

Chapter 12

Noise

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Glossary

Term	Definition
The proposed development	Y Bryn Wind Farm development

List of Abbreviations

Abbreviation	Description
AGL	Above Ground Level
AL	Advisory Leaflet
AM	Amplitude Modulation
BCBC	Bridgend County Borough Council
BS	British Standard
CEMPs	Construction Environmental Management Plans
dB	Decibel
DECC	Department of Energy & Climate Change
DNS	Developments of National Significance
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
ES	Environmental Statement
FI	Financially Involved
GPS	Global Positioning System
GPG	Good Practice Guide (to the Application of ETSU-R-97)
HMPL	Hayes McKenzie Partnership Limited
JNLD	Just Noticeable Level Difference
IOA	Institute of Acoustics
kWh	kilowatt/hour
LDP	Local Development Plan
LPA	Local Planning Authority
NPTCBC	Neath Port Talbot County Borough Council
NML	Noise Measurement Locations
NSR	Noise Sensitive Receptor
PPW	Planning Policy Wales
RUK	RenewableUK
SLM	Sound Level Meters
STE	Serrated Trailing Edges
TANs	Technical Advice Notes
WHO	World Health Organisation

12.1 INTRODUCTION

- 12.1.1 The Environmental Impact Assessment (EIA) process uses a systematic, evidence-based approach in order to evaluate and interpret the likely impacts and subsequent effects of the proposed development upon physical, biological and human receptors. This Environmental Statement (ES) has been prepared in accordance with The Town and Country Planning (EIA) (Wales) Regulations 2017 (EIA Regulations).
- 12.1.2 Hayes McKenzie Partnership Limited (HMPL) have undertaken an assessment of the potential operational noise levels resulting from the introduction of the proposed Y Bryn Wind Farm (referred to hereafter as the proposed development).
- 12.1.3 The operational assessment has been carried out in accordance with the recommendations of ETSU-R-97, The Assessment and Rating of Noise from Wind Farms, and the best practice guidance published by the Institute of Acoustics, A Good Practice Guide (GPG) to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise and its associated supplementary guidance documents. These documents are identified within planning guidance provided by the Welsh Government.
- 12.1.4 Baseline noise measurements were undertaken at 10 properties in the vicinity of the proposed development and correlated with on-site wind speeds. All locations were agreed with Neath Port Talbot County Borough Council (NPTCBC) and Bridgend County Borough Council (BCBC) environmental health officers.
- 12.1.5 Predictions of the noise levels associated with the operation of the proposed development, based on the installation of 18 wind turbines, have been compared with the noise limits derived from these baseline noise measurements, together with those carried out as part of planning applications for nearby wind turbine development, in line with the requirements of ETSU-R-97.
- 12.1.6 An assessment of the cumulative noise levels resulting from the proposed development operating at the same time as existing, proposed, and consented development in the area has also been undertaken. This includes potential operational noise associated with the existing Mynydd Brombil, Pen y Cymoedd, Ffynnon Oer and Llynfi Afan sites, the consented Foel Trawsant site, and the proposed Mynydd Fforch Dwm site. Consideration has also been given to a proposal to increase the turbine size at Foel Trawsant.
- 12.1.7 A possible mitigation scheme has been developed where the ETSU limits are predicted to be exceeded.
- 12.1.8 The chapter concludes that the appropriate cumulative noise limit for assessing the noise impact associated with the operation of the proposal are as follows:
- *Amenity Hours: the greater of 40 dB LA90 or Background + 5 dB; and*
 - *Night-time Hours: the greater of 43 dB LA90 or Background + 5 dB.*
- 12.1.9 Noise from construction and de-commissioning has also been assessed through consideration of typical plant and activities likely to be employed at this site.
- 12.1.10 The battery energy storage system proposed in the vicinity of the sub-station has been scoped out of noise assessment since it will be 1.6 km to the nearest residential property and highly unlikely to be audible.

12.2 PLANNING POLICY GUIDANCE

Planning Policy Wales – Edition 11 (February 2021)

- 12.2.1 Planning Policy Wales – Edition 11 (PPW11)¹ sets out the land use planning policies of the Welsh Government. It is supplemented by a series of Technical Advice Notes (TANs), Welsh Government Circulars, and policy clarification letters, which together with PPW11 provide the national planning policy framework for Wales.
- 12.2.2 PPW11, when considering the issue of Development Management and Renewable and Low Carbon Energy, states that: *‘Planning authorities should also identify and require suitable ways to avoid, mitigate or compensate adverse impacts of renewable and low carbon energy development. The construction, operation, decommissioning, remediation and aftercare of proposals should take into account:*
- *The need to minimise impacts on local communities, such as from noise and air pollution, to safeguard quality of life for existing and future generations;*
 - *The impact on the natural and historic environment; and*
 - *Cumulative impact’.*
- 12.2.3 The issue of sound / noise is considered within Section 6.7 Air Quality and Soundscape. The guidance suggests the following:
- ‘6.7.6 In proposing new development, planning authorities and developers must, therefore:*
- *Address any implication arising as a result of its association with, or location within, air quality management areas, noise action planning priority areas or areas where there are sensitive receptors;*
 - *Not create areas of poor air quality or inappropriate soundscape; and*
 - *Seek to incorporate measures which reduce overall exposure to air and noise pollution and create appropriate soundscapes.’*
- 12.2.4 New energy development is considered in Paragraph 6.7.15 where it is stated that:
- ‘Location of Commercial, Industrial and other Potentially Polluting Development’*
- 6.7.15 ‘For the purposes of this section, potentially polluting development includes commercial, industrial, energy and agricultural or transport infrastructure. Such development should be located in areas where there is low potential for public exposure, or where its impact can be minimised. Novel or new development types may potentially cause pollution and should be carefully considered, and where appropriate, decisions should be based on the precautionary principle.’*
- 12.2.5 The footnote to this section states the following with respect to noise from wind farm developments:
- ‘Further guidance on wind turbine noise assessment can be found in ETSU-R-97: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49869/ETSU_Full_copy_Searchable_.pdf and further good practice guidance published by the Institute of Acoustics: <https://www.ioa.org.uk/publications/wind-turbine-noise>.’*
- 12.2.6 Section 6.7.16 goes on to outline: *‘Relevant considerations in making planning decisions for potentially polluting development are likely to include:*
- *Location, including the reasons for selecting the chosen site itself;*
 - *Impact on health and amenity ...’*

¹ Welsh Government, (2021). *Planning Policy Wales*. Edition 11. Available from - https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf [Accessed 03/04/2023]

BCBC Local Development Plan (LDP) 2006 – 2021

- 12.2.7 Policy ENV18 Renewable Energy Developments references the issue of noise in the following manner:
- 'Proposals for renewable energy developments will be permitted provided that:
 - 6) They will not detrimentally affect local amenity by reason of noise emissions, visual dominance, shadow flicker, reflected light, the emission of smoke, fumes, harmful gases, dust, nor otherwise cause pollution to the local environment';
- 12.2.8 To that end, the Policy Guidance within PPW11 will provide sufficient protection to neighbours to the proposed development in that compliance with the requirements of the footnote to 6.7.15 of that document i.e., the requirements of ETSU-R-97 is sufficient for determination of acceptability.

NPTCBC LDP (2011 – 2026)

- 12.2.9 Policy RE 1 Criteria for the Assessment of Renewable and Low Carbon Energy Development states '4(b) There will be no unacceptable impacts on residential amenity.' Policy guidance within PPW11 will provide sufficient protection to neighbours to the proposal in that compliance with the requirements of the footnote to 6.7.15, i.e., the requirements of ETSU-R-97 is sufficient for determination of acceptability.

TAN 11: Noise 1997

- 12.2.10 TAN 11: Noise² provides technical advice with regard to the assessment of noise. It states in paragraph 1 that 'This Technical Advice Note (Wales) (TAN) should be read in conjunction with 'Planning Guidance (Wales): Planning Policy'. Planning Guidance, Technical Advice Notes and circulars should be taken into account by local planning authorities in Wales in the preparation of development plans.'
- 12.2.11 Specific direction on the noise issues raised by wind farm developments is given in Annex B, Paragraph B19 which states that: 'Detailed guidance on noise from wind turbines is contained in Planning Guidance (Wales), Technical Advice Note (Wales) 8, 'Renewable Energy', Welsh Office, 1996, Annex A, paragraphs A28-A38'.
- 12.2.12 It is noted, however, that TAN 8 was issued in 2005 and is no longer current guidance having been replaced by Future Wales, The National Plan 2040³.

Future Wales, The National Plan 2040

- 12.2.13 The Future Wales document discusses renewable development in Policies 17 & 18. Policy 17 states:
- 'The Welsh Government strongly supports the principle of developing renewable and low carbon energy from all technologies and at all scales to meet our future energy needs;
 - In determining planning applications for renewable and low carbon energy development, decision-makers must give significant weight to the need to meet Wales' international commitments and our target to generate 70% of consumed electricity by renewable means by 2030 in order to combat the climate emergency; and
 - In Pre-Assessed Areas for Wind Energy the Welsh Government has already modelled the likely impact on the landscape and has found them to be capable of accommodating development in an acceptable way. There is a presumption in favour of large-scale wind energy development (including repowering) in these areas, subject to the criteria in policy 18.'
- 12.2.14 Policy 18 in particular considers Developments of National Significance (DNS) and states:

- 'Proposals for renewable and low carbon energy projects (including repowering) qualifying as Developments of National Significance will be permitted subject to policy 17 and the following criteria; and
- 7. There are no unacceptable adverse impacts by way of shadow flicker, noise, reflected light, air quality or electromagnetic disturbance.'

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

- 12.2.15 ETSU-R-97, The Assessment and Rating of Noise from Wind Farms⁴ presents the recommendations of the Working Group on Noise from Wind Turbines, set up in 1993 by the Department of Trade and Industry (DTI) as a result of difficulties experienced in applying the noise guidelines existing at the time to wind farm noise assessments. The group comprised independent experts on wind turbine noise, wind farm developers, DTI personnel and local authority Environmental Health Officers. In September 1996, the Working Group published its findings by way of report ETSU-R-97. This document describes a framework for the measurement of wind farm noise and contains suggested noise limits, which were derived with reference to existing standards and guidance relating to noise emission from various sources.
- 12.2.16 ETSU-R-97 specifies that noise limits should be set relative to existing background noise levels and should reflect the variation of both turbine and background noise with wind speed. This can imply very low noise limits in particularly quiet areas, and it states that 'it is not necessary to use a margin above background in such low-noise environments. This would be unduly restrictive on developments which are recognised as having wider global benefits. Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to the wind farm neighbour'.
- 12.2.17 For daytime periods, the noise limit is 35 - 40 dB LA90 (the lower limiting value) or 5 dB above the 'quiet daytime hours' prevailing background noise, whichever is the greater. The actual value within the 35 - 40 dB LA90 range depends on a number of factors, namely:
- The number of dwellings in the vicinity;
 - The effect of the limit on the number of kilowatt/hour (kWh) generated; and
 - The duration of the level of exposure.
- 12.2.18 For night-time periods the noise limit is 43 dB LA90 (the lower limiting value) or 5 dB above the prevailing night-time hours background noise, whichever is the greater. The 43 dB LA90 lower limiting value is based on a sleep disturbance criterion of 35 dB(A) with an allowance of 10 dB for attenuation through an open window and 2 dB subtracted to account for the use of LA90 rather the LAeq (see Paragraph 12.2.22).
- 12.2.19 Where the occupier of a property has some financial involvement with the proposal, the day and night-time lower limiting values are increased to 45 dB LA90 and consideration can be given to increasing the permissible margin above background. These limits are applicable up to a wind speed of 12 m/s measured at 10 m height on Y Bryn site boundary.
- 12.2.20 Quiet daytime periods are defined as evenings from 18:00-23:00 plus Saturday afternoons from 13:00-18:00 and Sundays from 07:00-18:00. Night-time is defined as 23:00-07:00. The prevailing background noise level is set by calculation of a best fit curve through values of background noise plotted against wind speed as measured during the appropriate time period with background noise measured in terms of LA90,t. The LA90,t is the noise level which is exceeded for 90% of the measurement period 't'. It is recommended that at least 1 weeks' worth of measurements are required.

² Planning Guidance (Wales), Technical Advice Note (Wales) 11, Noise. Welsh Assembly Government, October 1997.

³ Future Wales. The National Plan 2040. The Welsh Government, February 2021.

⁴ ETSU-R-97, (1996). *The Assessment and Rating of Noise from Wind Farms*. Available from - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49869/ETSU_Full_copy_Searchable.pdf. [Accessed 03/04/2023]

- 12.2.21 Where predicted noise levels are low at the nearest residential properties, a simplified noise limit can be applied, such that noise is restricted to a level of 35 dB L_{A90} for wind speeds up to 10 m/s at 10 m height. This removes the need for extensive background noise measurements for smaller or more remote schemes.
- 12.2.22 It is stated that the $L_{A90,10min}$ noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5 dB less than the L_{Aeq} measured over the same period. The $L_{Aeq,t}$ is the equivalent continuous 'A' weighted sound pressure level occurring over the measurement period t . It is often used as a description of the average noise level. Use of the L_{A90} descriptor, the level exceeded for 90% of the measurement period, for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.
- 12.2.23 ETSU-R-97 also specifies that a penalty should be added to the predicted noise levels, where any audible tone is present. The level of this penalty, as shown on page 10 of the executive summary to ETSU-R-97, is described and varies according to the level by which any tonal components exceed audibility.
- 12.2.24 With regard to multiple wind farms in a given area, ETSU-R-97 specifies that the absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area contributing to the overall turbine noise received at the properties in question. Existing wind farms should therefore not be considered as part of prevailing background noise level and noise limits should be compared with cumulative predictions for proposed wind turbines operating in combination with existing sites.

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

- 12.2.25 In May 2013, the Institute of Acoustics (IOA) published A GPG to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise⁵. Under the guidance on wind turbine noise assessment section of their website, the Welsh Government encourages the use of the IOA document, and it is referred to in PPW11. The publication of the GPG followed a review of current practice carried out for the Department of Energy and Climate Change (DECC) and an IOA discussion document which preceded the GPG. The author of this chapter was a lead contributing author to the GPG.
- 12.2.26 The GPG includes sections on Context; Background Data Collection; Data Analysis and Noise Limit Derivation; Noise Predictions; Cumulative Issues; Reporting; and Other Matters including Planning Conditions; Amplitude Modulation; Post Completion Measurements; and Supplementary Guidance Notes. The Context section states that the guide '*presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine development above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published*'. It adds that '*the noise limits in ETSU-R-97 have not been examined as these are a matter for Government*'.
- 12.2.27 As well as expanding on and, in some areas, clarifying issues which are already referred to in ETSU-R-97, additional guidance is provided on noise prediction and a preferred methodology for dealing with wind shear.

BS 8233 Guidance on Sound Insulation and Noise Reduction for Buildings

- 12.2.28 British Standard (BS) 8233⁶ advises the use of ETSU-R-97 when assessing wind farm noise impact and states that reliable estimates of wind farm noise levels can be made by implementing the procedures set forth in the IOA GPG. It draws particular attention to the issues of amplitude modulation (AM) and excess AM; however, it goes on to state that such adverse effects cannot be predicted at the planning stage.

⁵ Institute of Acoustics, (2013). *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise*. Available from - <https://www.ioa.org.uk/sites/default/files/IOA%20Good%20Practice%20Guide%20on%20Wind%20Turbine%20Noise%20-%20May%202013.pdf> [Accessed 03/04/2023]

⁶ BS 8233: 2014: Guidance on sound insulation and noise reduction for buildings.

BS 5228 Code of Practice for Noise and Vibration Control on Construction and Open Sites

- 12.2.29 When considering the issue of noise associated with the construction and decommissioning of a wind farm, reference is made to British Standard BS 5228-1:2009 + A1:2014 & BS 5228-2:2009 + A1:2014 which provide example criteria for the assessment of the significance of construction noise and vibration effects and a method for the prediction of noise levels from construction activities. Two example methods are provided for assessing significance of noise.
- 12.2.30 The first is based on the use of criteria defined in Department of the Environment Advisory Leaflet (AL) 72, Noise Control On Building Sites, which sets a fixed limit of 70 dB(A) in rural suburban and urban areas away from main roads and traffic. Noise levels are generally taken as façade L_{Aeq} values with free-field levels taken to be 3 dB lower giving an equivalent noise criterion of 67 dB L_{Aeq} .
- 12.2.31 The second is based on noise change but applies minimum criteria of 45, 55 and 65 dB L_{Aeq} for night-time (23:00-07:00), evening and weekends (19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays), and daytime (07:00-19:00) including Saturdays (07:00-13:00) respectively. These limits are applicable irrespective of existing baseline noise levels, and where construction activities have a duration of one month or more. It should be noted that the time period to which each limit applies also defines the time averaging period for the calculated L_{Aeq} .
- 12.2.32 Guidance on air over-pressure as a consequence of any blasting associated with borrow pit activities is provided within Annex I to the Standard (BS 5228-1). Guidance with respect to Vibration induced from blasting is also provided within BS 5228_2 and additional advice for air over-pressure (Annex G).

Sleep Disturbance

- 12.2.33 The potential for sleep disturbance depends on the average and maximum levels of noise in sleeping areas during the night-time period. The night-time noise limits in ETSU-R-97 aim to protect against sleep disturbance by limiting the amount of turbine noise external to dwellings assuming a worst case of inhabitants sleeping with the windows open for ventilation. The internal noise levels in such circumstances can be calculated by assuming a 10-15 dB reduction in noise from outside to inside. The World Health Organisation (WHO) published recommendations in 1999⁷ to the effect that average night-time noise levels in sleeping areas should not exceed 30 dB L_{Aeq} . Although this figure relates to overall noise level in sleeping areas, the potential for sleep disturbance specifically from turbine noise, for worst case downwind propagation with windows open, can be evaluated for each dwelling by subtracting 10-15 dB from the predicted turbine noise level and comparing with this criterion, after also adding 2 dB to convert the predicted turbine noise level to an L_{Aeq} value.
- 12.2.34 It should be noted that guidance from the WHO on night noise levels, in the form of the Night Noise Guidelines for Europe⁸, recommends that the population is not exposed to average external night-time noise levels, over a whole year, of more than 40 dB L_{Aeq} . This average yearly noise level will depend on the variation in wind speed, wind direction and noise from other sources over each year period.
- 12.2.35 Further to the above, the latest guidance from the WHO Environmental Noise Guidelines for the European Region (2018)⁹ conditionally recommends that turbine noise should not exceed an L_{den} of 45 dB. L_{den} is the average noise level over one year, where noise during evening and night-time periods is penalised with a 5 and

⁷ WHO, (1999). *Guidelines for community noise*. Available from - <https://apps.who.int/iris/handle/10665/66217> [Accessed 03/04/2023]

⁸ WHO, (2009). *Night Noise Guidelines for Europe*. Available from - https://www.euro.who.int/_data/assets/pdf_file/0017/43316/E92845.pdf [Accessed 03/04/2023]

⁹ WHO, (2023). Available from - <https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/environmental-noise-guidelines-for-the-european-region-2018> [Accessed 03/04/2023]

10 dB correction respectively. Although compliance can be shown through predictions, it would be almost impossible to establish compliance with this limit through measurements at residential locations.

