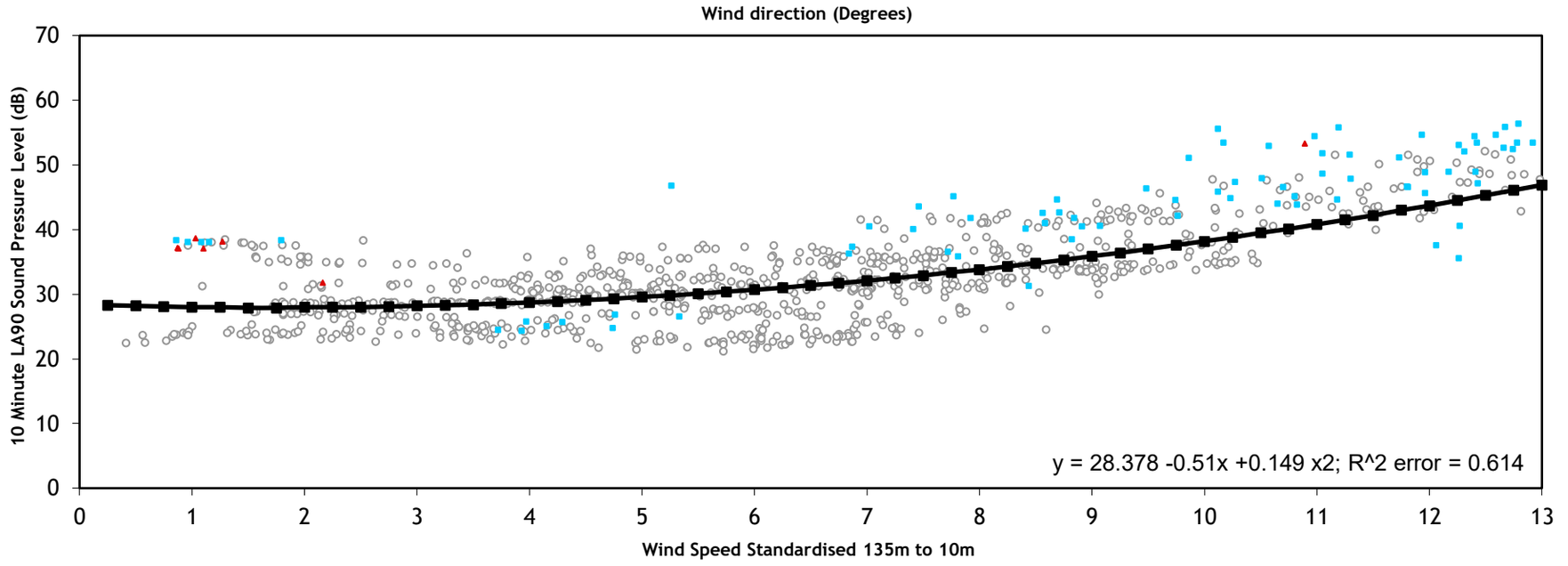
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	18	36	86	151	90	70	61	51	36	64	69	732
Prevailing Background	27.3	27.7	28.3	29.3	30.5	32	33.8	35.9	38.3	41	43.9	

ETSU-R-97 NIGHT-TIME - Greigwen(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	80	67	99	97	107	120	84	72	44	22	27	819
Prevailing Background	28	28.2	28.7	29.6	30.7	32.1	33.8	35.9	38.2	40.8	43.7	

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	Foel Fach
Client	Coriolis
Title	Wind Conditions&Regression Analysis Greigwen(NML2)
Figure Number	A1.2b
Drawn	MR
Checked	MC
Date	18/06/2025
Document Reference	16513-BG Model

Coriolis Energy

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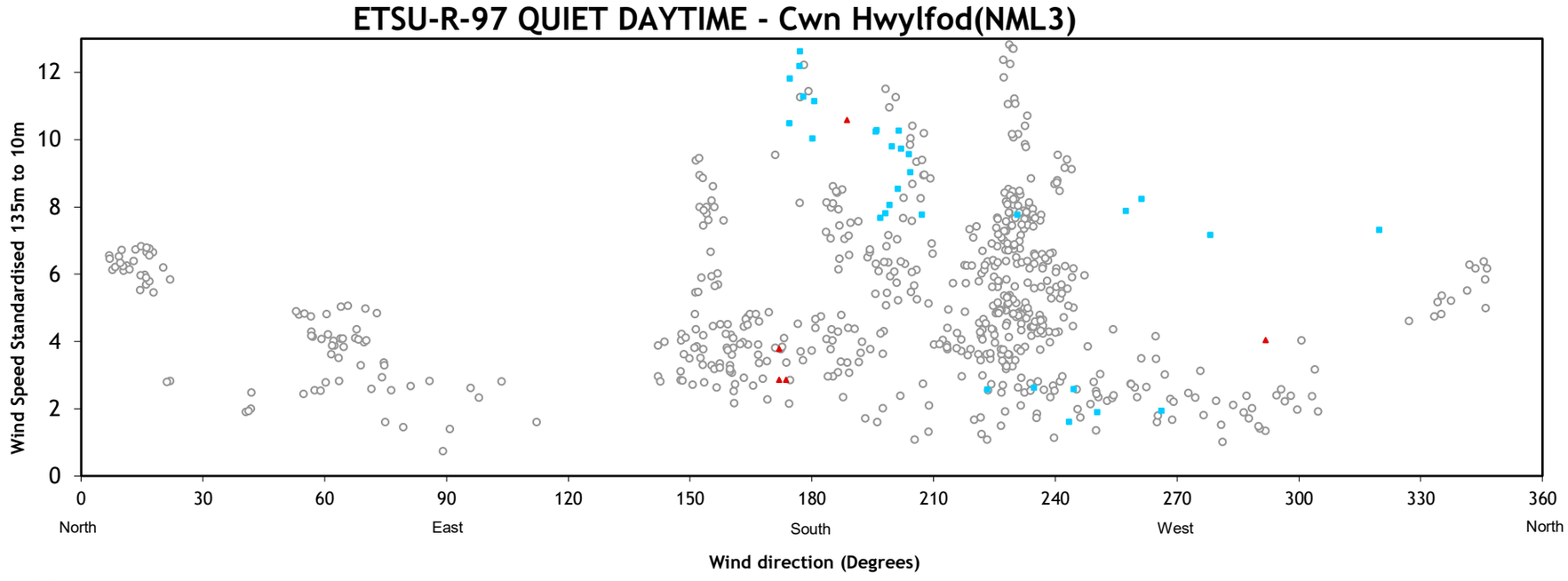
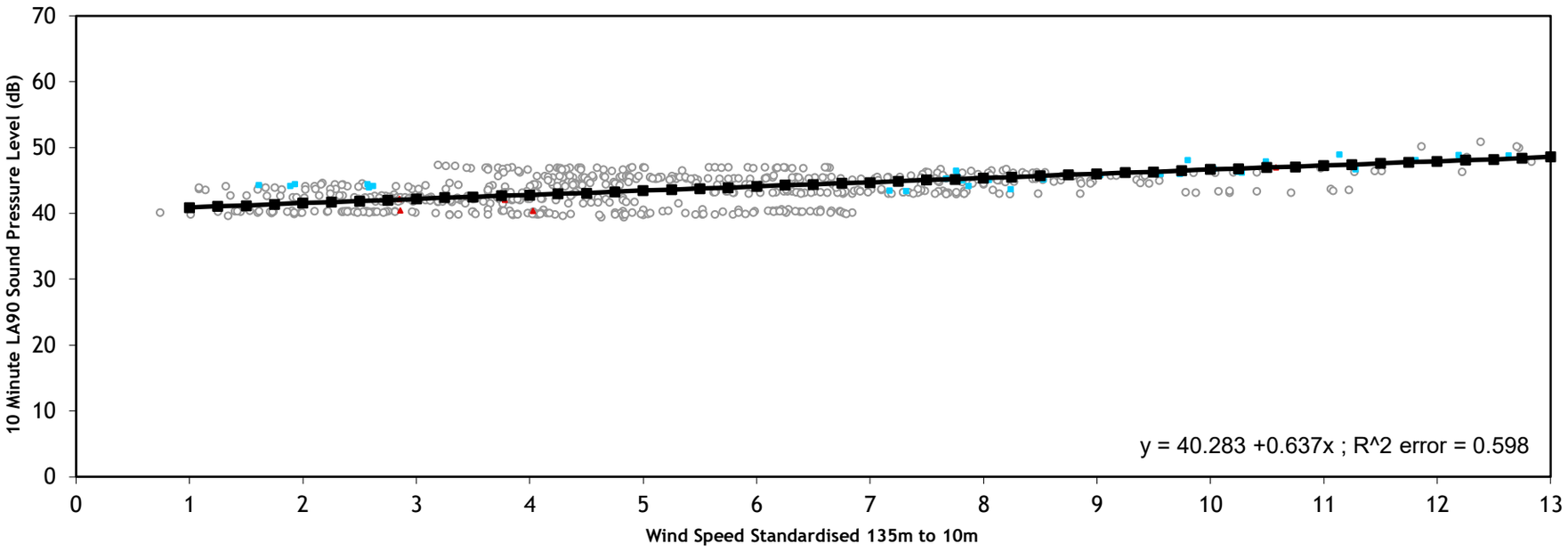
ETSU-R-97 QUIET DAYTIME - Cwn Hwylfod(NML3)

Wind Conditions Quiet Daytime



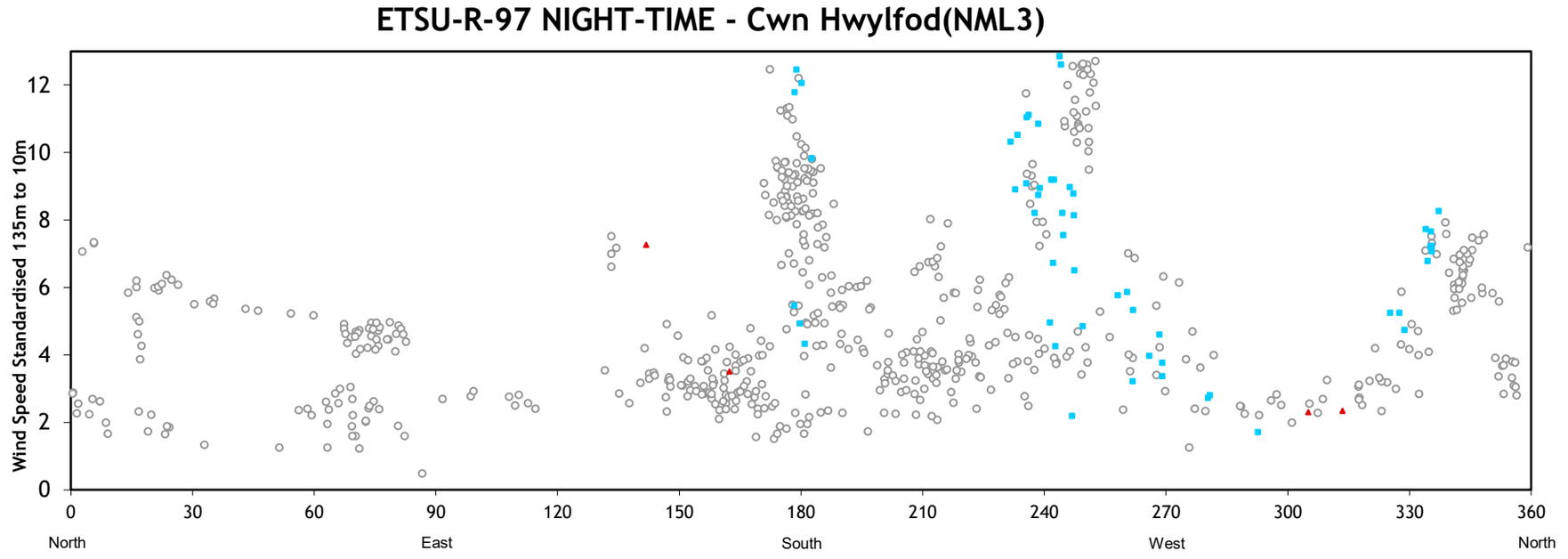
Regression Analysis Quiet Daytime



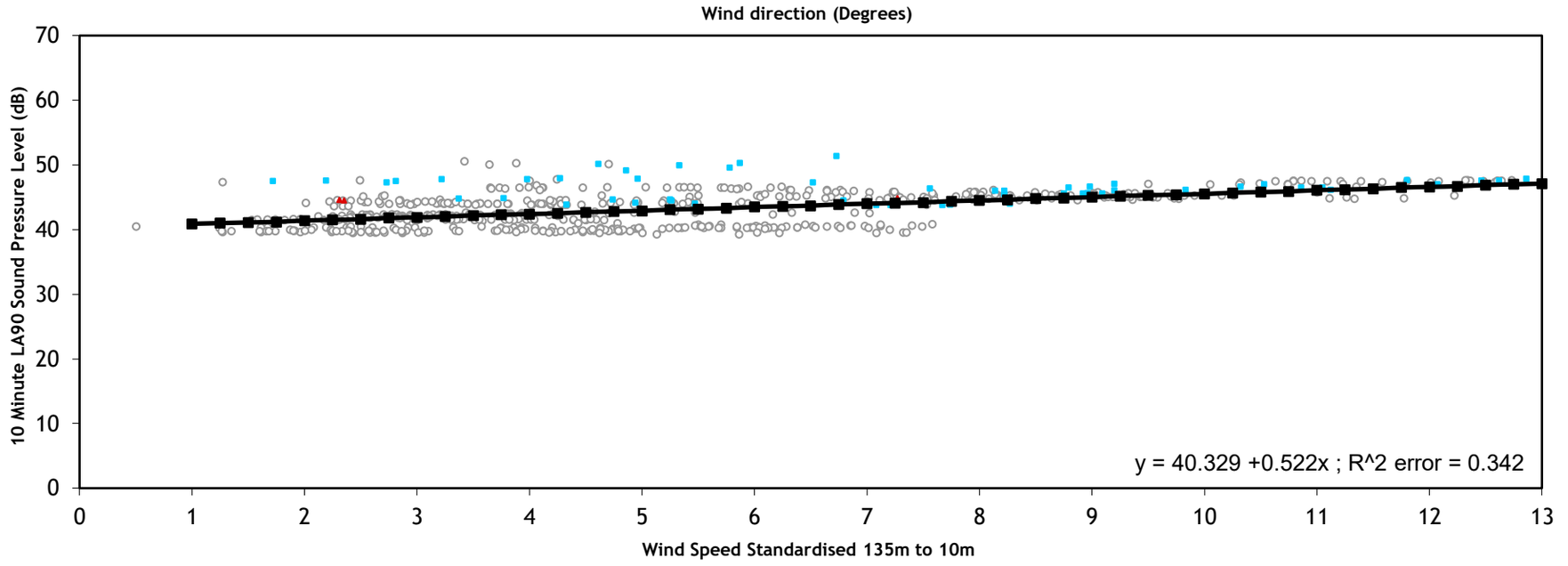
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	57	87	120	89	86	62	55	21	12	8	5	602
Prevailing Background	41.6	42.2	42.8	43.5	44.1	44.7	45.4	46	46.7	47.3	47.9	

ETSU-R-97 NIGHT-TIME - Cwn Hwylfod(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	64	126	110	68	57	40	31	35	19	16	11	577
Prevailing Background	41.4	41.9	42.4	42.9	43.5	44	44.5	45	45.5	46.1	46.6	

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	Foel Fach
Client	Coriolis
Title	Wind Conditions&Regression Analysis Cwn Hwylfod(NML3)
Figure Number	A1.2c
Drawn	MR
Checked	MC
Date	18/06/2025
Document Reference	16513-BG Model

Coriolis Energy

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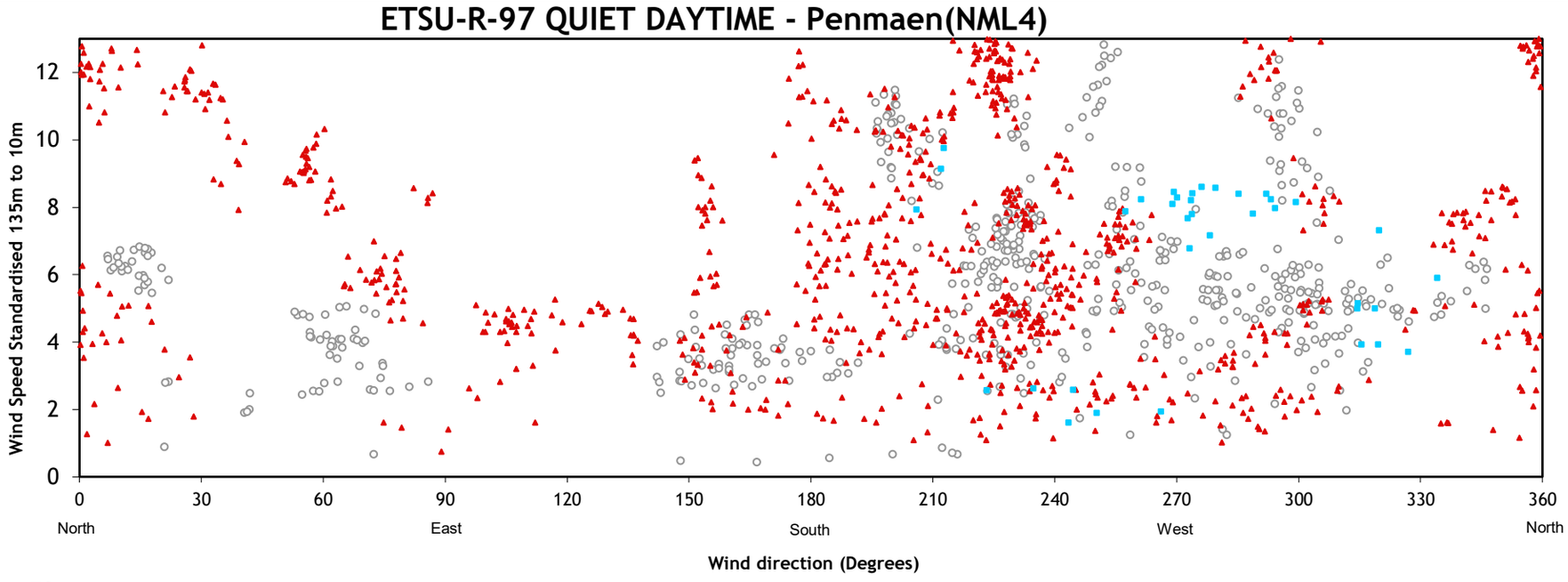
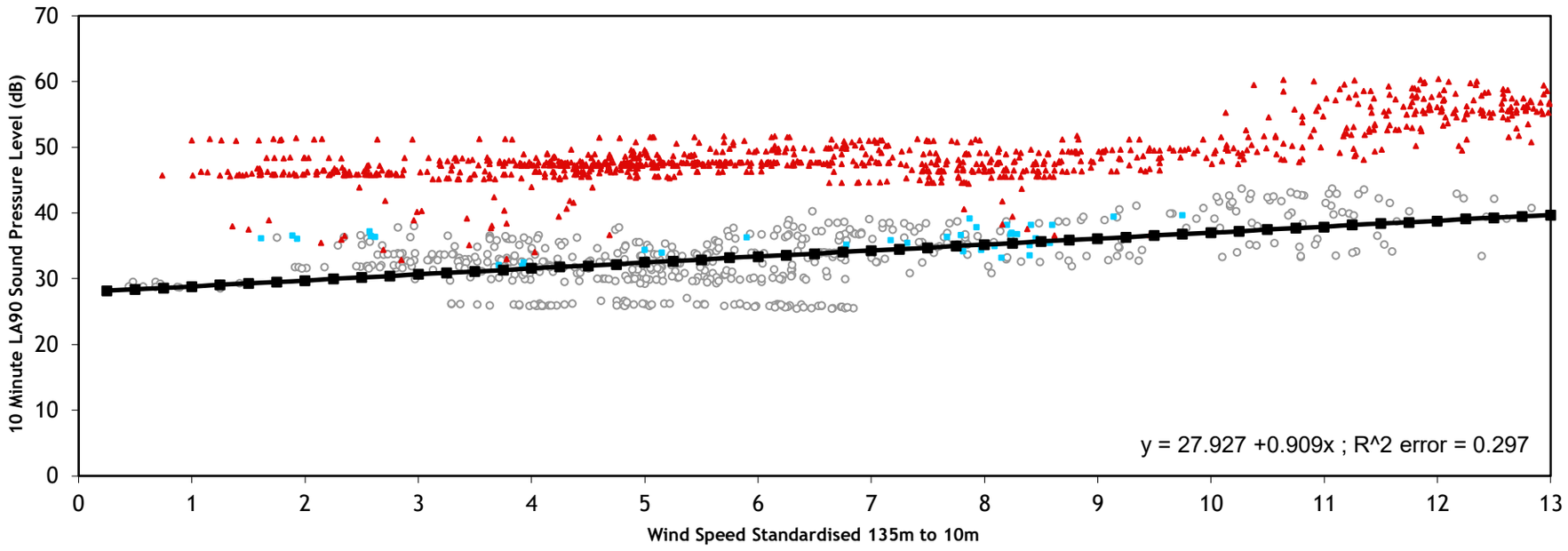
ETSU-R-97 QUIET DAYTIME - Penmaen(NML4)

Wind Conditions Quiet Daytime



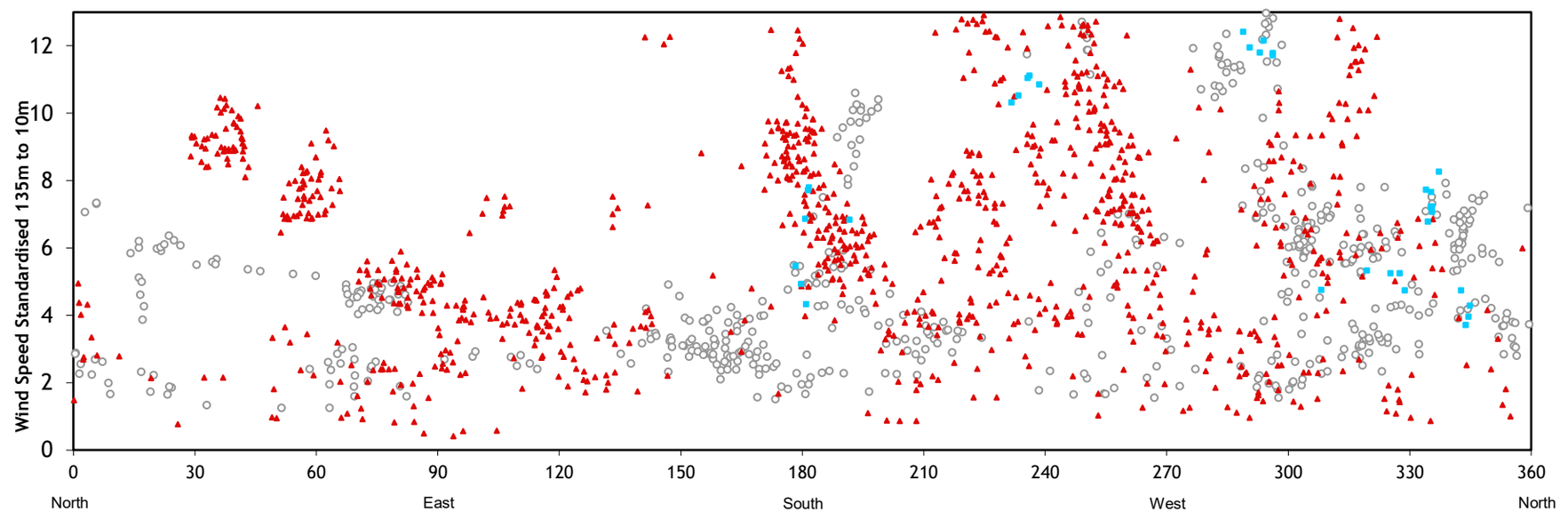
Regression Analysis Quiet Daytime



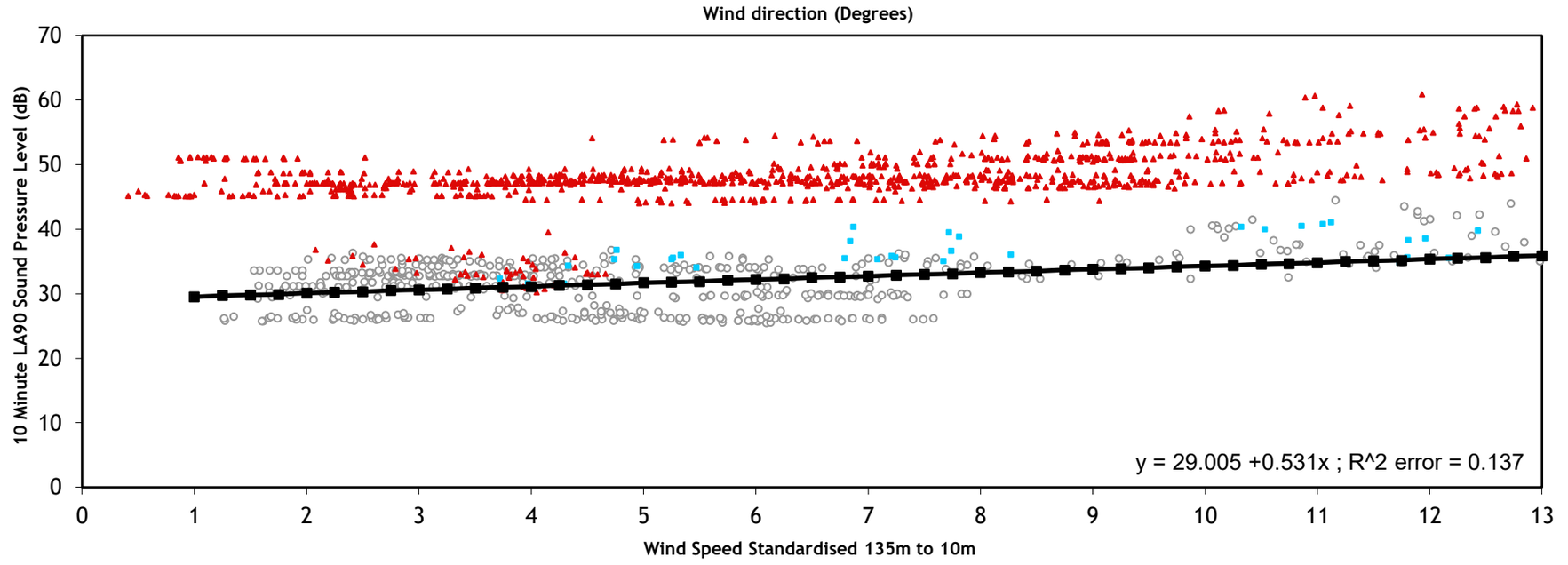
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	11	63	89	95	97	64	26	21	23	33	9	531
Prevailing Background	29.7	30.7	31.6	32.5	33.4	34.3	35.2	36.1	37	37.9	38.8	

ETSU-R-97 NIGHT-TIME - Penmaen(NML4)

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	73	126	85	61	77	50	17	6	13	13	16	537
Prevailing Background	30.1	30.6	31.1	31.7	32.2	32.7	33.3	33.8	34.3	34.8	35.4	

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	Foel Fach
Client	Coriolis
Title	Wind Conditions&Regression Analysis Penmaen(NML4)
Figure Number	A1.2d
Drawn	MR
Checked	MC
Date	27/05/2025
Document Reference	16513-BG Model

Coriolis Energy

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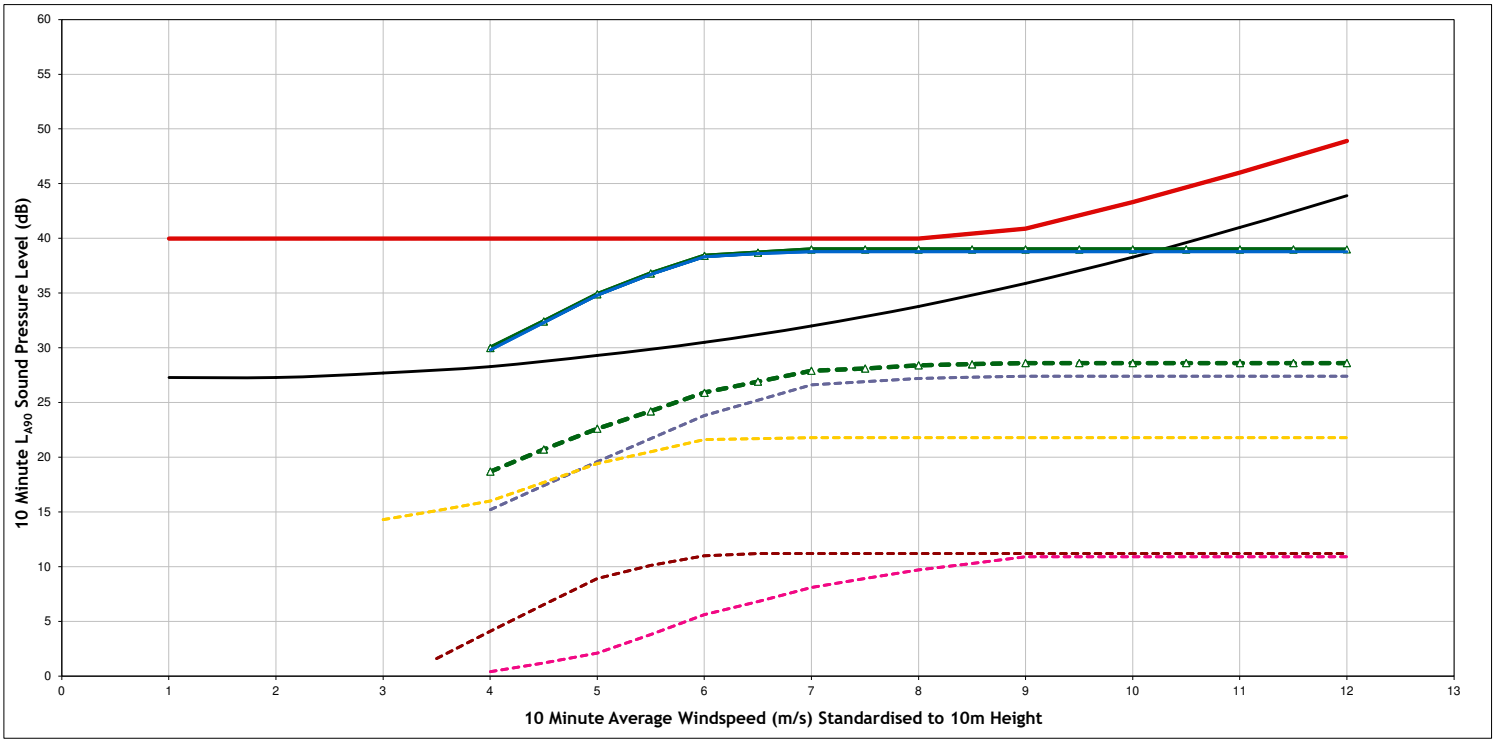
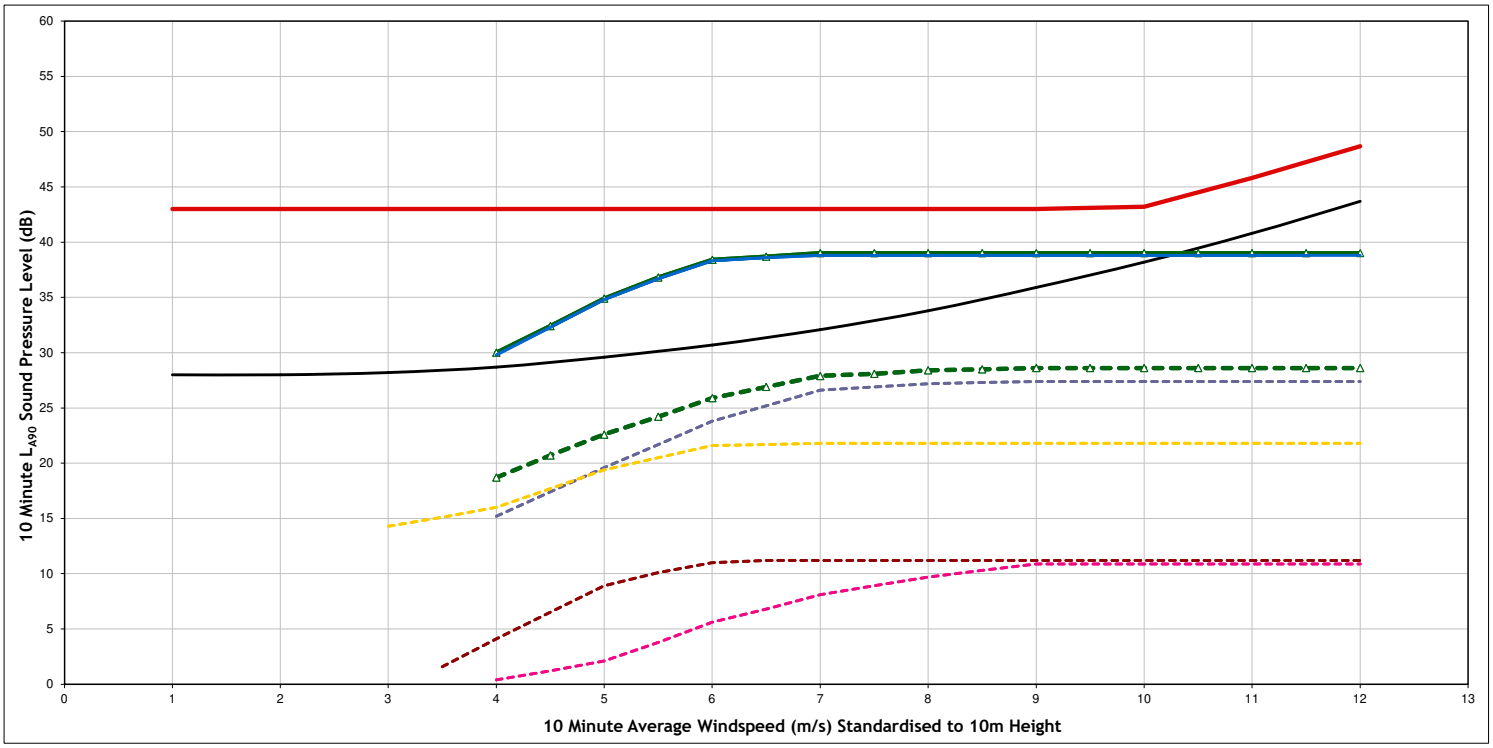
Daytime - Greigwen (NAL1)



Night Time - Greigwen (NAL1)



Legend:

- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=0°]
- Proposed Development with 10 x E-175 [WD=120°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Greigwen (NAL1)
Figure Number	Figure A1.3a
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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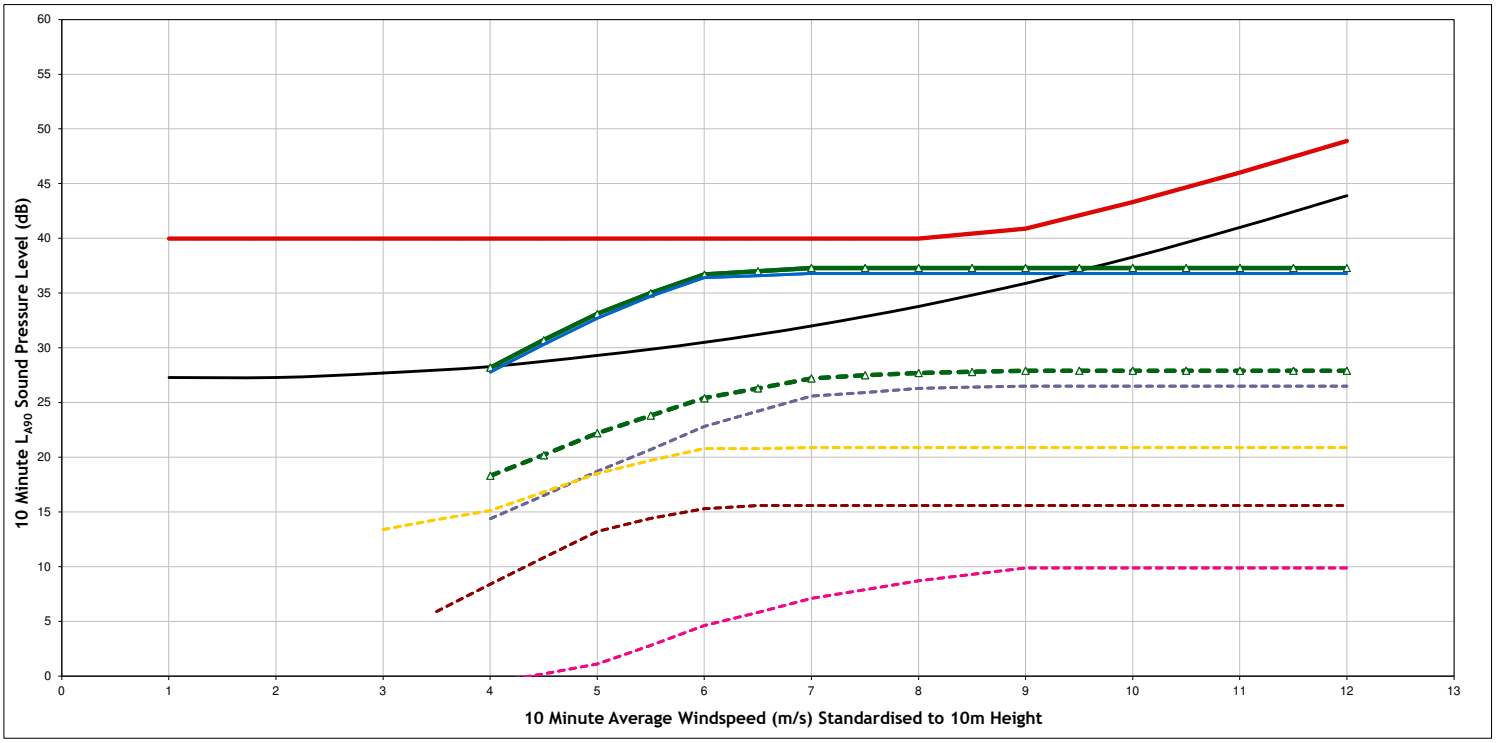
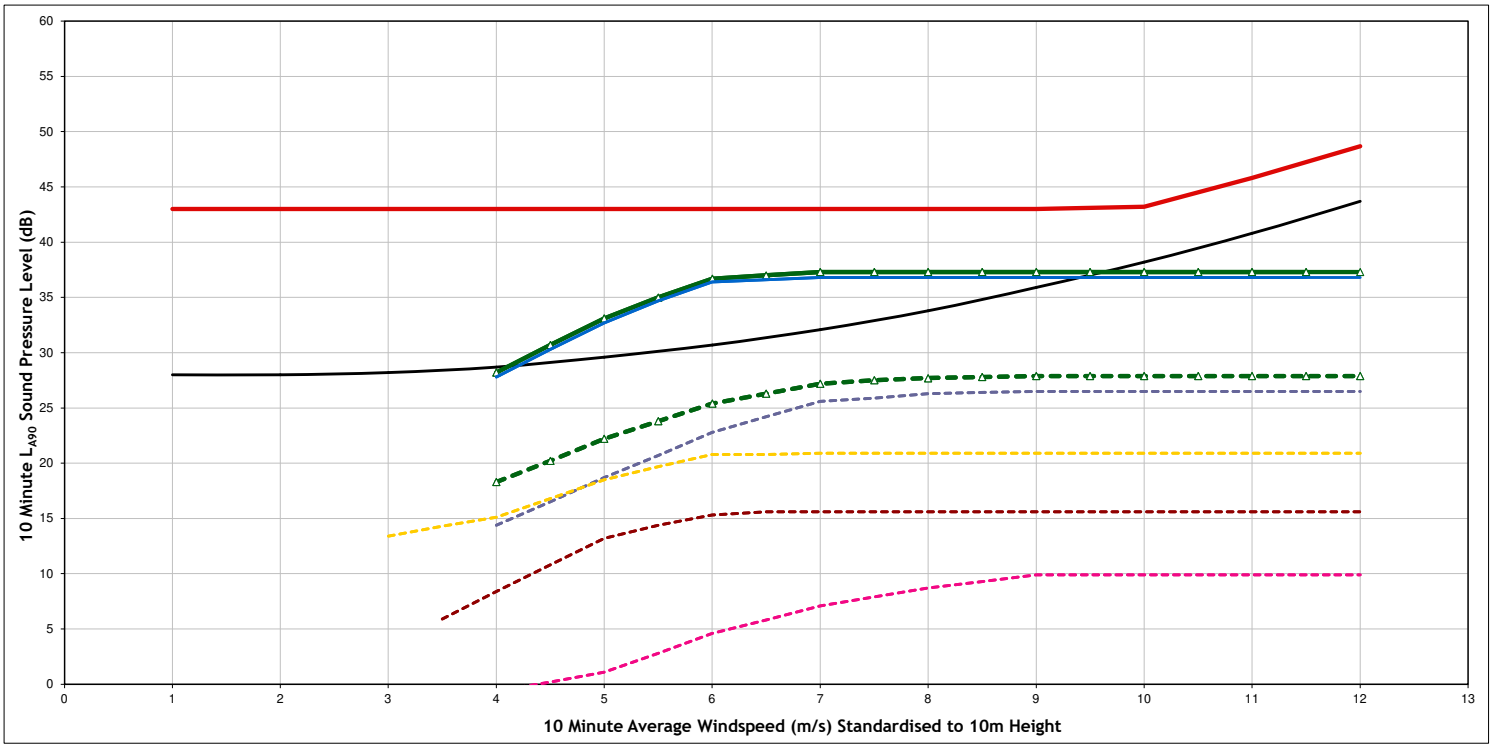
Daytime - Ty'n Y Ddol Uchaf (NAL2)



Night Time - Ty'n Y Ddol Uchaf (NAL2)



Legend:

- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=90°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Uchaf&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Ty'n Y Ddol Uchaf (NAL2)
Figure Number	Figure A1.3b
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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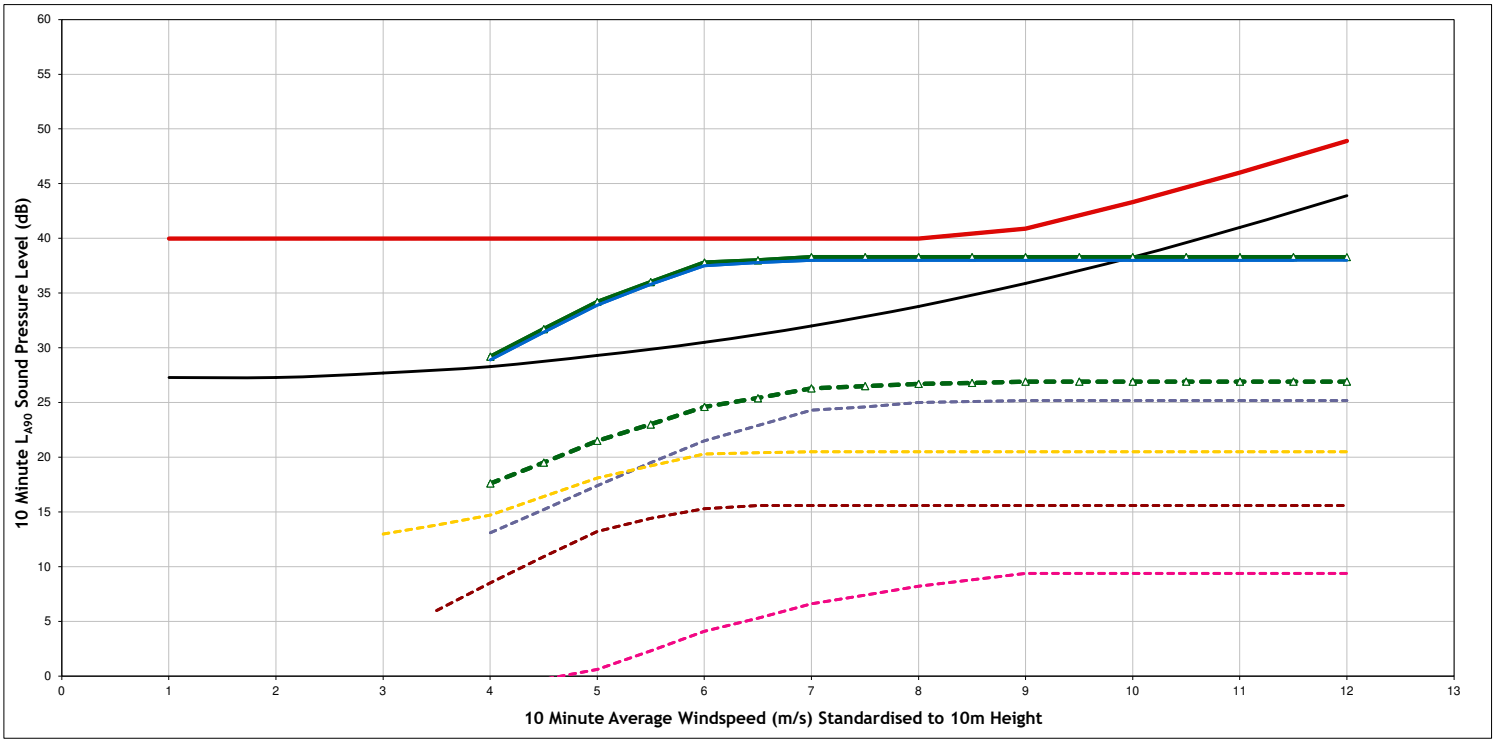
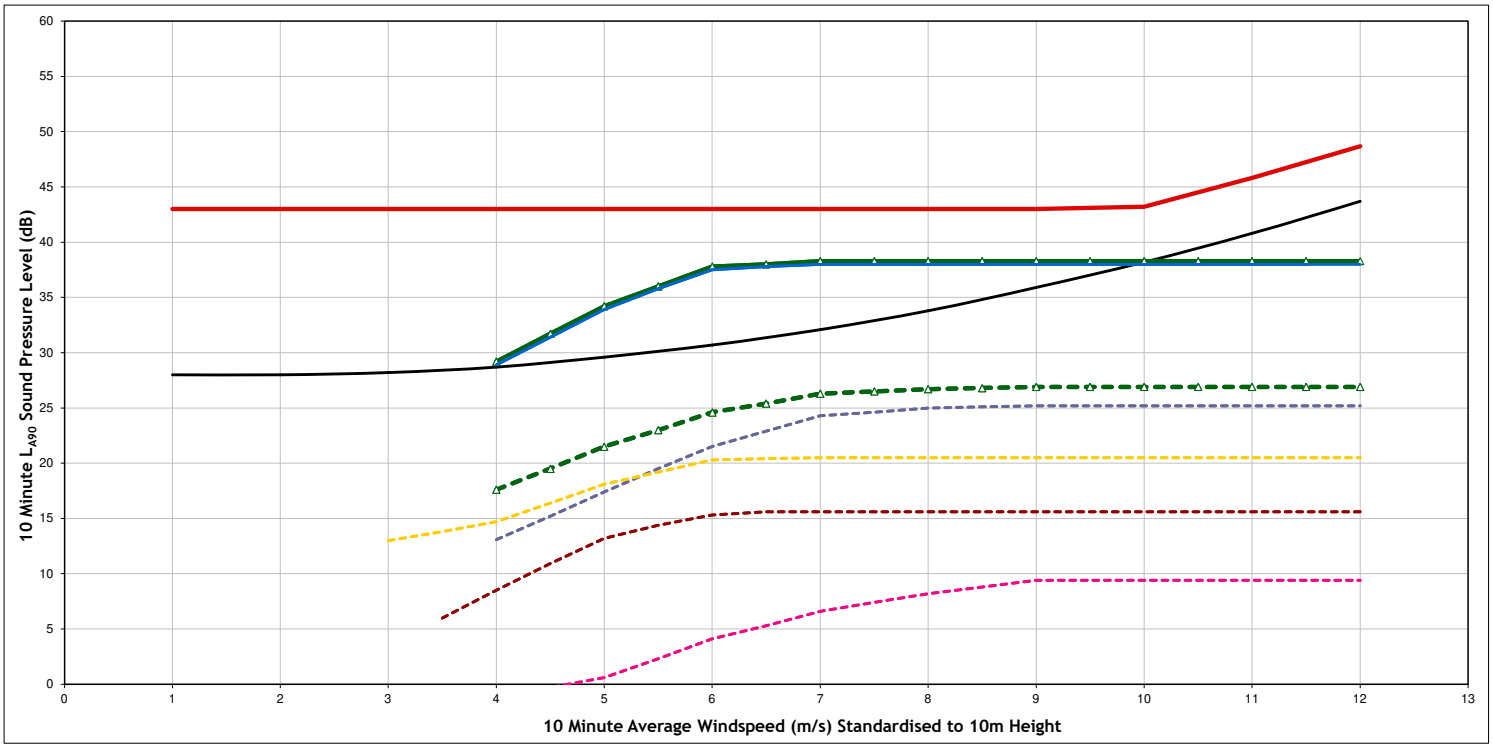
Daytime - Maespyllan (NAL3)



Night Time - Maespyllan (NAL3)



Legend:

- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=90°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Maespyllan (NAL3)
Figure Number	Figure A1.3c
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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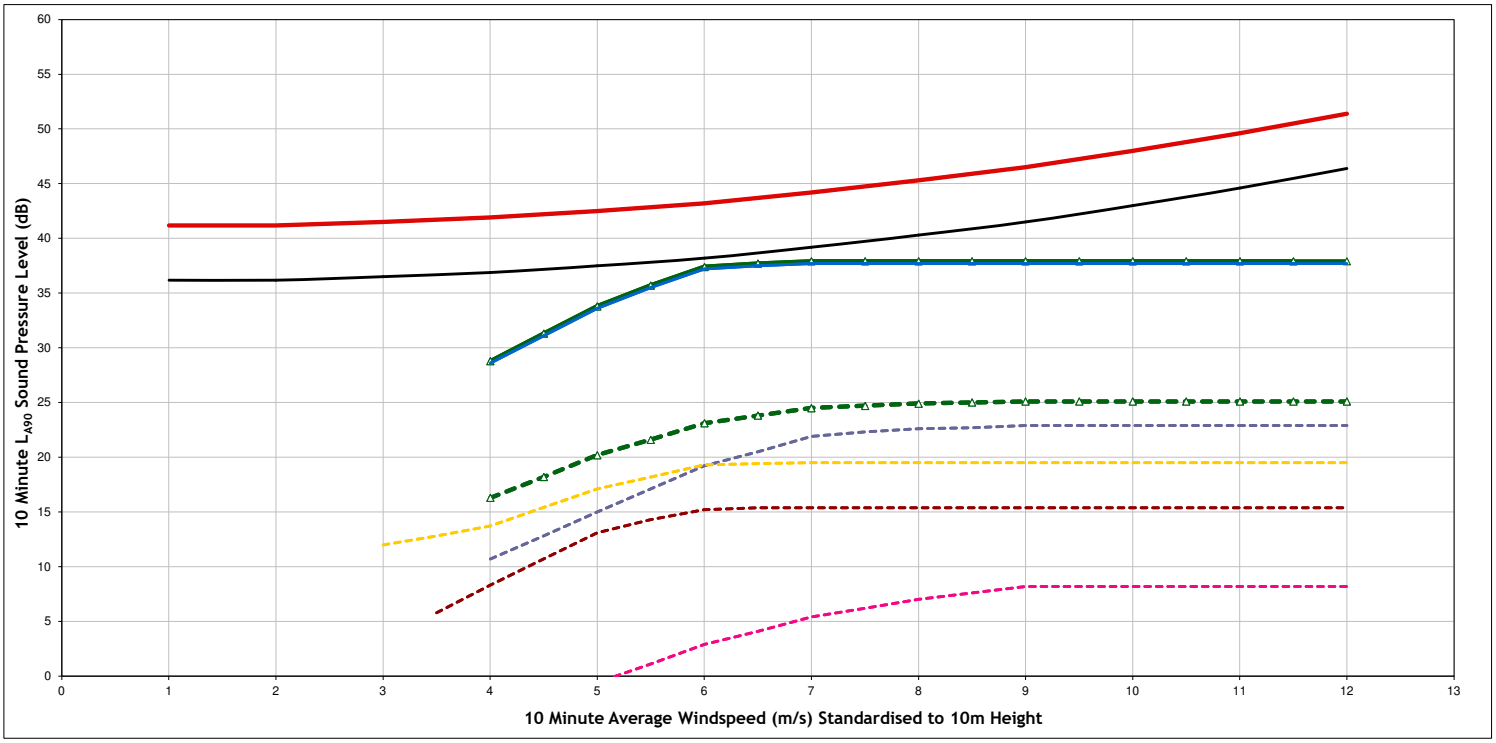
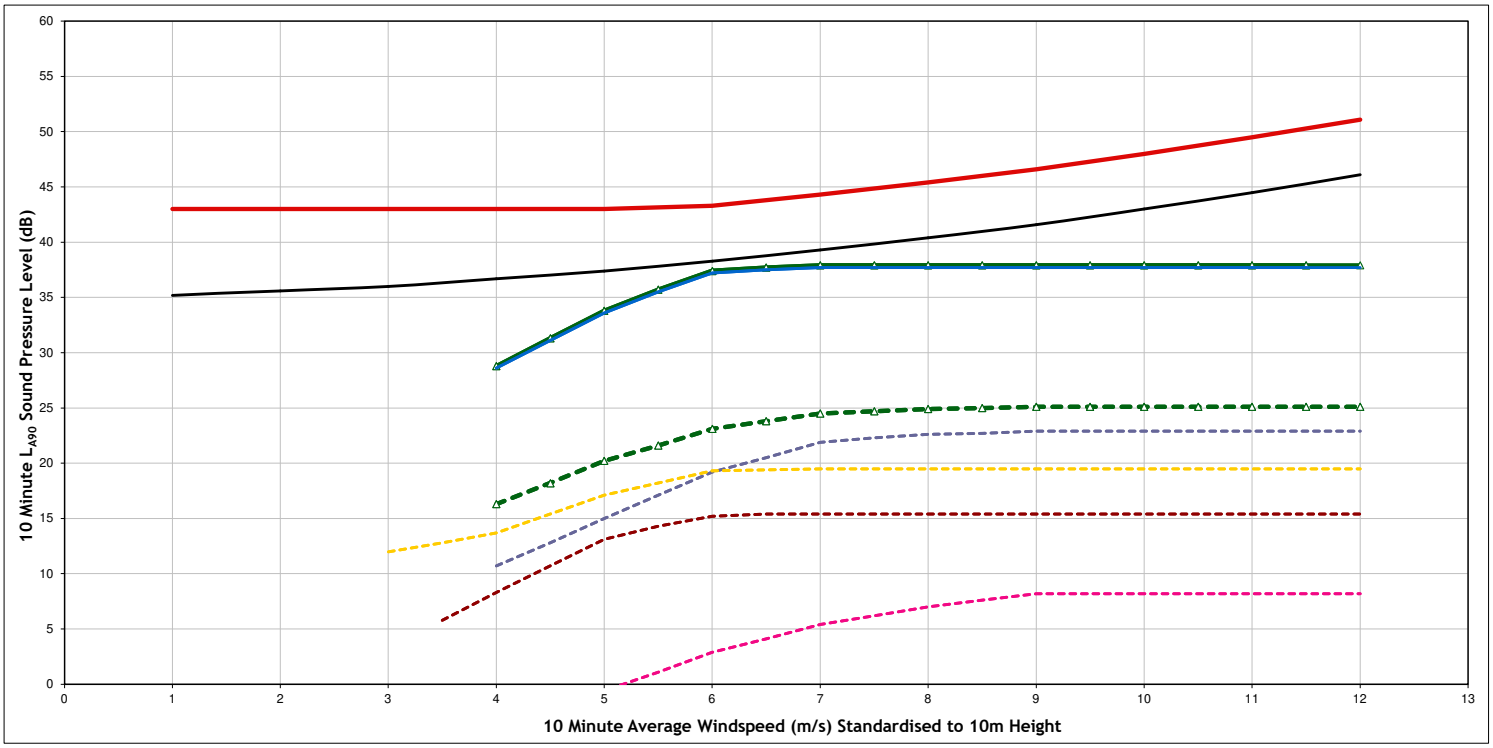
Daytime - Llaithgwm (NAL4)



Night Time - Llaithgwm (NAL4)



Legend:

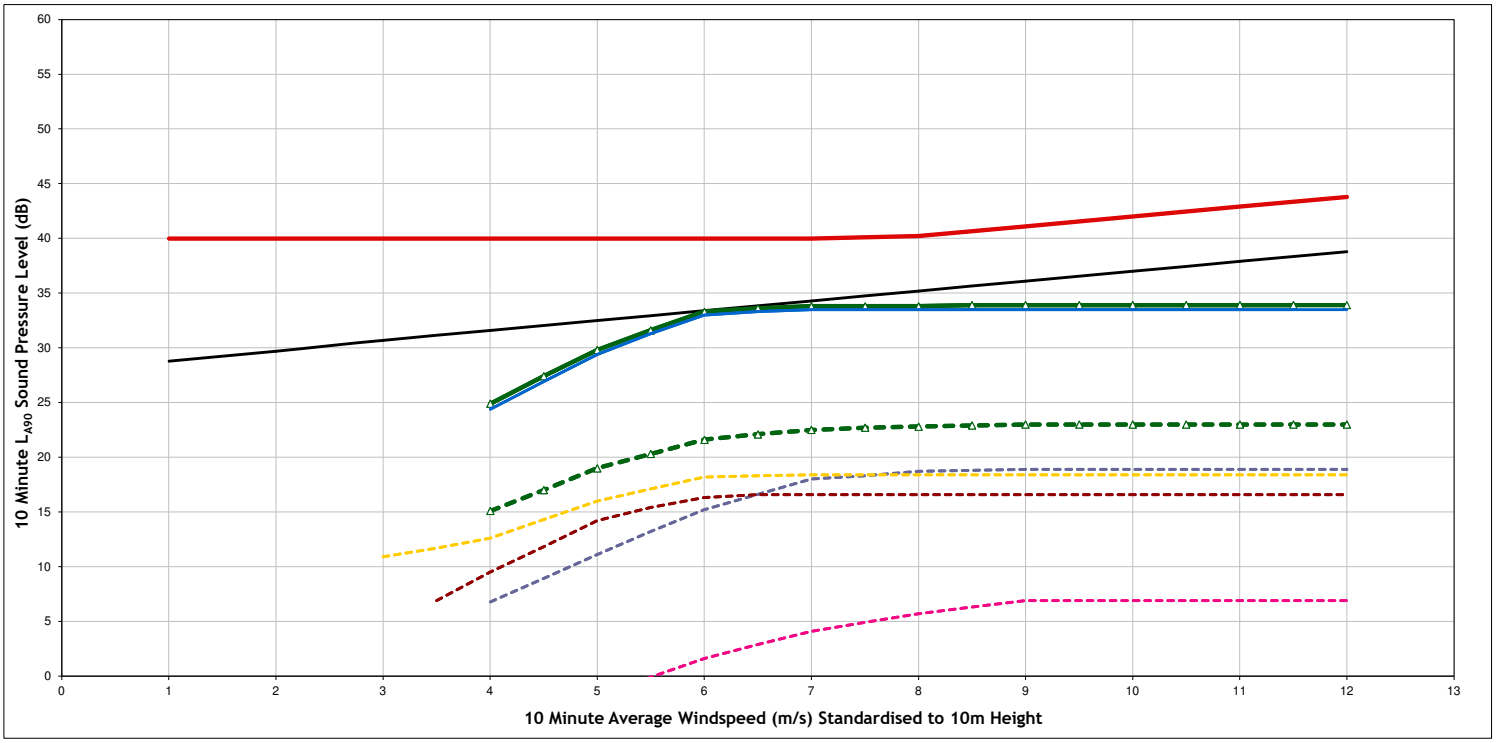
- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=30°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=30°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=30°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Llaithgwm (NAL4)
Figure Number	Figure A1.3d
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

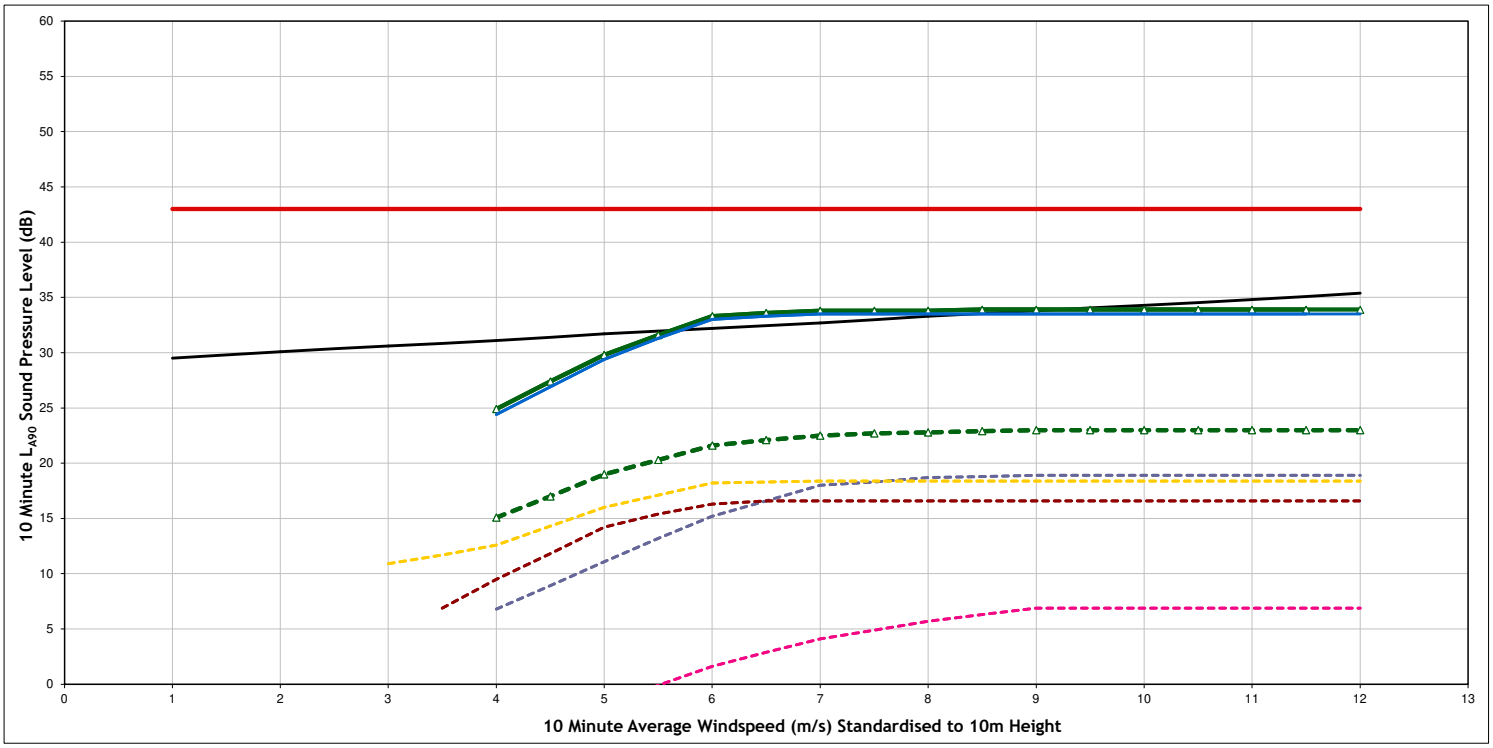
Coriolis Energy

tnei

Daytime - Penmaen Uchaf (NAL5)



Night Time - Penmaen Uchaf (NAL5)



Legend:

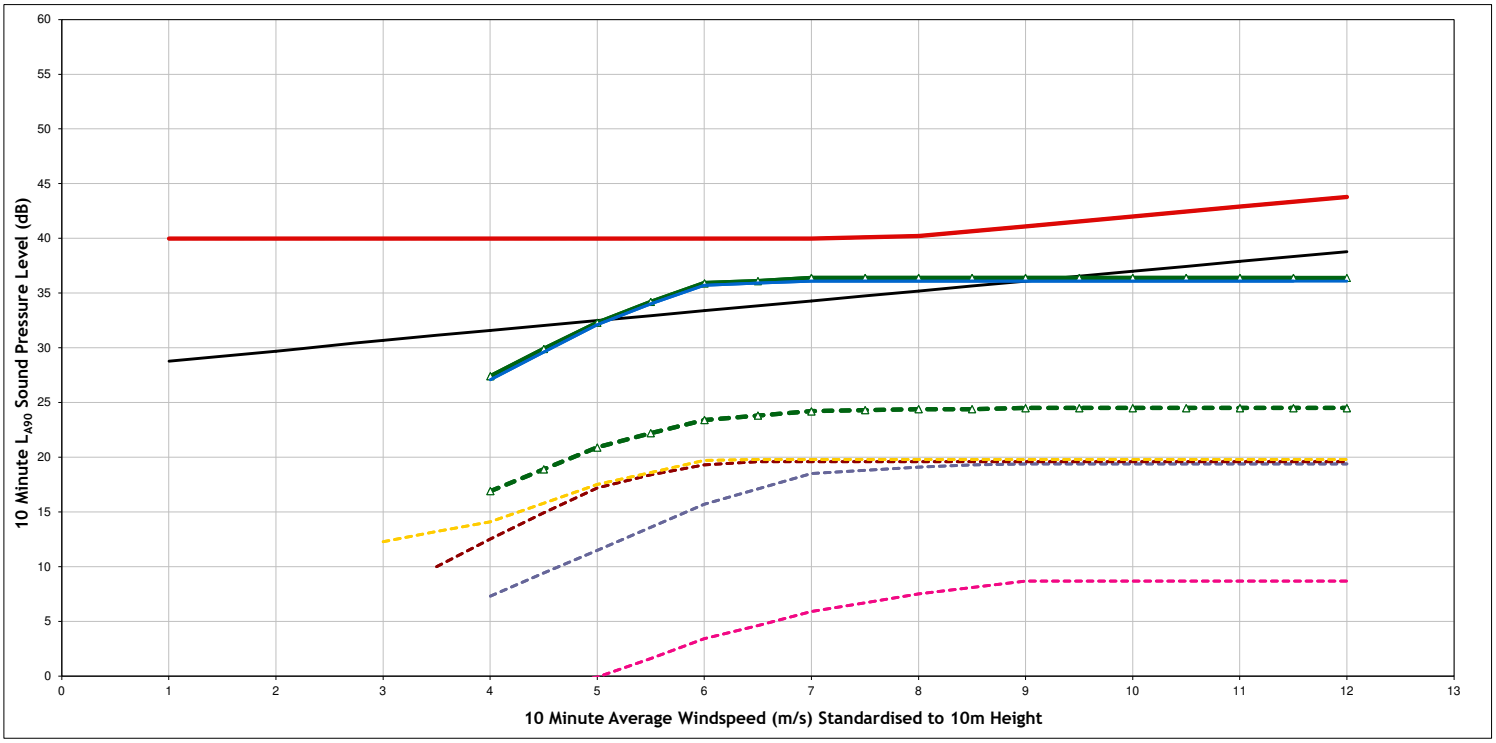
- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=30°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=0°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=30°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Penmaen Uchaf (NAL5)
Figure Number	Figure A1.3e
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

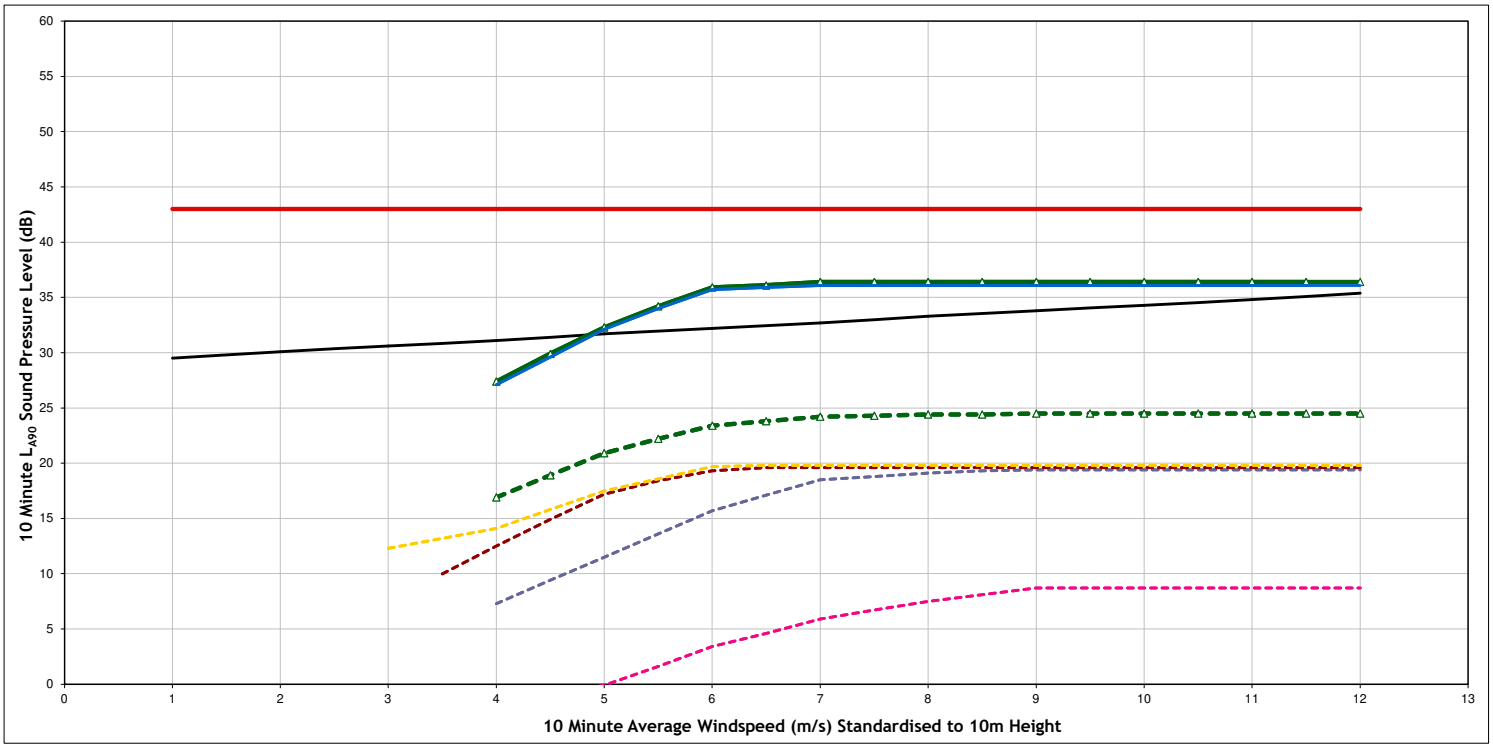
Coriolis Energy

tnei

Daytime - Creigiau Uchaf (NAL6)



