Contents

13. Noise

13.1 Introduction

13.1.1 This chapter presents an assessment of the likely significant effects of the Proposed Development with respect to noise. The assessment is based on information obtained to date. It should be read in conjunction with the Project description provided in **Chapter 4: Description of the Proposed Development**.

13.1.2 This chapter describes:

- The legislation, policy and technical guidance that has informed the assessment (**Section 13.2**);
- Consultation and engagement that has been undertaken and how comments from consultees relating to noise have been addressed (**Section 13.3**);
- The methods to be used for baseline data gathering (**Section 13.4**);
- Overall baseline (**Section 13.5**);
- Embedded measures relevant to noise (**Section 13.6**);
- The scope of the assessment for noise (**Section 13.7**);
- The methods used for the assessment (**Section 13.8**);
- The assessment of noise effects (**Section 13.9**);
- Assessment of cumulative (inter-project) effects (**Section 13.10**);
- A summary of the significance conclusions (**Section 13.11**); and
- An outline of further work to be undertaken for the Environmental Statement (ES) (**Section 13.11.5**).

Limitations and assumptions

13.1.3 The assessment of cumulative noise effects indicates that potential cumulative effects are dominated by the proposed Mynydd Maen Wind Farm. The layout and design of Mynydd Maen Wind Farm are not yet finalised, therefore the best available information on the layout of the scheme was used in the assessment, which was that made available during the public exhibition in June 2023[1], and an assumed turbine type has been used. As such, there is an element of uncertainty associated with the predicted noise levels due to Mynydd Maen Wind Farm. If additional or revised information on the layout and design of the Mynydd Maen Wind Farm is made available then this will be accounted for in the Final ES.

[1] RES. Mynydd Maen Wind Farm, Public Exhibition June 2023. (Online) Available at: https://www.mynyddmaen-windfarm.co.uk/consultation/public-exhibitions-june-2023/ (Accessed 30 October 2023).

13.2 Relevant legislation, planning policy and technical guidance

13.2.1 This section identifies the legislation, planning policy and technical guidance that has informed the assessment of effects with respect to noise. Further information on policies relevant to the Project is provided in **Chapter 5: Legislation and policy overview**.

Legislation

13.2.2 A summary of the relevant legislation is provided in **Table 13.1**.

Table 13.1 Legislation relevant to the noise assessment

Legislation	Legislative context
Environmental Protection Act 1990, Part III – as amended by the Noise and Statutory Nuisance Act 1993[2]	An Act to make provision for the improved control of pollution arising from certain industrial and other processes, including noise pollution.
Control of Pollution Act 1974[3]	An Act to make further provision with respect to waste disposal, water pollution, noise, atmospheric pollution, and public health; and for the purposes connected with the matters aforesaid.

Planning policy

13.2.3 A summary of the relevant national and local planning policy is provided in **Table 13.2**.

Table 13.2 Planning policy relevant to the noise assessment

Policy	Policy context
National planning policy	
National Policy Statements	NPS EN-1[4] advises that applicants include a noise assessment to consider both construction and operation effects where appropriate. EN-3[5] at 2.7.56 states that the applicant's assessment of noise from the operation of the wind turbines should use ETSU-R-97[6], taking account of the latest industry

[2] UK Government (1990), Environmental Protection Act 1990. (Online) Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 30 October 2023).
[3] UK Government (1974). Control of Pollution Act 1974. (Online) Available at: https://www.legislation.gov.uk/ukpga/1974/40/contents(Accessed 30 October 2023).
[4] Department of Energy & Climate Change (2011). Overarching National Policy Statement for Energy (EN-1). (Online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf (Accessed 30 October 2023).
[5] Department of Energy & Climate Change (2011). National Policy Statement for Renewable Energy Infrastructure (EN-3). (Online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf (Accessed 30 October 2023).
[6] The Working Group on Noise from Wind Turbines (1996). ETSU-R-97 The assessment and rating of noise from wind farms. (Online) Available at: https://regmedia.co.uk/2011/08/02/etsu_r_97.pdf (Accessed 30 October 2023).