- 12.2.36 It should also be noted that potential difficulty in getting to sleep, either at the start of the night or once awoken by other sources, may be more related to audibility indoors under specific circumstances than by average noise level.

12.3 CONSULTATIONS

- 12.3.1 A scoping report which included details as to relevant planning policy and guidance in respect of operational and construction noise was submitted in January 2021. This identified the policies above as relevant to the proposed development and described the general process to be taken in respect of assessing operational and construction noise levels from the proposed development.
- 12.3.2 The response, referred to as a scoping direction, was published in March 2021. This considered noise within Table 1 which sets out the Planning Inspectorate's comments with respect to all issues identified within the scoping report. Noise was considered by the Statutory Consultees of BCBC and NPTCBC.
- 12.3.3 The scoping direction does not raise any specific objections to the proposed approach but further points to specific aspects of relevant guidance (i.e., ETSU-R-97 and the GPG) and provides generalised commentary as to factors that may influence background noise measurements, prediction methodology and factors to consider when assessing cumulative noise levels resulting from the proposed development operating simultaneously with other existing, planned and consented wind farm developments in the area.
- 12.3.4 In considering the range of daytime noise limits provided by ETSU-R-97, consideration should be given to all three factors identified at Paragraph 12.2.17 to ensure that any agreed noise limit would reflect a balance between the concerns of neighbours to the proposed development whilst ensuring optimum generation of renewable energy.
- 12.3.5 Both consultees were provided with proposed background sound level measurement locations and confirmation of their acceptability was received via email on 23 June 2021.
- 12.3.6 Additional discussions were held (28/03/22, 06/04/22 & 14/04/22) subsequent to completion of the background noise survey to discuss an appropriate assessment criterion both for the proposed development acting alone and in combination with the existing and consented wind farms. These discussions indicated an acceptance of cumulative compliance with the ETSU-R-97 upper daytime limit, provided this could be combined with compliance with the ETSU-R-97 night-time limit incorporating a reduced lower limiting value of 40 dB L_{A90} instead of 43 dB L_{A90} . An alternative proposed by the LPAs noise consultant was compliance with the ETSU-R-97 daytime limit with a lower limiting value of 38 dB L_{A90} (roughly mid-way between the upper and lower values specified in ETSU-R-97) combined with the normal ETSU-R-97 night-time limit.
- 12.3.7 It should be noted, however, that the day and night-time limits proposed by the LPA are already exceeded cumulatively at one property leaving no noise budget for new development.
- 12.3.8 Appendix 3 within this ES contains a copy of the scoping report, scoping direction and key consultation undertaken as part of this proposed development.

¹⁰ Renewable UK, (2016). *Wind Turbine Amplitude Modulation*. Available from - <https://www.renewableuk.com/page/IndustryStatementOAM/page/CommunitiesEnergy> [Accessed 03/04/2023]

¹¹ Institute of Acoustics (2015). Discussion Document on "Methods for Rating Amplitude Modulation in Wind Turbine Noise". IOA

12.4 WIND TURBINE SOUND

Blade Swish (Amplitude Modulation of Aerodynamic Noise)

- 12.4.1 The variation in noise level associated with turbine operation, at the rate at which turbine blades pass any fixed point of their rotation (the blade passing frequency), is often referred to as blade swish and amplitude or aerodynamic modulation (AM) and is an inherent feature of wind turbine noise. This effect is identified within ETSU-R-97, where it is envisaged that '*... modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine...*' and that at distances further from the turbine where there are '*... more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)*'.
- 12.4.2 It has been noted that complaints to planning authorities regarding wind farm noise in the UK, where they have occurred, have often been specifically concerned with amplitude modulation. This is also apparent from ETSU-R-97, where it is noted that '*it is the regular variation of the noise with time that, in some circumstances, enables the listener to distinguish the noise of the turbines from the surrounding noise*'. The modulation of noise may increase annoyance over that for noise with the same overall sound pressure level.
- 12.4.3 RenewableUK (RUK), the main renewable energy trade association in the UK, completed research into the causes and subjective effects of AM following various reports of increased levels of AM being experienced at dwellings neighbouring some wind turbine sites. This concluded that the predominant cause is likely to be from individual blades being subject to flow separation (going in and out of stall) as they pass through regions of higher wind speed at the top of their rotation under high wind shear conditions. Subjective tests carried out by Salford University, using loudness matching techniques, demonstrated the extent to which higher levels of modulation depth result in increased perceived loudness.
- 12.4.4 This resulted in the inclusion of a mechanism to assess and regulate AM effects in the standard form of a potential planning condition¹⁰, which could be applied to wind farm developments in the same way as that included in the IOA GPG. The IOA reviewed this mechanism and released a discussion document¹¹ which reviews several different methods for rating amplitude modulation in wind turbine noise and subsequently released a recommended method¹² by which to characterise the peak to trough level in any given 10 minute period.
- 12.4.5 Although this document provides a definitive approach to the quantification of amplitude modulation, it does not provide any comment on what could be defined as an unacceptable level of AM nor any kind of penalty scheme, such as for tonal content, by which the overall turbine noise level should be corrected to account for its presence. This has subsequently been covered by a DECC commissioned project looking at human response to the amplitude modulated component of wind turbine noise.¹³
- 12.4.6 The combination of these two documents provides both a method of quantification of the level of amplitude modulation over a given 10-minute period and the appropriate penalty to apply where necessary. This is in addition to any penalty for tonal noise where tonality and modulation are not related.
- 12.4.7 It should be noted that most wind farms operate without significant AM, and that it is not possible to predict the likely occurrence of AM, but, like tonal noise, AM can be covered by a suitably worded planning condition if necessary.
- 12.4.8 Currently, AM is typically addressed in response to any complaints via a measurement scheme that refers to emerging best practice in this regard. There are no standard or agreed methods by which to predict, with any

¹² Available from - https://www.ioa.org.uk/sites/default/files/AMWG%20Final%20Report-09-08-2016_1.pdf [Accessed 03/04/2023]

¹³ GOV.UK, (2016). *Review of the evidence on the response to amplitude modulation from wind turbines*. Available from - <https://www.gov.uk/government/publications/review-of-the-evidence-on-the-response-to-amplitude-modulation-from-wind-turbines> [Accessed 03/04/2023]

certainty, the likelihood of amplitude modulation occurring at a level requiring a penalty at a particular development, only some indicators such as relatively high wind shear conditions under certain circumstances or particular turbine designs and/or dimensions for example. Therefore, no AM assessment has been undertaken as the relevant science is not developed enough to allow determination of any potential risk.

Wind Shear

- 12.4.9 Wind shear, or more specifically vertical wind shear, is the rate at which wind speed increases with height above ground level. This has particular significance to wind turbine noise assessment where background noise measurements are referenced to measurements of wind speed at 10 metres height, which is suggested as appropriate by ETSU-R-97, but which is not representative of wind at hub-height, which is what affects the noise generated by the turbines.
- 12.4.10 The preferred method of accounting for wind shear in noise assessments is by referencing background noise measurements to hub height wind speed. Hub height wind speed may be determined directly by using a tall mast or remote sensing technology (i.e., LiDAR or SoDAR) or indirectly from measurements at a number of heights below hub height in order to calculate the hub height wind speed during the background noise survey period, as described in the GPG. The hub height wind speeds are then converted to 'standardised 10 m wind speeds', assuming reference ground roughness conditions as used by turbine manufacturers when specifying turbine sound power levels.

Tonal Noise

- 12.4.11 ETSU-R-97 notes that, where complaints had been made over noise from wind farms existing at the time the report was written, the tonal character of the noise from machinery in the nacelle had been the feature that had caused greatest annoyance. The recommendation was, therefore, that any assessment carried out should include a correction to the predicted noise levels according to the level of any tonal components in the noise. A specific tonal assessment methodology is described in the report which is based on the well-established Joint Nordic Method for the Evaluation of Tones in Broadband Noise¹⁴ which has now been superseded by a revised version¹⁵ although this revision makes no substantive difference to the ETSU-R-97 methodology. A scale of corrections for tonal noise is included where the penalty is increased as the audibility of the tone level increases, to a maximum of 5 dB. The necessity of minimising tonal components in the noise output from the turbines is well understood by the turbine manufacturers and a guarantee should always be sought that any tonal noise will be below that requiring a penalty under the ETSU-R-97 scheme. It should be noted that modern wind turbines generally operate without significant tonal content. Tonal sound is generally warranted by a turbine supplier, either at the reference location for Sound Power Level determination of a wind turbine or at a receptor location. Planning Conditions dealing with wind turbine noise generally require assessment of tonality at a receptor location and follow the guidance which is contained within ETSU-R-97 with respect to appropriate measurement and penalties for such a character.

Infrasound

- 12.4.12 Infrasound is noise occurring at frequencies below that at which sound is normally audible, i.e., at less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range,

for sound to be perceptible, it has to be of very high amplitude, and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance.

- 12.4.13 Wind turbines have been cited by some as producers of infra-sound. This has, however, been due to the high levels of such noise, as well as audible low frequency thumping noise, occurring on older 'downwind' turbines which were installed in the USA prior to the large scale take up of wind power production in the UK. Downwind turbines are configured with the blades downwind of the tower such that the blades pass through the wake left in the wind stream by the tower resulting in a regular audible thump, with infra-sonic components, each time a blade passes the tower. Virtually all modern larger turbines are of the upwind design and is the case for the proposed development; that is with the blades upwind of the tower, such that this effect is eliminated.
- 12.4.14 A study into low frequency noise from wind farms¹⁶ concluded that '*infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion*'. It goes on to state that, based on information from the WHO, '*there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects*' and that '*it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour*'.
- 12.4.15 A considerable amount of research has been conducted in regard to the levels of infrasound that wind turbines emit^{17, 18, 19}. All reliable evidence suggests that at typical residential distances (e.g., at 500 m or more), the levels of infra-sound from a wind farm are significantly below accepted thresholds of perception. Even when measured in close proximity to a wind turbine, the measured levels of infra-sound are still below accepted thresholds of perception. This suggests that infrasound is not an issue for neighbours in the vicinity of wind turbines and has not been considered further within this assessment.

Low Frequency Noise

- 12.4.16 Noise from modern wind turbines is essentially broad band in nature in that it contains similar amounts of noise energy in all frequency bands from low to high frequency. As distance from a wind farm site increases, the noise level decreases as a result of the spreading out of the sound energy and also due to air absorption which increases with increasing sound frequency. This means that, although the energy across the whole frequency range is reduced, higher frequencies are reduced more than lower frequencies with the effect that as distance from the site increases the ratio of low to high frequencies also increases. This effect is not specific to wind turbines and may be observed with road traffic noise or natural sources, such as the sea, where higher frequency components are diminished relative to lower frequency components at long distances.

Vibration Associated with Turbine Operation

- 12.4.17 The ETSU study referenced²¹ found that vibration from wind turbines, as measured at 100 m from the nearest machine, was well below the criteria recommended for human exposure in critical working areas such as precision laboratories. At greater distances from turbines vibration levels are even lower. This has been confirmed by the Keele University study²² which showed vibration levels of around 10^{-8} m.s^{-2} at a distance of 2.4 km from the Dun Law Wind Farm site under high wind conditions, orders of magnitude lower than the criteria referred to above which specify levels in the region of 0.005 m.s^{-2} .

¹⁴ Danish National Agency of Environmental Protection (1984). Measurement of Environmental Noise from Industry - The Joint Nordic Method for the Evaluation of Tones in Broadband Noise (Guideline No. 6). Danish Ministry of Environment.

¹⁵ Pederson et al. (1999) AV 1952/99, Objective Method for Assessing the Audibility of Tones in Noise – Joint Nordic Method – Version 2. Delta.

¹⁶ Department of Trade and Industry (2006). ETSU W/45/00656/00/00, The Measurement of Low Frequency Noise at 3 UK Windfarms. ETSU/DTI.

¹⁷ Department of Trade and Industry (1997). ETSU W/13/00392/REP, Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm. ETSU/DTI.

¹⁸ Styles et al. (2005) Microseismic and Infrasound Monitoring of Low Frequency Noise and Vibrations from Wind Farms. Keele University.

¹⁹ Turnbull et al. (April 2012) Measurement and Level of Infrasound from Wind Farms and Other Sources. 40(1). Acoustics Australia.

Audibility

- 12.4.18 The potential audibility of noise from proposed wind turbines depends to a large extent on the amount by which the predicted turbine noise level exceeds the noise from other sources (the baseline or background noise level) and the presence of any acoustical 'features' which distinguish it. Such other noise may be steady and unchanging but is more likely to be continuously variable depending on the time of day and other factors including, particularly in rural areas, wind speed.
- 12.4.19 The results of baseline noise measurements carried out for the proposed development are expressed in terms of the level exceeded for 90% of each 10-minute interval which are shown plotted against wind speed on the background noise data analysis charts. The potential audibility of wind turbine noise from the proposed development, for the quiet daytime and night-time hours and for worst case downwind propagation from the site towards the various measurement locations, can be determined by comparing the relevant predicted turbine noise with the corresponding measured background noise level for each 10-minute measurement period. Where predicted noise levels are around the same level as the background noise, this suggests that the noise source may be just audible, with perceived audibility increasing with margin above background and also when taking into account any significant acoustic features such as tonality or amplitude modulation. Similarly, where predicted noise levels are lower than the existing background noise levels, audibility decreases correspondingly as it reduces.
- 12.4.20 Changes in levels which are detectable by the human ear are dependent upon the level of presentation (i.e., how loud a sound is at the human ear) and by how much that sound may vary. In general, environmental sound level changes are noticeable when level increases/decreases of around 3 dB occur, i.e., an observer will detect a change in level at a location from day to day when that level changes by around 3 dB. TAN11 sets out within its glossary that 'A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound'.
- 12.4.21 Just Noticeable Level Difference (JNLD) within a laboratory environment, when presentation levels are between 30 – 45 dB L_{Aeq} , are between 0.6 – 0.7 dB²⁰. Such situations are unlike external sound environments where other sounds will also be heard which result in masking. In these situations, JNLD is around 1 dB where Low Pass Noise limited to frequencies below 1 kHz is adopted as the masker when masking levels are between 30 – 40 dB. This is the level of existing masking sound predicted for the existing and consented wind farms at some locations neighbouring the proposed development. Therefore, the addition of more sound which results in less than 1 dB of change (increase) in the level is very unlikely to be detectable to the average listener in an external sound environment.

12.5 DETERMINATION OF BASELINE NOISE LEVELS

- 12.5.1 Measurements of the existing sound environment at the agreed representative Noise Measurement Locations (NML) neighbouring the proposed development were undertaken during the period from 28 July to 22 September 2021.
- 12.5.2 The general weather conditions during the survey were dry during August (around 50% average rainfall) and average during September with respect to rainfall. Temperatures were average or around 2°C warmer (August and September respectively) with below average sunshine for both months²¹. These weather conditions can be compared with the rainfall conditions that occurred during the background noise surveys (November/December 2012) undertaken for the Foel Trawsnant Wind Farm when rainfall conditions during the latter half of the survey period were between 175 – 200% more than the normal average conditions. As a consequence, when comparing measured levels between similar assessment locations, it is not uncommon to find that Foel Trawsnant reported sound levels are higher than those found and reported for the noise survey undertaken for

this development. Therefore, it may be considered that the noise levels reported below are indicative of the lower levels to be found at neighbouring noise sensitive receptors to the proposed development.

- 12.5.3 Calibration certificates for the equipment used for the measurements are provided at Appendix 12.1.
- 12.5.4 The measurement locations are shown on the noise contour figures at Appendix 12.5 and a description of each is provided. Photos of the equipment set-up at each one are provided within Appendix 12.2.

Measurement Locations

NML01: Highland Heights: SS 83381 90147

- 12.5.5 This dwelling is located to the east of the southern section of the proposed development on rising ground with views towards the east.
- 12.5.6 The noise monitoring equipment (HMP57) was placed in the garden of the property in a free-field location away from the trees. The location was around 10 metres (m) from the gable end of the conservatory of the property.
- 12.5.7 Noise sources noted during installation and removal of the equipment included birdsong, wind in the trees and foliage, water flowing in the valley to the south of the property, distant traffic and a vehicle climbing up towards the property, and a low flying helicopter.

NML02: The Pines: SS 83969 91037

- 12.5.8 This dwelling is located to the north-east of the southern section of the proposed development located in a valley with sheltering from the wind in most directions.
- 12.5.9 The noise monitoring equipment (HMP37) was placed in the front garden to the south of the property in a free-field location. The location was around 10 m from the gable end of the property adjacent to the main sitting out area.
- 12.5.10 Noise sources noted during installation and removal of the equipment included birdsong, wind in the trees and foliage, sheep, dog, very distant traffic, bell from neighbouring golf club, high frequency arcing sound from High Tension Lines running in valley.

NML03: Garn Wen Farm: SS 84690 92455

- 12.5.11 This dwelling is located to the south-east of the northern section of the proposed development located in an elevated position overlooking Maesteg and is sheltered for wind directions from a westerly direction.
- 12.5.12 The noise monitoring equipment (HMP55) was placed in the front garden to the east of the property in a free-field location. The location was around 10 m from the gable end of the property, 45 m from an engineering barn and around 145 m from neighbouring dwellings along Neath Road.
- 12.5.13 Noise sources noted during installation and removal of the equipment included birdsong, wind in the trees and foliage, calves, dogs, traffic along Neath Road and more distant traffic in Maesteg, metal working within the engineering barns and the flow of water at the end of the survey due to the increased flow within a watercourse around 10 m from the sound level meter.

NML04: Tŷ Canol Farm: SS 82338 95009

- 12.5.14 This dwelling is located to the north of the northern section of the proposed development located in an elevated position overlooking Afon Afan to the north and is sheltered for wind from most directions. This location is identified in the Foel Trawsnant Planning Conditions dealing with noise as R8. However, the setting of a noise

²⁰ Psychoacoustics: Facts and Models: E.Zwicker & H. Fastl: 7.1.2 Just-Noticeable Level Differences: page160 – 162.: Springer-Verlag: Edition 1: 1990.

²¹ Met Office. *UK actual and anomaly maps*. Available from - <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps> [Accessed 03/04/2023]

limit at this location within Foel Trawsnant Consent is based upon measurements of a proxy location which is further to the north-east at R6 Ty'n-y-pant Farm.