Night Time - Creigiau Uchaf (NAL6)



Legend:

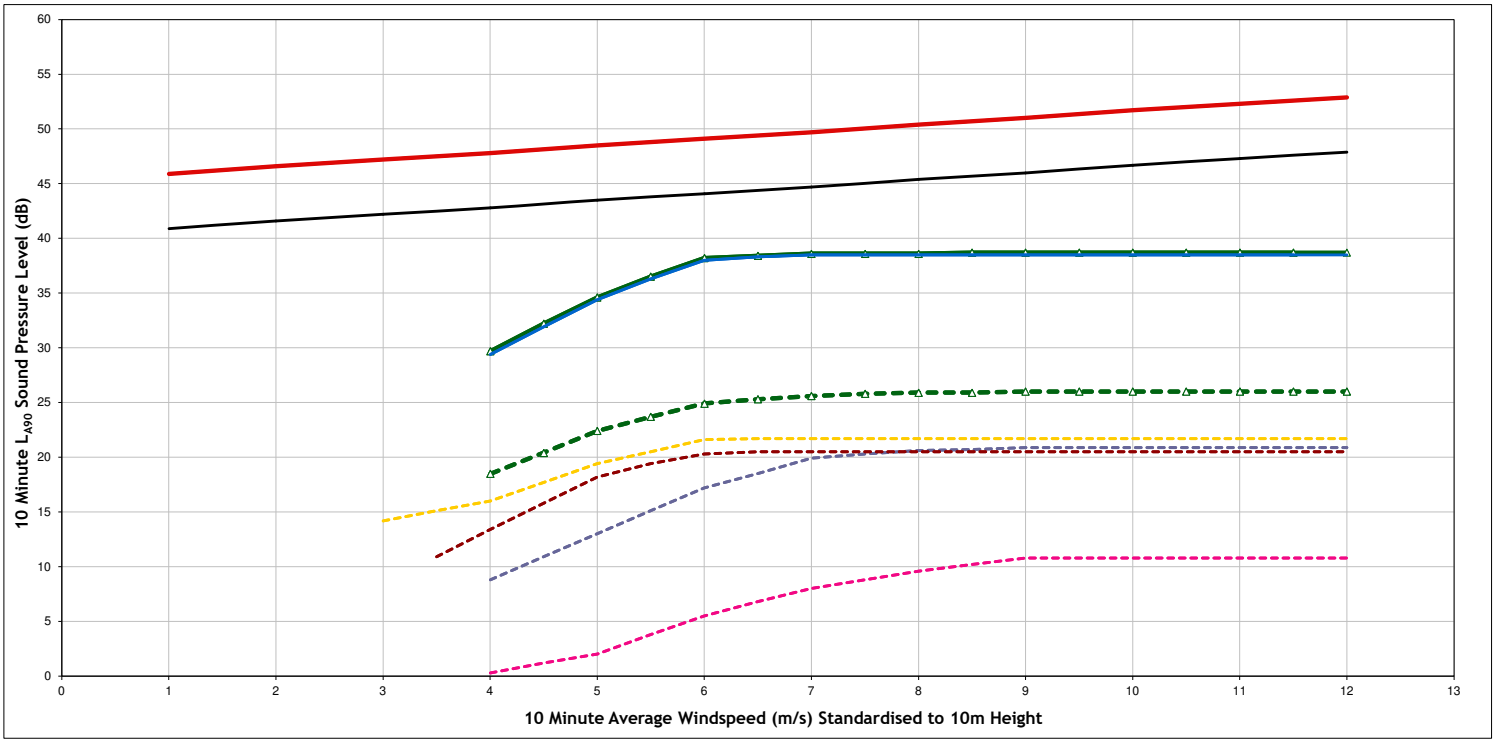
- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=0°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=0°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=30°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Creigiau Uchaf (NAL6)
Figure Number	Figure A1.3f
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

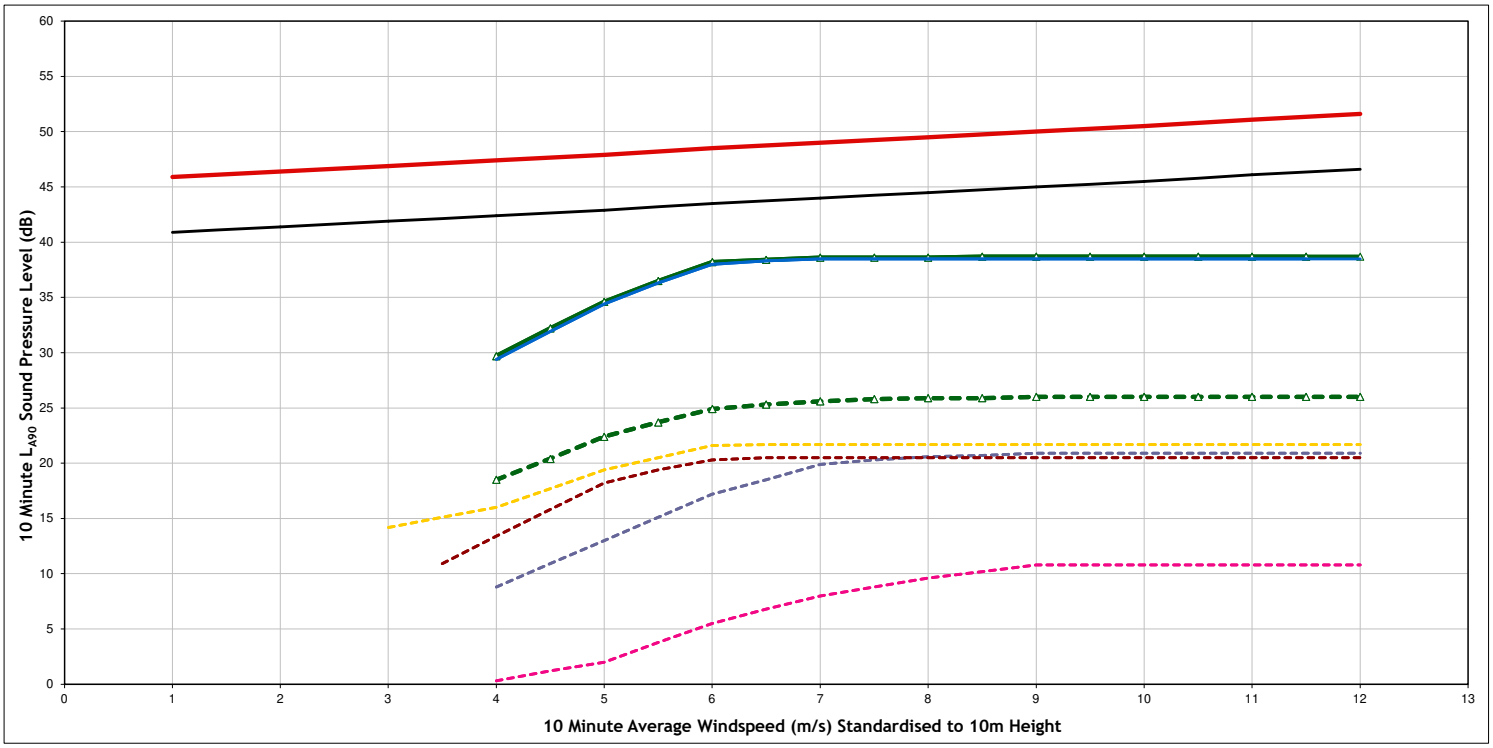
Coriolis Energy

tnei

Daytime - Pentre (NAL7)



Night Time - Pentre (NAL7)



Legend:

- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=330°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=270°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=30°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Pentre (NAL7)
Figure Number	Figure A1.3g
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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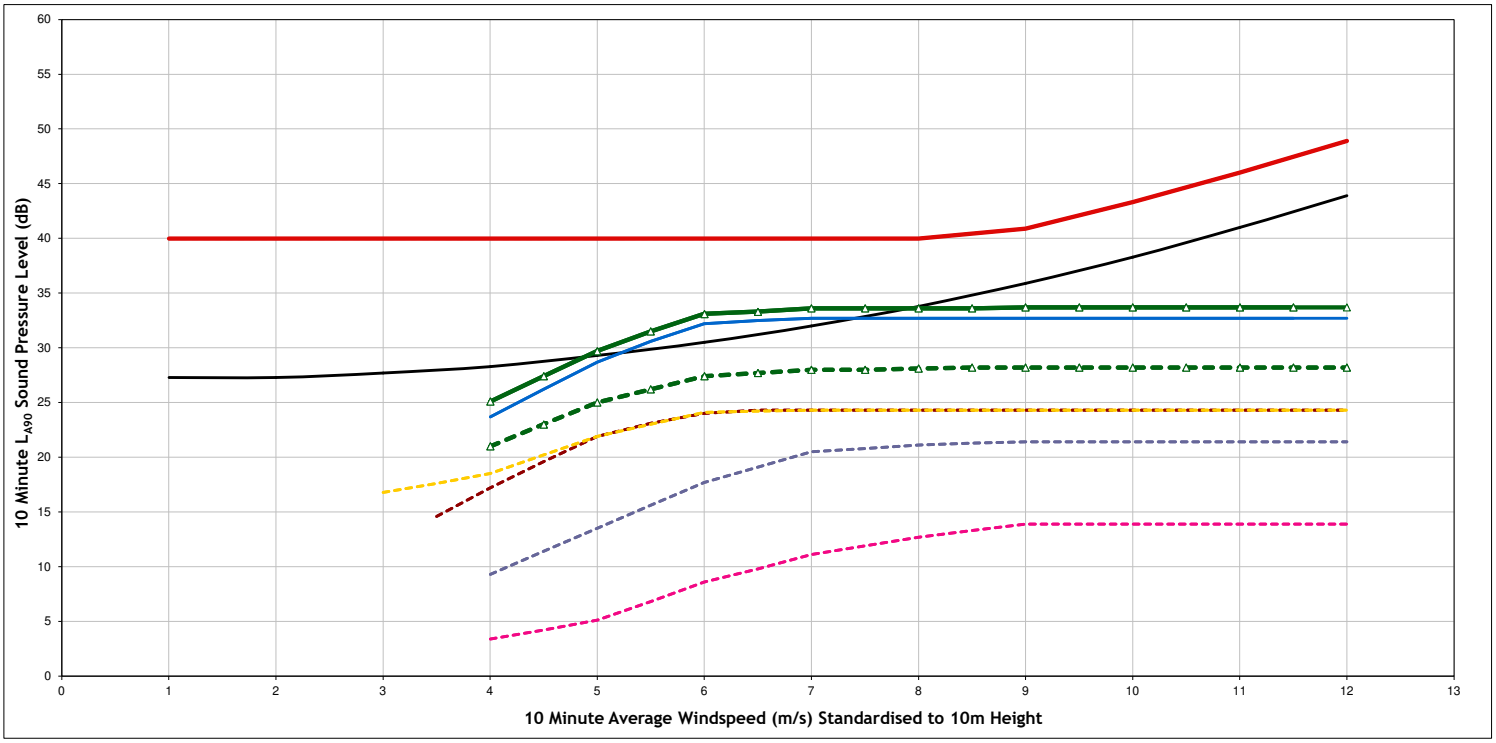
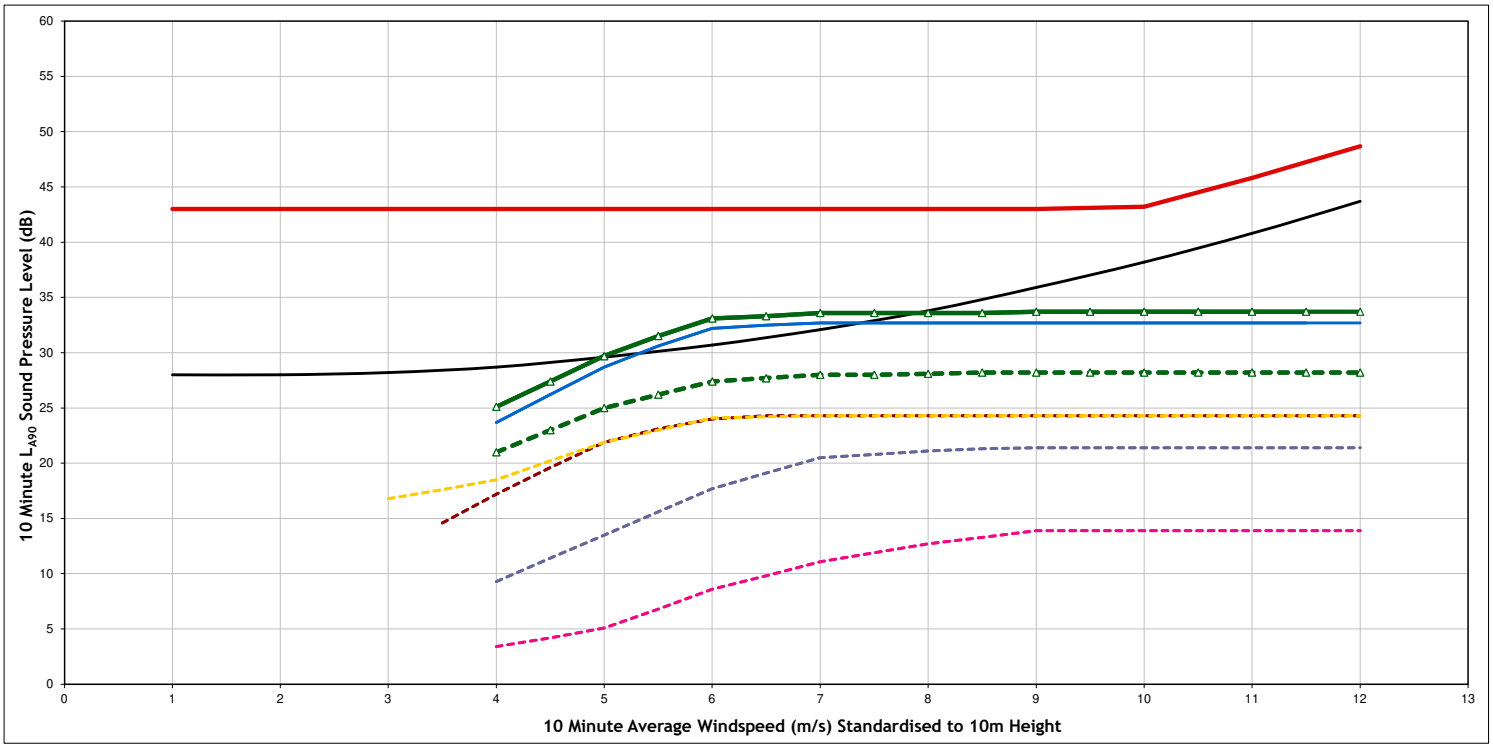
Daytime - Cwm Cywen (NAL8)



Night Time - Cwm Cywen (NAL8)



Legend:

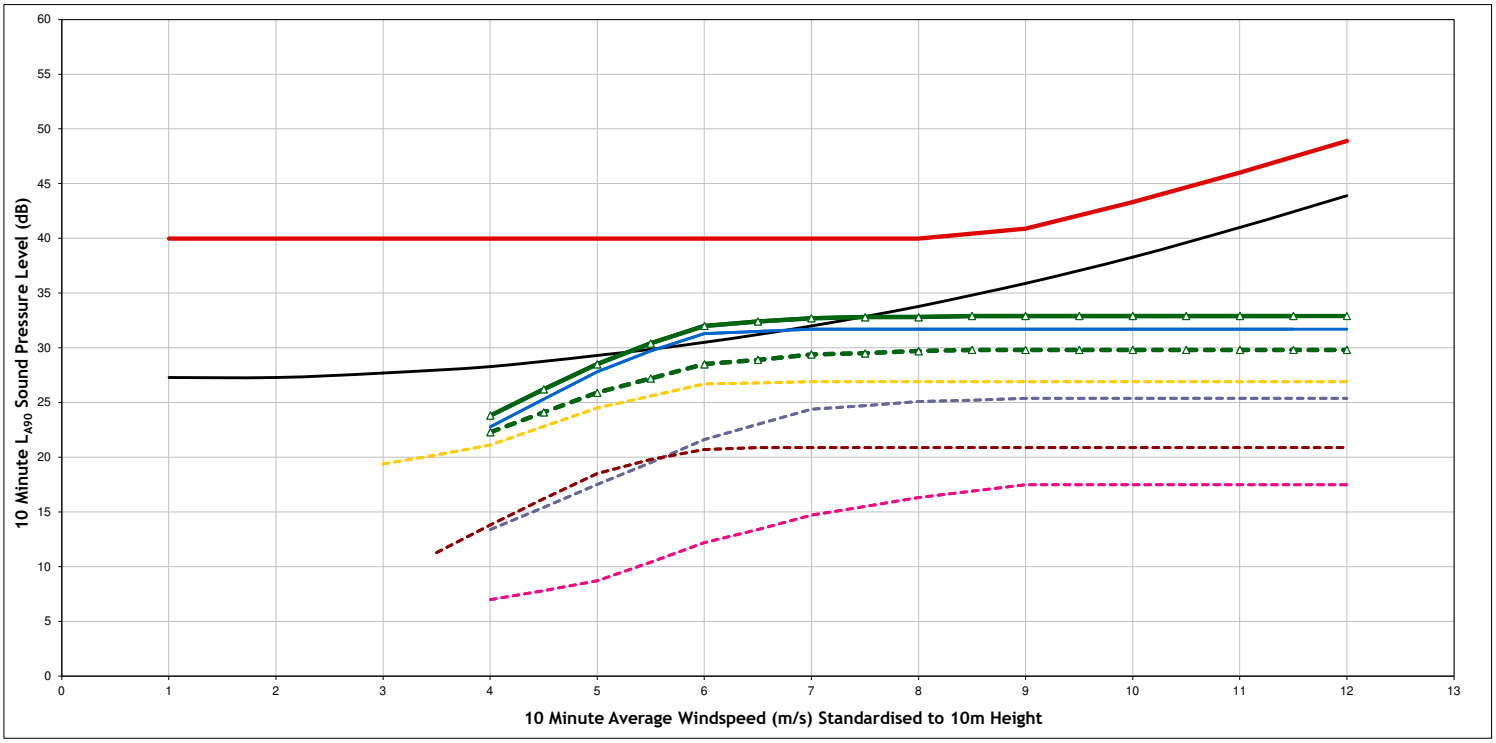
- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=330°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=240°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Cwm Cywen (NAL8)
Figure Number	Figure A1.3h
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

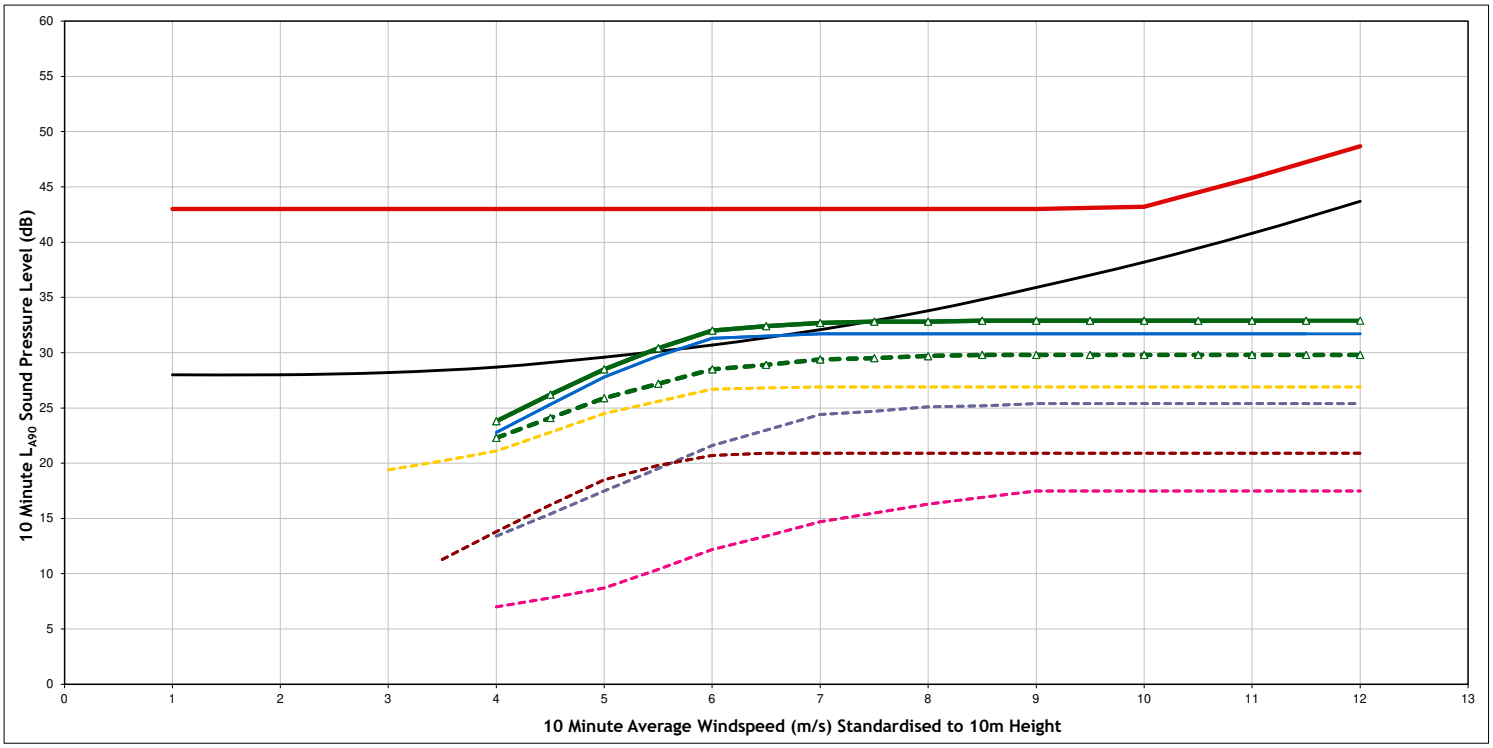
Coriolis Energy

tnei

Daytime - Cwm Llan (NAL9)



Night Time - Cwm Llan (NAL9)



Legend:

- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=270°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=180°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Cwm Llan (NAL9)
Figure Number	Figure A1.3i
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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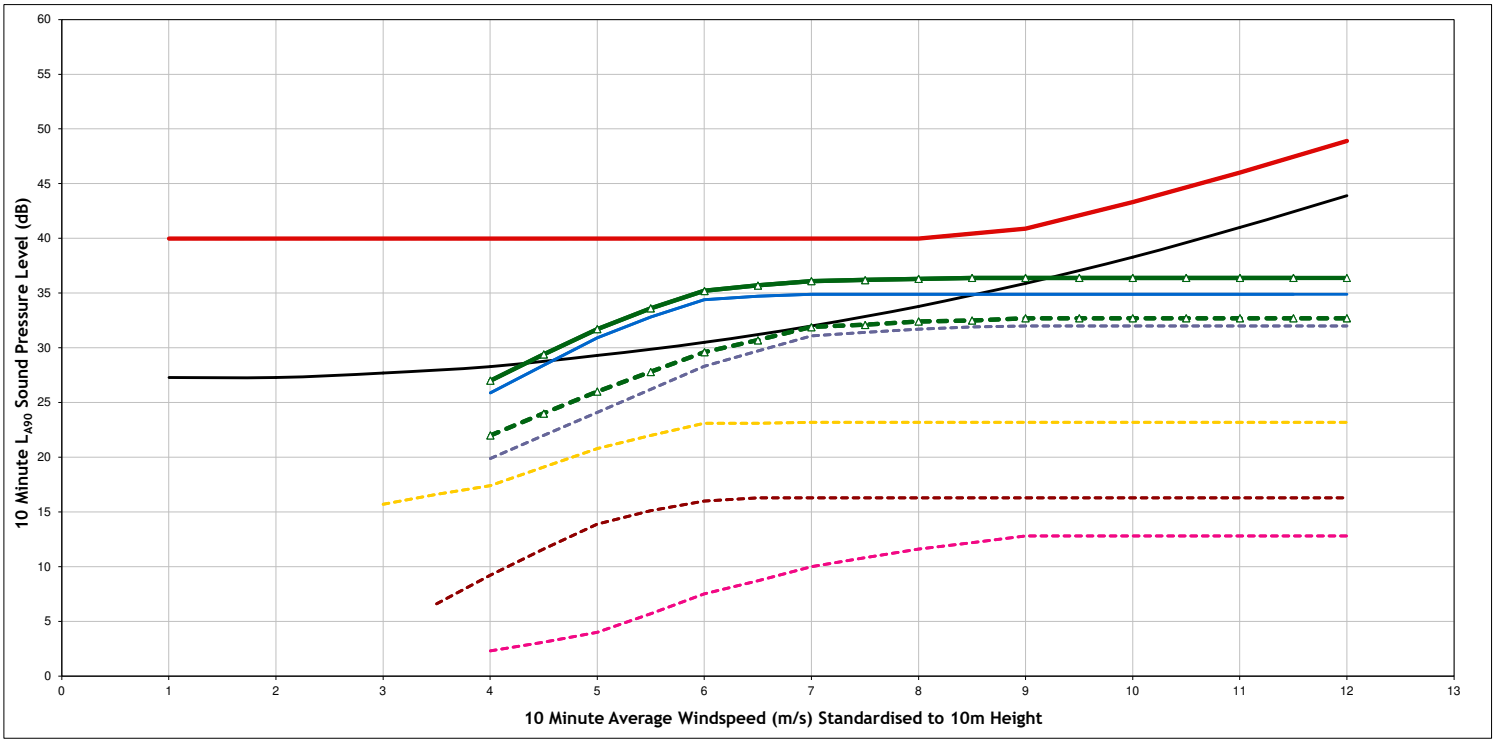
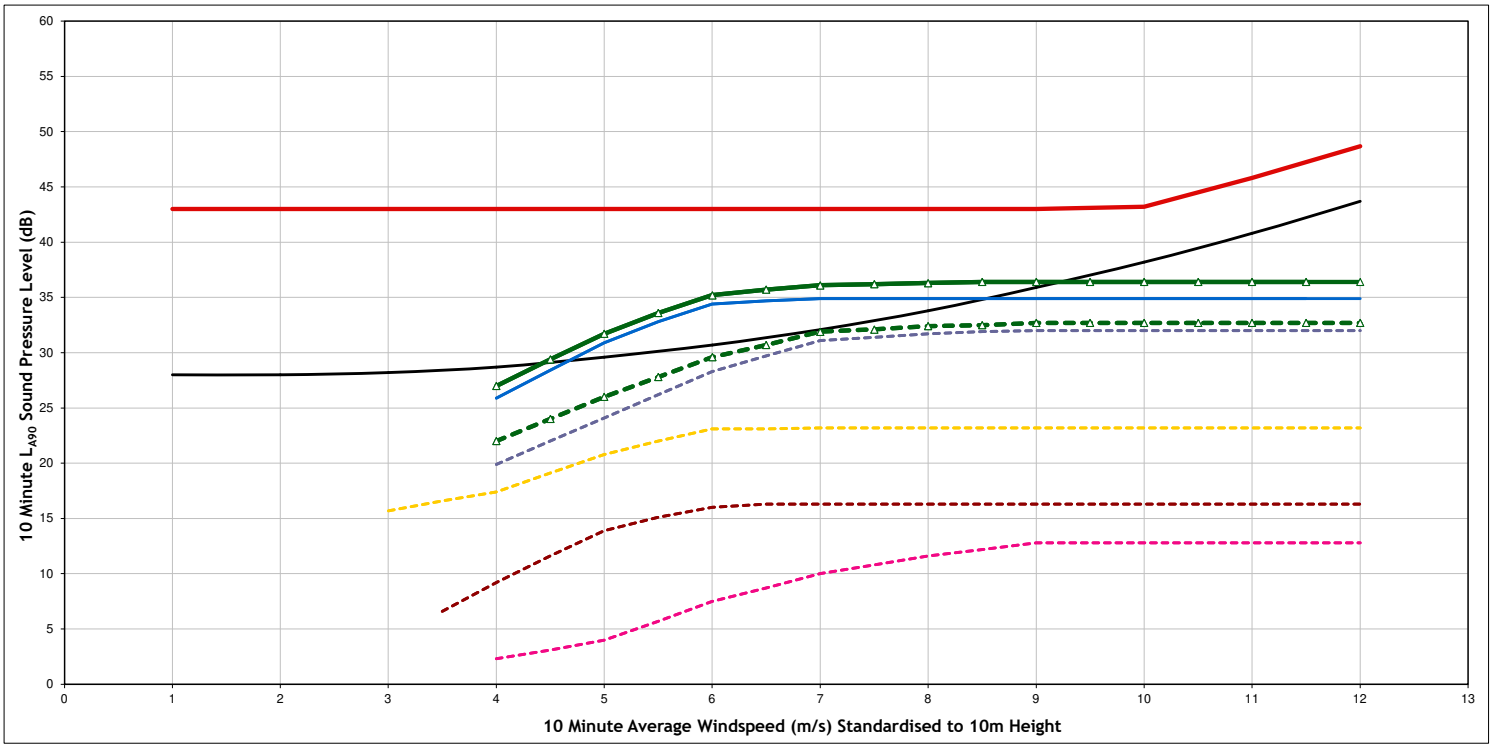
Daytime - Rhyd Yr Ewig (NAL10)



Night Time - Rhyd Yr Ewig (NAL10)



Legend:

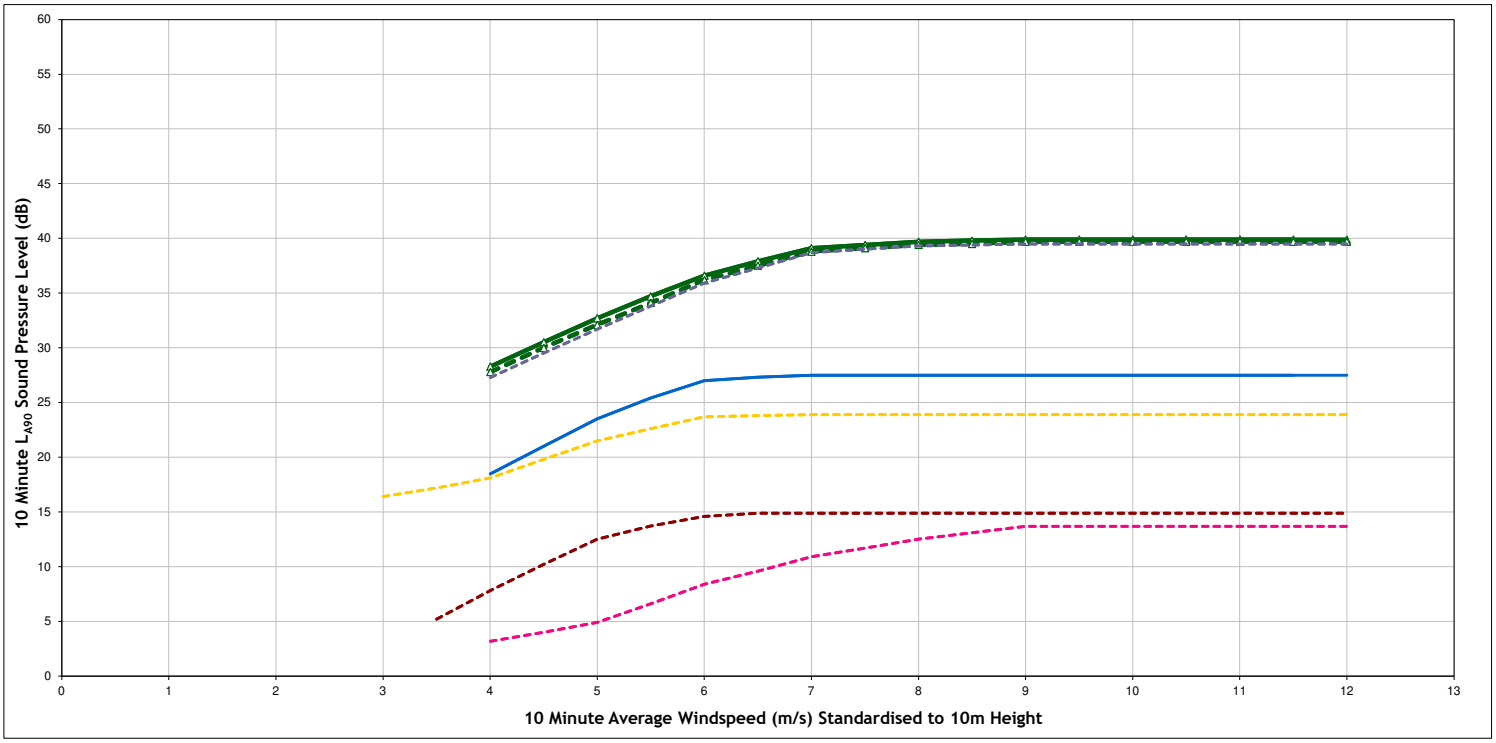
- Background Noise trendline
- Total ETSU-R-97 Noise Limits
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=120°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Rhyd Yr Ewig (NAL10)
Figure Number	Figure A1.3j
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