Policy	Policy context
	good practice. ETSU-R-97[6] is also referred to alongside associated good practice guides (see Table 1.3) in Planning Policy Wales (PPW)[7].
Planning Policy Wales[7]	PPW sets out the land use planning policies of the Welsh Government, supplemented by Technical Advice Notes (TANs). It notes that *'Wales has an abundant wind resource and, as a result, wind energy forms a key part of meeting the Welsh Government's vision for future renewable energy production.'* Policy 17 of PPW refers to *'...Pre-Assessed Areas where the Welsh Government has already modelled the likely impact* [of large scale wind farm development] *on the landscape and has found them to be capable of accommodating development in an acceptable way.'*
Policy 17 – Pre-assessed areas for wind energy[8]	Identifies an area containing the Proposed Development as a pre-assessed area for wind energy development.
Future Wales – The National Plan 2040[9]	Provides the national development framework up to 2040 and refers to the protection from noise through planning throughout, including renewables.
Welsh Assembly Government: Technical Advice Note (TAN) 11: Noise (1997)[10]	TAN 11 provides general advice on noise and refers to TAN 8[11] for guidance regarding noise from wind turbines and wind farms. TAN 8 has now been superseded by national development framework embedded within 'Future Wales'.
Local planning policy	
Caerphilly County Borough Local Development Plan to 2021 (November 2010)[12]	A review of the current Local Development Plan (LDP) undertaken in June 2021[13] indicated that LDP should be subject to review. However, there is no draft replacement guidance available at this time. As such the LDP to 2021 remains as the current local policy to guide appropriate development in the area. LDP **Policy CW2 – Amenity** states that development proposals must have regard for all relevant material considerations to satisfy the requirement that there is no unacceptable impact on the amenity of adjacent properties.

Technical guidance

13.2.4 A summary of the technical guidance for noise is provided in **Table 13.3**.

[7] Welsh Government, Planning Policy Wales. Edition 11: February 2021. (Online) Available at: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf (Accessed 30 October 2023).
[8] Welsh Government (2020). Policy 17 – Pre-assessed areas for wind energy. (Online) Available at: Policy 17 – Pre-assessed areas for wind energy | DataMapWales (gov.wales) (Accessed 30 October 2023).
[9] Welsh Assembly Government (2021). Future Wales. The National Plan 2020. (Online) Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf (Accessed 30 October 2023).
[10] Welsh Assembly Government (1997). Technical Advice Note 11: Noise. (Online) Available at: https://gov.wales/sites/default/files/publications/2018-09/tan11-noise.pdf (Accessed 30 October 2023).
[11] Welsh Assembly Government (2005). Technical Advice Note 8: Planning for Renewable Energy. (Online) Available at: https://gov.wales/sites/default/files/publications/2018-09/tan8-renewable-energy_0.pdf (Accessed 30 October 2023).
[12] Caerphilly County Borough Council. Local Development Plan up to 2021. Adopted November 2010. (Online) Available at: https://www.caerphilly.gov.uk/caerphillydocs/ldp/written-statement.aspx (Accessed 30 October 2023).
[13] Caerphilly County Borough Council. Adopted Local Development Plan up to 2021, Review Report. (Online) Available at: https://www.caerphilly.gov.uk/caerphillydocs/ldp/ldp_draft_review_report.aspx (Accessed 30 October 2023).

Table 13.3 Technical guidance relevant to the noise assessment

Technical guidance document	Context
ETSU-R-97 The Assessment and Rating of Noise from Wind Farms, The Working Group on Noise from Wind Turbines (1996)[6]	Information and advice to developers and planners on the environmental assessment of noise from wind turbines. The guidance offers a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours.
A Good Practice Guide ('IOA GPG') to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, Institute of Acoustics (2013)[14]	Presents current good practice in the application of ETSU-R-97[6] for all wind turbine developments above 50kW. The good practice guide gives information to assist consultants, developers and local planning authorities in using the correct technical and procedural methods for the assessment and determination of wind farm applications, reflecting the original principles within ETSU-R-97[6] and the results of research carried out and experience gained since its publication. Six Supplementary Guidance Notes (SGNs) present additional guidance on various topics: • SGN 1: Data collection[15]; • SGN 2: Data processing & derivation of ETSU-R-97 background curves[16]; • SGN 3: Sound power level data[17]; • SGN 4: Wind shear[18]; • SGN 5: Post completion measurements[19]; and • SGN 6: Noise propagation over water for on-shore wind turbines[20].
BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, BSI (2014)[21]	Detailed guidance on assessing noise from construction sites. Approved code of practice for construction noise under the Control of Pollution Act 1974.
Calculation of Road Traffic Noise (CRTN)[22]	Describes procedures for calculating road traffic noise.