12.5.15 The noise monitoring equipment (HMP54) was placed in the garden to the east of the property in a free-field location. The dwelling house and rental properties are surrounded by tall conifer trees. The location was around 20 m from the rear of the property. The location was selected to minimise the influence of traffic along the A4107 to the north and the vehicle movements associated with the bike centre located 100 m from the property. It was considered that this measurement location would represent the quieter areas surrounding the property as compared to the patio area to the front which overlooked the A4107 and was more influenced by traffic sound.

12.5.16 Noise sources noted during installation and removal of the equipment included birdsong, wind in the trees and foliage, dogs, traffic, wind chimes, Enduro Motor Bikes accessing the tracks past the property, bees, and gates associated with the cycle tracks.

NML05: Meadow Row Bryn: SS 81917 92389

12.5.17 This dwelling is located between the northern and southern sections of the proposed development, located in an elevated position overlooking Bryn settlement to the south. The location is exposed to wind from most directions.

12.5.18 The noise monitoring equipment (HMP41) was placed in the garden to the east of the property in a free-field location. The dwelling house garden is surrounded by a tall fence which provides a visual break to close neighbouring areas and protection from the wind from in an easterly direction. The location was around 20 m from the rear of the property.

12.5.19 Noise sources noted during installation and removal of the equipment included rain, birdsong, wind in the trees and foliage, dogs, traffic, wood working sounds from a southerly direction, distant traffic and high-tension line arcing sounds during damp conditions.

NML06: Station Terrace, Bryn: SS 81956 91856

12.5.20 This dwelling is located between the northern and southern sections of the proposed development. The location is sheltered from wind from most directions.

12.5.21 The noise monitoring equipment (HMP41) was placed in the garden to the south of the property in a free-field location. The dwelling house garden is surrounded by a tall fence. The location was around 16 m from the rear of the property.

12.5.22 Noise sources noted during installation and removal of the equipment included rain, birdsong, wind in the trees and foliage, dogs, traffic, and distant traffic.

NML07: Penrhiw Bungalow: SS 80776 91513

12.5.23 This dwelling is located to the north-west of the southern section of the proposed development. The location is sheltered from wind from an easterly direction.

12.5.24 The noise monitoring equipment (HMP53) was placed in the garden to the south-south-west of the property in a free-field location. The dwelling house has a number of structures to the east of the main dwelling house which included a hot tub. The pump associated with this was audible during installation in areas around the eastern side of the property and to the north, the front of the property. Therefore, to minimise the potential influence of this source the position to the south-south-west was selected. The location was around 10 m from the property.

12.5.25 Noise sources noted during installation and removal of the equipment included rain, birdsong, wind in the trees and foliage, traffic, and children in the garden.

NML08: Hafod Farm: SS 80146 89895

12.5.26 This location is located west of the southern section of the proposed development. The location is exposed to southerly and westerly wind with clear views out across Swansea Bay and is sheltered from wind from an

easterly direction. The location was positioned close to Hafod Farm Glass Blobbery. Three properties were identified as residential at the site all generally at around the same height and exposure as the measurement location.

12.5.27 When the site was visited for the initial installation, Western Power Distribution was undertaking an electrical power supply upgrade during the first week of the noise survey and a large diesel generator was located at Hafod to provide power to the valley. As a consequence, this early survey noise data set was not used for assessing the sound environment at the measurement location.

12.5.28 It was also noted that the Glass Blobbery also undertook activities during the early morning and daytime periods such that this also influenced the sound environment. Where these periods have been identified within the data set, they have also been excluded. They generally occurred during the working week but could start as early as 05:20 in the morning.

12.5.29 The neighbouring Mynydd Brombil Wind Farm is located to the south-west from this property at a distance around 1400 m from the measurement location. During site visits, to maintain the sound level meter, it was noted that the wind turbines could be audible during downwind conditions and that some aerodynamic sound was detectable. Rated power operational noise levels associated with this wind farm are calculated to be around 34 dB LA90.

12.5.30 The noise monitoring equipment (HMP52) was placed in a grassed area to the north of the main dwellings. The microphone was placed 20 m from the building located to the south and 30 m from the dwelling house to the west. A rain gauge was installed at this location.

12.5.31 Noise sources noted during installation and removal of the equipment included diesel generator sound, dogs, distant M4 traffic noise, faint wind turbine swish sounds, tonal sound character which was not related to the wind turbines (since it was audible when the turbines were parked) which was assumed to be associated with Port Talbot Steel Works, churning sounds from glass blubbery, local traffic accessing Hafod Farm and neighbouring dwellings, radio, bird song, and occasional aircraft both high and low. It was also apparent that during some nights reversing alarms were clearly audible which was associated with increased levels of general noise. Whilst it was beyond this survey to determine the likely cause of these effects it is suspected that the influence of the sea upon the temperature profile resulted in temperature inversions which resulted in significant increases in sound associated with the steel works being audible at the measurement location. Such occurrences, where they can be identified, have not been removed from the data set.

NML09: Llest Wen Farm: SS 84279 89022

12.5.32 This dwelling is located to the east of the southern section of the proposed development.

12.5.33 The noise monitoring equipment (HMP48) was placed in the garden to the south of the property in a free-field location. The location is a working farm with the main sheds located further to the north, however, the location would experience passing vehicles accessing the property and the sheds. The location was 10 m from the southern façade of the property on a downward south facing slope from the house. A rain gauge was installed at this location.

12.5.34 Noise sources noted during installation and removal of the equipment included rain, birdsong, wind in the trees and foliage, farm dogs, very distant traffic, and some stream noise from a water course located 70 m to the west.

NML10: Maesteg Community Hospital: SS 84529 91630

12.5.35 This location was selected to allow determination of the sound environment in the vicinity of the Maesteg Community Hospital. The hospital was undergoing a refurbishment at the time of the noise survey with no overnight stays. The measurement location was selected towards the eastern end of the hospital site to minimise the influence of traffic traversing along the B4282 and Heol Ty Gwyn. The location is positioned between the northern and southern sections of the proposed development.

- 12.5.36 The noise monitoring equipment (HMP56) was placed in a free-field location. The meter was around 14.5 m from the eastern façade. Reviewing the noise data indicates the presence of a continuous noise source, which was not identifiable. It was noted that the main boiler house for the hospital was located around 23.5 m to the north-west from the location. Audio recordings do not indicate whether this was the source or if activity further to the north-east, associated with the industrial estate was the cause, i.e., no clear source has been identified for this sound. It was noted that for two short periods in the early morning this source stopped, and noise levels fell by around 3 – 4 dB L_{A90}. It is assumed that the sound levels collected are indicative of the sound levels normally experienced at this location, i.e., that the unidentified noise source operates at all times, 24/7. It should also be noted that trees surrounded the site and that the microphone location was beneath trees although the sheltered nature of the measurement location minimise wind effects upon leaves.
- 12.5.37 Noise sources noted during installation and removal of the equipment included rain, birdsong, wind in the trees and foliage, traffic along neighbouring roads and to the industrial estate, whining sounds from a northerly direction which was mechanical in origin, and staff passing the location on foot and in vehicles.

Instrumentation

- 12.5.38 The background/baseline noise measurements were undertaken using RION model NL52 Sound Level Meters fitted with 1/2" microphones which comply with the Class 1 standard in IEC 61672-1:2002. The microphones were fitted with 45 mm radius foam ball windshields surrounded by 125 mm radius secondary windshields of 40 mm thickness, based on recommended design specifications within ETSU W/13/00386/REP, Noise Measurements in Windy Conditions, and mounted on tripods at a height of approximately 1.2 m to 1.5 m height. Pre-calibration and post calibration checks were carried out using Brüel & Kjær 4231 Acoustic Calibrator (s/n 3025352).
- 12.5.39 Concurrent onsite wind data was obtained from a free-standing 90 m mast installed within the southern section of the proposed development with wind speeds collected at 60, 75, 90 metres above local ground level.
- 12.5.40 Pluvimate rain gauges were installed at Hafod Farm and Lluest Wen Farm for the entire survey period to provide an indication of when it rained at all monitoring locations.

Measurement Procedure

- 12.5.41 The Sound Level Meters (SLM) were programmed to measure a number of statistical noise indices, including the L_{A90}, together with the maximum and minimum levels and the L_{Aeq} over consecutive 10-minute intervals. The equipment was synchronised to a Global Positioning System (GPS) time signal and the results were automatically stored at the end of each interval.
- 12.5.42 Calibration of the noise measurement equipment was carried out before the monitoring commenced and was checked during any service visits and at the end for each SLM. No SLM experienced a change of more than 0.5 dB which is within normal tolerances and indicates that the data collected is suitable for determination of the baseline sound levels.
- 12.5.43 Wind shear has been addressed by relating background noise measurements to 175 m height wind speed (i.e., the maximum possible hub height of the prospective turbine models for installation), determined from the wind speed measured at 60 m and 90 m height above ground level, and based on instantaneous wind shear exponent, α, for each period, as derived from the expression:

$$V_2/V_1 = [h_2/h_1]^\alpha$$

where,

h₁ and h₂ are the respective heights at which wind speeds V₁ and V₂ were measured.

- 12.5.44 This derived hub height wind speed has been corrected to 'standardised' 10 m height wind speed using the same methodology as is used by manufacturers to quantify sound power level data as required by IEC 61400-11 (IEC, 2012) and as detailed within the GPG, i.e.:

$$V_{10} = V_h [\ln(10/z_0) / \ln(h_h/z_0)]$$

- 12.5.45 Where, V₁₀ and V_h are the 'standardised' 10 m height and hub height (h_h) wind speeds respectively, and z₀ is the reference ground roughness length (z₀ = 0.05 m). In this way, it is ensured that the comparisons of predicted turbine noise level, background level and the corresponding noise limits are made on a like-for-like basis. The IOA GPG would suggest that the upper wind speed measurement height should be 60% of the hub height (i.e., 99 m agl). However, hub heights vary across the site ranging from 120 m - 164 m and for the lower hub heights the upper measurement height qualifies. It is considered that the measurement of wind speeds at 90 m is sufficient for the purpose of determining the prevailing sound levels at neighbouring noise sensitive receptors.
- 12.5.46 Rainfall data was taken from the two installed rain gauges, which both logged rainfall in 10-minute intervals, time synchronised to a GPS time signal. This allows for corresponding data, where noise levels may be affected by the presence of rainfall, to be removed from the analysis.

Survey Results

- 12.5.47 The noise, wind and rain data collected during the measurement campaign have been analysed in accordance with the requirements of ETSU-R-97, as refined by the GPG. The time-history charts of time-aligned noise, wind, and rainfall for each measurement location can be supplied on request.
- 12.5.48 Prevailing background noise levels during the night-time and quiet daytime hours have been derived by plotting the measured L_{A90} background noise levels against the standardised 10 m height wind speeds as described within ETSU-R-97 and the GPG and shown within Appendix 12.3 for the quiet daytime (referred to as 'amenity' on the charts) and night-time periods defined within ETSU-R-97. All data has been referenced to local time.
- 12.5.49 Any 10-minute period where rainfall was recorded at either of the rain measurement locations have been removed from the derivation of the prevailing background noise levels from the data collected at all the noise measurement locations.
- 12.5.50 Data collected between hours of 05:00 & 07:00 at some locations has been removed from the analysis as this represents times where dawn chorus and/or traffic that can influence the results during the night-time. Where no clear increase in background level has been discerned due to bird song or traffic then this data has not been removed.
- 12.5.51 Best fit lines have been calculated through the respective night-time and daytime background noise data for each time period to give the prevailing background noise levels over a range of wind speeds at each measurement location. Table 12.1 and 12.2 show these in tabular form for the amenity and night-time hours respectively.

Table 12.1: Prevailing Quiet Daytime Background Noise Level, dB L_{A90}

	Standardised 10 metre Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
NML 01	25.4	26.2	27.2	28.4	29.8	31.2	32.8	34.4	35.9	37.4	38.8	40.1
NML 02	18.1	21.3	23.9	26.0	27.8	29.2	30.5	31.7	33.1	34.6	36.4	38.6
NML 03	28.7	28.7	28.9	29.3	30.0	30.9	31.9	32.9	33.9	34.8	35.5	35.9
NML 04	27.6	27.6	27.6	28.1	29.0	30.3	31.9	33.6	35.4	37.2	38.8	40.2
NML 05	28.4	28.4	29.0	30.0	31.4	33.0	34.7	36.4	37.9	39.2	40.1	40.5
NML 06	26.8	27.2	27.7	28.1	28.6	29.0	29.4	29.9	30.3	30.7	31.2	31.6

	Standardised 10 metre Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
NML 07	30.4	30.5	30.8	31.4	32.1	33.0	33.9	34.7	35.5	36.2	36.6	36.7
NML 08	25.9	26.8	27.3	27.8	28.6	30.2	32.3	35.1	38.1	41.0	43.1	43.7
NML 09	25.3	25.4	25.9	26.7	27.7	28.9	30.3	31.6	32.9	34.1	35.2	35.9
NML 10	38.1	38.1	38.2	38.2	38.2	38.2	38.2	38.2	38.3	38.3	38.3	38.3
Average	26.3	26.9	27.6	28.4	29.4	30.6	32.0	33.4	34.8	36.1	37.3	38.1

Source: Hayes McKenzie

Table 12.2: Prevailing Night-Time Background Noise Level, dB LA90

	Standardised 10 Metre Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
NML 01	25.1	25.6	26.3	27.2	28.2	29.4	30.6	31.9	33.2	34.5	35.7	36.9
NML 02	16.3	17.6	19.0	20.6	22.2	24.0	25.8	27.6	29.5	31.4	33.2	35.1
NML 03	22.5	22.5	22.5	22.5	22.6	23.9	26.3	29.4	32.5	34.7	34.8	34.8
NML 04	24.6	26.1	26.7	26.8	26.8	27.1	27.8	29.0	30.7	32.8	35.1	37.2
NML 05	20.7	20.7	21.2	22.3	23.9	26.0	28.2	30.6	32.9	35.0	36.8	38.0
NML 06	20.4	21.0	21.5	22.0	22.6	23.1	23.6	24.2	24.7	25.2	25.8	26.3
NML 07	19.7	19.7	20.4	21.6	23.2	25.1	27.0	28.8	30.5	31.8	32.6	32.7
NML 08	26.6	27.2	27.3	27.3	27.3	27.8	29.1	31.2	34.6	39.4	39.4	39.4
NML 09	23.0	23.0	23.1	23.6	24.5	25.7	27.1	28.6	30.2	31.8	33.2	34.5
NML 10	32.1	32.4	32.6	32.9	33.1	33.4	33.6	33.8	34.1	34.3	34.6	34.8
Average	22.1	22.6	23.1	23.8	24.6	25.8	27.3	29.0	31.0	33.0	34.1	35.0

Source: Hayes McKenzie

12.5.52 The average level has been determined from the measurements undertaken for NML01 – 09 inclusive. This average background sound level has been adopted for assessment for locations at which representative noise measurements were not available as part of this, or other noise assessments for neighbouring wind farm development, as it represents the levels likely to be found at receptors neighbouring the proposed development. NML10 has not been included in this average since this represents the sound environment in and around the vicinity of the community hospital with associated plant in operation during the night-time periods.

12.5.53 Review of the data collected for NML08 indicates that there is the potential for the Mynydd Brombil Wind Farm to have affected the data collected. It was noted, for example, that during some quieter periods of the night-time there were increases in background noise levels. However, investigations of these periods through listening to audio recordings made as part of the measurements indicates that this appears to be associated with Port Talbot and the M4 rather than operation of the Mynydd Brombil Wind Farm. Just audible reversing alarms were recorded during the early morning (00:00 – 01:30) when levels were around 35 dB LA90 during low wind speed conditions, i.e., when Mynydd Brombil Wind Farm would not be operating or would result in sound levels below 25 dB LA90. It is presumed that this relates to activities towards Port Talbot. Whether this is as a consequence of noisy activity, or a localised effect associated with propagation of sound caused by the presence of the sea towards the west and thereby the development of an inversion layer (and hence increased noise levels from source located further away) is unclear and beyond the necessary scope of the noise survey undertaken. As such, it is considered that the background noise levels that have been collected for this location do not require additional analysis to account for the potential influence of Mynydd Brombil Wind Farm.

12.5.54 When assessing the potential cumulative noise levels, it is also necessary to consider the potential impacts associated with additional properties to the north and north-east of the proposed development. Foel Trawsnant Wind Farm is a consented wind farm which is located along the northern Y Bryn site boundary. The noise impact assessment carried out for the proposed development presented measured background noise levels for additional receptor locations which have been used as part of the assessment carried out here as presented.

Table 12.3: Foel Trawsnant Wind Farm: Prevailing Quiet Daytime Background Noise Level dB LA90

	Standardised 10 Metre Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
M1		34.1	34.6	35.1	35.6	36.0	36.4	36.7	37.1	37.3	37.6	37.8
M2/M2a		31.2	31.4	31.6	31.8	32.2	32.9	33.8	34.9	36.3	37.9	39.8
M3		33.7	34.0	34.3	34.6	35.1	35.7	36.4	37.2	38.2	39.3	40.5
M4		30.5	31.0	31.5	32.0	32.6	33.6	34.8	36.2	37.9	39.9	42.1
M5		47.5	48.1	48.7	49.3	50.0	50.9	51.7	52.6	53.4	54.1	54.7

Table 12.4: Foel Trawsnant Wind Farm: Prevailing Night-Time Background Noise Level dB LA90

	Standardised 10 Metre Height Wind Speed (m/s)											
	1	2	3	4	5	6	7	8	9	10	11	12
M1		29.6	29.9	30.2	30.5	31.1	31.9	32.9	34.2	35.7	37.5	39.5
M2/M2a		26.1	26.1	26.1	26.1	26.8	28.0	29.5	31.4	33.5	35.7	38.0
M3		33.2	33.5	33.8	34.1	34.6	35.3	36.1	37.1	38.2	39.5	41.0
M4		28.8	29.5	30.2	30.9	31.8	32.9	34.3	36.0	37.9	40.0	42.4
M5		48.4	48.7	49.0	49.3	49.8	50.4	51.2	52.3	53.8	55.7	58.0

12.5.55 The location of the measurement positions are set out in Table 12.5.

Table 12.5: Foel Trawsnant Wind Farm: Measurement Locations

Receptor	Name	Easting	Northing
M1	Tonnau Defaid	284994	193593
M2	Sunnyview	285335	194643
M2a*	Hartshorn Terrace	285309	194709
M3	Hendre Owen Farm	283572	195578
M4	Ty'n-y Pant Farm	282502	195048
M5	Nant-yr-hwyaid Farm	282847	195123

*Equipment moved part way through survey

12.5.56 When assessing cumulative impacts with locations to the south of the proposed development, reference has been made to the background noise levels which have been reported within the Noise Impact Assessment

undertaken for Mynydd Brombil Wind Farm²². Measurements were undertaken at five noise sensitive receptor locations near to Mynydd Brombil Wind Farm.

12.5.57 Tables 12.6 and 12.7 detail the reported background sound levels obtained for the 5 locations and Table 12.8 details the locations of the measurements.