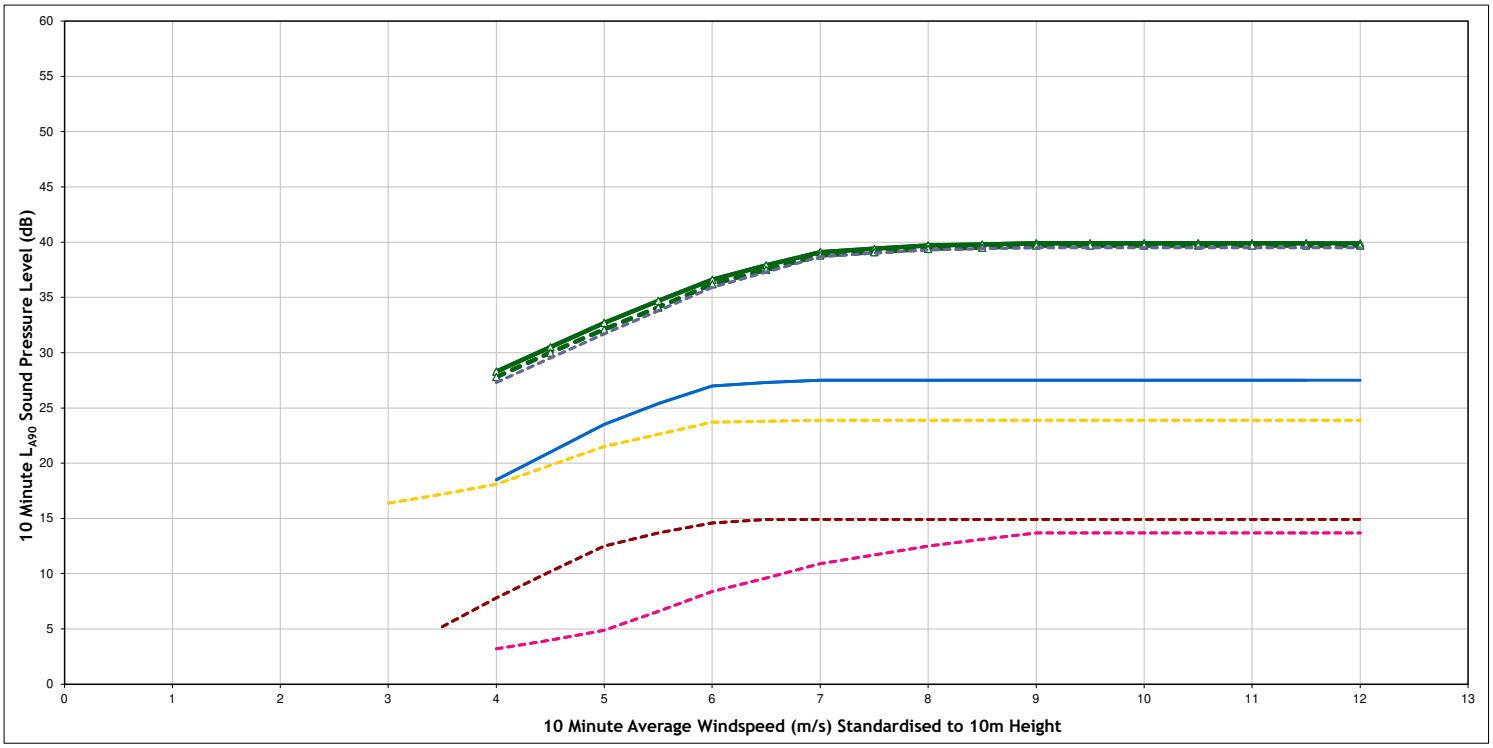
Coriolis Energy

tnei

Daytime - Gellioedd Uchaf (NAL11)



Night Time - Gellioedd Uchaf (NAL11)



Legend:

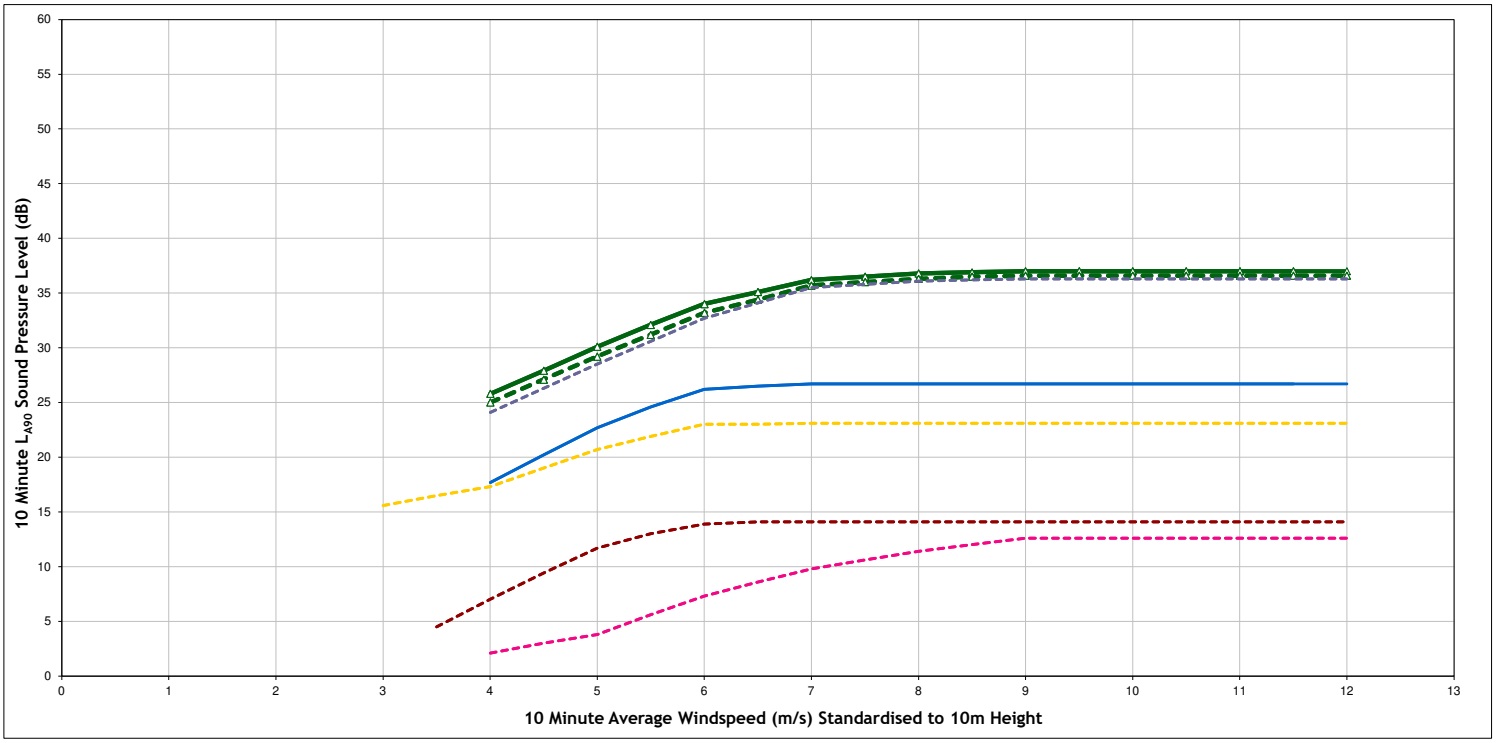
- N/A
- N/A
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=120°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=0°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Gellioedd Uchaf (NAL11)
Figure Number	Figure A1.3k
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

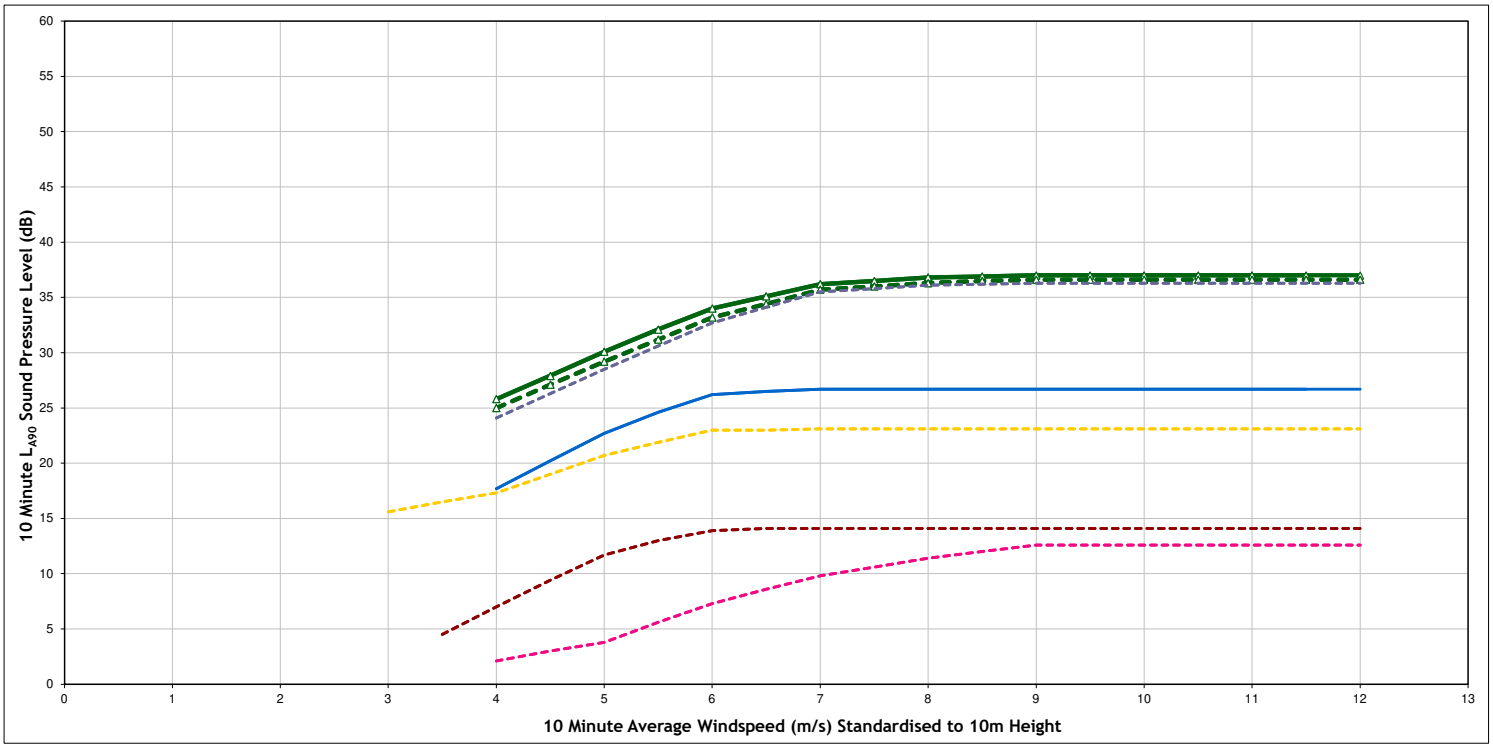
Coriolis Energy

tnei

Daytime - Castell (NAL12)



Night Time - Castell (NAL12)



Legend:

- N/A
- N/A
- Cumulative (including the Proposed Development) [WD=90°]
- Cumulative (excluding the Proposed Development) [WD=30°]
- Proposed Development with 10 x E-175 [WD=120°]
- Hafotty Uchaf&Bryn Ffynnon, Operational 4 x V52 + 1 x E-53 [WD=0°]
- Disgarth Ucha&Ty'n Gwyn, Operational 2 x E53 [WD=30°]
- Gaerwen, In Planning 9 x SG 6.0-155 [WD=60°]
- Moel Chwa, Scoping 12 x V162 [WD=30°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Cumulative Castell (NAL12)
Figure Number	Figure A1.3l
Scale	NTS
Drawn	MR
Checked	MC
Date	08/07/2025
Document Reference	16513 Noise Model

Coriolis Energy

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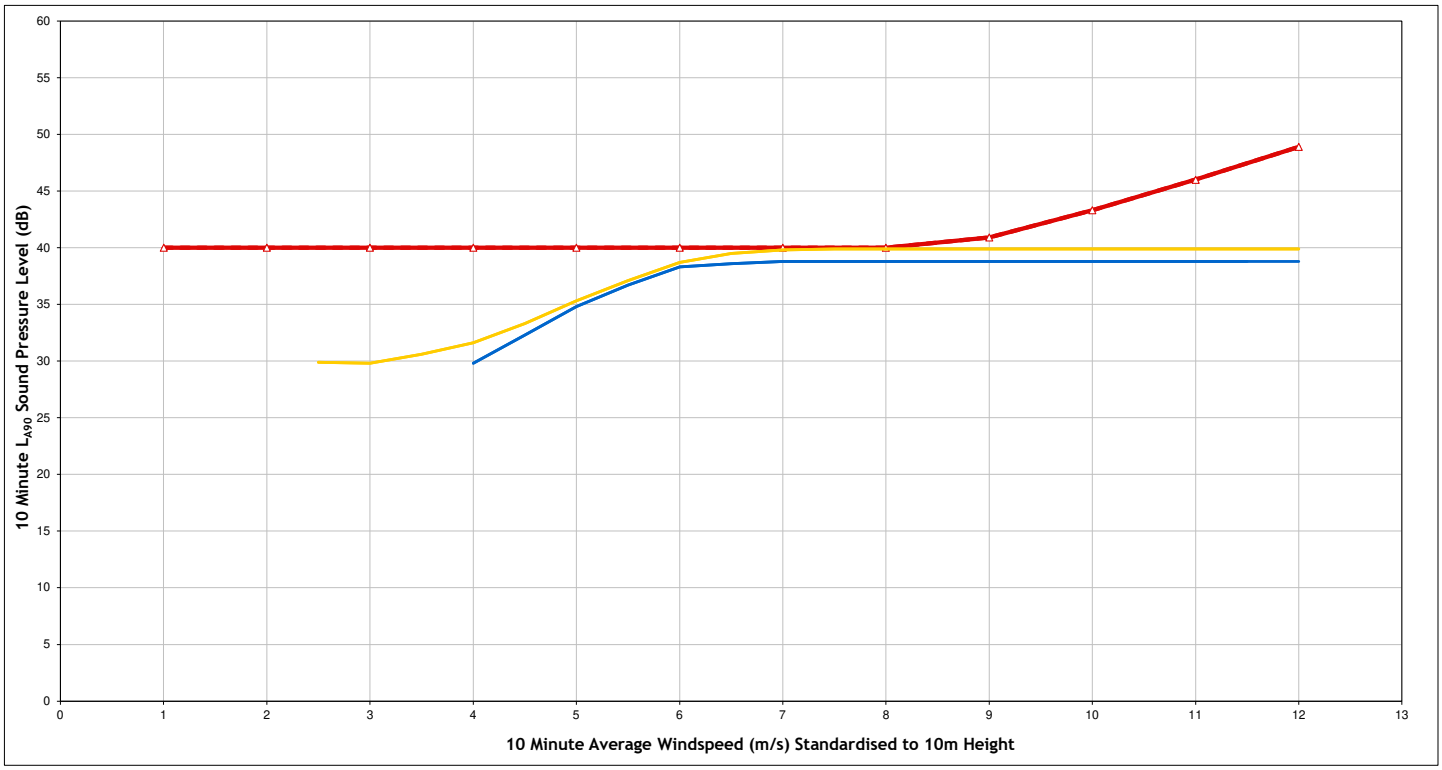
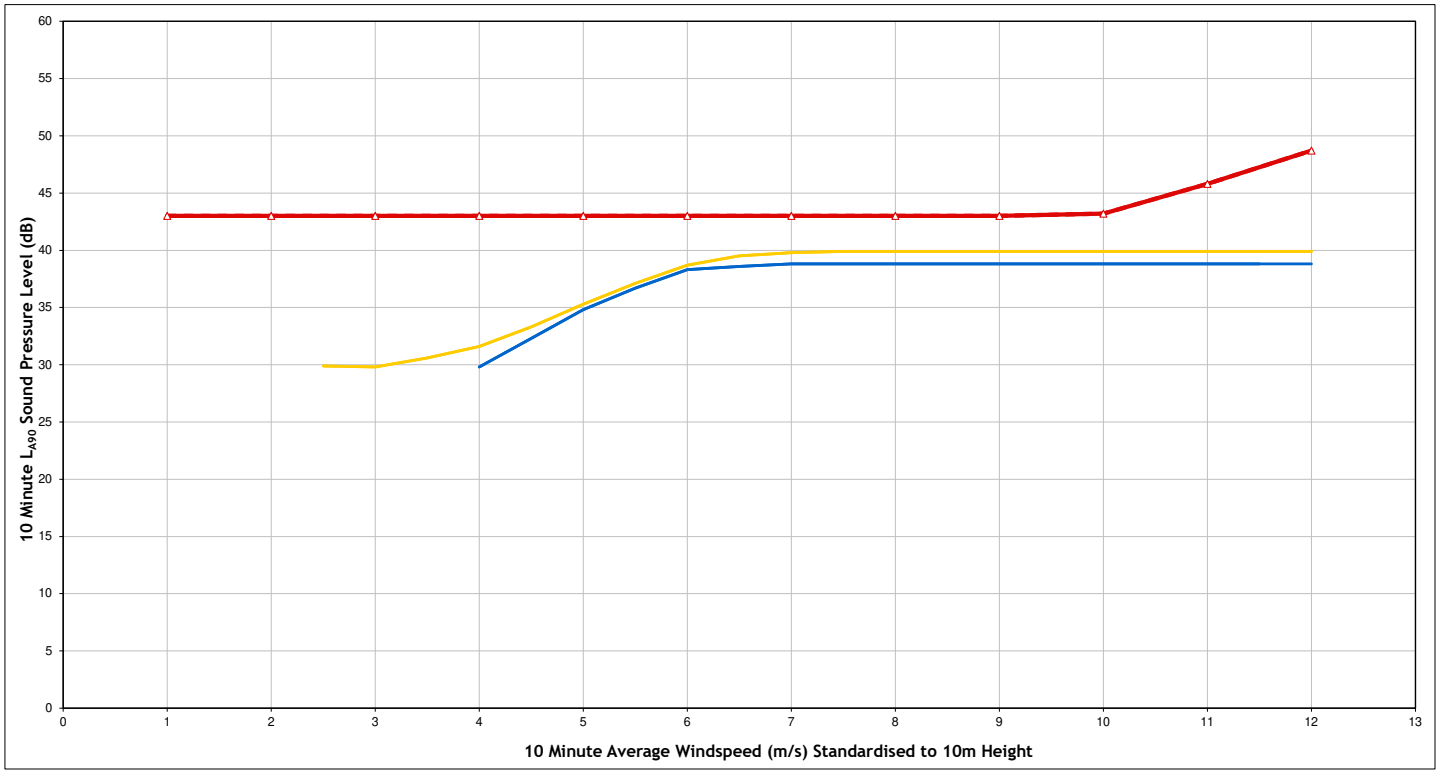
Daytime - Greigwen (NAL1)



Night Time - Greigwen (NAL1)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=120°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=120°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Greigwen (NAL1)
Figure Number	Figure A1.4a
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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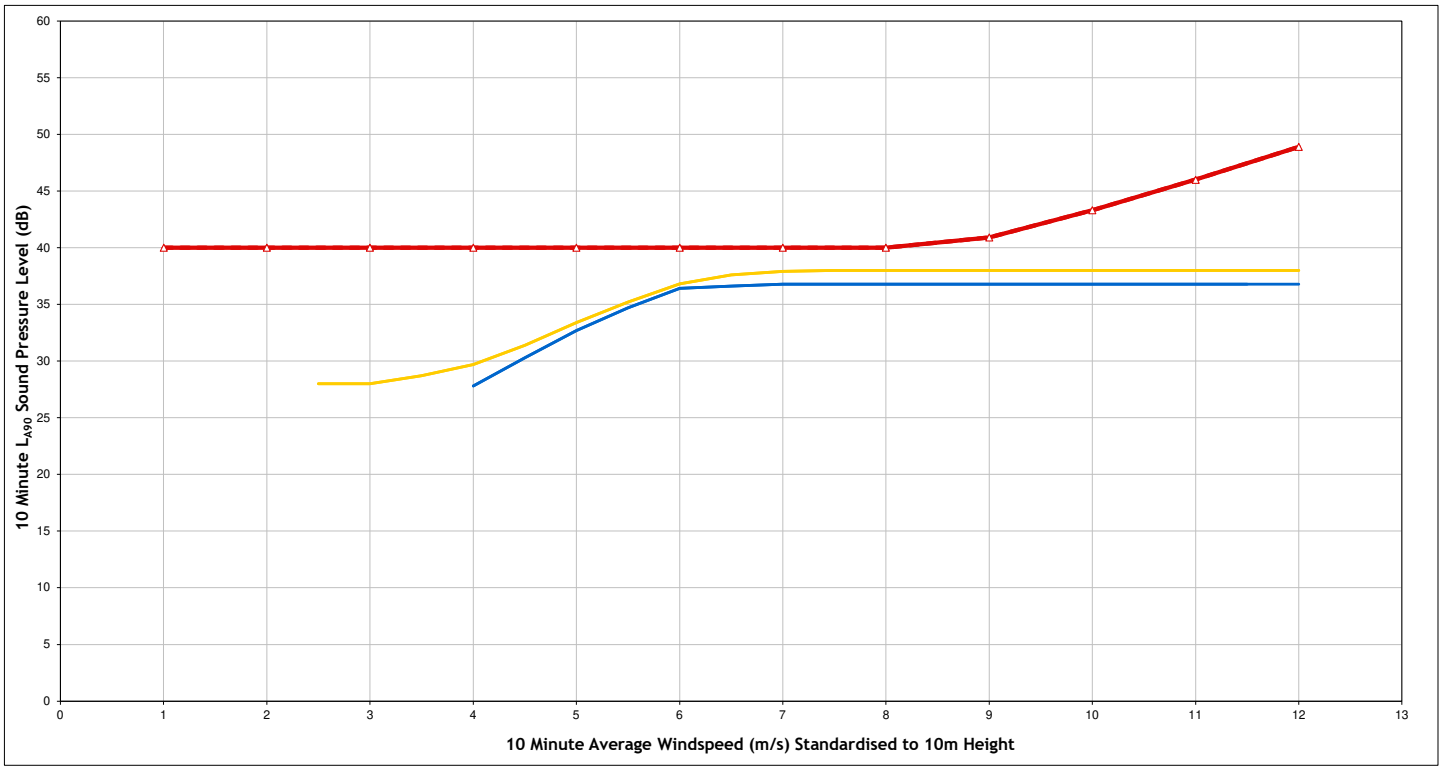
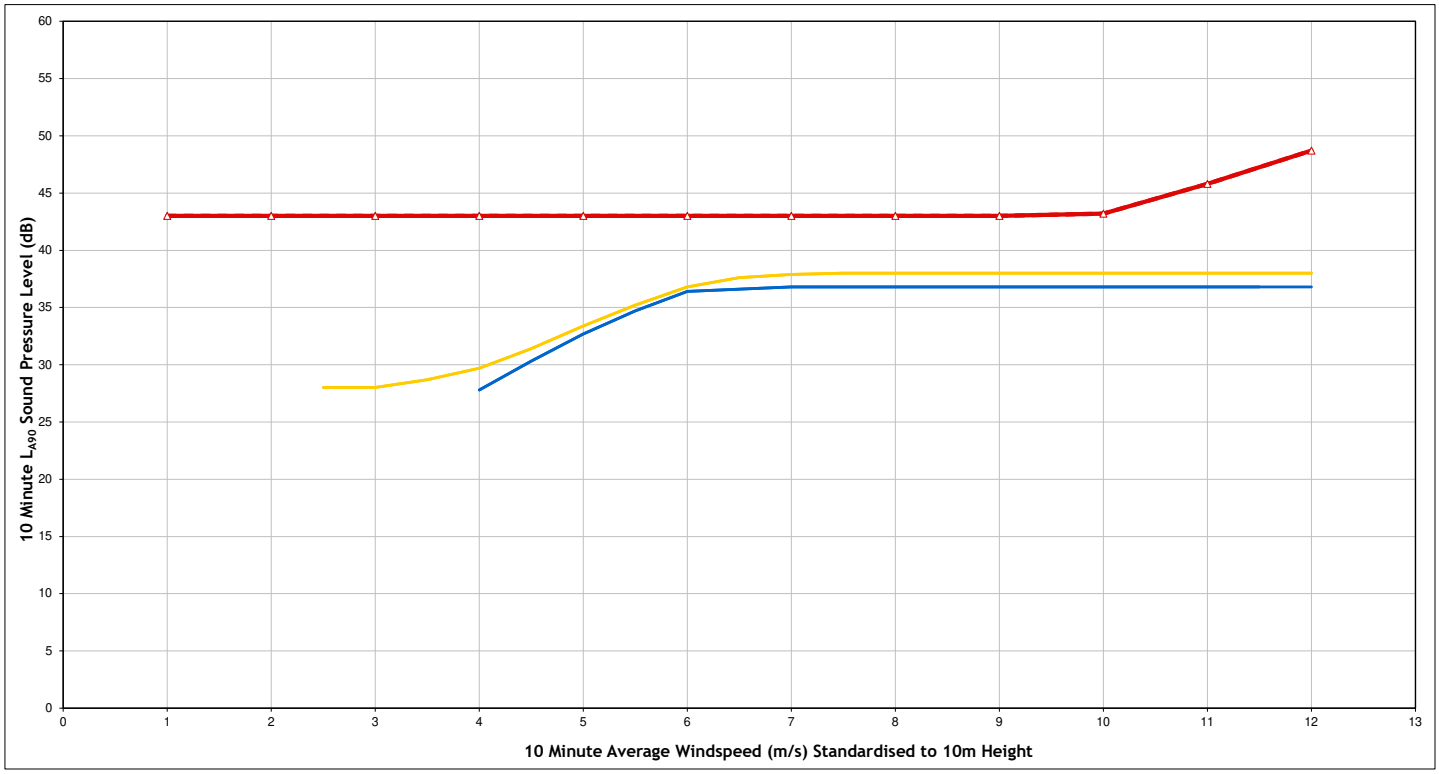
Daytime - Ty'n Y Ddol Uchaf (NAL2)



Night Time - Ty'n Y Ddol Uchaf (NAL2)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=90°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=90°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Ty'n Y Ddol Uchaf (NAL2)
Figure Number	Figure A1.4b
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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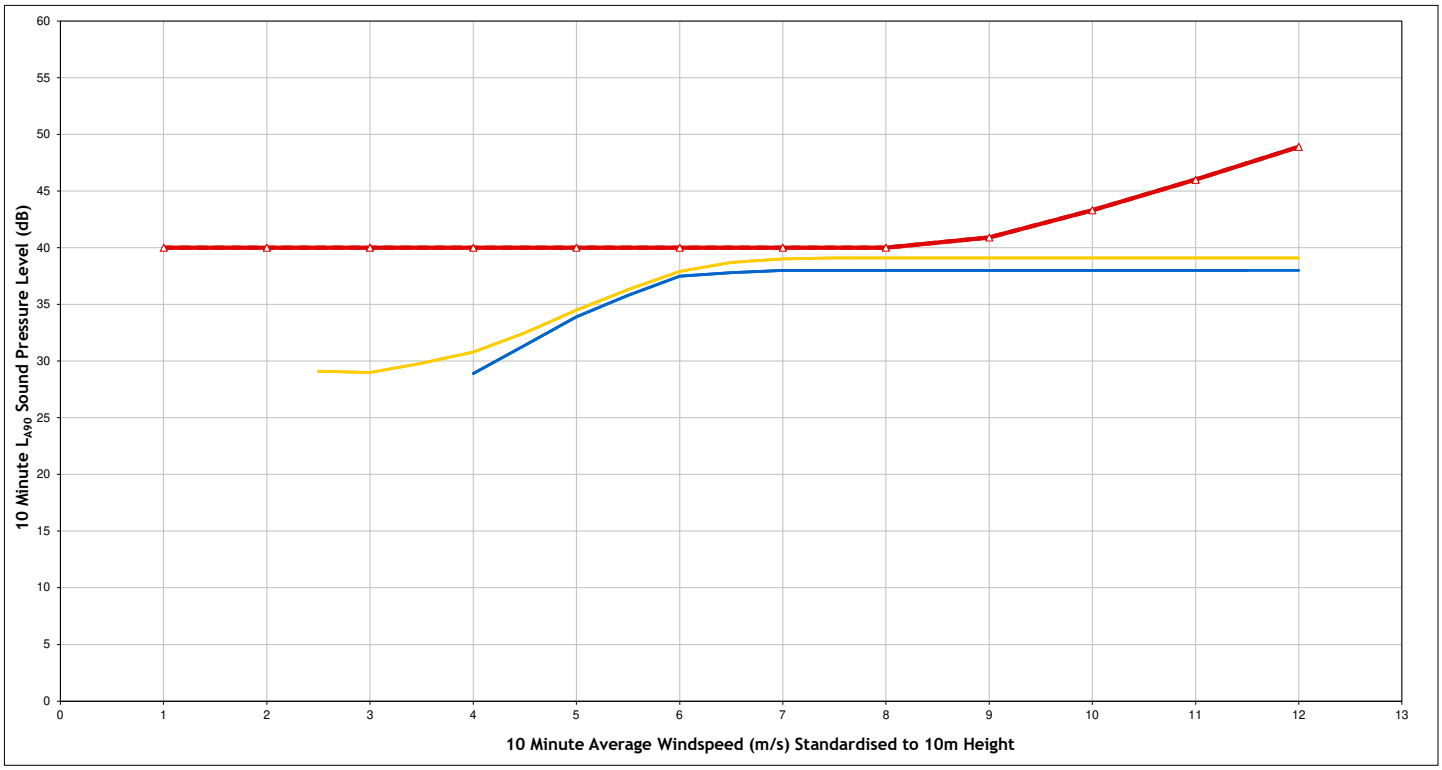
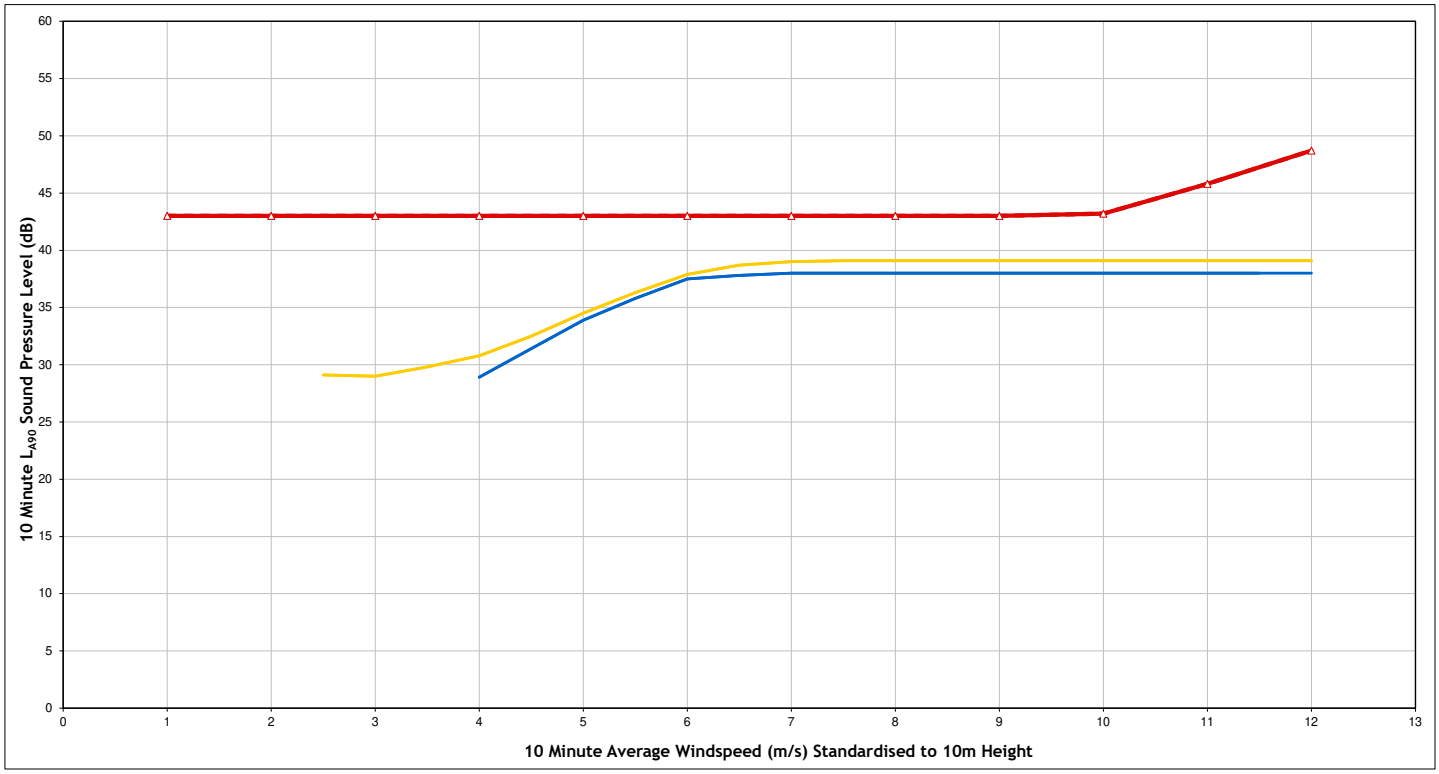
Daytime - Maespyllan (NAL3)