[14] Institute of Acoustics (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. (Online) Available at: https://www.ioa.org.uk/sites/default/files/IOA%20Good%20Practice%20Guide%20on%20Wind%20Turbine%20Noise%20-%20May%202013.pdf (Accessed 30 October 2023).
[15] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 1: Data collection.
[16] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 2: Data processing & derivation of ETSU-R-97 background curves.
[17] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 3: Sound power level data.
[18] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 4: Wind shear.
[19] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 5: Post completion measurements.
[20] Institute of Acoustics (2014). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. Supplementary guidance note 6: SGN 6: Noise propagation over water for on-shore wind turbines.
[21] British Standards Institution (2014). British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 1: Noise. BSI, London.
[22] HMSO (1988). Calculation of Road Traffic Noise.

Technical guidance document	Context
Design Manual for Roads and Bridges (DMRB) LA111: Noise and vibration [23]	Provides guidance on the assessment of impacts that road projects may have on levels of noise and vibration. Provides criteria for assessing changes in road traffic noise levels, which may be used in the assessment of increases in road traffic noise due to additional vehicle movements associated with the construction of the Proposed Development.

13.3 Consultation and engagement

Overview

13.3.1 The assessment has been informed by consultation responses and stakeholder engagement. An overview of the approach to consultation is provided in **Section 2.4** of **Chapter 2: Approach to Environmental Impact Assessment**.

Scoping Direction

13.3.2 A Scoping Direction was issued by PEDW, on behalf of the Welsh Ministers, on 2 December 2022. A summary of the relevant responses received in the Scoping Direction in relation to noise and confirmation of how these have been addressed within the assessment to date is presented in **Table 13.4**.

Table 13.4 Summary of EIA Scoping Direction responses for noise

Consultee	Consideration	How addressed in this Draft ES
PEDW	**[ID.47]** There is another Development of National Significance (DNS) adjacent to the Site, Mynydd Maen Wind Farm, which needs to be included within the cumulative noise assessment. The Local Planning Authority (LPA) also notes that the cumulative assessment should also include wind turbines that are within a 2 km radius that are operational, consented or at the planning stage.	The search radius used to identify other wind farms to be included within the cumulative noise assessment is 10km from the Application Site. Noise from Mynydd Maen Wind Farm, and other operational, proposed and consented wind farms identified in **Section 13.4,** has been assessed in **Section 13.10**.
PEDW	**[ID.48]** Liaison with an Environmental Health Officer (EHO) at Caerphilly County Borough Council (CCBC) to agree the baseline survey methodology is encouraged.	An EHO at CCBC was consulted to discuss and agree the survey methodology, as set out in **Table 13.5**. Borrow pits are no longer included as part of the Proposed Development.

[23] Transport Scotland et al. (2020). DMRB, LA111: Noise and vibration. Revision 2. (Online) Available at: https://www.standardsforhighways.co.uk/tses/attachments/cc8cfcf7-c235-4052-8d32-d5398796b364?inline=true (Accessed 30 October 2023).

Consultee	Consideration	How addressed in this Draft ES
	It is noted that borrow pits are proposed but the location is unknown, thus construction noise may affect nearby properties.	
CCBC	The proposed methodology for the noise assessment is considered generally acceptable. However, the number and location of baseline noise surveys will need to be agreed. The cumulative assessment should include wind turbines that are within a 2 km radius that are operational, consented or at the planning stage, including the proposed Mynydd Maen Wind Farm.	An EHO at CCBC was consulted to discuss and agree the survey methodology, as set out in **Table 13.5**. The search radius used to identify other wind farms to be included within the cumulative noise assessment is 10km from the Application Site. Noise from Mynydd Maen Wind Farm, and other operational, proposed and consented wind farms identified in **Section 13.4,** has been assessed in **Section 13.10**.