Table 12.6: Mynydd Brombil Wind Farm: Prevailing Quiet Daytime Background Noise Level dB LA90

	Standardised 10 Metre Height Wind Speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
16 Glan y Mor Avenue	46.2	47.2	48.1	48.9	49.7	50.3	50.9	51.3	51.7	51.8	51.9
18 Pellau Road	47.9	50.5	52.1	53.1	53.4	53.3	53.0	52.6	52.3	52.3	52.7
Goytre Farm	40.7	40.7	40.7	40.7	40.7	40.9	41.3	42.0	42.6	43.2	43.5
Llety Piod	44.1	44.1	44.1	44.1	44.0	44.3	44.9	45.6	46.2	46.6	46.6
Tyla Farm	46.8	47.7	48.4	49.0	49.5	49.8	50.0	50.2	50.2	50.1	50.0

Table 12.7: Mynydd Brombil Wind Farm: Prevailing Night-Time Background Noise Level dB LA90

	Standardised 10 Metre Height Wind Speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
16 Glan y Mor Avenue	47.0	47.0	47.0	47.2	47.9	48.8	49.8	50.7	51.5	51.8	51.6
18 Pellau Road	45.9	45.9	45.9	46.1	46.7	47.6	48.6	49.7	50.6	51.2	51.4
Goytre Farm	39.4	39.4	39.4	39.4	39.4	39.6	40.0	40.6	41.5	42.7	44.1
Llety Piod	40.8	40.8	40.8	40.8	40.7	41.1	42.0	43.4	45.2	47.5	50.3
Tyla Farm	45.7	46.2	46.5	46.7	46.9	47.1	47.5	48.0	48.8	50.0	51.6

Table 12.8: Mynydd Brobil Wind Farm: Measurement Locations

Receptor	Easting	Northing
16 Glan y Mor Avenue	278042	187893
18 Pellau Road	278257	188110
Goytre Farm	278859	189692
Llety Piod	278412	189336
Tyla Farm	279186	187643

12.5.58 All wind speeds presented in Tables 12.3, 12.4, 12.6 and 12.7 have been standardised to a height of 10 m above ground level. Wind speed measurements undertaken for Foel Trawsnant Wind Farm were performed using a remote sensing device. It is assumed that the wind speed measured at the hub height of the wind turbines has been adopted, i.e., a hub height of 100 m for the candidate wind turbine (although this is not stated within the Foel Trawsnant Wind Farm Noise Impact Assessment). Direct measurements of wind speeds at this height will minimise errors associated with wind shear and therefore it is considered appropriate to adopt the measured levels for the purpose of assessing operational noise levels at receptors identified within the Foel Trawsnant Wind Farm. Mynydd Brombil Wind Farm wind speed measurements were undertaken using a remote

sensing device with direct measurement of wind speed at a height of 60 m above ground level. The sound levels collected for Mynydd Brombil indicate a noisy sound climate which changes little with wind speed, i.e., the sound environment is determined by sources not associated with wind, and therefore the sound levels collected are representative for the purpose of assessing cumulative noise impacts associated with the proposed development.

12.6 PREDICTION OF WIND TURBINE NOISE

12.6.1 Noise predictions have been carried out using International Standard ISO 9613, Acoustics - Attenuation of Sound During Propagation Outdoors. The propagation model described in Part 2 of this standard²³ provides for the prediction of sound pressure levels based on either short-term downwind (i.e., worst case) conditions or long-term overall averages. In this case only the former has been considered except where otherwise indicated.

12.6.2 The ISO propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

$$\text{Predicted Octave Band Noise Level} = L_W + D - A_{\text{geo}} - A_{\text{atm}} - A_{\text{gr}} - A_{\text{bar}} - A_{\text{misc}}$$

12.6.3 These factors are discussed in detail below. The predicted octave band levels are summed together to give the overall 'A' weighted predicted sound level.

12.6.4 The turbine co-ordinates used for the assessment are shown in Table 12.9.

Table 12.9: Y Bryn Wind Farm Wind Turbine Grid Locations for Predictions

Turbine	Rated SWL + 2 dB	Easting	Northing	Hub Height: m
T1	109.2	282978	193397	120
T2	109.2	283552	193600	120
T3	109.2	282921	192990	120
T4	109.2	283805	193313	120
T5	109.2	283594	192814	120
T6	109.2	282453	190558	144
T7	109.2	281978	190586	144
T8	109.2	282300	189991	164
T9	109.2	282490	189646	164
T10	109.2	282783	189343	164
T11	109.2	283107	188997	120
T12	109.2	280945	189877	120
T13	109.2	281299	189545	164
T14	109.2	281770	189376	120
T15	109.2	282166	189165	120
T16	109.2	282459	188852	120
T17	109.2	280888	189123	120
T18	109.2	281227	188966	120

²² Neath Port Talbot Council - Planning Documents - P2012/0638 - Vol 1 Chapter 09 (Noise).

²³ International Organization for Standardization (1996). ISO 9613-2, Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation. ISO.

L_w - Source Sound Power Level

- 12.6.5 The sound power level of a noise source is normally expressed in dB re:1pW. Noise predictions for the proposed Y Bryn turbines are based on the sound power levels for the Nordex N163 5.7 STE turbine with a hub-heights between 120 – 164 m and with serrated trailing edges (STEs) installed on the blades, as provided by the turbine manufacturer.
- 12.6.6 The sound power levels for the turbine model are taken from specification documents provided by the manufacturer with 2 dB added to account for uncertainty. As such, the assumed sound power levels are likely to be comparable to a declared sound power level i.e., derived according to the methodology detailed within IEC 61400-14²⁴.
- 12.6.7 The provided source noise data is referenced to wind speeds experienced at the hub-height of the turbine. As a result, the data has been converted to reference standardised 10 m height wind speeds in accordance with procedures defined within IEC-61400-11²⁵.
- 12.6.8 Tables 12.10, 12.11 and 12.12 provide the overall source noise levels used for the noise predictions, including for the uncertainty described above, and taking into account the conversion from hub-height to standardised wind speeds explained above.

Table 12.10: Nordex N163 5.7 STE: HH: 120 m

Standardised Wind Speed: m/s	L _{WA}	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
4	100.1	83.2	89.8	92.7	93.7	94.1	92.3	86.6	77.4
5	104.8	86.1	92.7	96.4	98.5	99.8	97.9	88.3	80.4
6	108.9	90.2	96.8	100.5	102.6	103.9	102.0	92.4	84.5
7	109.2	90.6	97.1	100.8	102.9	104.2	102.4	92.8	84.9
8	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
9	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
10	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
11	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0

Table 12.11: Nordex N163 5.7 STE: HH: 144 m

Standardised Wind Speed: m/s	L _{WA}	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
4.0	100.4	83.6	90.2	93.1	94.1	94.5	92.7	87.0	77.8
5.0	105.3	86.6	93.2	96.9	99.0	100.3	98.4	88.8	80.9
6.0	109.2	90.5	97.1	100.8	102.9	104.2	102.3	92.7	84.8
7.0	109.2	90.6	97.1	100.8	102.9	104.2	102.4	92.8	84.9
8.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
9.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
10.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0

11.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
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Table 12.12 Nordex N163 5.7 STE: HH: 164 m

Standardised Wind Speed: m/s	L _{WA}	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
4.0	100.8	83.9	90.5	93.4	94.4	94.8	93.0	87.3	78.1
5.0	105.7	87.0	93.6	97.3	99.4	100.7	98.8	89.2	81.3
6.0	109.2	90.5	97.1	100.8	102.9	104.2	102.3	92.7	84.8
7.0	109.2	90.6	97.1	100.8	102.9	104.2	102.4	92.8	84.9
8.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
9.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
10.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0
11.0	109.2	90.9	97.1	100.8	103.4	104.1	101.6	94.0	86.0

D - Directivity Factor

- 12.6.9 The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In the case of wind turbines, the sound power level is measured in a downwind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment except as covered by wind direction effects (as discussed below).

A_{geo} - Geometrical Divergence

- 12.6.10 The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in an attenuation depending on distance according to:

$$A_{geo} = 20 \times \log(d) + 11$$

where, d = distance from the turbine

- 12.6.11 A wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

A_{atm} - Atmospheric Absorption

- 12.6.12 The atmospheric absorption accounts for the frequency dependant linear attenuation with distance over the frequency spectrum according to:

$$A_{atm} = d \times \alpha$$

where, α = the atmospheric absorption coefficient for the relevant frequency band.

²⁴ International Electrotechnical Commission (2005). IEC 61400-14, Wind turbines - Part 14: Declaration of apparent sound power level and tonality values. IEC

²⁵ International Electrotechnical Commission (2018 + A1:2018). IEC 61400-11, Wind turbine generator systems – Part 11: Acoustic noise measurement techniques. IEC

- 12.6.13 Published values of ‘α’ from ISO9613 Part 1²⁶ have been used, corresponding to a temperature of 10 °C and a relative humidity of 70%, which give relatively low levels of atmospheric attenuation, as given at Table 12.13. This provides a conservative basis for assessment.

Table 12.13 – Atmospheric Absorption Coefficients

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.0001	0.0004	0.0010	0.0019	0.0037	0.0097	0.0328	0.1170

A_{gr} - Ground Effect

- 12.6.14 Ground effect is the interference of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0 for ‘hard’ ground (includes paving, water, ice, concrete, and any sites with low porosity) and 1 for ‘soft’ ground (includes ground covered by grass, trees or other vegetation). The GPG recommends that the use of G = 0.5 and a receptor height of 4 m are appropriate assumptions for the determination of noise emission levels at receptor locations downwind of wind turbines, provided that an appropriate margin for uncertainty has been included within the source levels for the proposed turbine. Accordingly, predictions provided here are based on G = 0.5 with a receptor height of 4 m.

A_{bar} - Barrier Attenuation

- 12.6.15 The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU²⁷, concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of sight between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of sight. The effect of barrier attenuation, including the effects of increased distance from the turbine to surrounding dwellings as a result of the surrounding topography as compared with a ‘flat-earth’ model, has been included within the prediction model.
- 12.6.16 The potential attenuation of noise due to the topography of the site has been determined through the inclusion of a terrain map within the prediction model. The resultant attenuation due to the topographical barriers has been calculated using VDI 2720 Noise Control by Barriers Outdoors²⁸. The relevant inputs, C₁, C₂ and C₃, account for the proportional attenuation effects associated with line of sight between the source and receiver, the relative path difference, and the presence of any localised reflections near the barrier respectively. These factors have been calibrated, minimising the overall effect of each such that the resultant attenuation due to topography at neighbouring residences is limited to approximately 2 dB where there is clearly no line of sight between a turbine and the receptor, 5 dB in situations where there is a significant topographical barrier between a particular turbine and a receptor and 10 dB in exceptional situations where receptors are located relatively close to particularly large barriers such as tall cliff faces that obstruct any view from the wind farm sight.

²⁶ International Organization for Standardization (1992). ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Method of calculation of the attenuation of sound by atmospheric absorption. ISO.

A_{misc} - Miscellaneous Other Effects

- 12.6.17 ISO 9613 includes effects of propagation through foliage and industrial plants as additional attenuation effects. The attenuation due to foliage has not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

Concave Ground Profile

- 12.6.18 Studies have shown that sound propagation across a valley or ‘concave ground profile’ can result in noise levels which are higher than predicted due to a reduced ground effect and/or the focussing effect of the ground shape. Calculating the precise effect of this phenomenon is particularly difficult. However, a simplified approach to allow for it has been suggested in the GPG. Paragraph 4.3.9 in the GPG states that ‘A further correction of +3 dB (or +1.5 dB if using G=0.0) should be added to the calculated overall A-weighted noise level for propagation “across a valley”, i.e., a concave ground profile, or where the ground falls away significantly, between the turbine and the receiver location. The following criterion of application is recommended:

$$H_m \geq 1.5 \times [\text{abs}(h_s - h_r) / 2] h_m$$

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.

- 12.6.19 The GPG states that ‘care needs to be exercised when evaluating this condition, as small changes in distances and height may trigger (or not) the criterion when the actual situation has not changed significantly’. It is also evident that the criterion may also be triggered in situations where there is more than one valley between a particular source and receiver, where, in reality, the stated causes of the ‘concave ground profile’ effect could not occur.
- 12.6.20 The topography between the proposed turbines and surrounding properties have been considered here by plotting the topography between each proposed turbine and noise sensitive receptor.

Wind Direction Effects

- 12.6.21 Where wind direction effects have been included in the prediction model, a supplementary term has been added to the ISO9613-2 methodology to allow for the effects of wind direction as discussed in the IOA GPG. For any given wind direction, each nearby property is classified as being either downwind, crosswind, or upwind of each of the turbines. If the house is downwind (+/-80°) of the turbine no correction is required to the predicted turbine noise level. If it is crosswind (+/-10°) of the turbine a 2 dB reduction is made to the predicted turbine noise level. If the property is upwind (+/-80°) of the turbine a reduction is made to the predicted turbine noise level due to wind shadow effects according to the methodology described in Wyle Research Report WR 88-19 as referred to in the IOA GPG. Under these conditions, this additional factor increases linearly from zero, at distances up to 5.25 x hub height, to 20 log (f) – 30, at a distance of 15.75 x hub height for flat ground. For hilly terrain this value is halved. Hayes McKenzie have modified the original Wyle methodology to include a term to scale the upwind attenuation according to the cosine of the difference between the wind direction angle and the angle corresponding to completely upwind propagation. The IOA GPG provides examples of how upwind attenuation increases with separation distance, measured in terms of turbine tip height, for flat and complex (hilly) terrain.

²⁷ Department of Trade and Industry (2000). ETSU W/13/00385/REP, A Critical Appraisal of Wind Farm Noise Propagation. ETSU/DTI.

²⁸ Verein Deutscher Ingenieure (1997). VDI 2720, Noise control by barriers outdoors. VDI.

12.7 OPERATIONAL NOISE LEVELS – IN ISOLATION

12.7.1 The assessment of the noise levels associated with the proposed development have been undertaken in accordance with ETSU-R-97 and the GPG (i.e., via the comparison of derived noise limits with predicted operational noise levels at neighbouring dwellings over a range of wind speeds).

Assessment Locations

12.7.2 Table 12.14 shows the co-ordinates of the assessment locations used to represent residential properties, as considered within this chapter, and the corresponding locations from which background noise information is available to represent each. The background noise data used to represent locations where specific information is not available are prescribed on a reasonable basis which is considered to be conservative i.e., using the measurement location corresponding to a location that is considered to have a similar noise environment based on its surroundings.

12.7.3 A location representative of a property that is considered to be financially involved (FI) with a development and an indication of the corresponding background noise assumptions and corresponding limits are also marked accordingly.

12.7.4 Some locations which have been assessed relate to locations at which assessments have been undertaken as part of previous planning applications for neighbouring consented wind farms. The background sound levels collected at these locations have been used for determination of allowable noise levels from Foel Trawsnant and formed part of its consent. Measured levels for locations which are close, i.e., NML04 and R6, show similar levels of background sound.

12.7.5 When considering cumulative sound levels, the collected background sound levels from the Foel Trawsnant Noise Assessment have been adopted for this analysis. These locations are generally located to the north of the northern cluster and subject to levels of operational wind turbine noise from the proposed development of less than 35 dB LA90 at rated power.

12.7.6 Of particular relevance are the locations designated R1 – R9 which form the locations for which the neighbouring consented wind farm Foel Trawsnant have agreed noise limits. The location known as Goytre Farm formed part of the assessment for the neighbouring wind farm Mynydd Brombil and measured sound levels for the Mynydd Brombil Wind Farm have also been used for assessing this location. No significant noisy development has occurred in the vicinity of any of these locations since the sound surveys were undertaken and all have been accepted as providing an indication of the prevailing sound levels to be found at each measurement location when these two wind farms were granted consent.

Table 12.14: Receptor ID, Name, Location and Assumed Background Noise Level Representative Location for Assessment

Location ID	Name	Easting	Northing	Adopted Background Noise Measurement Location
NML01	Highland Heights	283345	190161	NML01
NML02	The Pines	283967	191030	NML02
NML03	Garn Wen	284670	192439	NML03
NML04	Tycanol	282322	194981	NML04
NML05	Bryn - North Side	281914	192389	NML05
NML06	Bryn - Station Terrace	281964	191858	NML06
NML07	Penrhiw Bungalow	280787	191529	NML07
NML08	Hafod	280160	189850	NML08

Location ID	Name	Easting	Northing	Adopted Background Noise Measurement Location
NML09	Lluest-wen	284251	189036	NML09
NML10	Maesteg Community Hospital	284496	191604	NML10
R1	Tonnau Dafydd	284994	193601	M1
R2	Pen-y-lan	284781	193054	M1
R3	Sunnyview	285331	194626	M2
R4	Griffiths Terrace / Teras Griffiths	285213	194602	M2
R5	Hendre Owen Farm (FI FT)	283612	195568	M3
R6	Ty'n-y-pant Farm (FI FT)	282515	195007	M4
R7	Nant yr Hwyaid Farm	282737	195073	M5
R8	Tycanol	282316	194987	M4
R9	Neuadd-wen	283168	195414	M3
Gallt-y-cwm	Gallt-y-cwm	280330	191129	NML07
Naid Yr Carw	Naid Yr Carw	280777	191424	NML07
Goytre Farm	Goytre Farm	278878	189645	Goytre Farm
Cwm Maelwg	Cwm Maelwg	280553	187184	NML08
Crugwyllt-fawr	Crugwyllt-fawr	279815	187074	NML08
Rhiwlas	Rhiwlas	283907	190209	NML01
Cwmcerwyn Farm	Cwmcerwyn Farm	283900	190823	NML02
Cwmcerwyn	Cwmcerwyn Cottages	284016	190596	NML02
Tair Waun Farm	Tair Waun Farm	284349	191642	NML Average
Kings Terrace	Kings Terrace	284867	192908	NML Average
Tudor Estate	Tudor Estate	285230	194118	M2
Heol-y-Gadarn	Heol -y-Gadarn Duffryn	284028	195607	NML04
Cynonville	Cynonville	282618	195180	NML04
Bryn - Village Central	Bryn – Village Central Location	281465	192377	NML Average
Heol Gelli Lenor	Heol Gelli Lenor Maesteg	284692	190359	NML Average
Fire Station	Fire Station Maesteg	285389	193343	NML Average

12.7.7 The use of a NML Average level provides a level which is indicative of the general sound environment within the areas neighbouring the proposed development. This has been determined through consideration of all measurement locations (NML01 – NML09) as discussed at Paragraph 12.5.52 (above). The change in sound levels with increasing wind speed and the lower levels obtained from measurements at each location indicate a similar pattern of sound was experienced for rural properties as found for properties within residential areas. It is considered that this level represents the general sound environment to be found within Maesteg and Bryn during the quiet daytime and night-time hours.