Night Time - Maespyllan (NAL3)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=90°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=90°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Maespyllan (NAL3)
Figure Number	Figure A1.4c
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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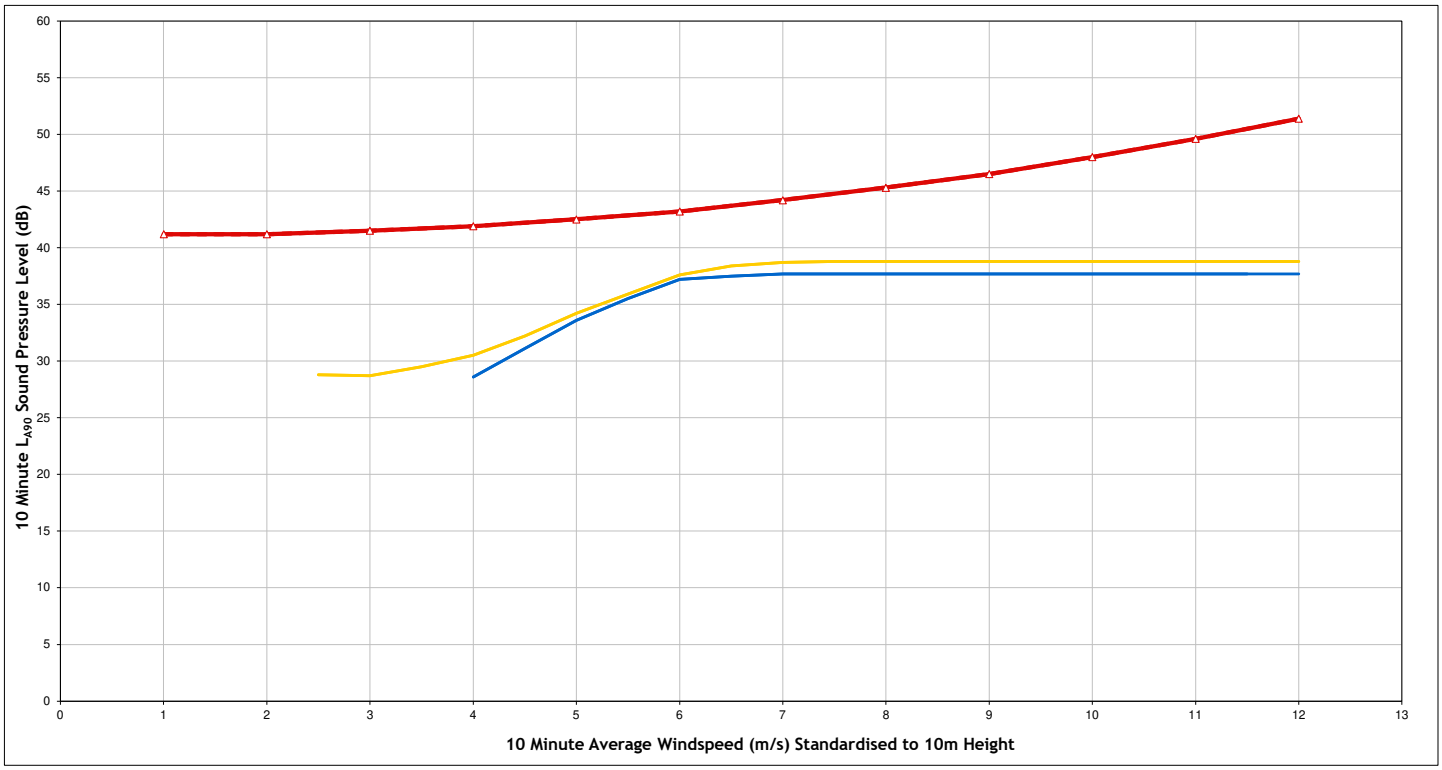
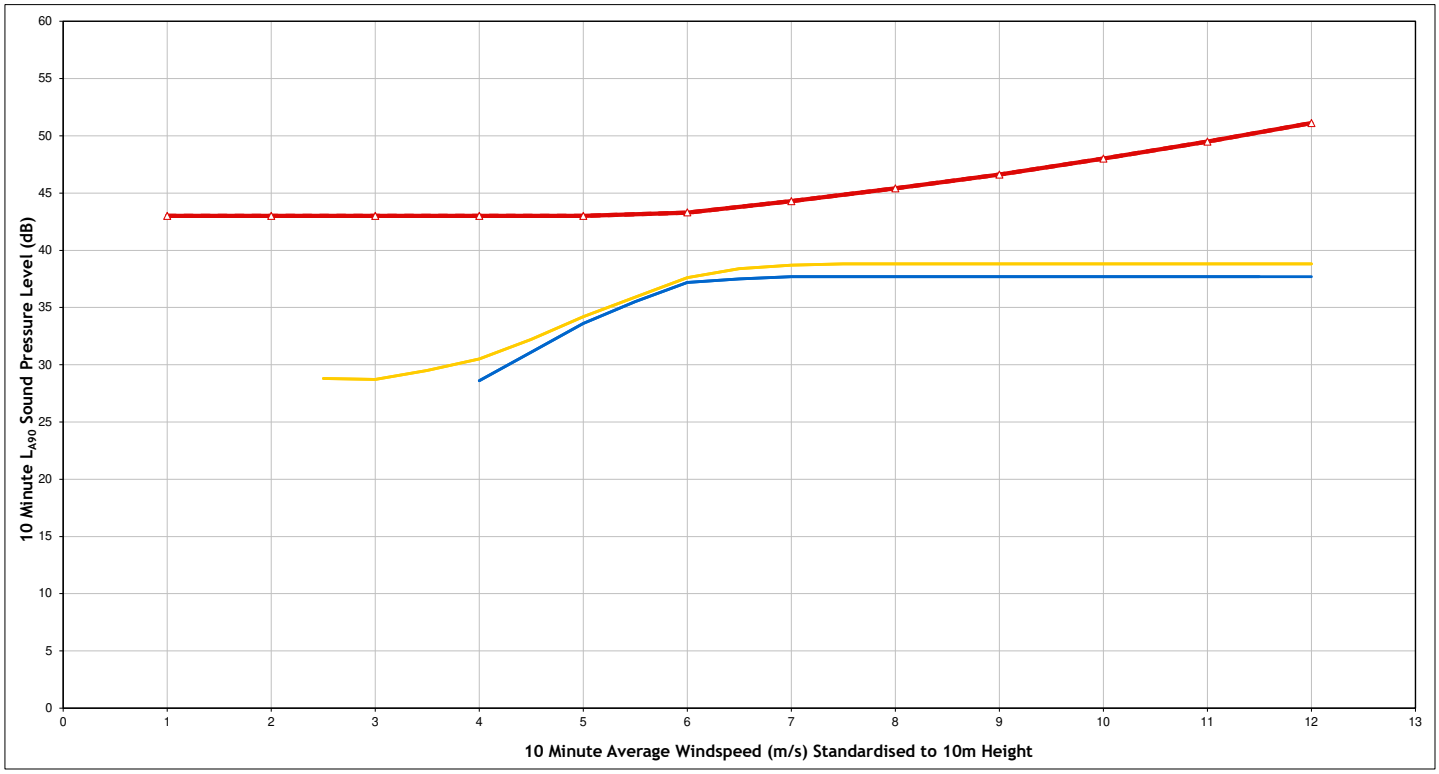
Daytime - Llaithgwm (NAL4)



Night Time - Llaithgwm (NAL4)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=30°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=30°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Llaithgwm (NAL4)
Figure Number	Figure A1.4d
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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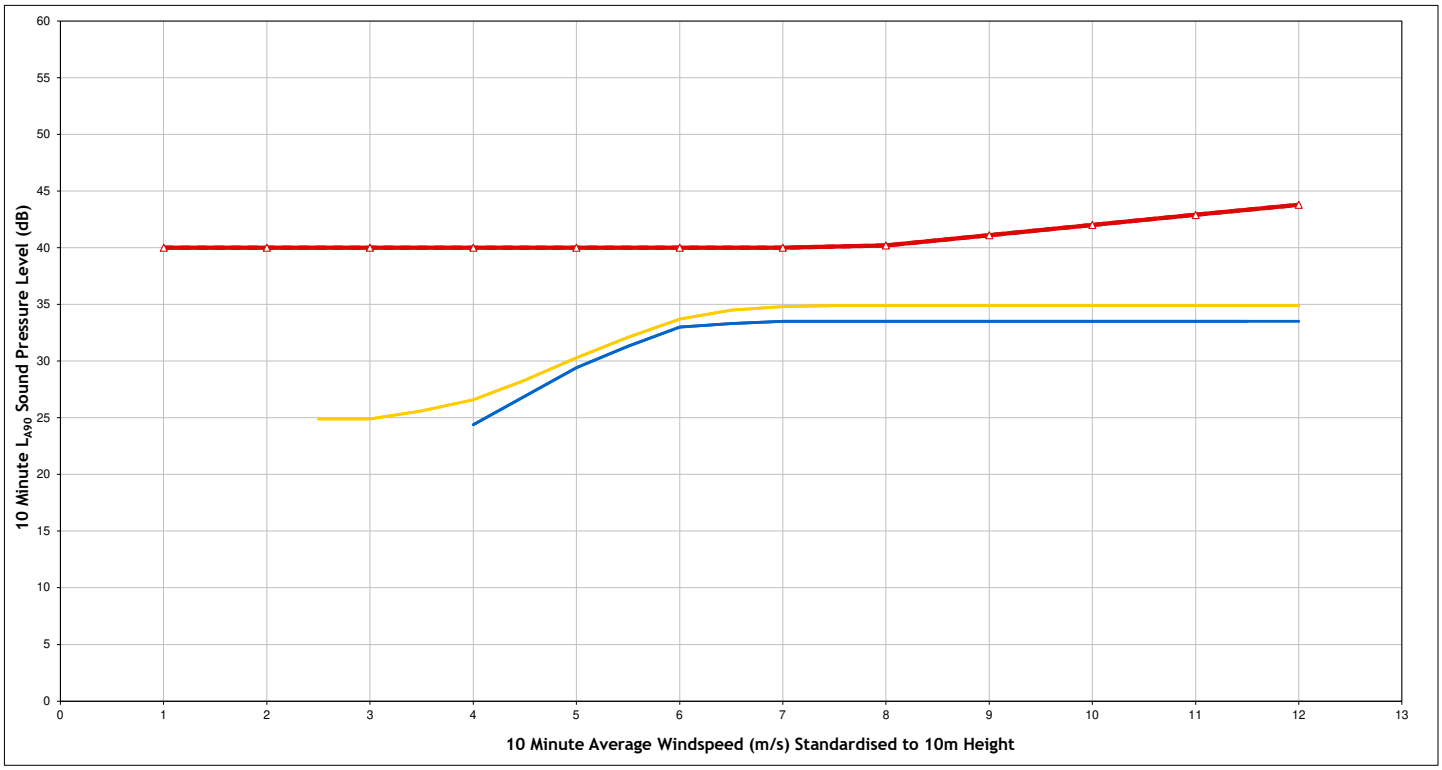
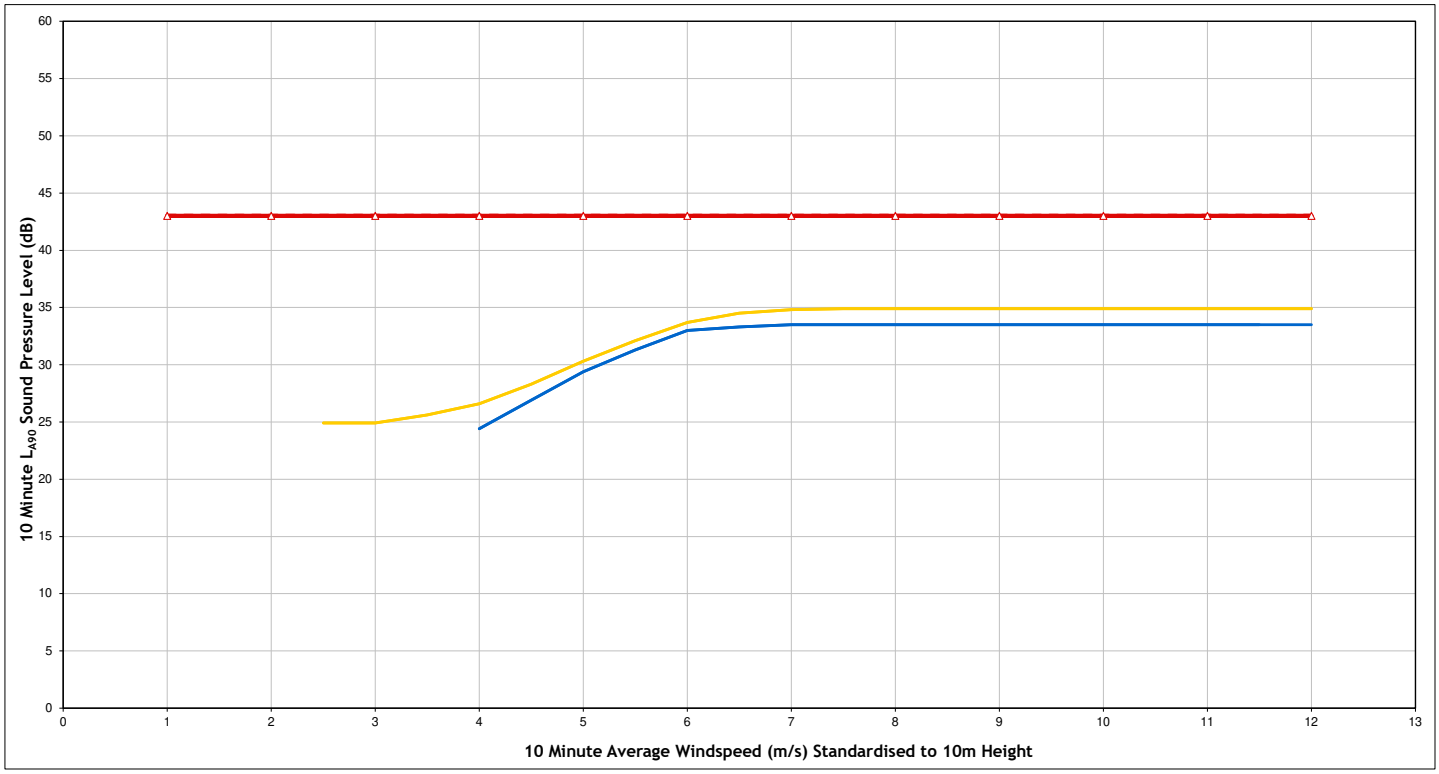
Daytime - Penmaen Uchaf (NAL5)



Night Time - Penmaen Uchaf (NAL5)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=0°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Penmaen Uchaf (NAL5)
Figure Number	Figure A1.4e
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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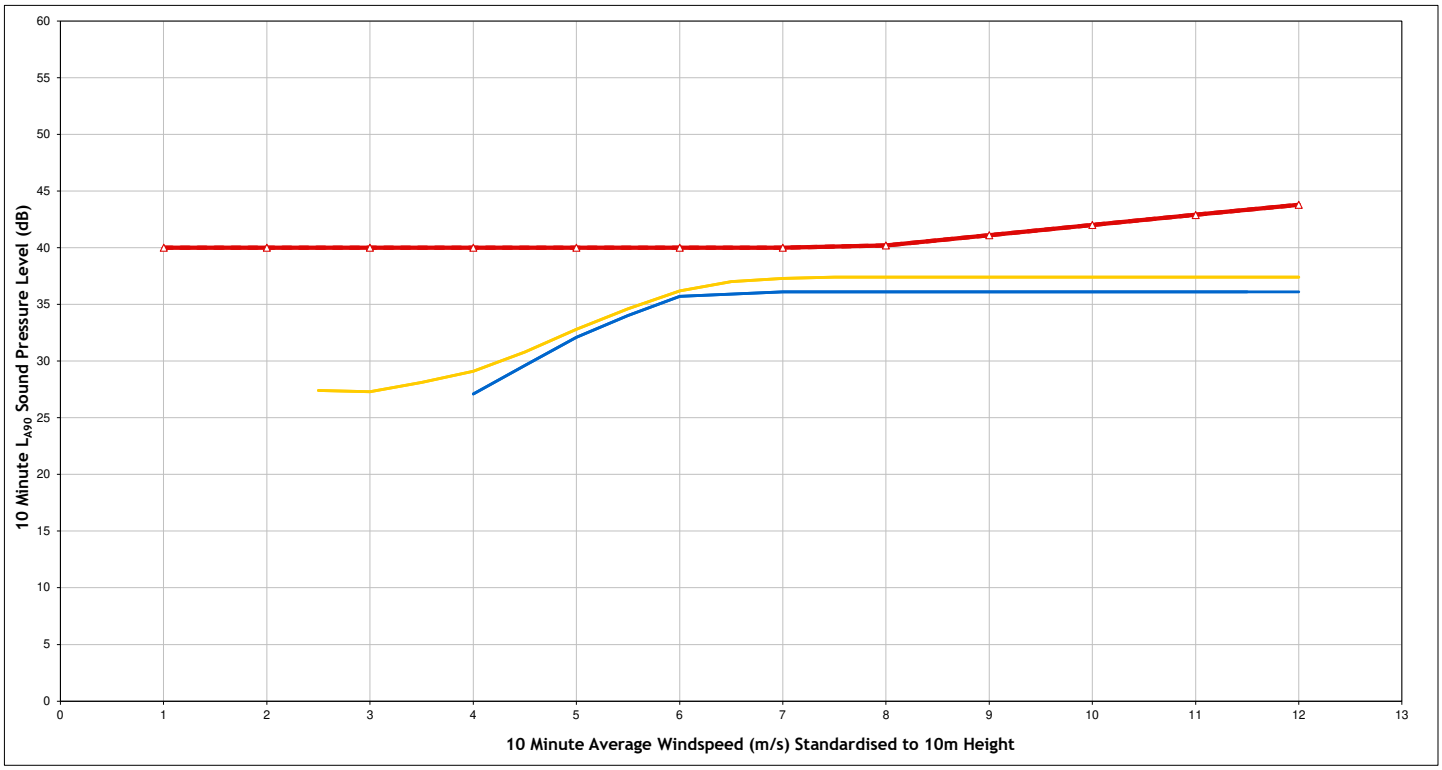
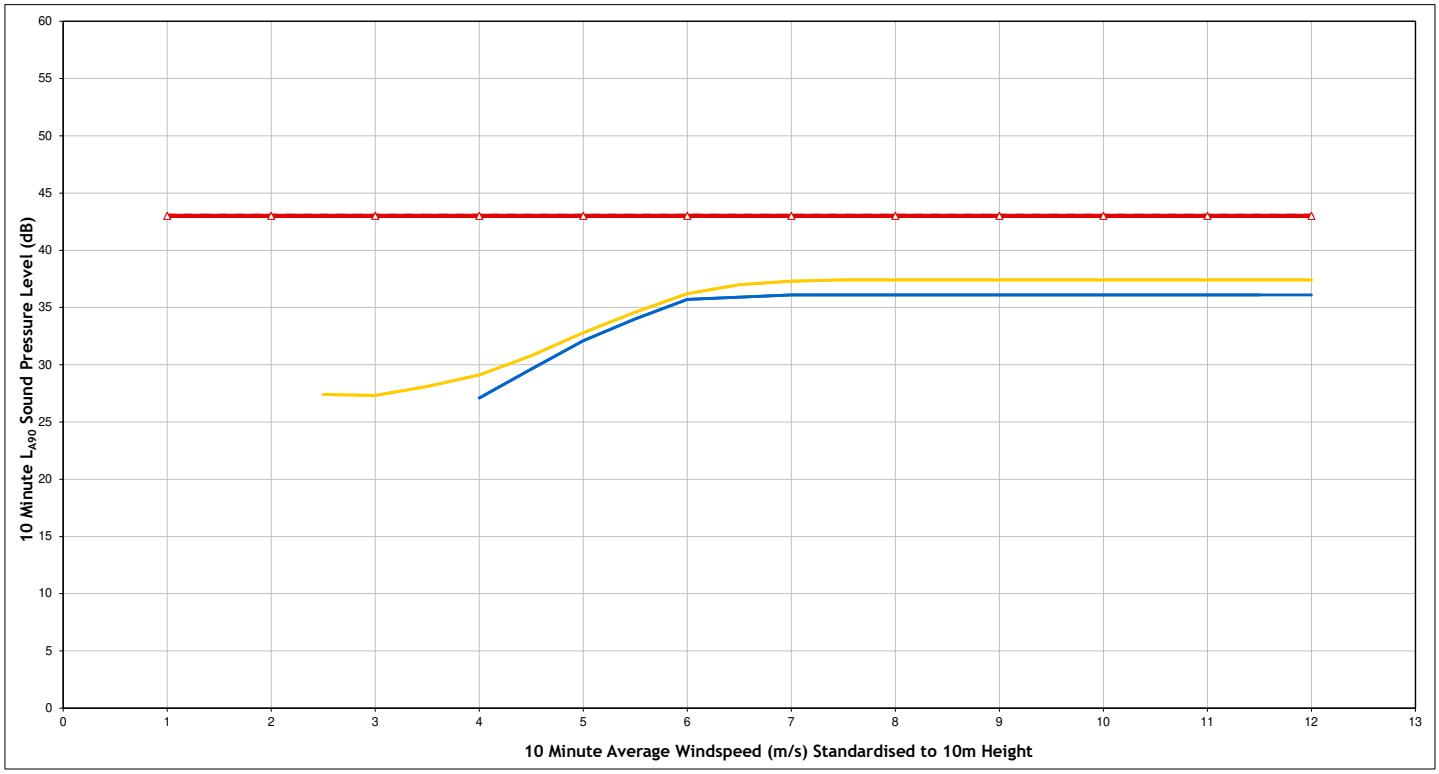
Daytime - Creigiau Uchaf (NAL6)



Night Time - Creigiau Uchaf (NAL6)

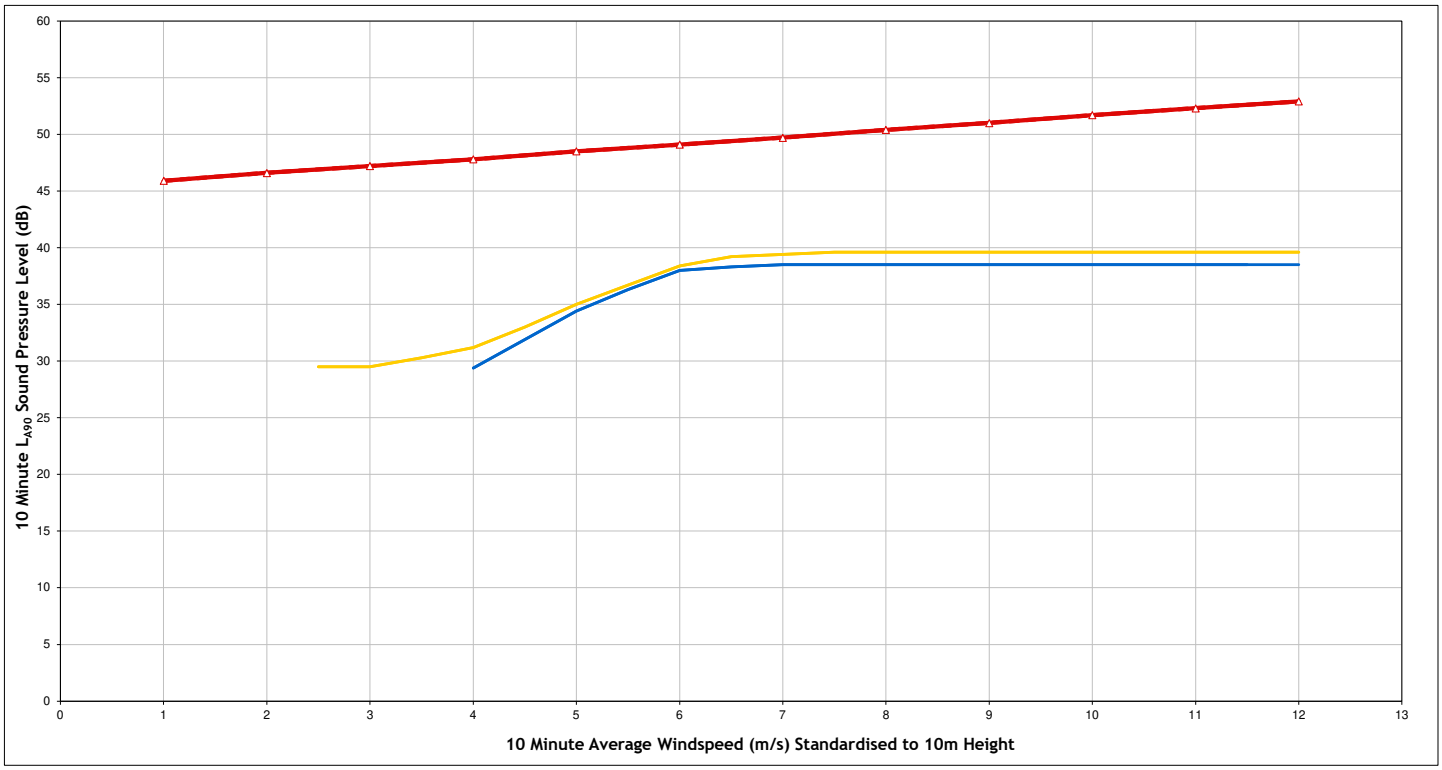


Legend:

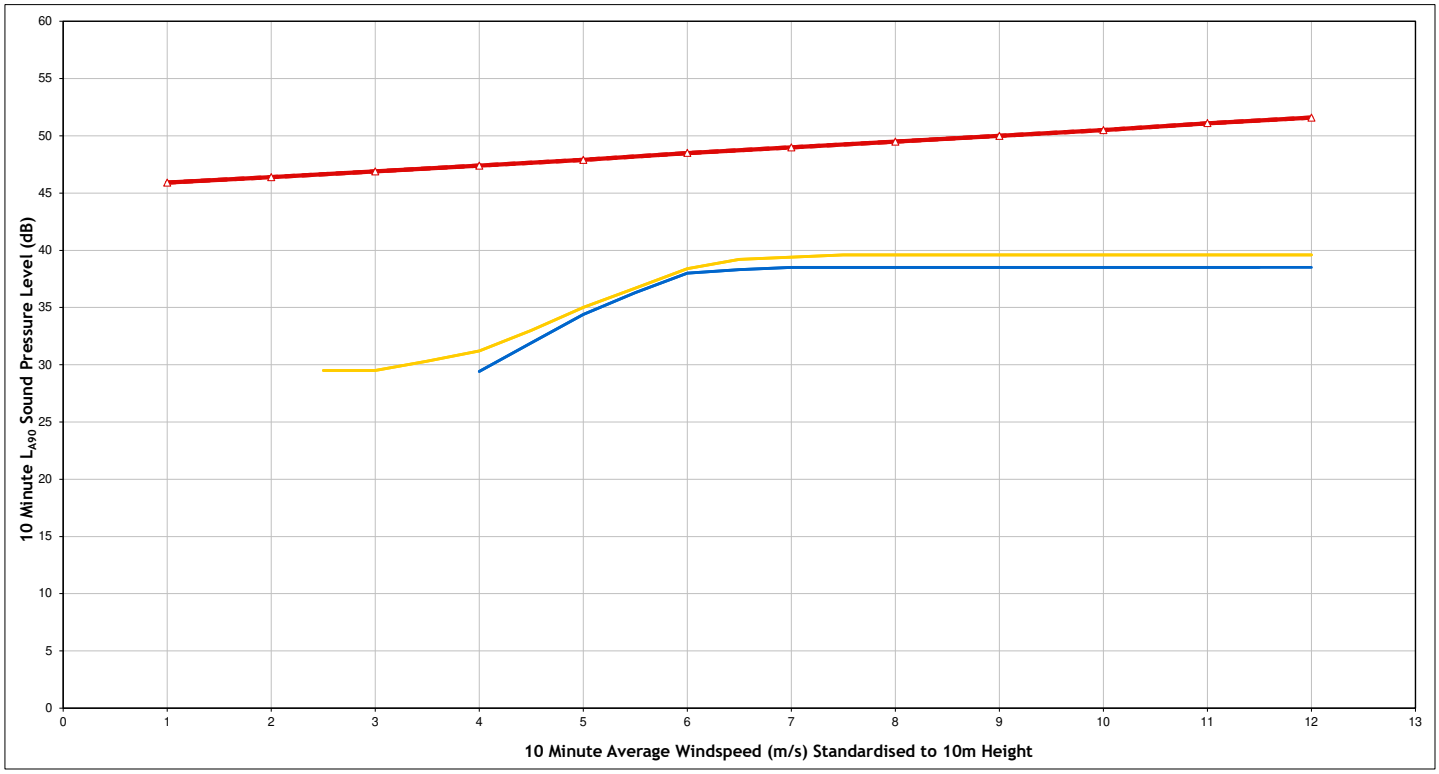
- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=0°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=0°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Creigiau Uchaf (NAL6)
Figure Number	Figure A1.4f
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Daytime - Pentre (NAL7)



Night Time - Pentre (NAL7)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=270°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=270°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Pentre (NAL7)
Figure Number	Figure A1.4g
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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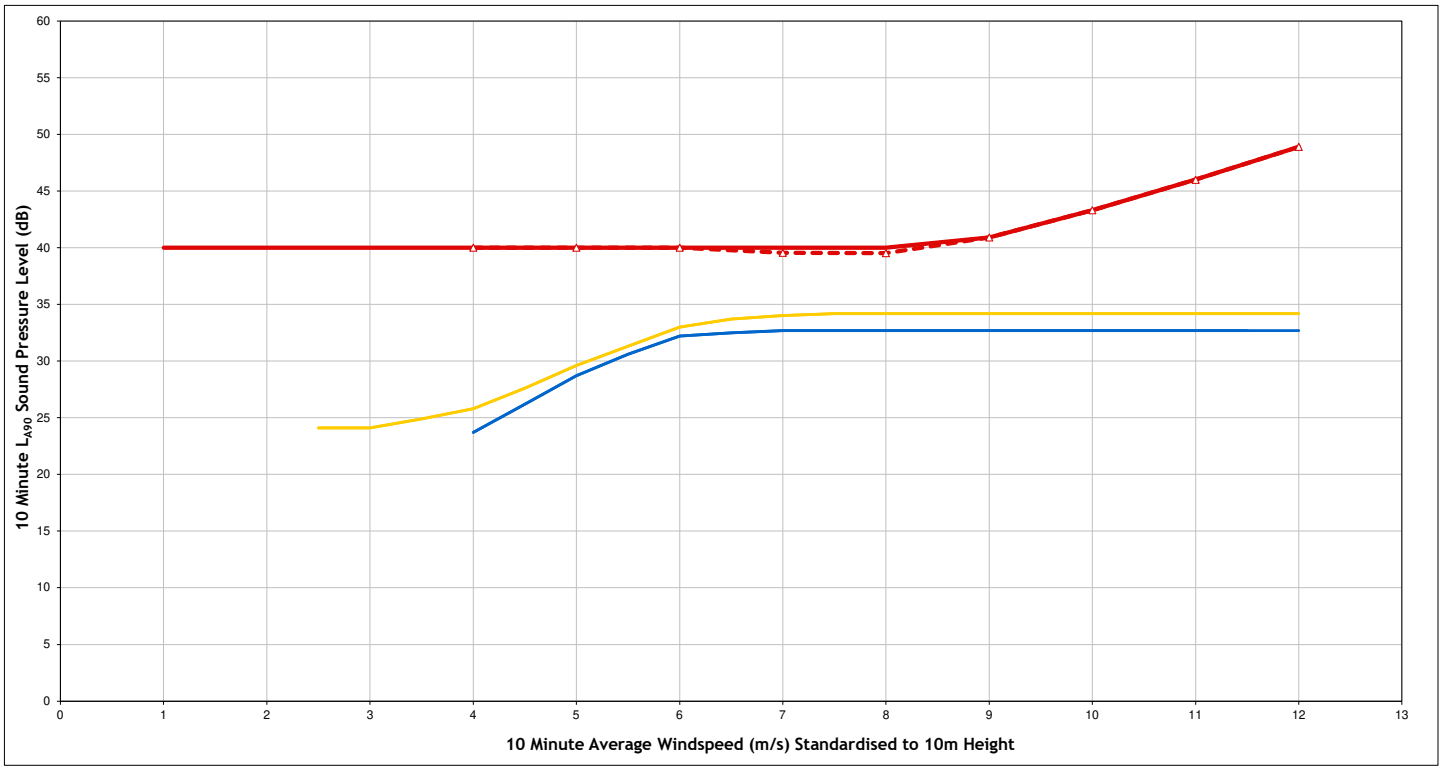
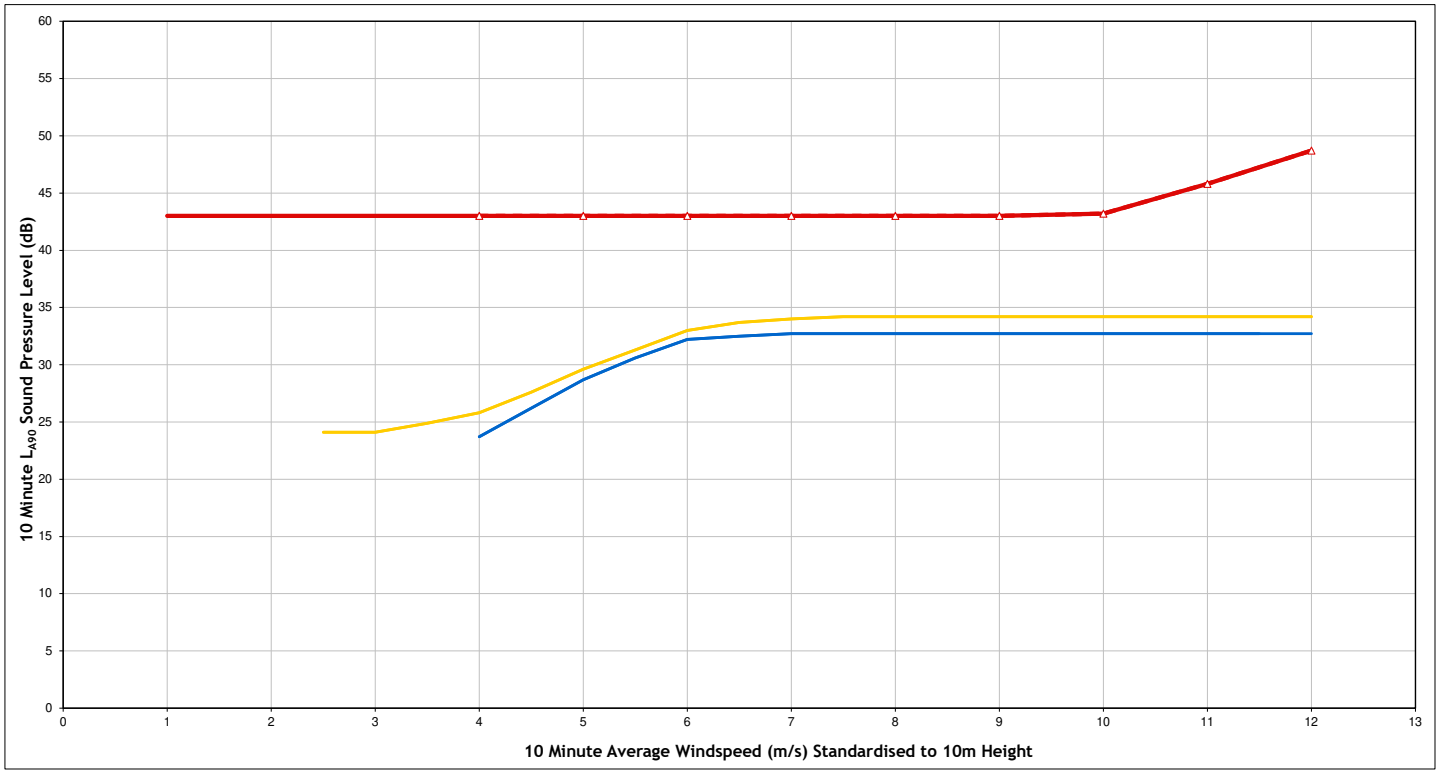
Daytime - Cwm Cywen (NAL8)