Technical engagement

13.3.3 Technical engagement with consultees in relation to noise is ongoing. A summary of the technical engagement undertaken to date is outlined in **Table 13.5**.

Table 13.5 Technical engagement on the noise assessment

Consultee	Consideration
CCBC	The baseline survey locations, durations and locations which survey data would be considered representative of were discussed and agreed with an EHO of CCBC in advance of carrying out the baseline surveys.

13.4 Data gathering methodology

Study area

Wind Farm development

13.4.1 The study area is based on a radius of 10km from the Proposed Development.

13.4.2 Within the 10km study area, other wind farm developments, including those that are consented but not built or at planning stage, have been considered as part of the assessment of cumulative effects.

Grid Connection

13.4.3 The study area is based on the Noise Sensitive Receptors (NSRs) within, or in close proximity to, the proposed grid connection corridor.

Desk study

13.4.4 A summary of the source of data, together with the nature of that data is outlined in **Table 13.6**.

Table 13.6 Data sources used to inform the noise assessment

Organisation	Data source	Data
Google & Maxar Technologies	Google Earth Pro 7.3.4.8248[24] (software), Maxar Technologies (image source)	Aerial imagery
British Standards Institute	BS 5228-1:2009+A1:2014[21]	Noise data for construction noise and vibration predictions.
Enercon	Sound power level of the Enercon E-53 Operational Mode 1 (Data sheet)[25] Sound emission according to IEC 61400-11[26]	Turbine noise data (Enercon E-53)
Vestas	DMS 0067-4767 V05. V150-4.0/4.2 MW Third octave noise emission[27]	Turbine noise data (Vestas V150)
Vestas	DMS 0067-7587 V01. V117-4.0 & 4.2 MW Third octave noise emission (strong wind and typhoon)[28]	Turbine noise data (Vestas V1117 Serrated Trailing Edge (STE))
Stuart Burke Associates	Single wind turbine application – Roundshaw Farm[29]	Turbine noise data (Vestas V27)
Gamesa	MCG G128-4.5MW Noise Spectrum[30] G128 4.5MW Power curve and noise levels[31]	Turbine noise data (Gamesa G128)

[24] Google (2021). Google Earth Pro, version 7.3.4.8248. (Online) Available at: https://www.google.com/earth/download/gep/agree.html?hl=en-GB (Accessed 30 October 2023).
[25] Enercon GmbH (2012). Sound power level of the Enercon E-53 Operational Mode 1 (Data sheet). Enercon GmbH, Aurich, Germany.
[26] Muller-BBM (2007). Enercon GmBH, Sound emission according to IEC 61400-11. Ebercon E-53 in 26409 Wittmun-Eggelingen in operational mode I. Test report No. M69 915/1. Muller-BBM, Germany.
[27] Vestas (2018). DMS 0067-4767 V05. V150-4.0/4.2 MW Third octave noise emission. Vestas, Denmark.
[28] Vestas (2018). DMS 0067-7587 V01. V150-4.0 & 4.2 MW Third octave noise emission (strong wind & typhoon). Vestas, Denmark.
[29] Stuart Burke Associates (2014). Single wind turbine application – Roundshaw Farm. Environmental Statement: Volume III – Technical Assessment. SBA, 2014.
[30] Gamesa (2013). General characteristics manual. MCG G128-4.5MW Noise Spectrum. Gamesa.
[31] Gamesa (2012). General characteristics manual. G128 4.5MW Power curve and noise levels. Gamesa.

Organisation	Data source	Data
Senvion	Octave & third octave band data [MM100/50Hz/60Hz][32]	Turbine noise data (Senvion MM100)
University of Groningen & University of Gothenburg	Project WINDFARMperception[33]	Turbine noise data (Vestas V66)
Nordex	Technical report. Octave sound power levels. Nordex N117/3000 – Standard Mode[34]	Turbine noise data (Nordex N117)
Enzygo Environmental Consultants	ETSU R97: Noise Impact Assessment for a proposed Wind Turbine Development[35]	Turbine noise data (Ropatec T30proS VAWT)

Survey work

Wind Farm development

13.4.5 A baseline sound level survey was carried out at three locations (M1, M2, M3) between Monday 4 September 2023 and Friday 22 September 2023 with meteorological data acquired from a full height met meteorological mast. In addition to the surveys outlined above, survey data from a fourth location (M4) was used. The fourth survey location measured sound levels from Wednesday 22 February to Wednesday 22 March 2023 and was originally undertaken to inform the assessment of the proposed Mynydd Llanhilleth Wind Farm. All surveying, and use of the measurement data from the fourth location, was in accordance with the approach agreed with the EHO of CCBC.