Predicted Operational Noise Levels - Downwind

12.7.8 Predictions of operational noise levels associated with the proposed development acting in isolation have been undertaken for the operating range from 3 m/s to 12 m/s standardised 10 metre height wind speed and are shown in Table 12.15.

12.7.9 The predictions detail the sound pressure levels at each receptor location assuming a worst case of down-wind propagation from all turbines simultaneously. At wind speeds around 7 m/s, the wind turbine rotor reaches its maximum rotation speed and noise levels do not increase above this point. The predicted levels for these conditions are shown on a noise contour plot for wind speeds corresponding to rated power and above at Figure 12.5.2 at Appendix 12.5.

Table 12.15 Predicted Noise Levels for proposed development in Isolation

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	30.8	33.8	38.4	42.2	42.3	42.4	42.4	42.4	42.4	42.4
NML02	25.8	28.7	33.0	36.9	37.0	37.2	37.2	37.2	37.2	37.2
NML03	24.2	26.9	31.3	35.3	35.6	35.7	35.7	35.7	35.7	35.7
NML04	20.3	23.0	27.2	31.2	31.5	31.7	31.7	31.7	31.7	31.7
NML05	27.2	29.9	34.3	38.3	38.5	38.7	38.7	38.7	38.7	38.7
NML06	27.4	30.1	34.5	38.5	38.7	38.8	38.8	38.8	38.8	38.8
NML07	24.8	27.6	31.9	35.8	36.0	36.1	36.1	36.1	36.1	36.1
NML08	29.3	32.0	36.5	40.5	40.8	40.9	40.9	40.9	40.9	40.9
NML09	25.4	28.3	32.7	36.6	36.8	36.9	36.9	36.9	36.9	36.9
NML10	23.8	26.5	30.8	34.8	35.1	35.2	35.2	35.2	35.2	35.2
R1	23.1	25.7	30.0	34.1	34.4	34.6	34.6	34.6	34.6	34.6
R2	25.0	27.6	32.0	36.1	36.4	36.5	36.5	36.5	36.5	36.5
R3	18.7	21.4	25.5	29.6	29.8	30.0	30.0	30.0	30.0	30.0
R4	19.2	21.8	25.9	30.0	30.3	30.5	30.5	30.5	30.5	30.5
R5	18.7	21.3	25.4	29.5	29.8	30.0	30.0	30.0	30.0	30.0
R6	20.7	23.3	27.5	31.6	31.9	32.0	32.0	32.0	32.0	32.0
R7	20.8	23.4	27.6	31.7	32.0	32.1	32.1	32.1	32.1	32.1
R8	20.3	22.9	27.1	31.2	31.5	31.6	31.6	31.6	31.6	31.6
R9	19.4	22.1	26.2	30.3	30.6	30.7	30.7	30.7	30.7	30.7
Gallt-y-cwm	25.3	28.1	32.4	36.4	36.6	36.8	36.8	36.8	36.8	36.8
Naid Yr Carw	24.8	27.6	31.8	35.8	36.0	36.1	36.1	36.1	36.1	36.1
Goytre Farm	21.4	24.1	28.3	32.2	32.4	32.6	32.6	32.6	32.6	32.6
Cwm Maelwg	21.1	23.8	28.0	32.0	32.2	32.4	32.4	32.4	32.4	32.4
Crugwyllt-fawr	19.2	22.0	26.1	30.0	30.2	30.4	30.4	30.4	30.4	30.4
Rhiwlas	27.4	30.4	34.8	38.6	38.7	38.9	38.9	38.9	38.9	38.9
Cwmceryn Farm	25.3	28.2	32.6	36.4	36.6	36.8	36.8	36.8	36.8	36.8
Cwmceryn Cottages	25.8	28.7	33.1	36.9	37.1	37.2	37.2	37.2	37.2	37.2
Tair Waun Farm	24.5	27.2	31.4	35.5	35.7	35.9	35.9	35.9	35.9	35.9
Kings Terrace	24.2	26.8	31.2	35.2	35.5	35.7	35.7	35.7	35.7	35.7
Tudor Estate	20.5	23.1	27.3	31.4	31.7	31.8	31.8	31.8	31.8	31.8
Heol-y-Gadarn Duffryn	18.1	20.8	24.9	28.9	29.2	29.4	29.4	29.4	29.4	29.4
Cynonville	20.0	22.6	26.8	30.9	31.2	31.3	31.3	31.3	31.3	31.3
Bryn – Village Central Location	25.6	28.4	32.6	36.6	36.8	37.0	37.0	37.0	37.0	37.0

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Heol Gelli Lenor Maesteg	23.3	26.2	30.4	34.3	34.5	34.6	34.6	34.6	34.6	34.6
Fire Station Maesteg	22.1	24.7	29.0	33.0	33.3	33.5	33.5	33.5	33.5	33.5

Operational Noise Limits

- 12.7.10 As noted, for daytime, the consultees have suggested use of the ETSU-R-97 upper limit, incorporating a lower limiting value of 40 dB LA90 (see Paragraph 12.2.17). This would be consistent with precedent for projects of similar scale and nature throughout Wales, including Pen y Cymoedd, Brechfa Forest West and Clocaenog, decisions on which all significantly predate the current Net Zero legislative and policy environments.
- 12.7.11 The normal ETSU-R-97 night-time limit incorporates a lower limiting value of 43 dB LA90 (see Paragraph 12.2.18).
- 12.7.12 The discussions with consultees for BCBC and NPTCBC in relation to the night-time noise limit indicated a preference for a reduced lower limiting value of 40 dB LA90 (coupled with a daytime lower limiting value 40 dB LA90) or a night-time lower limiting value of 43 dB LA90 coupled with a daytime lower limiting value of 38 - 39 dB LA90. It should be noted that the night-time noise limit for the neighbouring site of Foel Trawsnant has been consented with limits incorporating a daytime lower limiting value of 35 dB LA9 and night-time lower limiting value of 43 dB LA90. The operational Pen y Cymoedd has limits incorporating a daytime lower limiting value of 40 dB LA90 and a night-time lower limiting value of 43 dB LA90. Therefore, adoption of a night-time noise limit for the proposal which is below this will result in a number of consequences which are beyond the control of the proposal. Acceptance of a night-time lower limiting value of 40 dB LA90 can be achieved by the proposal in isolation with mitigation. However, discussions have centred around control of the total sound associated with all wind farms which may be experienced at a receptor location, i.e., a cumulative noise limit.
- 12.7.13 The consultees suggested cumulative limits will be exceeded since this level has already been exceeded through consents which have been permitted to date, i.e., Foel Trawsnant and Pen y Cymoedd Wind Farms even before the construction and operation of the proposal. It has also been indicated that the consultees would prefer to have a single noise limit for daytime and night-time. The adoption of a cumulative night-time lower limiting value of 40 dB LA90 for night-time operation of the proposal is, however, in conflict with the consents for the existing and consented wind farms.
- 12.7.14 On the basis of the above, the default scenario assessment of the operation of the proposal has adopted a single night-time lower limiting value 43 dB LA90. This maintains the desire for a consistent application of the ETSU-R-97 noise limits to all neighbouring receptors to the proposal and meets the requirements of ETSU-R-97 without a breach of the limit by the existing and consented neighbouring wind farms.
- 12.7.15 The ETSU-R-97 upper daytime and night-time operational noise limits have been derived from the prevailing background noise values presented at Tables 12.1 to 12.4 and Tables 12.6 and 12.7. These are shown for daytime and night-time at Tables 12.16 and 12.17 respectively. An additional Table 12.18 shows the night-time limits derived for a reduced lower limiting value of 40 dB LA90 as proposed by the Councils.

Table 12.16: Derived ETSU-R-97 Upper Daytime Noise Limit

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	40.0	40.0	40.0	40.0	40.0	40.0	40.9	42.4	43.8	45.1
NML02	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	43.6
NML03	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.5	40.9
NML04	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.2	43.8	45.2
NML05	40.0	40.0	40.0	40.0	40.0	41.4	42.9	44.2	45.1	45.5

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML06	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
NML07	40.0	40.0	40.0	40.0	40.0	40.0	40.5	41.2	41.6	41.7
NML08	40.0	40.0	40.0	40.0	40.0	40.1	43.1	46.0	48.1	48.7
NML09	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.2	40.9
NML10	43.2	43.2	43.2	43.2	43.2	43.2	43.3	43.3	43.3	43.3
R1	40.1	40.1	40.6	41.0	41.4	41.7	42.1	42.3	42.6	42.8
R2	40.1	40.1	40.6	41.0	41.4	41.7	42.1	42.3	42.6	42.8
R3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	42.9	44.8
R4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	42.9	44.8
R5	40.0	40.0	40.0	40.0	40.0	40.0	41.2	42.9	44.9	47.1
R6	40.0	40.0	40.0	40.0	40.0	40.0	41.2	42.9	44.9	47.1
R7	53.7	53.7	54.3	55.0	55.9	56.7	57.6	58.4	59.1	59.7
R8	40.0	40.0	40.0	40.0	40.0	40.0	41.2	42.9	44.9	47.1
R9	40.0	40.0	40.0	40.1	40.7	41.4	42.4	43.2	44.3	45.5
Gallt-y-cwm	40.0	40.0	40.0	40.0	40.0	40.0	40.5	41.2	41.6	41.7
Naid Yr Carw	40.0	40.0	40.0	40.0	40.0	40.0	40.5	41.2	41.6	41.7
Goytre Farm	45.7	45.7	45.7	45.9	46.3	47.0	47.7	48.2	48.5	48.5
Cwm Maelwg	40.0	40.0	40.0	40.0	40.0	40.1	43.1	46.0	48.1	48.7
Crugwyllt-fawr	40.0	40.0	40.0	40.0	40.0	40.1	43.1	46.0	48.1	48.7
Rhiwlas	40.0	40.0	40.0	40.0	40.0	40.0	40.9	42.4	43.8	45.1
Cwmceryn Farm	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	43.6
Cwmceryn Cottages	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	43.6
Tair Waun Farm	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.4	43.6
Kings Terrace	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.3	43.1
Tudor Estate	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	42.9	44.8
Heol-y-Gadarn Duffryn	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.2	43.8	45.2
Cynonville	40.0	40.0	40.0	40.0	40.0	40.0	40.4	42.2	43.8	45.2
Bryn – Village Central Location	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.3	43.1
Heol Gelli Lenor Maesteg	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.3	43.1
Fire Station Maesteg	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.1	42.3	43.1

Table 12.17: Derived ETSU-R-97 Night-time Noise Limit

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML02	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML03	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML04	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML05	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML06	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML07	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML08	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.4	44.4	44.4
NML09	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NML10	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R1	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
R2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
R3	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R4	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
R5	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4
R6	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4
R7	54.0	54.0	54.3	54.8	55.4	56.2	57.3	58.8	60.7	63.0
R8	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	47.4
R9	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.2	44.5
Gallt-y-cwm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Naid Yr Carw	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Goytre Farm	44.4	44.4	44.4	44.6	45.0	45.6	46.5	47.7	49.1	50.8
Cwm Maelwg	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.4	44.4
Crugwyllt-fawr	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.4	44.4
Rhiwlas	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Cwmceryn Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Cwmceryn Cottages	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tair Waun Farm	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Kings Terrace	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Tudor Estate	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Heol-y-Gadarn Duffryn	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Cynonville	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Bryn – Village Central Location	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Heol Gelli Lenor Maesteg	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Fire Station Maesteg	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Table 12.18: Derived ETSU-R-97 Night-time Noise Limit with 40 dB LA90 Lower Limiting Value

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	41.9	40.0
NML02	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	40.0
NML03	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
NML04	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	42.2	40.0
NML05	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.8	43.0	40.0
NML06	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
NML07	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
NML08	40.0	40.0	40.0	40.0	40.0	40.0	44.4	44.4	44.4	40.0
NML09	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
NML10	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
R1	40.0	40.0	40.0	40.0	40.0	40.0	40.7	42.5	44.5	40.0
R2	40.0	40.0	40.0	40.0	40.0	40.0	40.7	42.5	44.5	40.0
R3	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	43.0	40.0
R4	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	43.0	40.0
R5	40.0	40.0	40.0	40.0	40.0	41.0	42.9	45.0	47.4	40.0
R6	40.0	40.0	40.0	40.0	40.0	41.0	42.9	45.0	47.4	40.0
R7	54.0	54.3	54.8	55.4	56.2	57.3	58.8	60.7	63.0	54.0
R8	40.0	40.0	40.0	40.0	40.0	41.0	42.9	45.0	47.4	40.0
R9	40.0	40.0	40.0	40.3	41.1	42.1	43.2	44.5	46.0	40.0
Gallt-y-cwm	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Naid Yr Carw	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Goytre Farm	44.4	44.4	44.6	45.0	45.6	46.5	47.7	49.1	50.8	44.4
Cwm Maelwg	40.0	40.0	40.0	40.0	40.0	40.0	44.4	44.4	44.4	40.0
Crugwyllt-fawr	40.0	40.0	40.0	40.0	40.0	40.0	44.4	44.4	44.4	40.0
Rhiwlas	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	41.9	40.0
Cwmcerwyn Farm	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	40.0
Cwmcerwyn Cottages	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	40.0
Tair Waun Farm	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	40.0
Kings Terrace	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Tudor Estate	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	43.0	40.0
Heol-y-Gadarn Duffryn	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	42.2	40.0
Cynonville	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.1	42.2	40.0
Bryn – Village Central Location	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Heol Gelli Lenor Maesteg	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Fire Station Maesteg	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0

12.7.16 It should be noted that Location NML02 - The Pines, Cwmcerwyn Farm and Goytre Farm are all financially involved with the proposed development. As such, ETSU-R-97 would allow for an additional increase of the lower limiting value for both daytime and night-time to 45 dB LA90. However, for the purpose of this assessment, these locations have been treated as non-financially involved properties.

Compliance with ETSU-R-97 Noise Limits

12.7.17 Tables 12.19 and 12.20 detail the extent to which the predicted noise levels meet the ETSU-R-97 derived noise limits for the proposed development acting in isolation. Table 12.21 details the extent to which it would exceed the night-time limit with a lower limiting value of 40 dB LA90. In all cases, a negative value (highlighted red) indicates an exceedance.

Table 12.19: Predicted Compliance with Upper Daytime Noise Limit

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	6.2	1.6	-2.2	-2.3	-2.4	-1.5	0.0	1.4	2.6	6.2
NML02	11.3	7.0	3.1	3.0	2.8	2.8	2.8	4.2	6.4	11.3
NML03	13.1	8.7	4.7	4.4	4.3	4.3	4.3	4.7	5.2	13.1
NML04	17.0	12.8	8.8	8.5	8.3	8.7	10.5	12.1	13.5	17.0
NML05	10.1	5.7	1.7	1.5	2.7	4.3	5.6	6.4	6.8	10.1
NML06	9.9	5.5	1.5	1.3	1.2	1.2	1.2	1.2	1.2	9.9
NML07	12.4	8.1	4.2	4.0	3.9	4.4	5.0	5.4	5.6	12.4
NML08	8.0	3.5	-0.5	-0.8	-0.8	2.2	5.1	7.2	7.8	8.0
NML09	11.7	7.3	3.4	3.2	3.1	3.1	3.1	3.2	4.0	11.7
NML10	16.6	12.4	8.4	8.2	8.0	8.0	8.0	8.1	8.1	16.6
R1	14.4	10.6	6.9	7.0	7.1	7.5	7.7	8.0	8.2	14.4
R2	12.5	8.6	4.9	5.0	5.2	5.6	5.8	6.1	6.3	12.5
R3	18.6	14.5	10.4	10.2	10.0	10.0	11.3	12.9	14.8	18.6
R4	18.2	14.1	10.0	9.7	9.5	9.5	10.8	12.4	14.3	18.2
R5	18.7	14.6	10.5	10.2	10.0	11.2	12.9	14.9	17.1	18.7
R6	16.7	12.5	8.4	8.1	8.0	9.2	10.9	12.9	15.1	16.7
R7	30.3	26.7	23.3	23.9	24.6	25.5	26.3	27.0	27.6	30.3
R8	17.1	12.9	8.8	8.5	8.4	9.6	11.3	13.3	15.5	17.1
R9	17.9	13.8	9.8	10.1	10.7	11.5	12.5	13.6	14.8	17.9
Gallt-y-cwm	11.9	7.6	3.6	3.4	3.2	3.7	4.4	4.8	4.9	11.9
Naid Yr Carw	12.4	8.2	4.2	4.0	3.9	4.4	5.0	5.4	5.6	12.4
Goytre Farm	21.6	17.5	13.6	13.9	14.3	15.0	15.6	15.9	15.9	21.6
Cwm Maelwg	16.2	12.0	8.0	7.8	7.7	10.7	13.6	15.7	16.3	16.2
Crugwyllt-fawr	18.0	13.9	10.0	9.8	9.7	12.7	15.6	17.7	18.3	18.0
Rhiwlas	9.6	5.2	1.4	1.3	1.1	2.0	3.5	4.9	6.2	9.6
Cwmcerwyn Farm	11.8	7.4	3.6	3.4	3.2	3.2	3.2	4.6	6.9	11.8
Cwmcerwyn Cottages	11.3	6.9	3.1	2.9	2.8	2.8	2.8	4.1	6.4	11.3
Tair Waun Farm	12.8	8.6	4.5	4.3	4.1	4.1	4.1	5.5	7.7	12.8

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Kings Terrace	13.2	8.8	4.8	4.5	4.3	4.3	5.5	6.6	7.5	13.2
Tudor Estate	16.9	12.7	8.6	8.3	8.2	8.2	9.5	11.1	13.0	16.9
Heol-y-Gadarn Duffryn	19.2	15.1	11.1	10.8	10.6	11.0	12.8	14.4	15.8	19.2
Cynonville	17.4	13.2	9.1	8.8	8.7	9.1	10.8	12.4	13.8	17.4
Bryn – Village Central Location	11.6	7.4	3.4	3.2	3.0	3.0	4.2	5.3	6.2	11.6
Heol Gelli Lenor Maesteg	13.8	9.6	5.7	5.5	5.4	5.4	6.5	7.7	8.5	13.8
Fire Station Maesteg	15.3	11.0	7.0	6.7	6.5	6.5	7.7	8.8	9.7	15.3