Night Time - Cwm Cywen (NAL8)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=240°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=240°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Cwm Cywen (NAL8)
Figure Number	Figure A1.4h
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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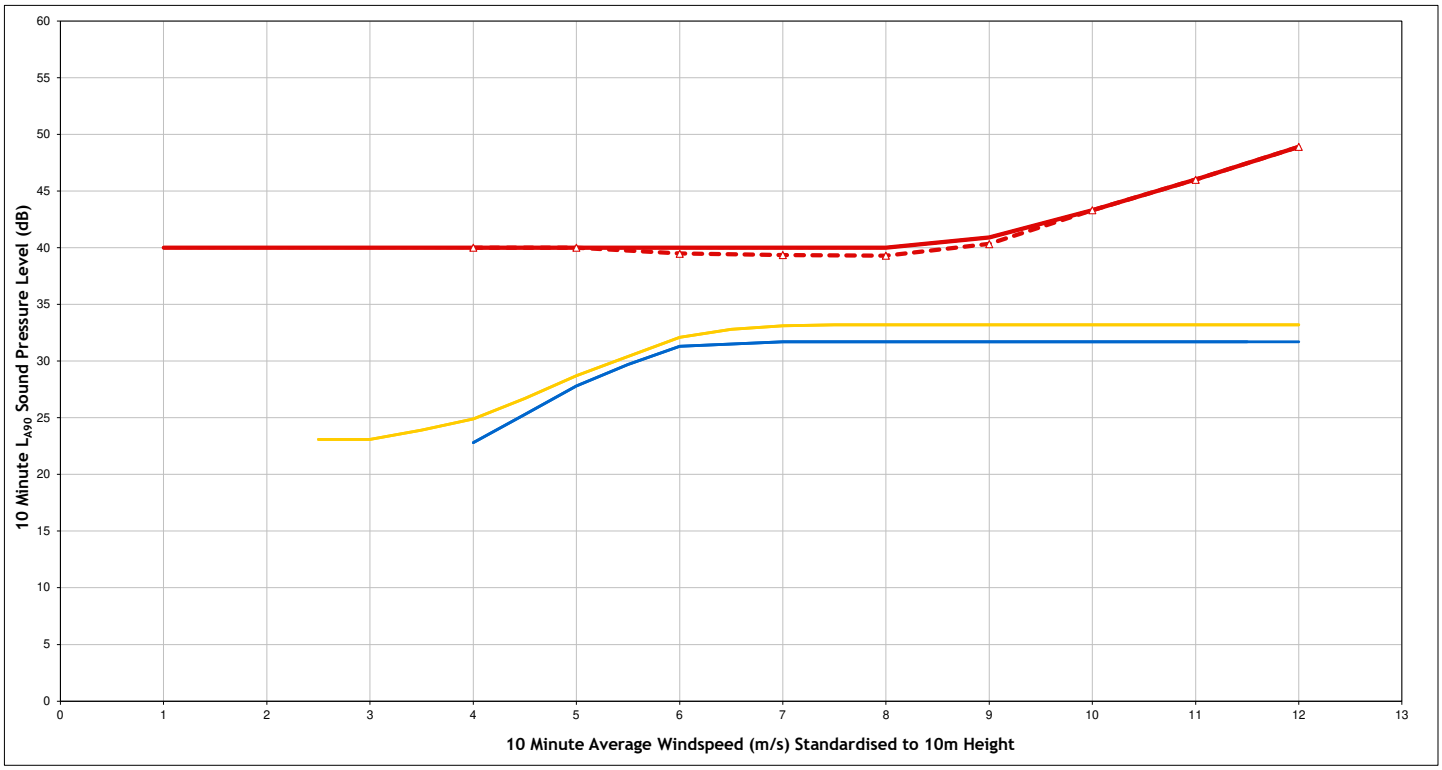
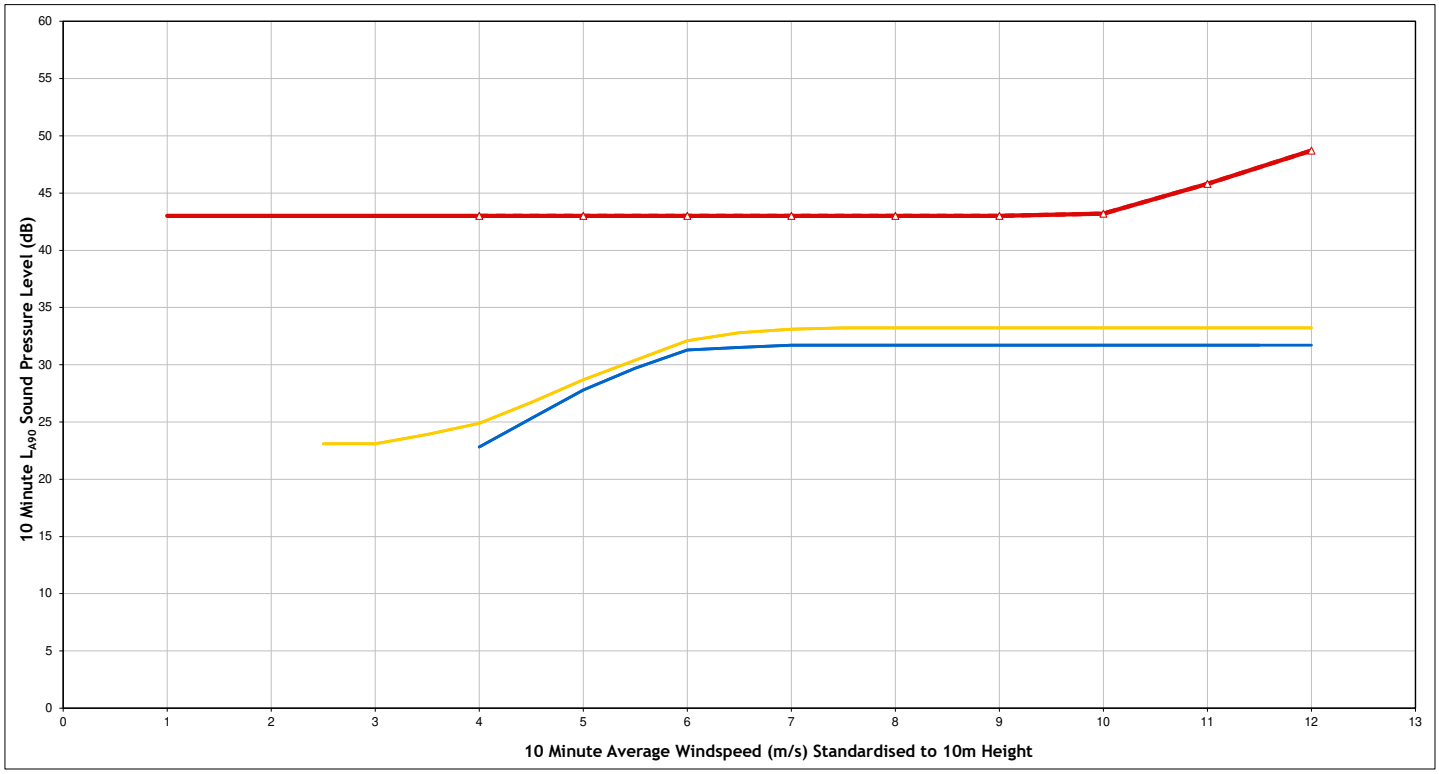
Daytime - Cwm Llan (NAL9)



Night Time - Cwm Llan (NAL9)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=180°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=180°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Cwm Llan (NAL9)
Figure Number	Figure A1.4i
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

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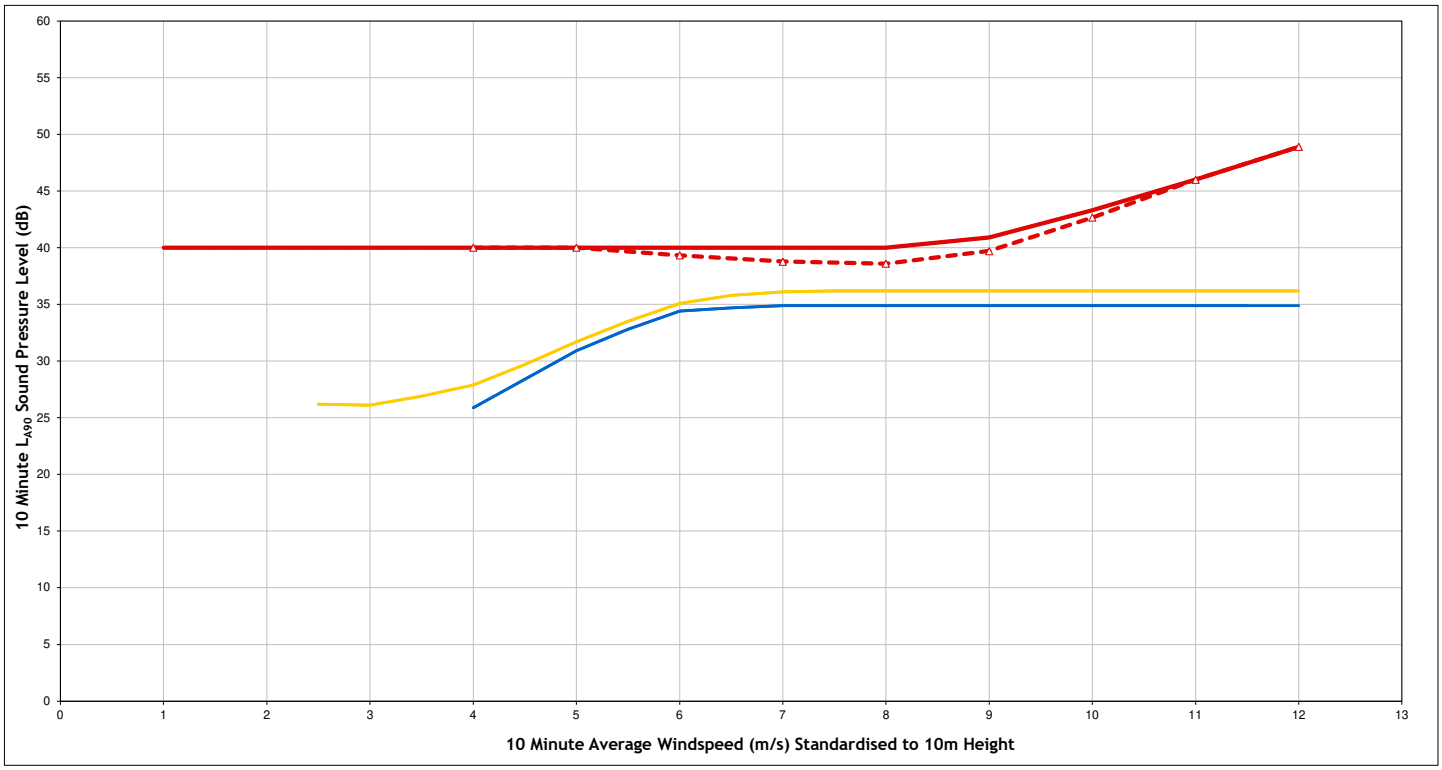
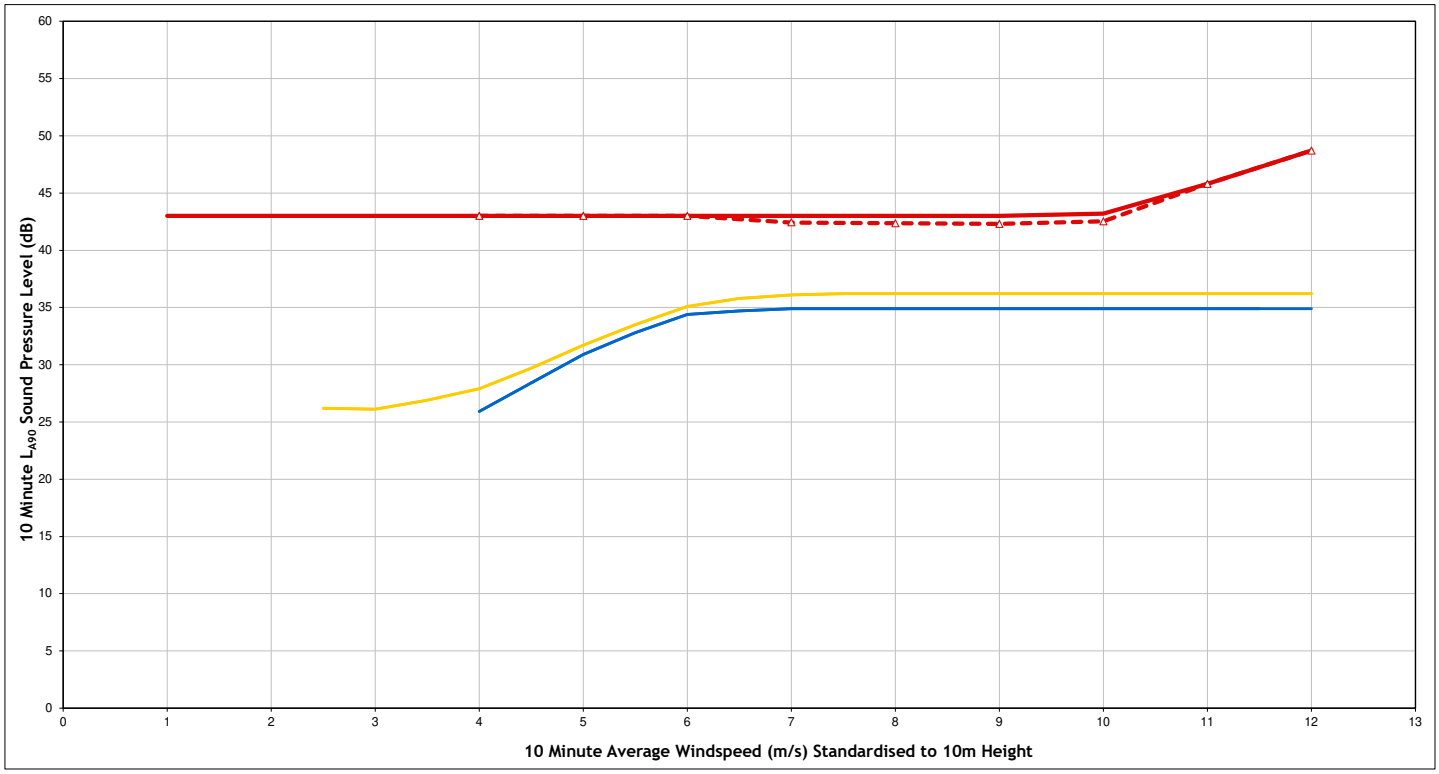
Daytime - Rhyd Yr Ewig (NAL10)



Night Time - Rhyd Yr Ewig (NAL10)



Legend:

- Total ETSU-R-97-Limit
- Site Specific Limits
- Proposed Development with 10 x Enercon E-175 OM-0-0 [WD=120°]
- Proposed Development with 10 x Vestas V172 PO7200 [WD=120°]

Project	Foel Fach
Client	Coriolis
Title	Noise Assessment - Site Specific Limits Rhyd Yr Ewig (NAL10)
Figure Number	Figure A1.4j
Scale	NTS
Drawn	MR
Checked	MC
Date	24/11/2025
Document Reference	16513 Noise Model

Coriolis Energy

tnei

Annex 2 – Consultation

10/09/2024

Ref: 16513-003- R1

Copy: Sent by email only

Environmental Health
Gwynedd Council & Conwy County Borough Council

Dear Sir/ Madam,

PROPOSED Foel Fâch Wind Farm : NOISE ASSESSMENT CONSULTATION ON BASELINE NOISE MONITORING

Introduction

RSK ('the Applicant') is seeking to submit a Development of National Significance (DNS) application for the proposed Foel Fâch Wind Farm ('the Proposed Development') on land located approximately 3.5 km south of the town of Bala, Gwynedd, North Wales. The Proposed Development is for up to 11 wind turbines with a tip height of 220m and associated infrastructure. The Applicant submitted an EIA Scoping Report to Planning and Environment Decisions Wales (PEDW) on 23rd of July 2024 (reference **DNS CAS-03527-H7Y5R9**).

An indicative turbine layout and identification of nearby Noise Sensitive Receptors (NSRs), which are scattered residential properties, is shown on the enclosed Figure 1 (at the end of this letter). The Figure also shows a selection of 10 x NSRs which we propose to assess in detail, they are labelled as Noise Assessment Locations (NALs) and are the nearest NSRs in any directions. Furthermore, the Figure also shows 4 x potential Noise Monitoring Locations (NMLs) that we would suggest for a noise survey, more context and details are included below in this letter. Two NALs to the north are located within the administrative boundary of Conwy County Borough Council, however both are outside typical selection criteria (more details below) and have only been selected for completeness to include receptors to the north. All NALs within typical selection criteria are within Gwynedd Council. This letter is intended for the Environmental Health team at both Gwynedd Council (likely to be the main Council where this is applicable) and Conwy County Borough Council (to ensure the opportunity for additional feedback for distant properties to the north).

The aim of this letter is to agree as soon as possible a baseline noise monitoring methodology with Environmental Health at both councils, so that baseline survey work can progress. Other assessment details are outlined in the scoping report which both councils will have an opportunity to respond to, and we would welcome further detailed discussions on other noise topics at a later stage in the process.

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7th Floor, West One
Forth Banks
Newcastle Upon Tyne
NE1 3PA
Tel: +44(0)191 211 1400
VAT Reg. GB 239 0146 20 | Company Reg. 03891836

Proposed Noise Monitoring Methodology

The proposed development is located within a rural location with areas of forestry, hills and valleys in the immediate surroundings. There are a relatively small number of scattered residential properties within and around, which will need to be considered as Noise Sensitive Receptors (NSRs). No existing operational wind farm developments are located nearby.

A comprehensive baseline noise monitoring survey is proposed to measure existing noise levels in the surrounding areas, at or near noise sensitive receptors which will be scattered residential properties. TNEI propose to take account of the guidance contained within ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' and the Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' to undertaken the baseline noise monitoring, as this would involve an extensive survey over several weeks and any data measured can be used for the purpose of the operational wind farm noise assessment and any other type of noise assessments that may also be undertaken for the Proposed Development.

In order to undertake a noise survey in accordance with ETSU-R-97 it is necessary to determine the relationship between wind speed measured at the proposed development site and background noise levels measured at the closest noise sensitive receptors. This requires the installation of wind monitoring equipment on the site itself and noise monitoring equipment at nearby residential properties . A minimum of 28 days of continuous monitoring is proposed, ten-minute measurements will be taken by each piece of equipment.

Proposed Wind Monitoring Location

Equipment for measuring wind conditions will be installed at the Site for the duration of the noise survey to collect wind speed and direction data at various heights, with the highest as close as possible to the proposed hub height, to determine the wind speed at turbine hub height.

Proposed Noise Monitoring Locations

A background noise survey is typically not required for situations where predicted wind turbine noise levels at the nearest noise sensitive receptors is limited to an LA90,10min of 35dB(A) up to wind speeds of 10 m/s at 10 m, as the protection of the amenity can be controlled through a simplified noise condition as detailed in ETSU-R-97. ETSU-R-97 states that, *"For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an LA90,10min of 35dB(A) up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary".*

Prior to commencing the noise survey, we would like to agree suitable locations at which to monitor background noise levels in order to provide a representative dataset for the area. Figure 1 enclosed is similar to the noise Figure submitted in the Scoping Report, it shows a draft wind turbine layout, the identified NSRs, a selection of NSRs labelled as NALs (suggested for a detailed assessment), an

indicative noise contour and potential Noise Monitoring Locations (NMLs) for discussion. The NMLs are also described in Table 1 with details of why they were selected.

Access to and consent for some of the properties situated in these potential locations may not be possible (i.e., consent from resident required, remote area) and for some there are very limited alternative locations. If monitoring was not possible, some land within the client control close to some of the properties may be used or using proxy data (from other quiet locations that will eventually be monitored) could also potentially be used to set representative background noise levels.

Table 1 - Suggested Noise Monitoring Locations (NMLs)

Property/Location	Justification
NML1- LLAITHGWM	The nearest receptor to the west and within the initial 35dB(A) noise contour. Access has already been secured.
NML2-GREIGWEN	One of the nearest receptor to the north west and within the initial 35dB(A) noise contour. Access has not been secured and other two properties labelled NAL02 and NAL03 in this area may be alternatives for monitoring representative background levels in this area.
NML3- PENTRE	The nearest receptor to the south east and within the initial 35 dB(A) noise contour. Access has not been secured and other property just outside the 35 dB(A) contour labelled NSR12 may be alternatives for monitoring representative background levels in this area.
NML4-PENMAEN GANOL	The nearest receptor to the south and well outside the initial 35dB(A) noise contour. In theory there is no need to undertake noise monitoring in this area to the south as receptors are far away, however this location is included as an additional location for completeness and could be used to represent background levels at NAL05 and NAL06. Alternatively to this location to the south, one location to the north west for example at NAL09 could be suggested, however NAL09 is even further outside the 35dB contour.

Background noise levels will be monitored at a height of between 1.2 m and 1.5 m above ground, in line with the ETSU-R-97 / IOA GPG guidance. The noise monitoring equipment will be located in a free-field position at least 3.5 m away from hard reflective surfaces where practicable and within the residential amenity area or a representative location nearby. At least one rain logger will also be installed by TNEI at one of the noise monitoring locations to record any periods of rainfall.

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

Summary

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

- You are happy with the proposed assessment methods outlined above which focuses on the baseline noise survey work?
- You agree with the general monitoring locations proposed (subject to exact siting and agreement with residents)?
- You or one of your colleagues would like to attend the noise kit installation?

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

Yours sincerely,

[redacted]

[redacted]

Will Conway

Technical Consultant

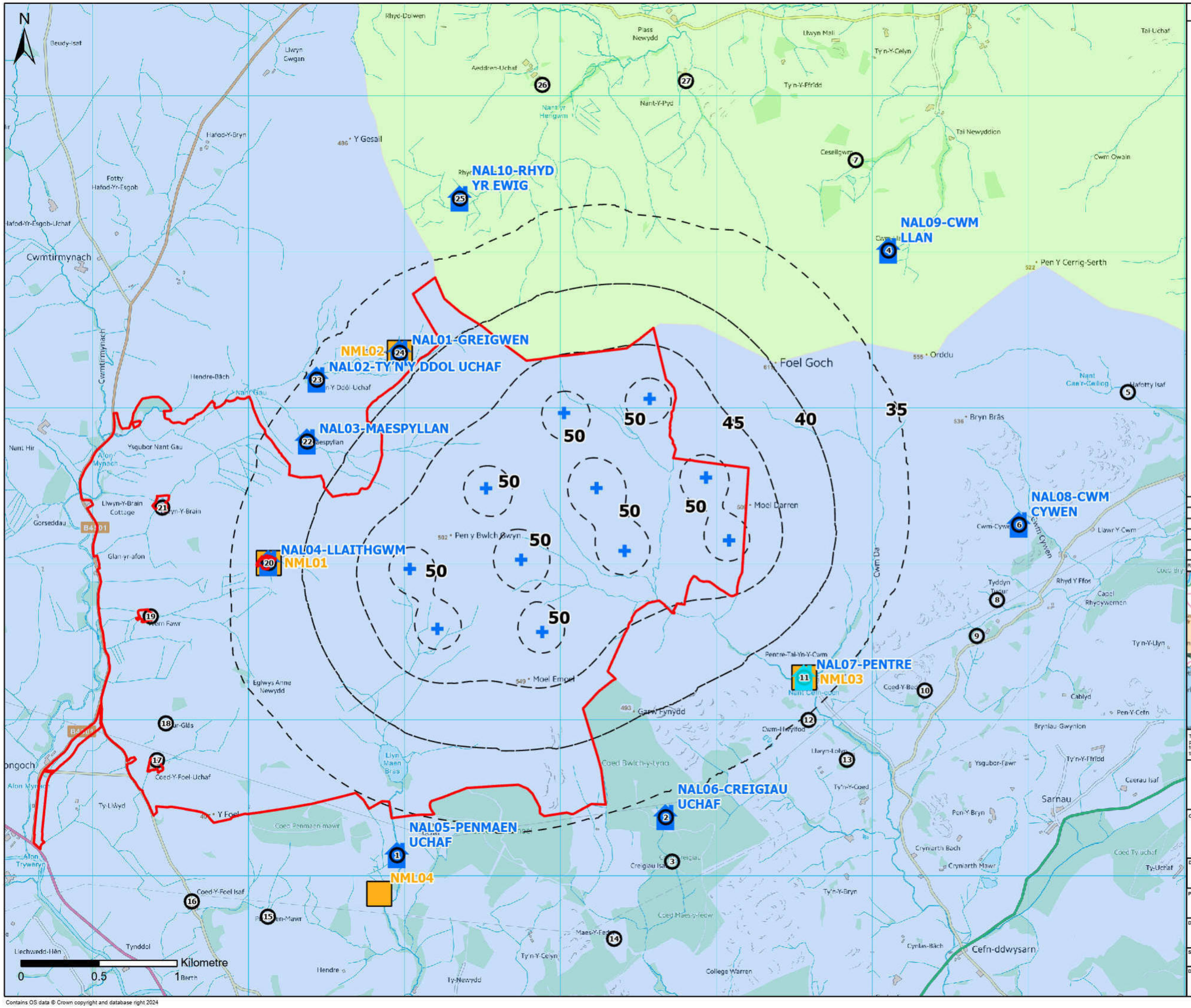
[redacted]

Moise Coulon

Principal Consultant

[redacted]

Enc. Figure 1 –Suggested Noise Monitoring and Assessment Locations



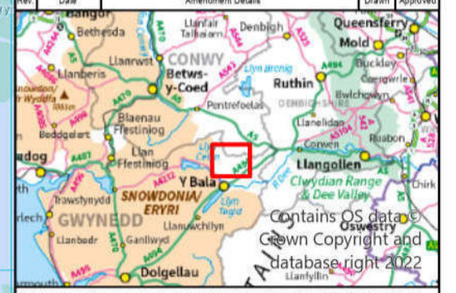
LEGEND

- Site Boundary
- Noise Monitoring Locations (NMLs) (Suggested)
- Noise Asessment Locations (NALs) (Suggested)
- Proposed Turbines
- Noise Sensitive Receptors (NSRs)
- Noise contours(dB LA90), based on a candidate turbine at 10 m/s standardised wind speed

Local Authority Area

- Gwynedd Council
- Conwy County Borough Council

Rev.	Date	Amendment Details	Drawn	Approved
0	23/08/2024	FIRST ISSUE	JCM	MC



tnei

Client: Coriolis Energy

Drawing Status: FOR PLANNING

Project Title: FOEL FACH WIND FARM

Drawing Title: FIGURE 1 - SUGGESTED NOISE MONITORING AND ASSESSMENT LOCATIONS

Scale:	Original Size:	Spatial Reference:
1:22,500	A3	British National Grid

Drawing Number: 16513-004

Annex 3 – Noise Survey Field Data Sheets

Noise Monitoring Record - NML1

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML1
Location Name	Llaithgwm
Description	The noise kit was installed in the field east of Llaithgwm. This location is east of the proposed Foel Fach wind turbines. The exact kit location was selected on the eastern edge of the field to move the kit away from watercourses and to remove the risk of damage from animals in the adjacent fields. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.95551238
Longitude	-3.607153705
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of small water courses running in all directions around the property, but in particular towards a field to the north where it was judged too close to watercourse. The watercourses were faintly audible from this location and the dominant noise was the wind induced foliage noise. A number of farm animals such as sheep, goats, cows, and dogs were also audible on occasions.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 48	NL52	00386761	03/01/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	Rain Gauge - RG1
Equipment Notes	The rain gauge had fallen during the second month of survey. Also, due to the the sound meter memory card reaching full capacity during the first survey period, there is a gap in the measured noise data from 23/10 to 14/11.

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, Leq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0101	17/10/2024 09:40	14/11/2024 14:50	94.0	94.0	0.0	Installation 17/10 by WC: The conditions were damp underfoot, heavily overcast (7 oktas) and 12°C. Small water courses are running in all directions around the property, they are audible but as dominant as the wind and wind induced foliage noise. A number of farm animals also audible, sheep/goats cows, dogs. Intermediate visit 14/11 by WC: Animal calls are dominant but transient, the small watercourses around the site are audible as part of background noise, they are not dominant.

0102	14/11/2024 15:00	16/12/2024 17:10	94.0	93.8	0.2	Decomission 16/12 by MC: Main noise source was wind in trees nearby, circa 40 dBA and more when wind was gusting. Farm animal noise heard (geese, dogs and cattle). Burst of generator type noise in sheds for around 30 seconds. Windy, had rained before on day but not raining at time of collection.

NML1 PHOTOGRAPHS

North	West
	
South	**East**
	

Noise Monitoring Record - NML2

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML2
Location Name	Griegwen
Description	The noise kit was installed to the south of the residence, before field. This location in northwest of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.96804954
Longitude	-3.596000333
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of wind-induced noise, which was dominant, followed by wind induced foliage rustle. No other aspects of the soundscape have been identified. Very quiet isolated rural location relatively elevated above the valley and exposed to south westerly winds (topography slope from south-west to north-east).

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 51	NL52	00410237	13/07/2023
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	Due to an abnormal sould level meter failure, no data was recorded on the memory card from 17/10 to 14/11.

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, Leq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	17/10/2024 11:10	14/11/2024 14:00	94.0	94	0.0	Installation 17/10 by WC: Wind induced noise is dominant, followed by wind induced foliage rustle. Very rural, no other aspects of the soundscape have been identified. Intermediate site visit 14/11 by WC: found that meter failed to record anything (SD card issue). Replaced with a new meter (TNEI SLM61) for redeployment. Absence of wind induced noise lead to the location seeming quieter than previously, birds calls and sheep bleats are dominant when they occur.

0202	14/11/2024 14:10	16/12/2024 16:30	94.0	93.7	0.3	Decomission 16/12: Windy, drizzly rain and dark cloud, weather turning to rain during being on site. Mostly wind in trees is the noise source.

NML2 PHOTOGRAPHS

South east	West
	
East	**North East**
	

Noise Monitoring Record - NML3

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC

MONITORING LOCATION

Location Number	NML3
Location Name	Cwm Hwylfod
Description	The noise monitoring equipment was installed in a field immediately north of the dwelling at Cym Hwylfod, which is also immediately south of Pentre. This location is southeast of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.94754061
Longitude	-3.554815997
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of sheep calls, some foliage rustle, and a small watercourse towards the north which was faintly audible.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 61	NL52	00721060	05/08/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	None

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	Laeq, la90	10 Mins	Fast	20-110	No

DATA

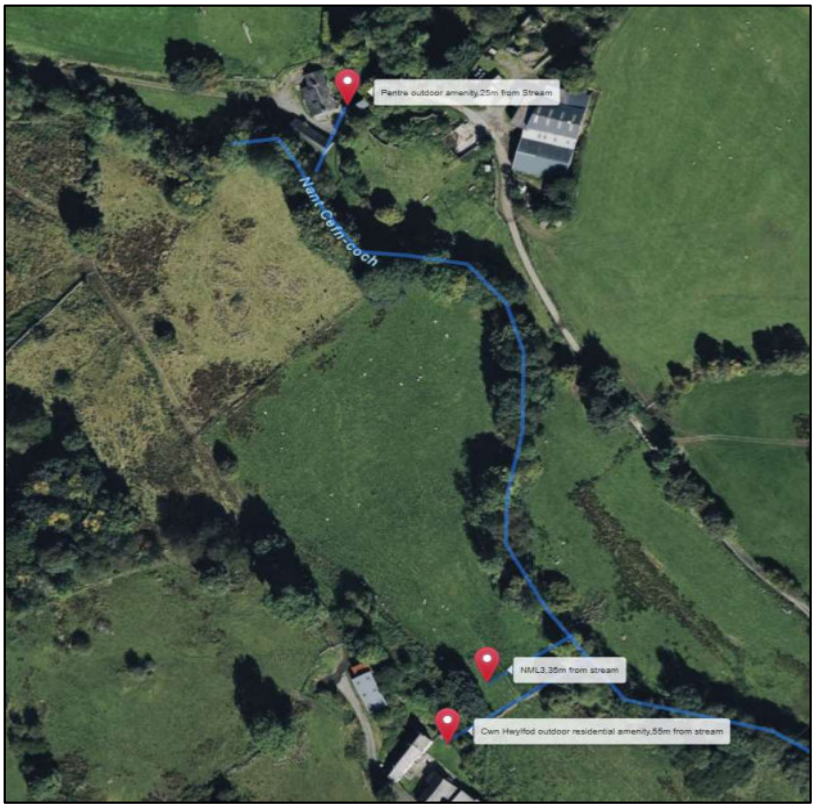
File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0301	17/10/2024 13:20	14/11/2024 14:50	94.0	94.0	0.0	Installation 17/10 by WC: Conditions were mild in temperature and breeze. Sheep calls, some foliage rustle, small water course towards the north is audible. Decomission 14/11 by WC: Sheep bleats are dominant, water courses audible again, but not dominant in the soundscape. Decomissionned at resident request.

NML3 PHOTOGRAPHS

North	South
	
East	**West**
	

Analysis of distances between NML3, the local stream and residential amenities:

(showing distances to stream as NML3=35 m,Pentre=25 m, Cwn Hwylfod=55 m)



Noise Monitoring Record - NML4

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML4
Location Name	Penmaen Uchaf
Description	The noise monitoring equipment was installed in a field along the track between Penmaen Ganol and Penmaen Uchaf, where it was agreed with the landowner that cattle could not access the equipment. Another location was considered with the landowner on the day, further south at the unoccupied dwelling of Penmaen Ganol, however this would have been within a few meters of another watercourse and may have required building fences to avoid cattle accessing the equipment so this location was not used. This location is south of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.93788998
Longitude	-3.594331303
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of wind-induced foliage rustle, which was dominant, there was also a water course towards the east which was audible. Very remote and isolated derelict property.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 59	NL52	00721001	05/08/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	None

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, laeq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0401	17/10/2024 14:20	14/11/2024 10:17	94.0	94.0	0.0	Installation on 17/10 by WC: Conditions were bright, sunny, warm at 14°C. There was wind induced foliage rustle which was dominant. Water course also audible. Intermediate site visit on 14/11 by WC: Conditions were 10°C, damp underfoot, 2 oktas, bright sunny. Quiet location. Birds are audible and the watercourse is faintly audible as part of the background noise.

0402	14/11/2024 10:30	16/12/2024 14:27	94.0	93.9	0.1	Decomission on 16/12 by MC: Constant noise around 48-50db from watercourse and wind in trees, mostly from watercourse clearly audible. Also overhead flight heard. Relatively windy conditions. cloudy with grey/dark rain clouds above. Not raining but all damp on ground and may have had light rain in morning or previous days /nights.

NML4 PHOTOGRAPHS

North	South
	
East	**West**
	

Noise Monitoring Record - NML1

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML1
Location Name	Llaithgwm
Description	The noise kit was installed in the field east of Llaithgwm. This location is east of the proposed Foel Fach wind turbines. The exact kit location was selected on the eastern edge of the field to move the kit away from watercourses and to remove the risk of damage from animals in the adjacent fields. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.95551238
Longitude	-3.607153705
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of small water courses running in all directions around the property, but in particular towards a field to the north where it was judged too close to watercourse. The watercourses were faintly audible from this location and the dominant noise was the wind induced foliage noise. A number of farm animals such as sheep, goats, cows, and dogs were also audible on occasions.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 48	NL52	00386761	03/01/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	Rain Gauge - RG1
Equipment Notes	The rain gauge had fallen during the second month of survey. Also, due to the the sound meter memory card reaching full capacity during the first survey period, there is a gap in the measured noise data from 23/10 to 14/11.

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, Leq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0101	17/10/2024 09:40	14/11/2024 14:50	94.0	94.0	0.0	Installation 17/10 by WC: The conditions were damp underfoot, heavily overcast (7 oktas) and 12°C. Small water courses are running in all directions around the property, they are audible but as dominant as the wind and wind induced foliage noise. A number of farm animals also audible, sheep/goats cows, dogs. Intermediate visit 14/11 by WC: Animal calls are dominant but transient, the small watercourses around the site are audible as part of background noise, they are not dominant.

0102	14/11/2024 15:00	16/12/2024 17:10	94.0	93.8	0.2	Decomission 16/12 by MC: Main noise source was wind in trees nearby, circa 40 dBA and more when wind was gusting. Farm animal noise heard (geese, dogs and cattle). Burst of generator type noise in sheds for around 30 seconds. Windy, had rained before on day but not raining at time of collection.

NML1 PHOTOGRAPHS

North	West
	
South	**East**
	

Noise Monitoring Record - NML2

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML2
Location Name	Griegwen
Description	The noise kit was installed to the south of the residence, before field. This location in northwest of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.96804954
Longitude	-3.596000333
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of wind-induced noise, which was dominant, followed by wind induced foliage rustle. No other aspects of the soundscape have been identified. Very quiet isolated rural location relatively elevated above the valley and exposed to south westerly winds (topography slope from south-west to north-east).

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 51	NL52	00410237	13/07/2023
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	Due to an abnormal sould level meter failure, no data was recorded on the memory card from 17/10 to 14/11.

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, Leq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	17/10/2024 11:10	14/11/2024 14:00	94.0	94	0.0	Installation 17/10 by WC: Wind induced noise is dominant, followed by wind induced foliage rustle. Very rural, no other aspects of the soundscape have been identified. Intermediate site visit 14/11 by WC: found that meter failed to record anything (SD card issue). Replaced with a new meter (TNEI SLM61) for redeployment. Absence of wind induced noise lead to the location seeming quieter than previously, birds calls and sheep bleats are dominant when they occur.

0202	14/11/2024 14:10	16/12/2024 16:30	94.0	93.7	0.3	Decomission 16/12: Windy, drizzly rain and dark cloud, weather turning to rain during being on site. Mostly wind in trees is the noise source.

NML2 PHOTOGRAPHS

South east	West
	
East	**North East**
	

Noise Monitoring Record - NML3

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC

MONITORING LOCATION

Location Number	NML3
Location Name	Cwm Hwylfod
Description	The noise monitoring equipment was installed in a field immediately north of the dwelling at Cym Hwylfod, which is also immediately south of Pentre. This location is southeast of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.94754061
Longitude	-3.554815997
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of sheep calls, some foliage rustle, and a small watercourse towards the north which was faintly audible.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 61	NL52	00721060	05/08/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	None

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	Laeq, la90	10 Mins	Fast	20-110	No

DATA

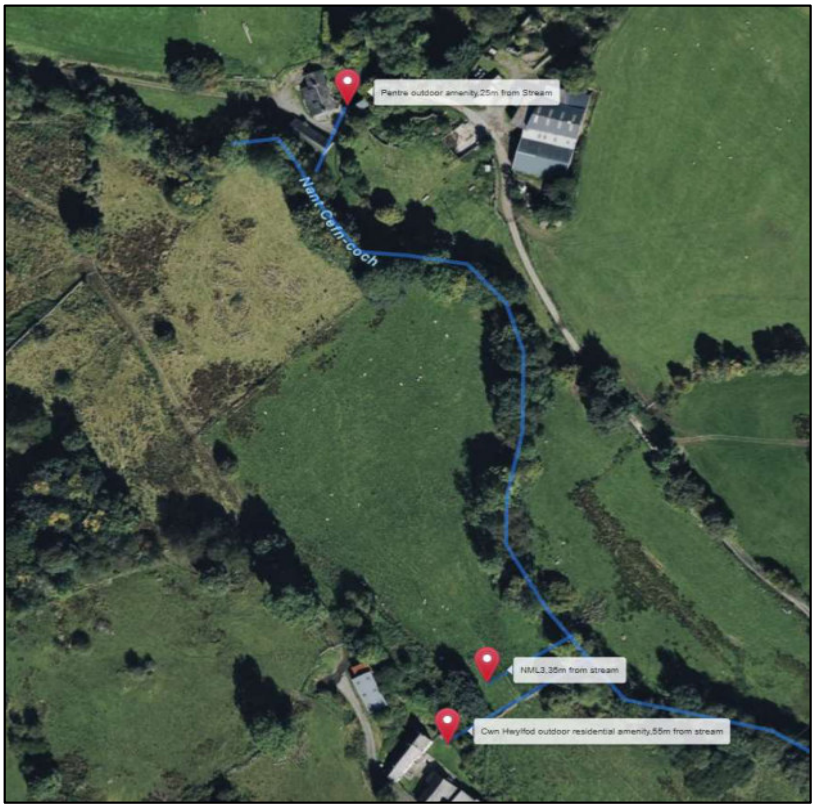
File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0301	17/10/2024 13:20	14/11/2024 14:50	94.0	94.0	0.0	Installation 17/10 by WC: Conditions were mild in temperature and breeze. Sheep calls, some foliage rustle, small water course towards the north is audible. Decomission 14/11 by WC: Sheep bleats are dominant, water courses audible again, but not dominant in the soundscape. Decomissionned at resident request.

NML3 PHOTOGRAPHS

North	South
	
East	**West**
	

Analysis of distances between NML3, the local stream and residential amenities:

(showing distances to stream as NML3=35 m,Pentre=25 m, Cwn Hwylfod=55 m)



Noise Monitoring Record - NML4

Project Title	Foel Fach Wind Farm	**Project Number**	16513
Client	Coriolis	**Surveyor**	WC & MC

MONITORING LOCATION

Location Number	NML4
Location Name	Penmaen Uchaf
Description	The noise monitoring equipment was installed in a field along the track between Penmaen Ganol and Penmaen Uchaf, where it was agreed with the landowner that cattle could not access the equipment. Another location was considered with the landowner on the day, further south at the unoccupied dwelling of Penmaen Ganol, however this would have been within a few meters of another watercourse and may have required building fences to avoid cattle accessing the equipment so this location was not used. This location is south of the proposed Foel Fach wind turbines. Equipment located >3.5m from nearby facades or reflective surfaces.
Latitude	52.93788998
Longitude	-3.594331303
Noise sources noted during installation, weekly inspection and removal	The soundscape at this location consisted of wind-induced foliage rustle, which was dominant, there was also a water course towards the east which was audible. Very remote and isolated derelict property.

NOISE MONITORING EQUIPMENT DETAILS

	Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 59	NL52	00721001	05/08/2024
Calibrator	CAL 8	NC75	35002724	15/03/2024

Weather Measurement	None
Equipment Notes	None

NOISE MONITORING EQUIPMENT SETTINGS

	Frequency Weighting	Index	Interval	Time Weighting	Range	Audio Recording
Parameters Recorded	A	La90, laeq	10 Mins	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0401	17/10/2024 14:20	14/11/2024 10:17	94.0	94.0	0.0	Installation on 17/10 by WC: Conditions were bright, sunny, warm at 14°C. There was wind induced foliage rustle which was dominant. Water course also audible. Intermediate site visit on 14/11 by WC: Conditions were 10°C, damp underfoot, 2 oktas, bright sunny. Quiet location. Birds are audible and the watercourse is faintly audible as part of the background noise.

0402	14/11/2024 10:30	16/12/2024 14:27	94.0	93.9	0.1	Decomission on 16/12 by MC: Constant noise around 48-50db from watercourse and wind in trees, mostly from watercourse clearly audible. Also overhead flight heard. Relatively windy conditions. cloudy with grey/dark rain clouds above. Not raining but all damp on ground and may have had light rain in morning or previous days /nights.

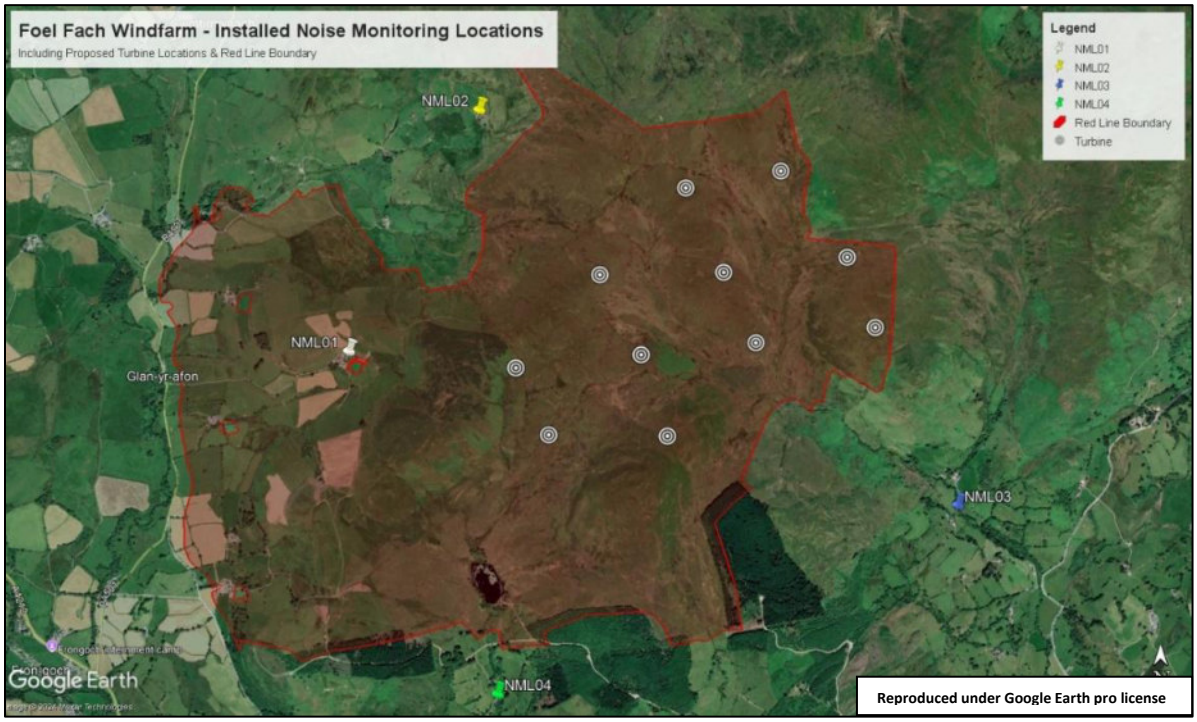
NML4 PHOTOGRAPHS

North	South
	
East	**West**
	

Noise Monitoring Locations Installation Report

Written by Will Conway of TNEI on 25/10/2024

Foel Fach Windfarm Background Noise Survey



Noise monitoring equipment was installed at four locations on 17th of October 2024. Present during the installation was :

- Will Conway, Technical Consultant, TNEI.

Unless specified, all noise kits were installed at least 3.5 m from any hard-reflecting surface except the ground and away from unwanted noise sources such as boiler flues. All installation locations were as suggested during consultation.

Detailed information and pictures for each of the installed locations are provided below. The original full-size pictures are available on request.

Noise Monitoring Locations

NML	Installation Location Coordinates (Lat,Long)
NML1 - Llaithgwm	52.95551238, -3.607153705
NML2 – Greigwen	52.96804954, -3.596000333
NML3 – Cwn Hwylfod	52.94754061, -3.554815997
NML4 – Penmaen	52.93788998, -3.594331303

NML1 - Llaithgwm

North

East

South

No Picture

Description

Installed at Llaithgwm, to the west of the proposed Foel Fach Windfarm site as suggested during consultation. This monitoring location is intended to be used to represent background noise in for any properties found in this area.

The noise monitoring equipment was installed in the field to the east of the dwelling on the property and a rain gauge was also installed.

The soundscape at this location consisted of small water courses running in all directions around the property, but in particular towards a field to the north where it was judged too close to water course. The exact kit location was selected on the eastern edge of the field to move the kit away from water courses and to remove the risk of damage from animals in the adjacent fields surrounding. The water courses were faintly audible from this location and the dominant noise was the wind induced foliage noise. A number of farm animals such as sheep, goats, cows, and dogs were also audible on occasions.

NML2 – Greigwen

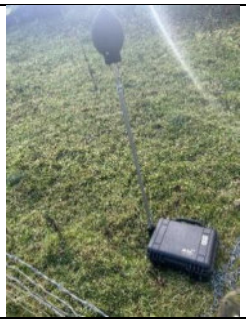
Calibration Photo

Description

Installed at Greigwen, to the northwest of the proposed Foel Fach Windfarm site as suggested during consultation. This monitoring location is intended to be used to represent background noise in for any properties found in this area. It may also be used if required for properties much further to the north.

The noise monitoring equipment was installed within a fenced area of the property. On the day of installation, unfortunately photos of the surroundings were not taken during installation and only a photo of the equipment calibration is available at the time of writing this installation report. More photos will be undertaken on the next site visit and can be made available on request.

The soundscape at this location consisted of wind-induced noise, which was dominant, followed by wind induced foliage rustle. Very rural location, no other aspects of the soundscape have been identified as it was windy at the time of installation.

NML3 – Cwn Hwylfod	
	
North	**East**
	
South	**Southwest**
	

Description

Installed at Cwn Hwylfod, to the southeast of the proposed Foel Fach Windfarm site as suggested during consultation. This monitoring location is intended to be used to represent background noise in for any properties found in this area, inclusive of property at Pentre which is adjacent and where it was not possible to gain access permissions prior to the day of installation and there was a closed gate found on the day of installation.

The noise monitoring equipment was installed in a field immediately north of the dwelling at Cym Hwylfod, which is also immediately south of Pentre.

The soundscape at this location consisted of Sheep calls, some foliage rustle, and a small water course towards the north which was faintly audible at the time of installation.

NML4 – Penmaen Ganol

North

East

South

West

Description

Installed at Penmaen Ganol, to the south of the proposed Foel Fach Windfarm site as suggested during consultation. This monitoring location is intended to be used to represent background noise in for any properties found in this area.

The noise monitoring equipment was installed in a field along the track between Penmaen Ganol and Penmaen Uchaf, where it was agreed with the landowner that cattle could not access the equipment. A rain gauge was also installed. Another location was considered with the landowner on the day, further south at the unoccupied dwelling of Penmaen Ganol, however this would have been within a few meters of another water course and may have required building fences to avoid cattle accessing the equipment so this was not used.

The soundscape at this location consisted of wind-induced foliage rustle, which was dominant, there was also a water course towards the east which was audible. Due to the very quiet rural nature of the location, in low wind conditions there may be a very low noise floor due to the watercourse.

Annex 4 – Calibration Certificates

SLM 61

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 05 August 2024 **Certificate Number: UCRT24/2053**

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

Approved Signatory

K. Mistry

Customer	TNEI 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-52	00721060
	Rion	Firmware		2.1
	Rion	Pre Amplifier	NH-25	22166
	Rion	Microphone	UC-59	22048
	Rion	Calibrator	NC-75	34334830
		Calibrator adaptor type if applicable		NC-75-022
Performance Class	1			
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*			
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*			
Date Received	02 August 2024	ANV Job No.	UKAS24/08562	
Date Calibrated	05 August 2024			

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

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	Initial Calibration		

CERTIFICATE OF CALIBRATION

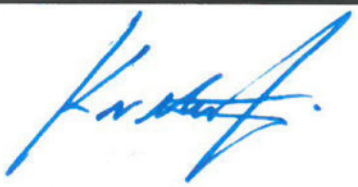
0653

Date of Issue: 15 March 2024

Certificate Number: UCRT24/1425

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

Approved Signatory



K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA
Order No.	5001
Test Procedure	Procedure TP 14 Calibration of Sound Calibrators (60942:2017)
Description	Acoustic Calibrator

Identification

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

Public evidence of Type Approval Yes Approved by PTB

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

ANV Job No.	UKAS24/03232
Date Received	14 March 2024
Date Calibrated	15 March 2024

Previous Certificate

Dated	28 March 2023
Certificate No.	UCRT23/1424
Laboratory	0653

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 03 January 2024 **Certificate Number: UCRT24/1019**

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

Approved Signatory

K. Mistry

Customer	TNEI 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-52	00386761
	Rion	Firmware		2.0
	Rion	Pre Amplifier	NH-25	76911
	Rion	Microphone	UC-59	12788
	Rion	Calibrator	NC-75	34334830
		Calibrator adaptor type if applicable		NC-75-022

Performance Class	1
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*
Date Received	22 December 2023 ANV Job No. UKAS23/12873
Date Calibrated	03 January 2024

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

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	23 February 2022	TCRT22/1158	ANV Measurement Systems

SLM 59

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 05 August 2024

Certificate Number: UCRT24/2055

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

Approved Signatory

K. Mistry

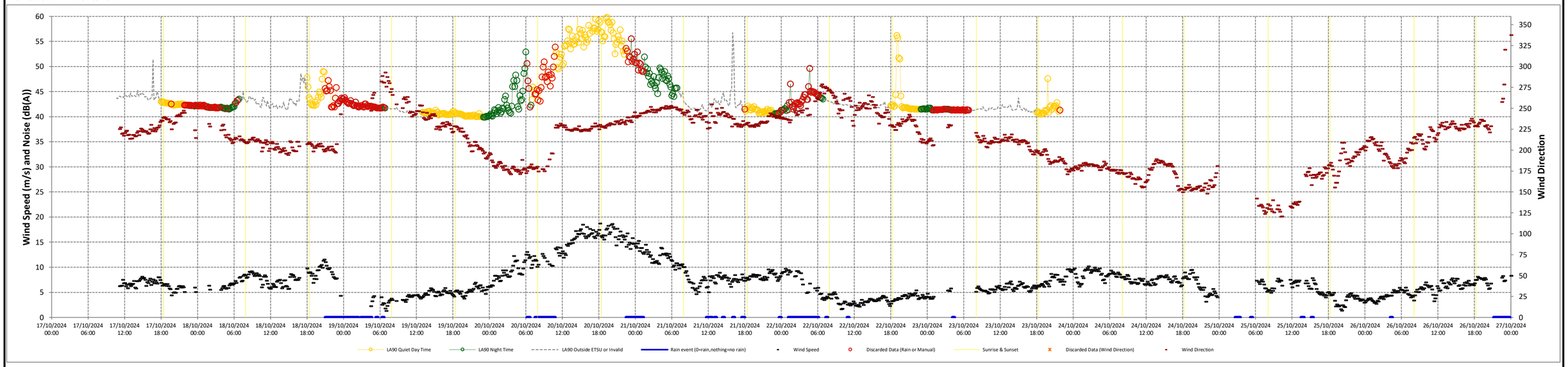
Customer	TNEI 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA			
Order No.	5001			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-52	00721001
	Rion	Firmware		2.1
	Rion	Pre Amplifier	NH-25	22107
	Rion	Microphone	UC-59	21939
	Rion	Calibrator	NC-75	34334830
		Calibrator adaptor type if applicable		NC-75-022
Performance Class	1			
Test Procedure	TP 10. SLM 61672-3:2013 *Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*			
Type Approved to IEC 61672-1:2013	Yes *If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*			
Date Received	02 August 2024	ANV Job No.	UKAS24/08562	
Date Calibrated	05 August 2024			

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

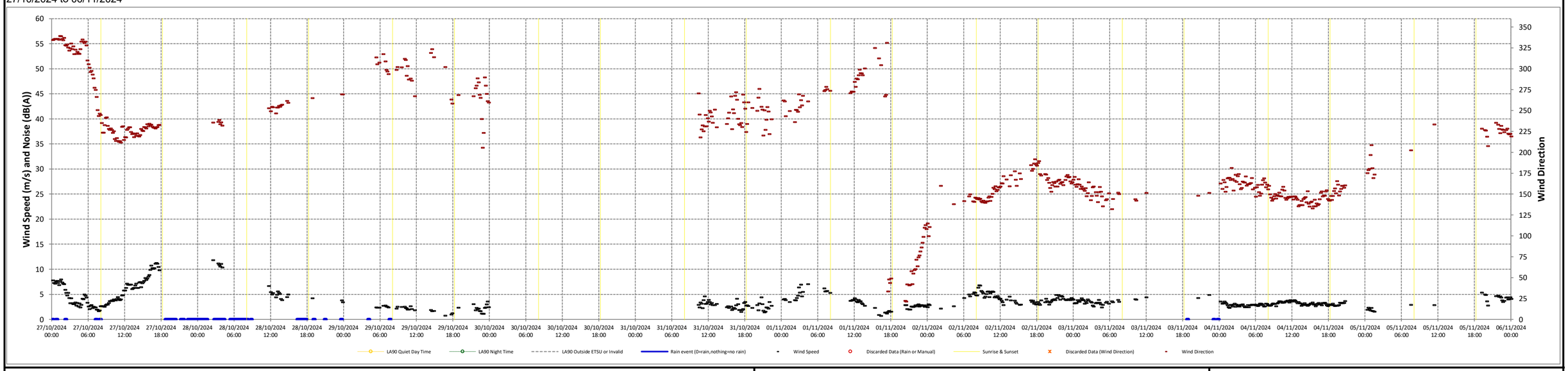
Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	Initial Calibration		

Annex 5 – Time Series

17/10/2024 to 27/10/2024

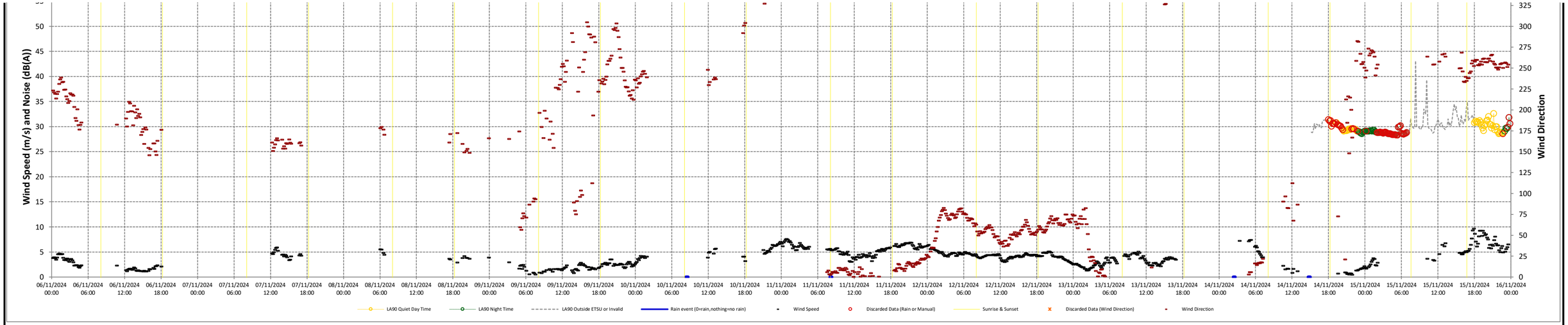


27/10/2024 to 06/11/2024

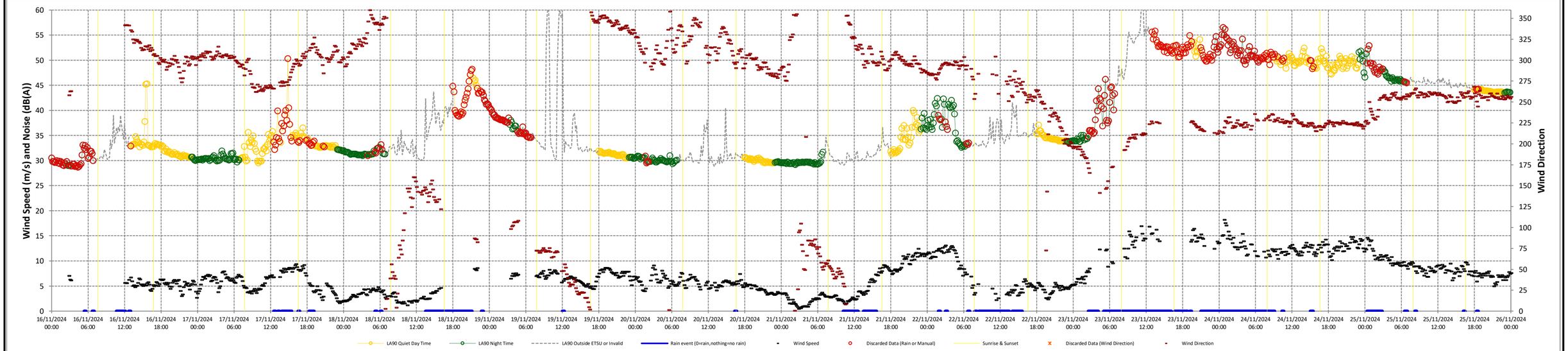


Project	Foel Fach
Client	Coriolis
Title	Time Series for Llaithgwm(NML1) Page 1 of 3
Date	18/06/2025

06/11/2024 to 16/11/2024

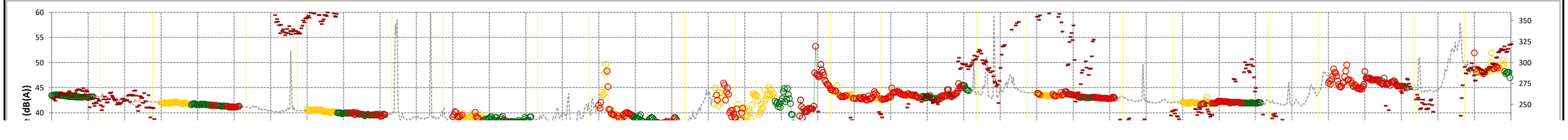


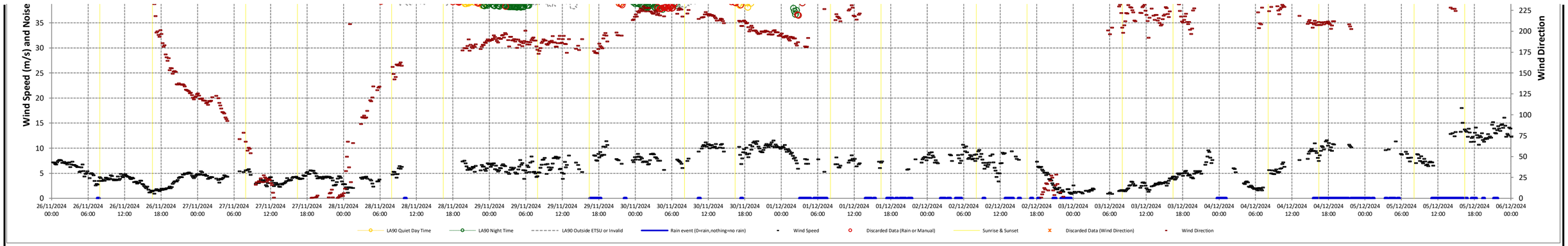
16/11/2024 to 26/11/2024



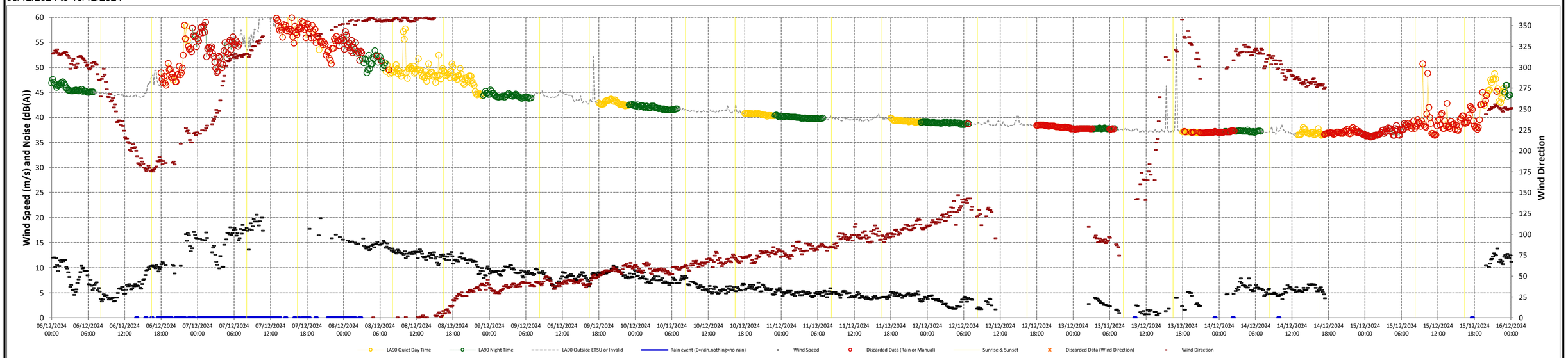
Project	Foel Fach
Client	Coriolis
Title	Time Series for Llaithgwm(NML1) Page 2 of 3
Date	18/06/2025

26/11/2024 to 06/12/2024



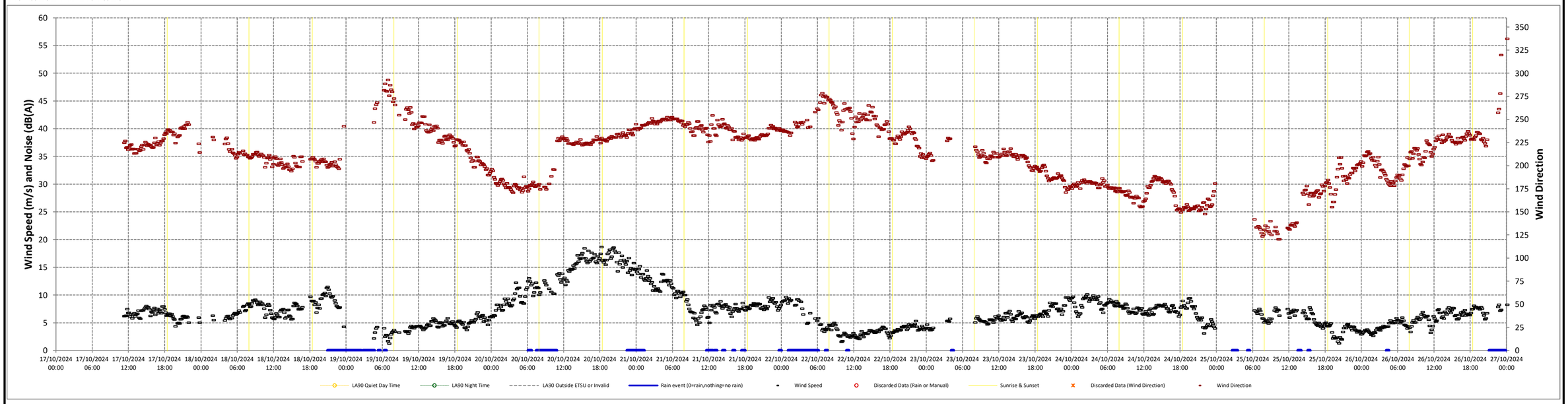


06/12/2024 to 16/12/2024

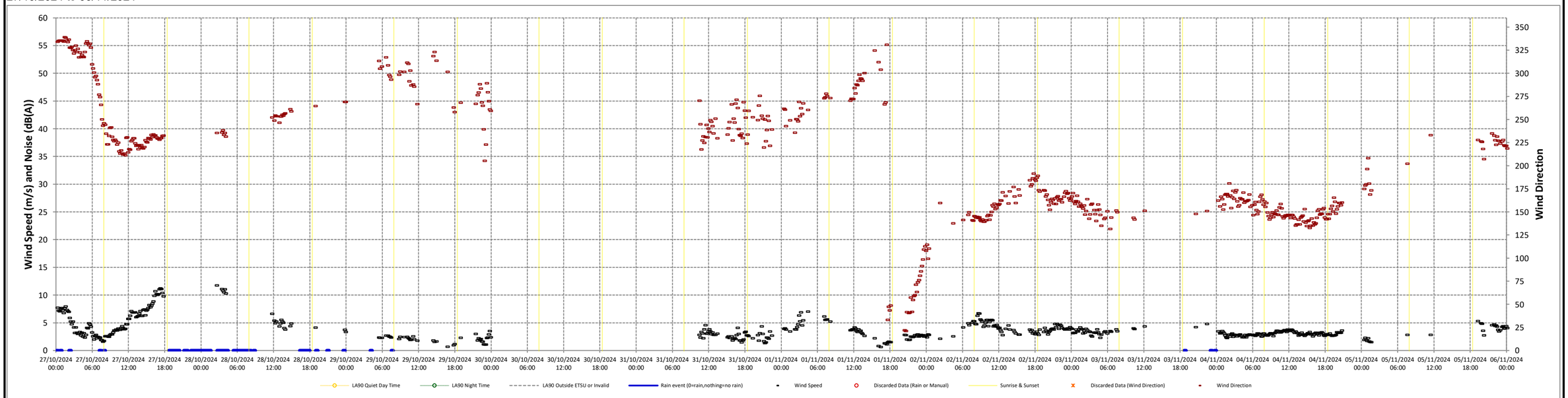


Project	Foel Fach
Client	Coriolis
Title	Time Series for Llaithgwm(NML1) Page 3 of 3
Date	18/06/2025