Table 12.20: Predicted Compliance with Night-Time Noise Limit

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	9.2	4.6	0.8	0.7	0.6	0.6	0.6	0.6	0.6	9.2
NML02	14.3	10.0	6.1	6.0	5.8	5.8	5.8	5.8	5.8	14.3
NML03	16.1	11.7	7.7	7.4	7.3	7.3	7.3	7.3	7.3	16.1
NML04	20.0	15.8	11.8	11.5	11.3	11.3	11.3	11.3	11.3	20.0
NML05	13.1	8.7	4.7	4.5	4.3	4.3	4.3	4.3	4.4	13.1
NML06	12.9	8.5	4.5	4.3	4.2	4.2	4.2	4.2	4.2	12.9
NML07	15.4	11.1	7.2	7.0	6.9	6.9	6.9	6.9	6.9	15.4
NML08	11.0	6.5	2.5	2.2	2.1	2.1	3.5	3.5	3.5	11.0
NML09	14.7	10.3	6.4	6.2	6.1	6.1	6.1	6.1	6.1	14.7
NML10	16.5	12.2	8.2	7.9	7.8	7.8	7.8	7.8	7.8	16.5
R1	17.3	13.0	8.9	8.6	8.4	8.4	8.4	8.4	9.9	17.3
R2	15.4	11.0	6.9	6.6	6.5	6.5	6.5	6.5	8.0	15.4
R3	21.6	17.5	13.4	13.2	13.0	13.0	13.0	13.0	13.0	21.6
R4	21.2	17.1	13.0	12.7	12.5	12.5	12.5	12.5	12.5	21.2
R5	21.7	17.6	13.5	13.2	13.0	13.0	13.0	15.0	17.4	21.7
R6	19.7	15.5	11.4	11.1	11.0	11.0	11.0	13.0	15.4	19.7
R7	30.6	26.7	23.1	23.4	24.1	25.2	26.7	28.6	30.9	30.6
R8	20.1	15.9	11.8	11.5	11.4	11.4	11.4	13.4	15.8	20.1
R9	20.9	16.8	12.7	12.4	12.3	12.3	12.5	13.8	15.3	20.9
Gallt-y-cwm	14.9	10.6	6.6	6.4	6.2	6.2	6.2	6.2	6.2	14.9
Naid Yr Carw	15.4	11.2	7.2	7.0	6.9	6.9	6.9	6.9	6.9	15.4
Goytre Farm	20.3	16.1	12.4	12.5	13.0	13.9	15.1	16.5	18.2	20.3
Cwm Maelwg	19.2	15.0	11.0	10.8	10.6	10.6	12.0	12.0	12.0	19.2
Crugwyllt-fawr	21.0	16.9	13.0	12.8	12.6	12.6	14.0	14.0	14.0	21.0
Rhiwlas	12.6	8.2	4.4	4.3	4.1	4.1	4.1	4.1	4.1	12.6
Cwmceryn Farm	14.8	10.4	6.6	6.4	6.2	6.2	6.2	6.2	6.2	14.8
Cwmceryn Cottages	14.3	9.9	6.1	5.9	5.8	5.8	5.8	5.8	5.8	14.3

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Tair Waun Farm	15.8	11.6	7.5	7.3	7.1	7.1	7.1	7.1	7.1	15.8
Kings Terrace	16.2	11.8	7.8	7.5	7.3	7.3	7.3	7.3	7.3	16.2
Tudor Estate	19.9	15.7	11.6	11.3	11.2	11.2	11.2	11.2	11.2	19.9
Heol-y-Gadarn Duffryn	22.2	18.1	14.1	13.8	13.6	13.6	13.6	13.6	13.6	22.2
Cynonville	20.4	16.2	12.1	11.8	11.7	11.7	11.7	11.7	11.7	20.4
Bryn – Village Central Location	14.6	10.4	6.4	6.2	6.0	6.0	6.0	6.0	6.0	14.6
Heol Gelli Lenor Maesteg	16.8	12.6	8.7	8.5	8.4	8.4	8.4	8.4	8.4	16.8
Fire Station Maesteg	18.3	14.0	10.0	9.7	9.5	9.5	9.5	9.5	9.5	18.3

Table 12.21: Predicted Compliance with Night-Time Noise Limit with Reduced Lower Limiting Value of 40 dB LA90

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	6.2	1.6	-2.2	-2.3	-2.4	-2.4	-2.4	-1.7	-0.5	6.2
NML02	11.3	7.0	3.1	3.0	2.8	2.8	2.8	2.8	2.9	11.3
NML03	13.1	8.7	4.7	4.4	4.3	4.3	4.3	4.3	4.3	13.1
NML04	17.0	12.8	8.8	8.5	8.3	8.3	8.3	8.4	10.5	17.0
NML05	10.1	5.7	1.7	1.5	1.3	1.3	1.3	3.1	4.4	10.1
NML06	9.9	5.5	1.5	1.3	1.2	1.2	1.2	1.2	1.2	9.9
NML07	12.4	8.1	4.2	4.0	3.9	3.9	3.9	3.9	3.9	12.4
NML08	8.0	3.5	-0.5	-0.8	-0.9	-0.9	3.5	3.5	3.5	8.0
NML09	11.7	7.3	3.4	3.2	3.1	3.1	3.1	3.1	3.1	11.7
NML10	13.5	9.2	5.2	4.9	4.8	4.8	4.8	4.8	4.8	13.5
R1	14.3	10.0	5.9	5.6	5.4	5.4	6.1	7.9	9.9	14.3
R2	12.4	8.0	3.9	3.6	3.5	3.5	4.2	6.0	8.0	12.4
R3	18.6	14.5	10.4	10.2	10.0	10.0	10.0	10.7	13.0	18.6
R4	18.2	14.1	10.0	9.7	9.5	9.5	9.5	10.2	12.5	18.2
R5	18.7	14.6	10.5	10.2	10.0	11.0	12.9	15.0	17.4	18.7
R6	16.7	12.5	8.4	8.1	8.0	9.0	10.9	13.0	15.4	16.7
R7	30.6	26.7	23.1	23.4	24.1	25.2	26.7	28.6	30.9	30.6
R8	17.1	12.9	8.8	8.5	8.4	9.4	11.3	13.4	15.8	17.1
R9	17.9	13.8	9.7	9.7	10.4	11.4	12.5	13.8	15.3	17.9
Gallt-y-cwm	11.9	7.6	3.6	3.4	3.2	3.2	3.2	3.2	3.2	11.9
Naid Yr Carw	12.4	8.2	4.2	4.0	3.9	3.9	3.9	3.9	3.9	12.4
Goytre Farm	20.3	16.1	12.4	12.5	13.0	13.9	15.1	16.5	18.2	20.3
Cwm Maelwg	16.2	12.0	8.0	7.8	7.6	7.6	12.0	12.0	12.0	16.2
Crugwyllt-fawr	18.0	13.9	10.0	9.8	9.6	9.6	14.0	14.0	14.0	18.0
Rhiwlas	9.6	5.2	1.4	1.3	1.1	1.1	1.1	1.8	3.0	9.6

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Cwmcerwyn Farm	11.8	7.4	3.6	3.4	3.2	3.2	3.2	3.2	3.3	11.8
Cwmcerwyn Cottages	11.3	6.9	3.1	2.9	2.8	2.8	2.8	2.8	2.8	11.3
Tair Waun Farm	12.8	8.6	4.5	4.3	4.1	4.1	4.1	4.1	4.2	12.8
Kings Terrace	13.2	8.8	4.8	4.5	4.3	4.3	4.3	4.3	4.3	13.2
Tudor Estate	16.9	12.7	8.6	8.3	8.2	8.2	8.2	8.9	11.2	16.9
Heol-y-Gadarn Duffryn	19.2	15.1	11.1	10.8	10.6	10.6	10.6	10.7	12.8	19.2
Cynonville	17.4	13.2	9.1	8.8	8.7	8.7	8.7	8.8	10.8	17.4
Bryn – Village Central Location	11.6	7.4	3.4	3.2	3.0	3.0	3.0	3.0	3.0	11.6
Heol Gelli Lenor Maesteg	13.8	9.6	5.7	5.5	5.4	5.4	5.4	5.4	5.4	13.8
Fire Station Maesteg	15.3	11.0	7.0	6.7	6.5	6.5	6.5	6.5	6.5	15.3

12.7.18 The analysis above shows that without operational mitigation for the candidate turbine model the predicted noise level for the proposed development in isolation meets the night-time noise limits at all neighbouring receptor locations but that the upper daytime limit, and night-time limit with reduced lower limiting value, is exceeded at only the closest location to the east and west of the southern turbine cluster; NML01 and NML08.

12.8 CUMULATIVE NOISE LEVEL ASSESSMENT

12.8.1 A cumulative noise assessment of the existing and consented wind farms with the addition of the proposed development has been undertaken as follows.

Foel Trawsnant Wind Farm

12.8.2 The recently consented Foel Trawsnant Wind Farm based its noise impact assessment on a Nordex N90/2500 Wind Turbine with a hub height of 100 metres. The locations and source noise levels are as set out in Tables 12.4.1 and 12.4.2 at Appendix 12.4.

12.8.3 Further to acquiring consent for the Foel Trawsnant Wind Farm, a S.73 application has subsequently been submitted which proposes an increase in the 90 m turbine rotor diameter, previously consented, to 117 and 133 m utilising Nordex N117 and N133 turbines respectively, whilst maintaining the consented tip height. Three turbines have been dropped from the scheme and will not be built. It is suggested within the associated noise impact assessment that mitigation will be required for a number of turbines to achieve the consented noise limits as set out within the original permission. The locations and source noise levels for this revised scheme are as set out in Tables 12.4.3, 12.4.4 & 12.4.5 in Appendix 12.4.

Ffynnon Oer Wind Farm

12.8.1 The operational Ffynnon Oer Wind Farm has installed RePower MM70 wind turbines with a hub height of 68 m above ground level. The locations and source noise levels are as set out in Tables 12.4.6 and 12.4.7 in Appendix 12.4.

Llynfi Afan Wind Farm

12.8.2 The operational Llynfi Afan Wind Farm has installed Gamesa G80/2000 wind turbines with a hub height of 78 m above ground level. The locations and source noise levels are as set out in Tables 12.4.8 and 12.4.9 in Appendix 12.4.

Mynydd Brombil Wind Farm

12.8.3 The operational Mynydd Brombil Wind Farm has installed Gamesa G80/2000 wind turbines with a hub height of 60 m above ground level. The locations and source noise levels are as set out in Tables 12.4.10 and 12.4.11 in Appendix 12.4.

Pen y Cymoedd Wind Farm

12.8.4 The operational Pen y Cymoedd Wind Farm has been assessed on the basis of a Siemens SWT 108 3 MW and SWT 113 3 MW Wind Turbine I. The locations and source noise levels are as set out in Tables 12.4.12, 12.4.13 and 12.4.14 in Appendix 12.4.

Mynydd Fforch Dwm Wind Farm

12.8.5 Mynydd Fforch Dwm wind farm is a proposal which is at the pre-application scoping stage of the planning process. The proposal is for seven turbines and a candidate Vestas V150 6.0 MW turbine has been assumed for this development with locations and source noise levels as set out in Tables 12.4.15 and 12.4.16 in Appendix 12.4.

Results of Cumulative Assessment

12.8.6 Predictions of cumulative operational noise levels for the proposed development acting in combination with the wind farm developments described above in isolation have been undertaken for the operating range from 3 to 12 m/s standardised 10 metre height wind speed and are shown in Table 12.22. Where noise levels from any site acting individually is predicted to exceed its own noise limits then the noise levels have been capped at that limit. This is only observed for the noise immissions from Foel Trawsnant at R8 during daytime between 6-8 m/s²⁹. Where predicted noise levels from all cumulative sites exceed the ETSU-R-97 cumulative noise limits, the noise from the proposed development is limited to 10 dB below the predicted cumulative noise level.

12.8.7 The predictions detail the sound pressure levels at each receptor location assuming a worst case of down-wind propagation from all turbines simultaneously. The predicted noise levels for a standardised 10 m height wind speed of 10 m/s, for which all turbines have reached their rated power, are shown on a noise contour plot for wind speeds corresponding to rated power and above at Figure 12.5.2 in Appendix 12.5.

12.8.8 Tables 12.23 and 12.24 detail the extent to which the predicted noise levels exceed the ETSU-R-97 derived noise limits for the proposed development, without operational mitigation for the candidate turbine model, acting alongside the other wind farm developments considered as part of this assessment. Table 12.25 details the extent to which such noise levels would exceed the night-time limit with a lower limiting value of 40 dB LA90. In all cases, a negative level difference (highlighted red) indicates an exceedance. For clarity, the consented Foel Trawsnant site has been included here and not the proposal for larger turbines which is considered separately.

Table 12.22: Predicted Cumulative Noise Levels for Downwind Propagation from All Turbines Simultaneously (Foel Trawsnant as Consented)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	31.1	34.2	38.7	42.4	42.6	42.8	42.8	42.8	42.8	42.8
NML02	26.7	29.8	34.0	37.7	38.0	38.3	38.3	38.3	38.3	38.3
NML03	26.9	30.3	34.3	37.8	38.4	38.7	38.7	38.7	38.7	38.7
NML04	29.3	33.2	36.8	40.0	40.9	41.4	41.4	41.4	41.4	41.4

²⁹ The Foel Trawsnant Limits for R3 during the daytime are set at 26.8 dB LA90. It has been assumed that this is an error and should be 36.8 dB LA90.

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML05	28.1	31.1	35.3	39.1	39.5	39.7	39.8	39.8	39.8	39.8
NML06	28.1	31.1	35.3	39.1	39.5	39.7	39.7	39.7	39.7	39.7
NML07	25.9	29.0	33.2	36.8	37.2	37.4	37.4	37.4	37.4	37.5
NML08	30.0	33.2	37.7	41.4	41.6	41.7	41.7	41.7	41.7	41.7
NML09	25.8	28.7	33.1	36.9	37.2	37.3	37.3	37.3	37.3	37.3
NML10	25.4	28.6	32.7	36.4	36.8	37.1	37.1	37.1	37.1	37.1
R1	28.6	32.3	36.1	39.3	40.1	40.5	40.5	40.5	40.5	40.5
R2	29.7	33.4	37.2	40.5	41.3	41.6	41.6	41.7	41.7	41.7
R3	26.5	30.4	34.2	37.3	38.1	38.5	38.6	38.6	38.6	38.6
R4	26.9	30.8	34.6	37.7	38.6	39.0	39.0	39.0	39.0	39.0
R5	28.7	32.6	36.4	39.6	40.6	41.1	41.1	41.1	41.2	41.2
R6	30.7	34.6	38.2	41.3	42.3	42.7	42.8	42.8	42.8	42.8
R7	31.6	35.5	39.1	42.2	43.2	43.7	43.7	43.7	43.7	43.7
R8	29.2	33.1	36.7	39.9	40.8	41.3	41.3	41.3	41.3	41.4
R9	29.4	33.3	36.9	40.1	41.1	41.6	41.6	41.6	41.6	41.6
Gallt-y-cwm	26.1	29.2	33.6	37.3	37.5	37.7	37.7	37.7	37.7	37.7
Naid Yr Carw	25.9	29.1	33.2	36.9	37.2	37.5	37.5	37.5	37.5	37.5
Goytre Farm	26.8	31.1	35.7	38.4	38.6	38.6	38.6	38.6	38.6	38.6
Cwm Maelwg	22.1	25.4	29.7	33.2	33.5	33.6	33.6	33.6	33.6	33.7
Crugwyllt-fawr	21.4	25.1	29.5	32.7	32.9	33.0	33.0	33.0	33.0	33.0
Rhiwlas	27.9	31.0	35.4	39.1	39.3	39.5	39.5	39.5	39.5	39.5
Cwmceryn Farm	26.2	29.3	33.5	37.2	37.5	37.7	37.8	37.8	37.8	37.8
Cwmceryn Cottages	26.4	29.5	33.8	37.5	37.7	37.9	37.9	37.9	37.9	37.9
Tair Waun Farm	26.0	29.2	33.3	37.0	37.4	37.7	37.7	37.7	37.7	37.7
Kings Terrace	28.2	31.7	35.6	39.0	39.7	40.0	40.0	40.0	40.0	40.0
Tudor Estate	26.7	30.6	34.4	37.5	38.3	38.7	38.8	38.8	38.8	38.8
Heol-y-Gadarn Duffryn	27.9	31.8	35.6	38.9	39.9	40.4	40.4	40.5	40.5	40.5
Cynonville	30.1	33.9	37.6	40.7	41.7	42.2	42.2	42.2	42.2	42.2
Bryn – Village Central Location	26.6	29.6	33.8	37.5	37.9	38.1	38.1	38.1	38.1	38.2
Heol Gelli Lenor Maesteg	24.0	27.1	31.3	35.0	35.3	35.5	35.5	35.5	35.5	35.5
Fire Station Maesteg	26.8	30.4	34.3	37.6	38.3	38.6	38.7	38.7	38.7	38.7

Table 12.23: Predicted Cumulative Compliance with Upper Daytime Noise Limit (Foel Trawsnant as Consented)

ID	Standardised 10 Metre Height Wind Speed (m/s)								
	4	5	6	7	8	9	10	11	12
NML01	5.8	1.3	-2.4	-2.6	-2.8	-1.8	-0.3	1.1	2.3
NML02	10.2	6.0	2.3	2.0	1.7	1.7	1.7	3.1	5.3
NML03	9.7	5.7	2.2	1.6	1.3	1.3	1.3	1.8	2.2
NML04	6.8	3.2	0.0	-0.9	-1.4	-1.0	0.8	2.4	3.7
NML05	8.9	4.7	0.9	0.5	1.6	3.2	4.5	5.3	5.7
NML06	8.9	4.7	0.9	0.5	0.3	0.3	0.3	0.3	0.3
NML07	11.0	6.8	3.2	2.8	2.6	3.1	3.7	4.1	4.3
NML08	6.8	2.3	-1.4	-1.6	-1.6	1.4	4.3	6.4	6.9
NML09	11.3	6.9	3.1	2.8	2.7	2.7	2.7	2.8	3.6
NML10	14.6	10.5	6.8	6.4	6.2	6.2	6.2	6.2	6.2
R1	7.8	4.5	1.7	1.3	1.2	1.6	1.8	2.1	2.3
R2	6.7	3.4	0.5	0.1	0.1	0.5	0.6	0.9	1.1
R3	9.6	5.8	2.7	1.9	1.5	1.4	2.7	4.3	6.2
R4	9.2	5.4	2.3	1.4	1.0	1.0	2.3	3.9	5.8
R5	7.4	3.6	0.4	-0.6	-1.1	0.1	1.8	3.7	5.9
R6	5.4	1.8	-1.3	-2.3	-2.7	-1.6	0.1	2.1	4.3
R7	18.2	15.2	12.8	12.7	13.0	13.9	14.7	15.4	16.0
R8	6.9	3.3	0.1	-0.8	-1.3	-0.1	1.6	3.6	5.7
R9	6.7	3.1	0.0	-0.4	-0.2	0.6	1.6	2.7	3.9
Gallt-y-cwm	10.8	6.4	2.7	2.5	2.3	2.8	3.4	3.9	4.0
Naid Yr Carw	10.9	6.8	3.1	2.8	2.5	3.0	3.7	4.1	4.2
Goytre Farm	14.6	10.0	7.5	7.8	8.3	9.0	9.6	9.9	9.9
Cwm Maelwg	14.6	10.3	6.8	6.5	6.5	9.5	12.3	14.4	15.0
Crugwyllt-fawr	14.9	10.5	7.3	7.1	7.1	10.1	13.0	15.1	15.6
Rhiwlas	9.0	4.6	0.9	0.7	0.5	1.4	2.9	4.3	5.6
Cwmceryn Farm	10.7	6.5	2.8	2.5	2.3	2.2	2.2	3.6	5.8
Cwmceryn Cottages	10.5	6.2	2.5	2.3	2.1	2.1	2.1	3.5	5.7
Tair Waun Farm	10.8	6.7	3.0	2.6	2.3	2.3	2.3	3.7	5.9
Kings Terrace	8.3	4.4	1.0	0.3	0.0	0.0	1.1	2.2	3.1
Tudor Estate	9.4	5.6	2.5	1.7	1.3	1.2	2.5	4.1	6.0
Heol-y-Gadarn Duffryn	8.2	4.4	1.1	0.1	-0.4	0.0	1.7	3.3	4.7
Cynonville	6.1	2.4	-0.7	-1.7	-2.2	-1.8	0.0	1.6	2.9
Bryn – Village Central Location	10.4	6.2	2.5	2.1	1.9	1.9	3.0	4.1	5.0
Heol Gelli Lenor Maesteg	12.9	8.7	5.0	4.7	4.5	4.5	5.6	6.7	7.6
Fire Station Maesteg	9.6	5.7	2.4	1.7	1.4	1.3	2.5	3.6	4.4

Table 12.24: Predicted Cumulative Compliance with Night-Time Noise Limit (Foel Trawsnant as Consented)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
NML01	8.8	4.3	0.6	0.4	0.2	0.2	0.2	0.2	0.2	
NML02	13.2	9.0	5.3	5.0	4.7	4.7	4.7	4.7	4.7	
NML03	12.7	8.7	5.2	4.6	4.3	4.3	4.3	4.3	4.3	
NML04	9.8	6.2	3.0	2.1	1.6	1.6	1.6	1.6	1.6	
NML05	11.9	7.7	3.9	3.5	3.3	3.2	3.2	3.2	3.3	
NML06	11.9	7.7	3.9	3.5	3.3	3.3	3.3	3.3	3.3	
NML07	14.0	9.8	6.2	5.8	5.6	5.6	5.6	5.6	5.5	
NML08	9.8	5.3	1.6	1.4	1.3	1.3	2.7	2.7	2.7	
NML09	14.3	9.9	6.1	5.8	5.7	5.7	5.7	5.7	5.7	
NML10	14.4	10.3	6.6	6.2	5.9	5.9	5.9	5.9	5.9	
R1	10.7	6.9	3.7	2.9	2.5	2.5	2.5	2.5	4.0	
R2	9.6	5.8	2.5	1.7	1.4	1.4	1.3	1.3	2.8	
R3	12.6	8.8	5.7	4.9	4.5	4.4	4.4	4.4	4.4	
R4	12.2	8.4	5.3	4.4	4.0	4.0	4.0	4.0	4.0	
R5	10.4	6.6	3.4	2.4	1.9	1.9	1.9	3.8	6.2	
R6	8.4	4.8	1.7	0.7	0.3	0.2	0.2	2.2	4.6	
R7	18.5	15.2	12.6	12.2	12.5	13.6	15.1	17.0	19.3	
R8	9.9	6.3	3.1	2.2	1.7	1.7	1.7	3.7	6.0	
R9	9.7	6.1	2.9	1.9	1.4	1.4	1.6	2.9	4.4	
Gallt-y-cwm	13.8	9.4	5.7	5.5	5.3	5.3	5.3	5.3	5.3	
Naid Yr Carw	13.9	9.8	6.1	5.8	5.5	5.5	5.5	5.5	5.5	
Goytre Farm	13.3	8.7	6.2	6.4	7.0	7.9	9.1	10.5	12.2	
Cwm Maelwg	17.6	13.3	9.8	9.5	9.4	9.4	10.8	10.8	10.8	
Crugwyllt-fawr	17.9	13.5	10.3	10.1	10.0	10.0	11.4	11.4	11.4	
Rhiwlas	12.0	7.6	3.9	3.7	3.5	3.5	3.5	3.5	3.5	
Cwmceryn Farm	13.7	9.5	5.8	5.5	5.3	5.2	5.2	5.2	5.2	
Cwmceryn Cottages	13.5	9.2	5.5	5.3	5.1	5.1	5.1	5.1	5.1	
Tair Waun Farm	13.8	9.7	6.0	5.6	5.3	5.3	5.3	5.3	5.3	
Kings Terrace	11.3	7.4	4.0	3.3	3.0	3.0	3.0	3.0	3.0	
Tudor Estate	12.4	8.6	5.5	4.7	4.3	4.2	4.2	4.2	4.2	
Heol-y-Gadarn Duffryn	11.2	7.4	4.1	3.1	2.6	2.6	2.5	2.5	2.5	
Cynonville	9.1	5.4	2.3	1.3	0.8	0.8	0.8	0.8	0.8	
Bryn – Village Central Location	13.4	9.2	5.5	5.1	4.9	4.9	4.9	4.9	4.8	
Heol Gelli Lenor Maesteg	15.9	11.7	8.0	7.7	7.5	7.5	7.5	7.5	7.5	
Fire Station Maesteg	12.6	8.7	5.4	4.7	4.4	4.3	4.3	4.3	4.3	

Table 12.25: Predicted Cumulative Compliance with Night-Time Noise Limit with Reduced Lower Limiting Value of 40 dB LA90 (Foel Trawsnant as Consented)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
NML01	5.8	1.3	-2.4	-2.6	-2.8	-2.8	-2.8	-2.0	-0.9	
NML02	10.2	6.0	2.3	2.0	1.7	1.7	1.7	1.7	1.8	
NML03	9.7	5.7	2.2	1.6	1.3	1.3	1.3	1.3	1.3	
NML04	6.8	3.2	0.0	-0.9	-1.4	-1.4	-1.4	-1.3	0.7	
NML05	8.9	4.7	0.9	0.5	0.3	0.2	0.2	2.0	3.3	
NML06	8.9	4.7	0.9	0.5	0.3	0.3	0.3	0.3	0.3	
NML07	11.0	6.8	3.2	2.8	2.6	2.6	2.6	2.6	2.5	
NML08	6.8	2.3	-1.4	-1.6	-1.7	-1.7	2.7	2.7	2.7	
NML09	11.3	6.9	3.1	2.8	2.7	2.7	2.7	2.7	2.7	
NML10	11.4	7.3	3.6	3.2	2.9	2.9	2.9	2.9	2.9	
R1	7.7	3.9	0.7	-0.1	-0.5	-0.5	0.2	2.0	4.0	
R2	6.6	2.8	-0.5	-1.3	-1.6	-1.6	-1.0	0.8	2.8	
R3	9.6	5.8	2.7	1.9	1.5	1.4	1.4	2.1	4.4	
R4	9.2	5.4	2.3	1.4	1.0	1.0	1.0	1.7	4.0	
R5	7.4	3.6	0.4	-0.6	-1.1	-0.1	1.8	3.8	6.2	
R6	5.4	1.8	-1.3	-2.3	-2.7	-1.8	0.1	2.2	4.6	
R7	18.5	15.2	12.6	12.2	12.5	13.6	15.1	17.0	19.3	
R8	6.9	3.3	0.1	-0.8	-1.3	-0.3	1.6	3.7	6.0	
R9	6.7	3.1	-0.1	-0.8	-0.5	0.5	1.6	2.9	4.4	
Gallt-y-cwm	10.8	6.4	2.7	2.5	2.3	2.3	2.3	2.3	2.3	
Naid Yr Carw	10.9	6.8	3.1	2.8	2.5	2.5	2.5	2.5	2.5	
Goytre Farm	13.3	8.7	6.2	6.4	7.0	7.9	9.1	10.5	12.2	
Cwm Maelwg	14.6	10.3	6.8	6.5	6.4	6.4	10.8	10.8	10.8	
Crugwyllt-fawr	14.9	10.5	7.3	7.1	7.0	7.0	11.4	11.4	11.4	
Rhiwlas	9.0	4.6	0.9	0.7	0.5	0.5	0.5	1.2	2.4	
Cwmceryn Farm	10.7	6.5	2.8	2.5	2.3	2.2	2.2	2.2	2.3	
Cwmceryn Cottages	10.5	6.2	2.5	2.3	2.1	2.1	2.1	2.1	2.2	
Tair Waun Farm	10.8	6.7	3.0	2.6	2.3	2.3	2.3	2.3	2.4	
Kings Terrace	8.3	4.4	1.0	0.3	0.0	0.0	0.0	0.0	0.0	
Tudor Estate	9.4	5.6	2.5	1.7	1.3	1.2	1.2	1.9	4.2	
Heol-y-Gadarn Duffryn	8.2	4.4	1.1	0.1	-0.4	-0.4	-0.5	-0.4	1.7	
Cynonville	6.1	2.4	-0.7	-1.7	-2.2	-2.2	-2.2	-2.1	-0.1	
Bryn – Village Central Location	10.4	6.2	2.5	2.1	1.9	1.9	1.9	1.9	1.8	
Heol Gelli Lenor Maesteg	12.9	8.7	5.0	4.7	4.5	4.5	4.5	4.5	4.5	
Fire Station Maesteg	9.6	5.7	2.4	1.7	1.4	1.3	1.3	1.3	1.3	

12.8.9 It can be seen that, without operational mitigation for the candidate turbine model, there are exceedances of the daytime limits, and night-time limits where the reduced lower limiting value is applied, at a number of properties, particularly to the north (NML04, R5, R6, R8, R9, Hoel-y-Gadarn, Cynonville) and east (R1, R2) of the proposed development due to the combined effect with the consented Foel Trawsnant site. There are no exceedances of the normal ETSU-R-97 night-time limit. The exceedances at the properties to the east and west of the southern cluster are increased slightly by the cumulative assessment. The exceedances will be reduced to an extent by wind direction depending on the location of the properties relative to each wind turbine considered.

S.73 Application – Foel Trawsnant Wind Farm

12.8.10 As discussed in Paragraph 12.8.3, Foel Trawsnant Wind Farm has submitted a S.73 application to increase the rotor diameters of the proposed wind turbines for installation and indicated a reduction in the number of turbines to be constructed and the application of mitigation to some of the proposed wind turbines to meet the requirements of their consented noise levels for daytime operation.

12.8.11 Predictions of operation noise levels for the proposed new turbines for installation, N117 and N133, as presented within the revised Noise Assessment for Foel Trawsnant indicate that mitigation to turbine operation is required to meet the consented noise limits. This has been identified within the assessment in Table 12.28: Summary of results of mitigation investigation where it is stated that turbines T5, T6 and T11 will be operated in noise reduced modes to meet the consented noise limits.

12.8.12 A further cumulative noise assessment, which takes account the above change to the Foel Trawsnant development is provided at Tables 12.26, 12.27 and 12.28 which show the predicted cumulative noise level, compliance with the upper-daytime limit and with the night-time limit respectively. The predicted noise levels for a standardised 10 metre height wind speed of 10 m/s, for which all turbines have reached their rated power, are shown on a noise contour plot for wind speeds corresponding to rated power and above at Figure 12.5.3 at Appendix 12.5.

Table 12.26: Predicted Cumulative Noise Levels for Downwind Propagation from All Turbines Simultaneously (Foel Trawsnant Section 73 Application)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
NML01	31.0	34.0	38.6	42.3	42.5	42.6	42.6	42.6	42.6	42.6
NML02	26.3	29.2	33.6	37.4	37.7	37.8	37.9	37.9	37.9	37.9
NML03	26.0	28.9	33.4	37.0	37.7	37.8	37.8	37.8	37.8	37.8
NML04	29.6	30.9	35.9	40.0	41.9	41.5	41.5	41.6	41.6	41.6
NML05	27.8	30.5	34.9	38.8	39.2	39.3	39.4	39.4	39.4	39.4
NML06	27.9	30.7	35.1	38.9	39.3	39.4	39.4	39.4	39.5	39.5
NML07	25.3	28.3	32.6	36.4	36.7	36.8	36.9	36.9	36.9	36.9
NML08	30.0	33.1	37.7	41.4	41.6	41.7	41.7	41.7	41.7	41.7
NML09	25.7	28.6	33.0	36.8	37.1	37.2	37.2	37.2	37.2	37.3
NML10	24.9	27.8	32.2	35.9	36.4	36.5	36.6	36.6	36.6	36.6
R1	27.0	30.0	34.5	37.9	38.9	38.9	38.9	38.9	38.9	38.9
R2	27.7	30.7	35.2	38.6	39.4	39.5	39.5	39.6	39.6	39.6
R3	25.1	27.9	32.5	35.9	37.2	37.0	37.1	37.1	37.2	37.2
R4	25.2	28.1	32.7	36.0	37.3	37.2	37.3	37.3	37.3	37.3
R5	28.1	30.2	35.0	38.9	40.6	40.4	40.4	40.5	40.5	40.5
R6	31.3	32.4	37.6	41.6	43.7	43.2	43.3	43.3	43.3	43.3

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
R7	32.2	33.3	38.4	42.5	44.6	44.2	44.2	44.2	44.2	44.2
R8	29.5	30.8	35.8	39.9	41.8	41.4	41.5	41.5	41.5	41.5
R9	29.1	30.6	35.6	39.6	41.4	41.1	41.2	41.2	41.2	41.2
Gallt-y-cwm	26.0	29.1	33.5	37.2	37.5	37.6	37.6	37.6	37.6	37.6
Naid Yr Carw	25.4	28.3	32.6	36.4	36.7	36.8	36.9	36.9	36.9	36.9
Goytre Farm	26.8	31.0	35.7	38.4	38.5	38.6	38.6	38.6	38.6	38.6
Cwm Maelwg	22.1	25.3	29.6	33.2	33.4	33.6	33.6	33.6	33.6	33.6
Crugwylt-fawr	21.4	25.0	29.4	32.6	32.8	32.9	32.9	33.0	33.0	33.0
Rhiwlas	27.8	30.8	35.2	39.0	39.2	39.3	39.4	39.4	39.4	39.4
Cwmcerwyn Farm	25.8	28.7	33.1	36.9	37.2	37.3	37.3	37.3	37.3	37.3
Cwmcerwyn Cottages	26.2	29.2	33.6	37.3	37.6	37.7	37.7	37.7	37.7	37.7
Tair Waun Farm	25.5	28.3	32.7	36.5	37.0	37.1	37.1	37.1	37.1	37.1
Kings Terrace	26.5	29.4	33.9	37.5	38.3	38.3	38.3	38.4	38.4	38.4
Tudor Estate	25.4	28.3	32.8	36.2	37.3	37.3	37.3	37.4	37.4	37.4
Hoel-y-Gadarn Duffryn	27.1	29.2	34.0	37.9	39.7	39.5	39.5	39.6	39.6	39.6
Cynonville	30.5	31.7	36.8	40.8	42.8	42.4	42.4	42.4	42.4	42.4
Bryn – Village Central Location	26.3	29.1	33.4	37.3	37.7	37.8	37.8	37.8	37.8	37.8
Heol Gelli Lenor Maesteg	23.8	26.8	31.0	34.8	35.1	35.3	35.3	35.3	35.3	35.3
Fire Station Maesteg	25.1	28.1	32.5	36.0	36.8	36.9	36.9	36.9	36.9	36.9

Table 12.27: Predicted Cumulative Compliance with Upper Daytime Noise Limit (Foel Trawsnant Section 73 Application)

ID	Standardised 10 Metre Height Wind Speed (m/s)								
	4	5	6	7	8	9	10	11	12
NML01	6.0	1.4	-2.3	-2.5	-2.6	-1.7	-0.2	1.2	2.4
NML02	10.8	6.4	2.6	2.3	2.2	2.1	2.1	3.5	5.7
NML03	11.1	6.6	3.0	2.3	2.2	2.2	2.2	2.7	3.1
NML04	9.1	4.1	0.0	-1.9	-1.5	-1.1	0.6	2.2	3.6
NML05	9.5	5.1	1.2	0.8	2.0	3.6	4.9	5.7	6.1
NML06	9.3	4.9	1.1	0.7	0.6	0.6	0.6	0.5	0.5
NML07	11.7	7.4	3.6	3.3	3.2	3.7	4.3	4.7	4.8
NML08	6.9	2.3	-1.4	-1.6	-1.6	1.4	4.3	6.4	7.0
NML09	11.4	7.0	3.2	2.9	2.8	2.8	2.8	2.9	3.7
NML10	15.3	11.0	7.3	6.8	6.7	6.7	6.7	6.7	6.7
R1	10.1	6.1	3.1	2.5	2.8	3.2	3.4	3.7	3.9
R2	9.4	5.4	2.4	2.0	2.2	2.6	2.7	3.0	3.2
R3	12.1	7.5	4.1	2.8	3.0	2.9	4.2	5.7	7.6
R4	11.9	7.3	4.0	2.7	2.8	2.7	4.0	5.6	7.5

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
R5	9.8	5.0	1.1	-0.6	-0.4	0.8	2.4	4.4	6.6	
R6	7.6	2.4	-1.6	-3.7	-3.2	-2.1	-0.4	1.6	3.8	
R7	20.4	15.9	12.5	11.3	12.5	13.4	14.2	14.9	15.5	
R8	9.2	4.2	0.1	-1.8	-1.4	-0.3	1.4	3.4	5.6	
R9	9.4	4.4	0.5	-0.7	0.3	1.0	2.0	3.1	4.3	
Gallt-y-cwm	10.9	6.5	2.8	2.5	2.4	2.9	3.5	3.9	4.1	
Naid Yr Carw	11.7	7.4	3.6	3.3	3.2	3.7	4.3	4.7	4.8	
Goytre Farm	14.7	10.0	7.5	7.8	8.4	9.1	9.7	10.0	10.0	
Cwm Maelwg	14.7	10.4	6.8	6.6	6.5	9.5	12.4	14.5	15.1	
Crugwyllt-fawr	15.0	10.6	7.4	7.2	7.1	10.2	13.0	15.1	15.7	
Rhiwlas	9.2	4.8	1.0	0.8	0.7	1.6	3.1	4.5	5.7	
Cwmceryn Farm	11.3	6.9	3.1	2.8	2.7	2.7	2.7	4.0	6.3	
Cwmceryn Cottages	10.8	6.4	2.7	2.4	2.3	2.3	2.3	3.6	5.9	
Tair Waun Farm	11.7	7.3	3.5	3.0	2.9	2.9	2.9	4.3	6.5	
Kings Terrace	10.6	6.1	2.5	1.7	1.7	1.7	2.8	3.9	4.8	
Tudor Estate	11.7	7.2	3.8	2.7	2.7	2.7	3.9	5.5	7.4	
Heol-y-Gadarn Duffryn	10.8	6.0	2.1	0.3	0.5	0.9	2.6	4.2	5.5	
Cynonville	8.3	3.2	-0.8	-2.8	-2.4	-2.0	-0.3	1.4	2.7	
Bryn – Village Central Location	10.9	6.6	2.7	2.3	2.2	2.2	3.3	4.5	5.3	
Heol Gelli Lenor Maesteg	13.2	9.0	5.2	4.9	4.7	4.7	5.8	7.0	7.8	
Fire Station Maesteg	11.9	7.5	4.0	3.2	3.1	3.1	4.2	5.3	6.2	