17/10/2024 to 27/10/2024

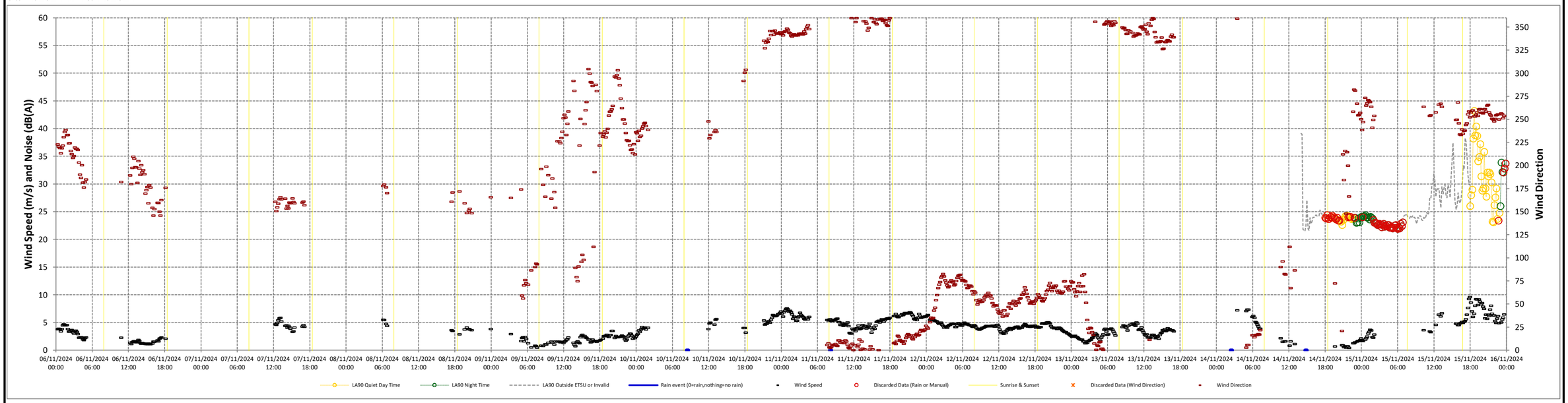


27/10/2024 to 06/11/2024

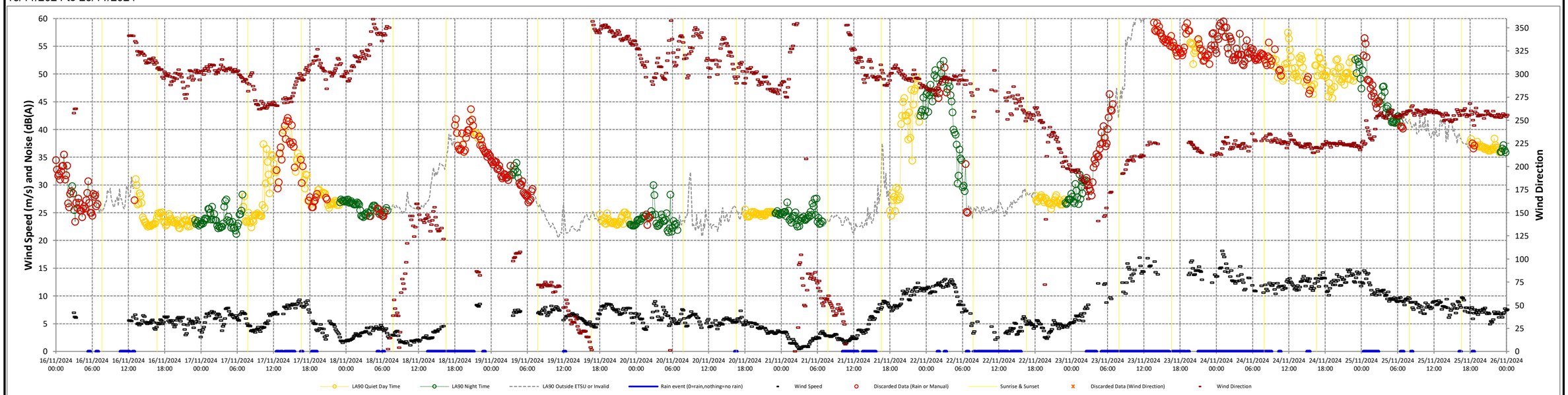


Project	Foel Fach
Client	Coriolis
Title	Time Serie for Greigwen(NML2) Page 1 of 3
Date	18/06/2025

06/11/2024 to 16/11/2024

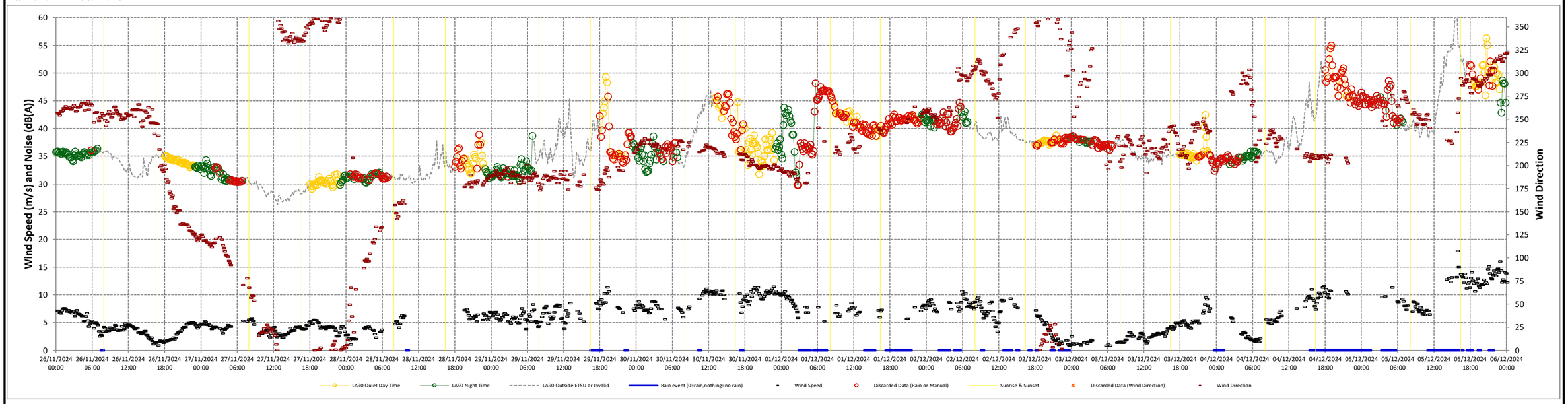


16/11/2024 to 26/11/2024

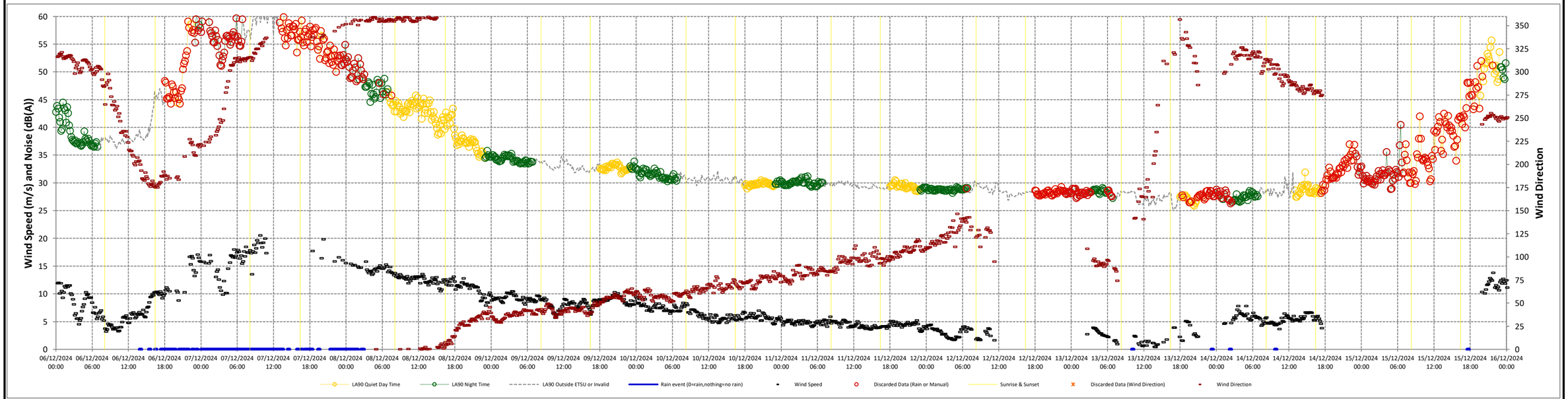


Project	Foel Fach
Client	Coriolis
Title	Time Serie for Greigwen(NML2) Page 2 of 3
Date	18/06/2025

26/11/2024 to 06/12/2024

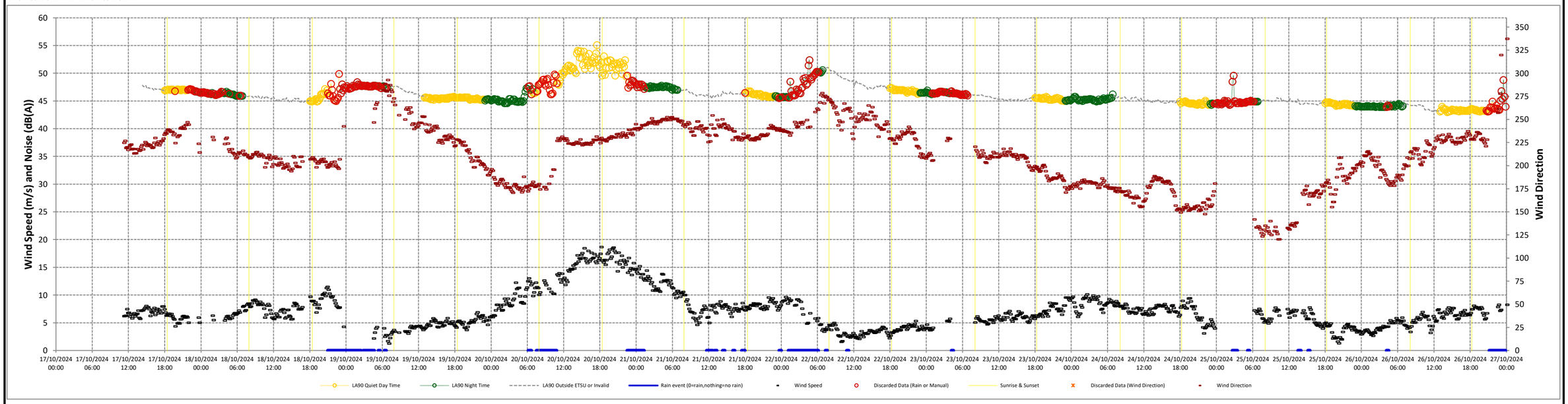


06/12/2024 to 16/12/2024

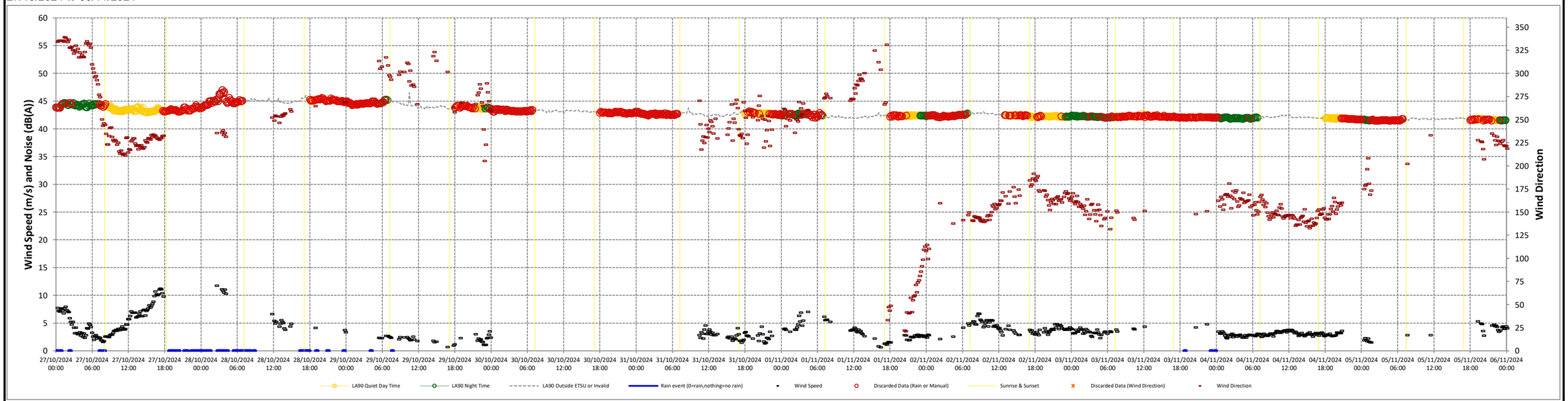


Project	Foel Fach
Client	Coriolis
Title	Time Serie for Greigwen(NML2) Page 3 of 3
Date	18/06/2025

17/10/2024 to 27/10/2024

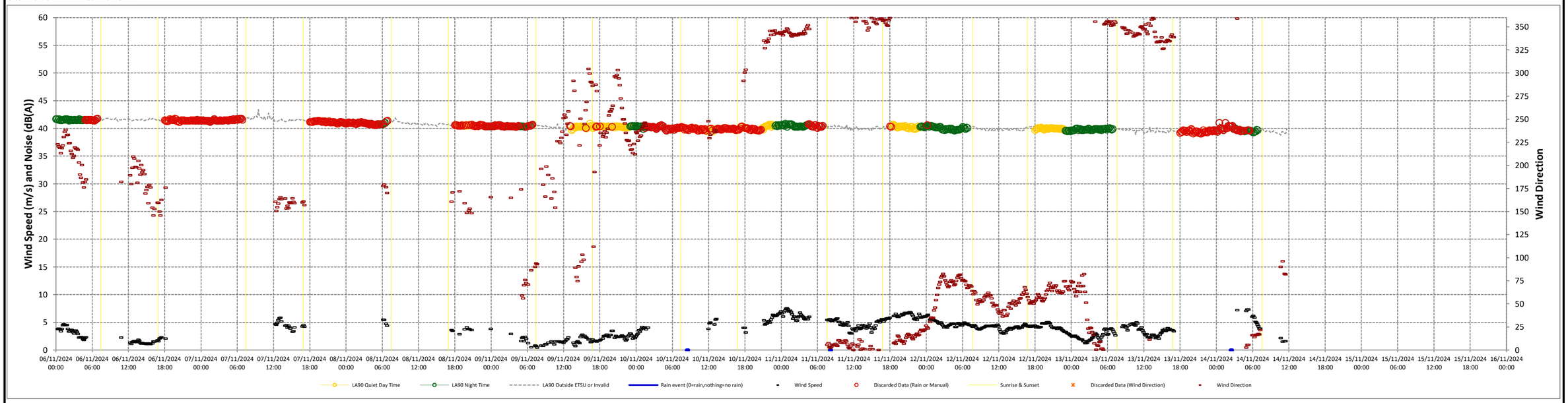


27/10/2024 to 06/11/2024



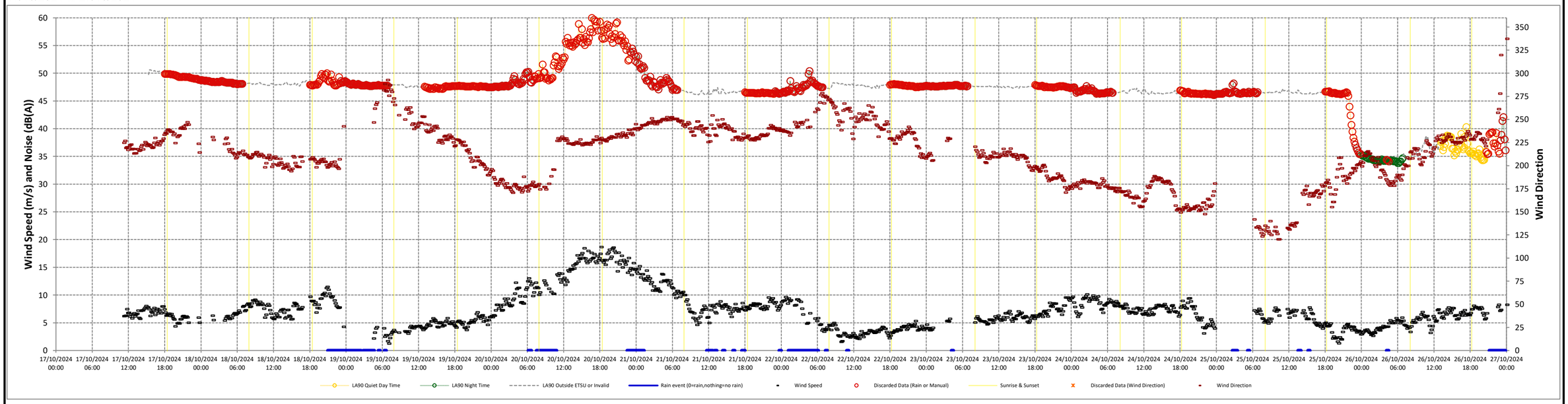
Project	Foel Fach
Client	Coriolis
Title	Time Serie for Cwn Hwylfod(NML3) Page 1 of 2
Date	18/06/2025

06/11/2024 to 16/11/2024

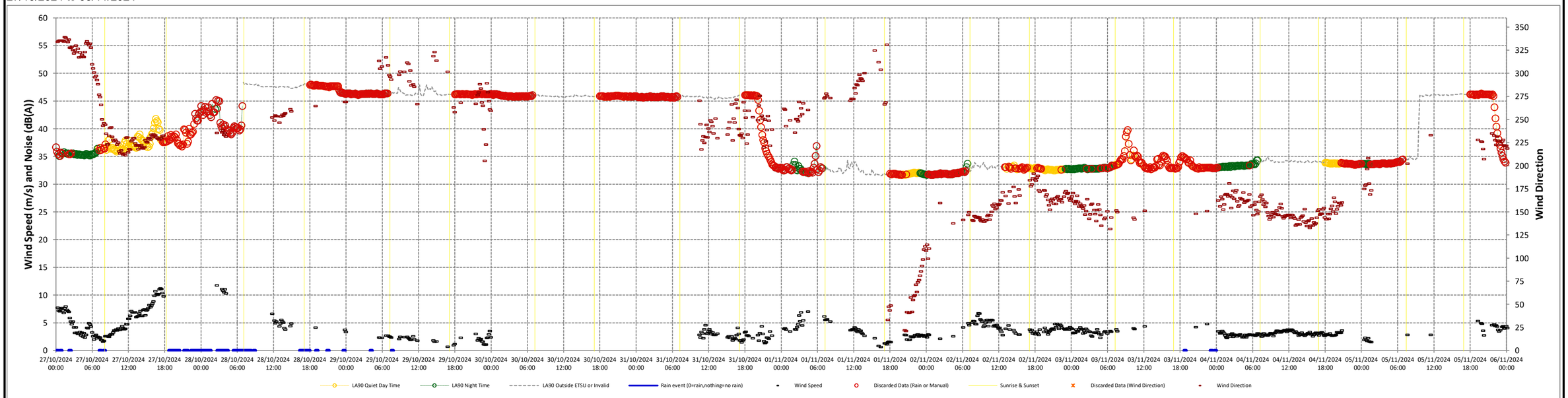


	Project	Foel Fach
	Client	Coriolis
	Title	Time Serie for Cwn Hwylfod(NML3) Page 2 of 2
	Date	18/06/2025

17/10/2024 to 27/10/2024

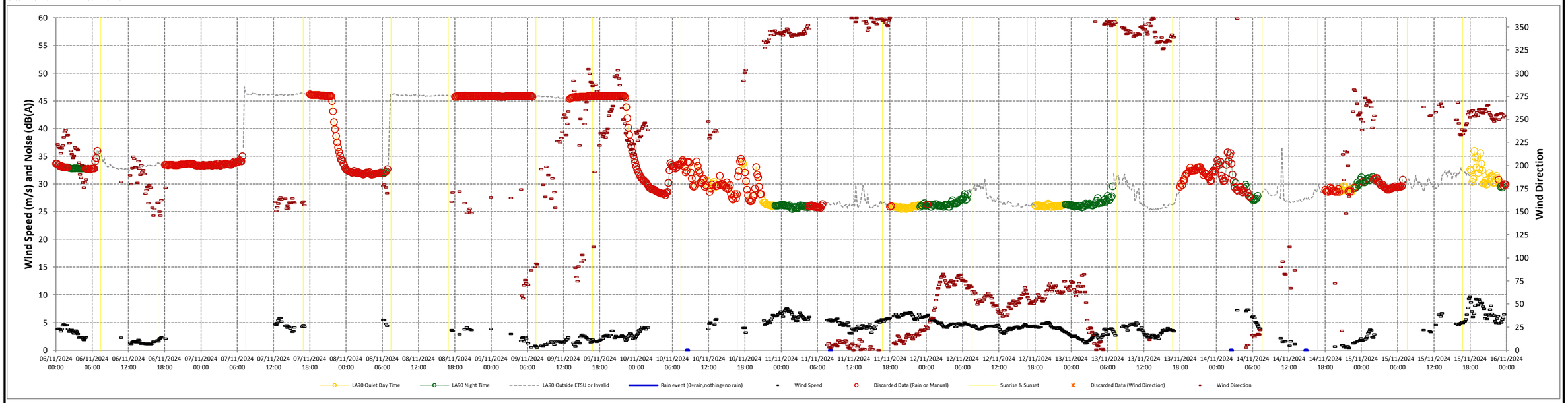


27/10/2024 to 06/11/2024

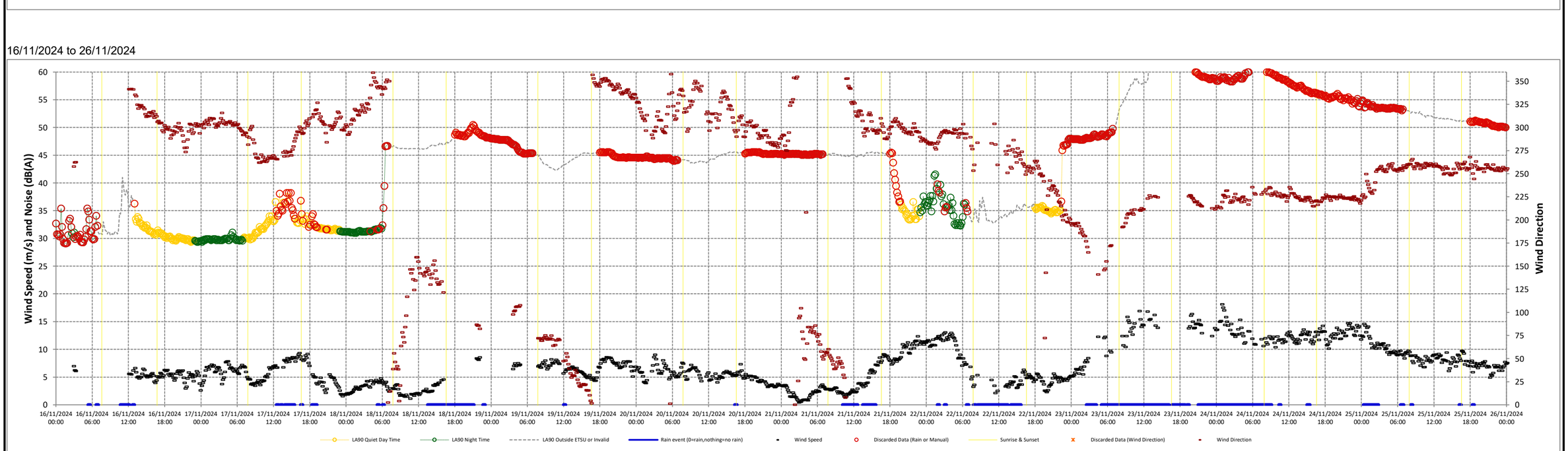


Project	Foel Fach
Client	Coriolis
Title	Time Serie for Penmaen(NML4) Page 1 of 3
Date	18/06/2025

06/11/2024 to 16/11/2024

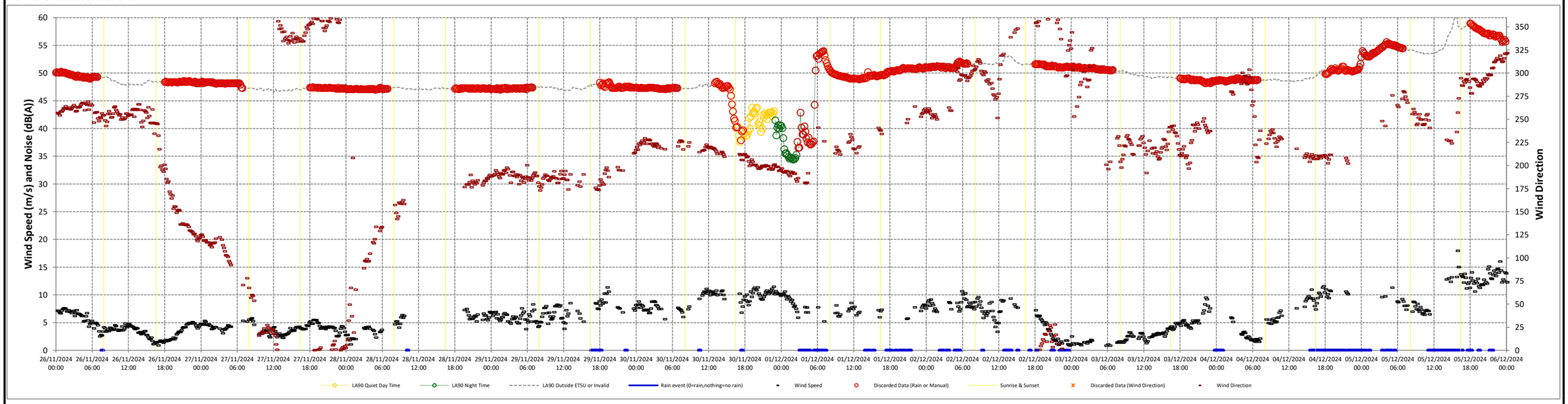


16/11/2024 to 26/11/2024

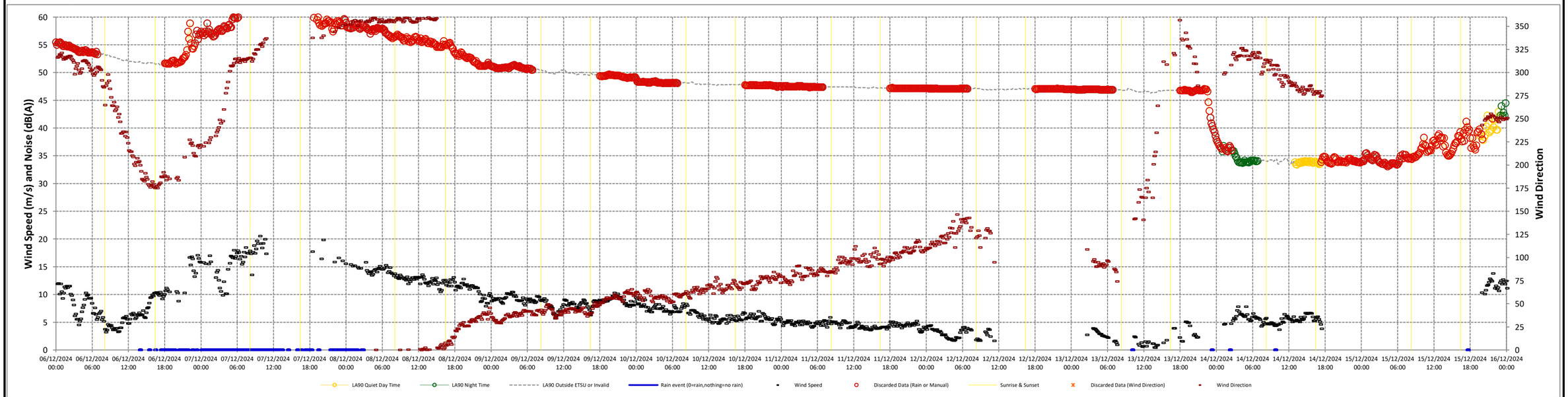


Project	Foel Fach
Client	Coriolis
Title	Time Serie for Penmaen(NML4) Page 2 of 3
Date	18/06/2025

26/11/2024 to 06/12/2024



06/12/2024 to 16/12/2024



Project	Foel Fach
Client	Coriolis
Title	Time Serie for Penmaen(NML4) Page 3 of 3
Date	18/06/2025

Annex 6 – Topographical Corrections/ Turbine Coordinates

Topographical (concave ground/ barrier) Adjustment Table and coordinates

Notes/Comments

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

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

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

Wind Farm	Hub	ID	Noise Senstive Receptor												X	Y	Turbine Considered
			1	2	3	4	5	6	7	8	9	10	11	12			
Foel Fach-WT1	112.4	1	0	0	0	0	0	0	0	0	-2	0	0	0	293056.67	340953	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT2	112.4	2	0	0	0	0	0	0	0	0	-2	0	0	0	293524.79	341484	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT3	132.5	3	0	0	0	0	0	0	0	0	-2	0	0	0	293653.26	340969	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT4	112.4	4	0	0	0	0	0	0	0	3	-2	0	0	0	294106.05	340506	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT5	132.5	5	0	0	0	0	0	3	0	0	-2	0	0	3	294515.13	342160	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT6	132.5	6	0	0	0	0	0	0	0	0	-2	0	0	0	294044.81	341858	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT7	132.5	7	0	0	0	0	0	0	0	0	-2	0	0	0	294250.72	341484	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT8	132.5	8	0	0	0	0	0	0	0	0	-2	0	0	0	294492.62	341198	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT9	132.5	9	-2	0	0	0	0	0	0	0	-2	0	0	0	294985.18	341545	Enercon E-175 EP5 E2 7 MW
Foel Fach-WT10	112.4	10	0	0	0	0	0	0	0	0	0	0	0	0	295070.71	341093	Enercon E-175 EP5 E2 7 MW
Hafotty Uchaf(Operational)_1	65	11	3	3	3	3	3	3	3	3	-2	3	0	0	293407	345511	Vestas V52 850kW
Hafotty Uchaf(Operational)_2	65	12	3	3	3	3	3	3	3	3	3	3	0	0	293694	345635	Vestas V52 850kW
Hafotty Uchaf(Operational)_3	65	13	3	3	3	3	3	3	3	3	-2	3	0	0	293715	345498	Vestas V52 850kW
Hafotty Uchaf(Operational)_4	65	14	3	3	3	3	3	3	3	3	3	3	0	0	293917	345650	Vestas V52 850kW
Gaerwen(180m tip at scoping)_1	102.5	16	-2	3	3	3	3	3	3	3	3	3	3	3	301693	340569	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_2	102.5	17	-2	3	3	3	3	3	3	3	3	3	3	3	302226	340716	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_3	122.5	18	-2	3	3	3	3	3	0	3	3	3	3	3	301875	340015	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_4	102.5	19	-2	3	3	3	3	3	3	3	3	3	3	3	302428	340265	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_5	122.5	20	-2	3	3	3	3	3	0	3	3	3	3	3	301652	339478	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_6	102.5	21	-2	3	3	3	0	0	0	3	3	3	3	3	302198	339685	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_7	102.5	22	-2	3	3	3	3	3	3	3	3	3	3	3	301140	339131	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_8	102.5	23	-2	3	3	3	3	3	0	3	3	3	3	3	302010	339167	Siemens Gamesa SG 6.0-155 6MW
Gaerwen(180m tip at scoping)_9	102.5	24	-2	3	3	3	3	3	3	3	3	3	3	3	301430	338857	Siemens Gamesa SG 6.0-155 6MW
Moel Cha(200tip at soping)_1	119	25	3	3	3	3	3	3	3	3	3	3	3	3	297889	346596	Vestas V162 7.2MW
Moel Cha(200tip at soping)_2	119	26	3	3	3	3	3	3	3	3	3	3	3	3	298239	347319	Vestas V162 7.2MW
Moel Cha(200tip at soping)_3	119	27	3	3	3	3	3	3	3	3	3	3	3	3	298602	346821	Vestas V162 7.2MW
Moel Cha(200tip at soping)_4	119	28	3	3	3	3	3	3	3	3	3	3	3	3	299016	346456	Vestas V162 7.2MW
Moel Cha(200tip at soping)_5	119	29	3	3	3	3	3	3	3	3	3	3	3	3	299270	346039	Vestas V162 7.2MW
Moel Cha(200tip at soping)_6	119	30	3	3	3	3	3	3	3	3	3	3	3	3	299697	346636	Vestas V162 7.2MW
Moel Cha(200tip at soping)_7	119	31	3	3	3	3	3	3	3	3	3	3	3	3	299326	347079	Vestas V162 7.2MW
Moel Cha(200tip at soping)_8	119	32	3	3	3	3	3	3	3	3	3	3	3	3	298910	347384	Vestas V162 7.2MW
Moel Cha(200tip at soping)_9	119	33	3	3	3	3	3	3	3	0	3	3	3	3	298828	347820	Vestas V162 7.2MW
Moel Cha(200tip at soping)_10	119	34	3	3	3	3	3	3	0	0	0	0	0	3	299587	348148	Vestas V162 7.2MW
Moel Cha(200tip at soping)_11	119	35	3	3	3	3	3	0	3	3	0	3	0	0	299921	347572	Vestas V162 7.2MW
Moel Cha(200tip at soping)_12	119	36	3	3	3	3	3	3	3	3	3	3	3	0	300004	347143	Vestas V162 7.2MW
Bryn Ffynnon	60	37	-2	3	3	3	3	3	3	3	3	3	0	0	294060	345752	Enercon-E-53
Disgarth Ucha/ Ty'n Gwyn, Llangwm	60	38	3	3	3	3	3	3	3	3	3	3	3	3	298332	346353	Enercon-E-53
Disgarth Ucha/ Ty'n Gwyn, Llangwm	60	39	3	3	3	3	3	3	3	3	3	3	3	3	298256	346507	Enercon-E-53

Annex 7 – Summary of Wind Turbine Noise Source Data

Wind Turbine Noise Data assumptions

Table A7.1: Sound Power Level Data

Wind Farm	Wind Turbine	Hub height of source data (Modelled hub heights are presented in A6.1)	Uncertainty added	Reference Wind Speed (ms^{-1}) Standardised to 10 m Height									
				3	4	5	6	7	8	9	10	11	12
Foel Fach Candidate 1	Enercon E-175 EP5 E2 7 MW Standard Blades OM-0-0	119	2	#N/A	99.6	104.6	108.4	108.9	108.9	108.9	108.9	108.9	108.9
Foel Fach Candidate 2	Vestas V172 7.2MW Serrated Blades PO7200	155	2	99.7	101.7	105.8	109.2	109.8	109.8	109.8	109.8	109.8	109.8
Hafotty Uchaf	Vestas V52 850kW Generic Blades	60	2	#N/A	94.2	98.7	102.9	105.7	106.3	106.5	106.5	106.5	106.5
Caerwen	Siemens Gamesa SG 6.0-155 6MW AM0	122.5	2	NDA Restricted Data									
Moel Chwa	Vestas V162 7.2MW Serrated Blades 119 m hub S01	119	2	98.0	99.7	103.1	105.4	105.5	105.5	105.5	105.5	105.5	105.5
Bryn Ffynnon/Disgarth Ucha & Ty'n Gwyn	Enercon-E-53-Generic blade-Full mode	60	2	#N/A	93.0	94.7	98.2	100.7	102.3	103.5	103.5	103.5	103.5

Table A7.2: Octave Band Data

Wind Farm	Wind Turbine	Reference Wind Speed (m/s)	Octave Band (Hz)								
			63	125	250	500	1000	2000	4000	8000	Overall
Foel Fach Candidate 1	Enercon E-175 EP5 E2 7 MW Standard Blades OM-0-0	9	90.2	95.0	99.6	103.0	103.8	102.2	95.4	81.0	108.9
Foel Fach Candidate 2	Vestas V172 7.2MW Serrated Blades PO7200	7	91.8	98.8	103.4	102.4	103.0	101.9	100.3	87.5	109.8
Hafotty Uchaf	Vestas V52 850kW Generic Blades	8	88.2	93.9	98.9	100.9	100.4	98.2	92.4	77.3	106.3
Caerwen	Siemens Gamesa SG 6.0-155 6MW AM0	5	NDA Restricted Data								
Moel Chwa	Vestas V162 7.2MW Serrated Blades 119 m hub S01	8	89.2	96.7	99.9	100.1	98.5	94.0	86.5	75.9	105.5
Bryn Ffynnon/Disgarth Ucha & Ty'n Gwyn	Enercon-E-53-Generic blade-Full mode	9	84.0	91.2	94.2	96.2	98.7	97.0	91.4	82.4	103.5