Table 12.28: Predicted Cumulative Compliance with Night-Time Noise Limit (Foel Trawsant Section 73 Application)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
NML01	9.0	4.4	0.7	0.5	0.4	0.4	0.4	0.4	0.4	
NML02	13.8	9.4	5.6	5.3	5.2	5.1	5.1	5.1	5.1	
NML03	14.1	9.6	6.0	5.3	5.2	5.2	5.2	5.2	5.2	
NML04	12.1	7.1	3.0	1.1	1.5	1.5	1.4	1.4	1.4	
NML05	12.5	8.1	4.2	3.8	3.7	3.6	3.6	3.6	3.7	
NML06	12.3	7.9	4.1	3.7	3.6	3.6	3.6	3.5	3.5	
NML07	14.7	10.4	6.6	6.3	6.2	6.1	6.1	6.1	6.1	
NML08	9.9	5.3	1.6	1.4	1.3	1.3	2.7	2.7	2.7	
NML09	14.4	10.0	6.2	5.9	5.8	5.8	5.8	5.8	5.7	
NML10	15.2	10.8	7.1	6.6	6.5	6.4	6.4	6.4	6.4	
R1	13.0	8.5	5.1	4.1	4.1	4.1	4.1	4.1	5.6	
R2	12.3	7.8	4.4	3.6	3.5	3.5	3.4	3.4	4.9	

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
R3	15.1	10.5	7.1	5.8	6.0	5.9	5.9	5.8	5.8	
R4	14.9	10.3	7.0	5.7	5.8	5.7	5.7	5.7	5.7	
R5	12.8	8.0	4.1	2.4	2.6	2.6	2.5	4.5	6.9	
R6	10.6	5.4	1.4	-0.7	-0.2	-0.3	-0.3	1.7	4.1	
R7	20.7	15.9	12.3	10.8	12.0	13.1	14.6	16.5	18.8	
R8	12.2	7.2	3.1	1.2	1.6	1.5	1.5	3.5	5.9	
R9	12.4	7.4	3.4	1.6	1.9	1.8	2.0	3.3	4.8	
Gallt-y-cwm	13.9	9.5	5.8	5.5	5.4	5.4	5.4	5.4	5.4	
Naid Yr Carw	14.7	10.4	6.6	6.3	6.2	6.1	6.1	6.1	6.1	
Goytre Farm	13.4	8.7	6.2	6.5	7.1	8.0	9.1	10.5	12.3	
Cwm Maelwg	17.7	13.4	9.8	9.6	9.4	9.4	10.8	10.8	10.8	
Crugwyllt-fawr	18.0	13.6	10.4	10.2	10.1	10.1	11.5	11.4	11.4	
Rhiwlas	12.2	7.8	4.0	3.8	3.7	3.6	3.6	3.6	3.6	
Cwmceryn Farm	14.3	9.9	6.1	5.8	5.7	5.7	5.7	5.7	5.7	
Cwmceryn Cottages	13.8	9.4	5.7	5.4	5.3	5.3	5.3	5.3	5.3	
Tair Waun Farm	14.7	10.3	6.5	6.0	5.9	5.9	5.9	5.9	5.9	
Kings Terrace	13.6	9.1	5.5	4.7	4.7	4.7	4.6	4.6	4.6	
Tudor Estate	14.7	10.2	6.8	5.7	5.7	5.7	5.6	5.6	5.6	
Heol-y-Gadarn Duffryn	13.8	9.0	5.1	3.3	3.5	3.5	3.4	3.4	3.4	
Cynonville	11.3	6.2	2.2	0.2	0.6	0.6	0.6	0.6	0.6	
Bryn – Village Central Location	13.9	9.6	5.7	5.3	5.2	5.2	5.2	5.2	5.2	
Heol Gelli Lenor Maesteg	16.2	12.0	8.2	7.9	7.7	7.7	7.7	7.7	7.7	
Fire Station Maesteg	14.9	10.5	7.0	6.2	6.1	6.1	6.1	6.1	6.1	

Table 12.29: Predicted Cumulative Compliance with Night-Time Noise Limit with Reduced Lower Limiting Value of 40 dB LA90 (Foel Trawsant Section 73 Application)

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
NML01	6.0	1.4	-2.3	-2.5	-2.6	-2.6	-2.6	-1.9	-0.8	
NML02	10.8	6.4	2.6	2.3	2.2	2.1	2.1	2.1	2.2	
NML03	11.1	6.6	3.0	2.3	2.2	2.2	2.2	2.2	2.2	
NML04	9.1	4.1	0.0	-1.9	-1.5	-1.5	-1.6	-1.5	0.6	
NML05	9.5	5.1	1.2	0.8	0.7	0.6	0.6	2.4	3.7	
NML06	9.3	4.9	1.1	0.7	0.6	0.6	0.6	0.5	0.5	
NML07	11.7	7.4	3.6	3.3	3.2	3.1	3.1	3.1	3.1	
NML08	6.9	2.3	-1.4	-1.6	-1.7	-1.7	2.7	2.7	2.7	
NML09	11.4	7.0	3.2	2.9	2.8	2.8	2.8	2.8	2.7	
NML10	12.2	7.8	4.1	3.6	3.5	3.4	3.4	3.4	3.4	

ID	Standardised 10 Metre Height Wind Speed (m/s)									
	4	5	6	7	8	9	10	11	12	
R1	10.0	5.5	2.1	1.1	1.1	1.1	1.8	3.6	5.6	
R2	9.3	4.8	1.4	0.6	0.5	0.5	1.1	2.9	4.9	
R3	12.1	7.5	4.1	2.8	3.0	2.9	2.9	3.5	5.8	
R4	11.9	7.3	4.0	2.7	2.8	2.7	2.7	3.4	5.7	
R5	9.8	5.0	1.1	-0.6	-0.4	0.6	2.4	4.5	6.9	
R6	7.6	2.4	-1.6	-3.7	-3.2	-2.3	-0.4	1.7	4.1	
R7	20.7	15.9	12.3	10.8	12.0	13.1	14.6	16.5	18.8	
R8	9.2	4.2	0.1	-1.8	-1.4	-0.5	1.4	3.5	5.9	
R9	9.4	4.4	0.4	-1.1	0.0	0.9	2.0	3.3	4.8	
Gallt-y-cwm	10.9	6.5	2.8	2.5	2.4	2.4	2.4	2.4	2.4	
Naid Yr Carw	11.7	7.4	3.6	3.3	3.2	3.1	3.1	3.1	3.1	
Goytre Farm	13.4	8.7	6.2	6.5	7.1	8.0	9.1	10.5	12.3	
Cwm Maelwg	14.7	10.4	6.8	6.6	6.4	6.4	10.8	10.8	10.8	
Crugwylt-fawr	15.0	10.6	7.4	7.2	7.1	7.1	11.5	11.4	11.4	
Rhiwlas	9.2	4.8	1.0	0.8	0.7	0.6	0.6	1.4	2.5	
Cwmceryn Farm	11.3	6.9	3.1	2.8	2.7	2.7	2.7	2.7	2.7	
Cwmceryn Cottages	10.8	6.4	2.7	2.4	2.3	2.3	2.3	2.3	2.3	
Tair Waun Farm	11.7	7.3	3.5	3.0	2.9	2.9	2.9	2.9	3.0	
Kings Terrace	10.6	6.1	2.5	1.7	1.7	1.7	1.6	1.6	1.6	
Tudor Estate	11.7	7.2	3.8	2.7	2.7	2.7	2.6	3.3	5.6	
Heol-y-Gadarn Duffryn	10.8	6.0	2.1	0.3	0.5	0.5	0.4	0.5	2.5	
Cynonville	8.3	3.2	-0.8	-2.8	-2.4	-2.4	-2.4	-2.3	-0.3	
Bryn – Village Central Location	10.9	6.6	2.7	2.3	2.2	2.2	2.2	2.2	2.2	
Heol Gelli Lenor Maesteg	13.2	9.0	5.2	4.9	4.7	4.7	4.7	4.7	4.7	
Fire Station Maesteg	11.9	7.5	4.0	3.2	3.1	3.1	3.1	3.1	3.1	

12.8.13 Where the reduced night-time lower limiting value is applied, there are exceedances at a greater number of properties and wind speeds compared to the normal ETSU-R-97 night-time limit. These properties with exceedances are mostly to the north and east of the proposed development and exceedances are due to the combined effect with the Foel Trawsnant site. There are only marginal exceedances of the normal ETSU-R-97 night-time limit at R6 by up to 0.7 dB.

12.8.14 As for the cumulative assessment considering the Foel Trawsnant site as consented, the exceedances will be reduced to an extent by wind direction depending on the location of the properties relative to each wind turbine considered.

12.9 MITIGATION

12.9.1 Example mitigation strategies have been developed to demonstrate how the daytime and night-time noise limits could be met by the proposed development acting cumulatively with the other sites considered. These take into account the wind direction in 30-degree sectors as described in Paragraph 12.6.21. Where there is already

predicted exceedance of the limits, such that there is no remaining noise budget, noise from the proposed development has been mitigated to the extent that it will be at least 10 dB below the predicted noise level (taking account of wind speed and direction) which would otherwise exist. Where noise levels from any site acting individually is predicted to exceed its own noise limits for a given wind speed and wind direction, the noise levels from that site have been capped at that its limit for those operating conditions. This is only observed for a few sectors and properties for Foel Trawsnant Wind Farm. The resultant mitigation strategies are shown at Appendix 12.7

12.9.2 The default scenario - complying with the precedent cumulative daytime limit of 40dB and the precedent night-time limit of 43dB - is expected to result in a minimal reduction in energy yields for either the consented or S73 Foel Trawsnant cases.

12.9.3 The alternative scenario – of complying with a reduced 40dB night-time lower limiting value, in spite of local precedent – would result in losses to energy yield versus the default scenario of up to 3.9% for individual turbines, and between 1.0% and 1.5% overall for the S73 Foel Trawsnant and consented cases respectively (equivalent to the average annual demand of between 1124 to 1907 households³⁰).

Conclusions on Operational Noise

12.9.1 The prediction of operational noise levels associated with existing and consented wind farms has highlighted the issue of cumulative noise levels already exceeding the suggested cumulative noise limits from the Local Planning Authorities Noise Consultant, i.e., the greater of 40 dB LA90 or prevailing background noise level + 5 dB (daytime) and 40 dB LA90 or prevailing background noise level + 5 dB (night-time. Night-time operation of consented and existing schemes would result in an allowable level greater than these proposed limits since these neighbouring schemes have already been consented with a limits of 43 dB LA90 or prevailing background noise + 5 dB. As such, constraining the proposal to a cumulative level which is already exceeded by existing consents unnecessarily penalises the proposal.

12.9.2 With mitigation applied to the candidate turbine noise model, the normal ETSU-R-97 upper daytime and night-time limits can be met with minimal energy impacts. To that end, it is proposed that the potential noise impacts associated with the proposal that cumulative sound levels are restricted to the following noise criteria.

- Daytime Hours: the greater of 40 dB LA90 or prevailing background noise + 5 dB; and
- Night-time Hours: the greater of 43 dB LA90 or prevailing background noise + 5 dB.

12.9.3 Applying a non-standard and locally inconsistent reduced night-time limit would result in significant energy impacts.

12.10 CONSTRUCTION NOISE ASSESSMENT

12.10.1 An indicative assessment of noise from the construction and decommissioning of the proposed development has been carried out. Relevant tables associated with this assessment may be found in Appendix 12.6.

Assessment Methodology

12.10.2 Noise during the construction period will arise from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks. Noise from vehicles on local roads and access tracks will also arise resulting from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

12.10.3 Noise will also arise during decommissioning from the removal of the turbines and breaking of the exposed part of the concrete bases.

³⁰ Energy losses estimated from energy yield assessment by Natural Power, based on noise candidate 5.7MW Nordex 163 turbine, rescaled to maximum indicative nameplate capacity 7.2MW, equates to 4.2 GWh/annum for S73 Foel Trawsnant and 7.1

GWh/annum for consented Foel Trawsnant. Number of households based on 3,709 kWh GB household average electricity domestic consumption figure in 2021(BEIS Energy Consumption in Great Britain).

Predicted Construction and Decommissioning Noise Levels

- 12.10.4 Predictions have been made of noise levels at locations representative of the nearest residential properties to the proposed development, using the methods prescribed in BS 5228:2014. It is assumed that all construction works will occur during daytime hours (0700-1900) including Saturdays (0700-1300). These properties are set out within Table 12.6.1: Appendix 12.6
- 12.10.5 In carrying out the predictions it has been assumed that all plant involved with track construction is located at the nearest possible point to each property. It should be noted that this is unlikely to occur in practice but gives very much worst-case noise levels. The plant assumed for each activity is shown in Table 12.6.2 (Appendix 12.6) with assumed octave band sound power levels for each item provided in Table 12.6.3 (Appendix 12.6). For the calculations, 50% soft ground attenuation has been used throughout with no topographical barrier attenuation. In practice it is likely that at least some of the plant will be screened from view, but the calculation represents a realistic worst case.
- 12.10.6 For the M4 access track construction asphalt laying will be required along part of the route, so the plant involved in this activity are included in addition for predictions of track construction related to those activities.
- 12.10.7 The results of worst-case noise predictions are shown in Table 12.6.4 (Appendix 12.6). It should be noted that average noise levels over the construction period will be lower, particularly where high levels are predicted for work on the access tracks at close proximity to housing.
- 12.10.8 It can be seen that predicted noise levels are below the 65 dB L_{Aeq} daytime criterion for all considered construction and decommissioning activities other than Quasi-Static Track Construction at NML02 and the Quasi Static Track Construction and Track Improvement associated with the M4 access route at Morlais Road and Arnallt Brook, where the worst-case daytime noise levels could be 70-74 dB L_{Aeq} .
- 12.10.9 NML02 is the landowner for the access track which approaches and neighbours the property. The track construction activities would be above the 65 dB L_{Aeq} daytime criterion for 80 m of track construction from the existing road towards the turbines. Track construction is usually completed at a rate of approximately 150 m per eight-hour day, meaning that the levels would be above the criterion for only 4-5 hours. The combination of the low time period of exposure and the financial benefit the scheme (and specifically access tracks) has to this receptor results in the likelihood of a significant impact from these works being minimal, and therefore this is not considered further.
- 12.10.10 The Anallt Brook nearest property is also a landowner for the existing section of the M4 access track, and it therefore also receives financial benefit from the track works. Although the nearby track improvements are likely to be slower than normal track construction due to the large amount of material involved, this location will have a large amount of masking noise due to the proximity and raised elevation compared to the M4 (approximately 125 m to the SW).
- 12.10.11 The Morlais Road nearest property is approximately 35 m from the M4. Although screened to some extent by a lower comparative elevation and trees along the motorway bund, this property will have very high daytime noise levels due to traffic along the M4 (as well as nearby industrial activities) which will have the potential to mask plant activities associated with construction. In addition, the quasi-static nature of the track construction will result in these works only being in the worst-case proximity for a few hours per day.
- 12.10.12 The mitigating factors for these three locations result in the likelihood of a significant impact from these works being minimal, and therefore this is not considered further.

Blasting at Borrow Pits

- 12.10.13 There may be a need for blasting in the process of creating borrow pits for the construction activities. BS 5228 states regarding blasting and its potential effect on neighbours to site that, '*Vibration and air overpressure from blasting operations is a special case and can under some circumstances give rise to concern or even alarm to*

persons unaccustomed to it. The adoption of good blasting practices will reduce the inherent and associated impulsive noise: prior warning to members of the public, individually if necessary, is important.'

- 12.10.14 BS 5228 states that practical measures, including good blast design, that have been found to reduce air overpressure and/or vibration are:
- Ensuring appropriate burden to avoid over or under confinement of the charge;
 - Accurate setting out and drilling;
 - Appropriate charging;
 - Appropriate stemming with appropriate material such as sized gravel or stone chippings;
 - Using delay detonation to ensure smaller maximum instantaneous charges (MICs);
 - Using decked charges and in-hole delays;
 - Blast monitoring to enable adjustment of subsequent charges;
 - Designing each blast to maximize its efficiency and reduce the transmission of vibration; and
 - Avoiding the use of exposed detonating cord on the surface in order to minimize air overpressure – if detonating cord is to be used in those cases where down-the-hole initiation techniques are not possible, it should be covered with a reasonable thickness of selected overburden.
- 12.10.15 The above factors should be considered when creating the Construction Environmental Management Plans (CEMPs) for the construction works and a combination of minimising blasting activities and ensuring nearby residents are fully warned should mitigate any adverse impact from these activities which are high in sound and vibration energy but of very short duration.

Construction Noise Summary

- 12.10.16 Noise associated with the construction of the proposed development has been predicted and found to conform to the guideline values set out within BS 5228-1:2014. The locations adopted for this assessment are representative of neighbouring noise sensitive receptors to the proposed development. Most properties will experience sound levels associated with construction that are no greater than existing ambient sound levels.
- 12.10.17 Guidance with respect to blasting associated with the borrow pits is provided. It is not expected that vibration associated with the winning of aggregate will result in unacceptable vibration levels.

12.11 CONCLUSION

- 12.11.1 An assessment of the potential noise impacts associated with the proposed development has been undertaken and has included the following:
- Assessment of the existing sound levels at 10 neighbouring noise sensitive receptors to determine the levels of existing background noise in accordance with the requirements of ETSU-R-97;
 - Review of existing and consented noise limits for neighbouring wind farms to establish allowable levels of operational noise for the proposed development;
 - Cumulative predictions for neighbouring noise sensitive receptors to determine the existing level of cumulative noise associated with existing and consented wind farms in accordance with the method outlined within the IOA GPG;
 - Operational noise level predictions for the proposed development in isolation and determination of compliance with the requirements of ETSU-R-97;
 - Identification of locations at which the existing and consented wind farms exceed the suggested cumulative noise limits by the Local Planning Authorities for both day and night-time operation;

- Cumulative noise level predictions for the proposed development and neighbouring operational and consented wind farms to determine the total cumulative levels of noise associated with wind farm operation;
- Set out limits for assessment of cumulative noise levels with the proposed development to determine the acceptability of the proposed development with respect to noise;
- Demonstration that the proposed development, with the assumed candidate wind turbine, can meet these sound level requirements during operation of the proposed wind turbines; and
- Provision of an assessment of potential noise associated with construction activities which demonstrate that construction noise is within acceptable levels for all neighbouring noise sensitive receptors.