13.4.6 The positions of the monitoring locations are shown in **Figure 13.1** and listed in **Table 13.7**.

Table 13.7 Noise monitoring locations

Monitoring location	Location	Approximate distance to nearest proposed turbine, m	Approximate Easting	Approximate Northing
M1	Glan Shon Farm	400	322448	195985

[32] Senvion (2014). Octave & third octave band data [MM100/50Hz/60Hz]. General information. Doc.-ID: GI-2.21-WT.PO.04-A-A-EN. Senvion, Hamburg, Germany.
[33] Frits van den Berg, et al (2008). Project WINDFARMperception. Visual and acoustic impact of wind turbine farms on residents. FP6-2005-Science-and-society-20, Specific Support Action, Project no. 044628. Final Report. University of Groningen & University of Gothenburg.
[34] Nordex (2015). Technical report. Octave sound power levels. Nordex N117/3000 – Standard Mode. Document no. F008_244_A04_EN. Nordex Energy GmbH, Germany.
[35] Enzygo Ltd (2015).

Monitoring location	Location	Approximate distance to nearest proposed turbine, m	Approximate Easting	Approximate Northing
M2	Blaengawney Farm	850	322932	197830
M3	Ty Oakley	1250	322866	198323
M4	Cefn-y-Crib Farm	1700	324314	199856
Met Mast	-	-	323370	197953

13.4.7 Based on the survey results, the background levels identified from the measured levels at each location using a polynomial curve as per ETSU-R-97[6] requirements are presented in **Table 13.8** and **Table 13.9**. In some cases, at higher wind speeds, there was an inadequate number of data points, and in these cases sound level data for the next lowest wind speed has been used, which is a more stringent criteria than if the data was available.

Table 13.8 Background sound levels dB $L_{A90,10min}$ - quiet daytime

Monitoring location	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
M1	35.8	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8*
M2	29.5	30.7	32.3	34.1	36.3	38.9	41.7	45.0	48.5	48.5*
M3	30.9	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0*
M4	28.1	29.9	32.5	35.3	38.0	40.1	41.2	41.2*	41.2*	41.2*

* Preceding value used.

Table 13.9 Background sound levels dB $L_{A90,10min}$ - night-time

Monitoring location	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
M1	29.9	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8*
M2	24.6	26.1	28.2	30.8	33.6	36.6	39.4	41.9	44.0	44.0*
M3	26.6	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1*
M4	22.9	25.4	28.2	31.2	34.4	37.5	40.6	40.6*	40.6*	40.6*

Monitoring location	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12

* Preceding value used.

Turbine data

13.4.8 A range of turbine models would be appropriate for the Proposed Development. The final selection of turbine would follow a competitive tendering process and thus the actual model of turbine may differ from that which this assessment has been based. However, the final choice of turbine would be required to comply with the noise criterion levels which have been established for the development within this noise assessment and which will be confirmed in the Final ES.

13.4.9 The candidate turbine used in this assessment is a Vestas V117 STE 4.2 MW turbine, with a hub height of 84m and rotor diameter of 117m. Broadband sound power level data for the candidate turbine used in the noise modelling is shown in **Table 13.10**, with octave band data in **Table 13.11**. The numbers listed in the tables are corrected to a standardised 10m height and include 2 dB uncertainty, in line with best practice.

Table 13.10 Broadband sound power data for candidate turbine

Turbine	Sound power level, dB L_{WA}, per wind speed at standardised 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
Vestas V117 STE	95.0	97.8	102.0	105.7	107.8	108.0	108.0	108.0	108.0	108.0

Table 13.11 Octave band sound power data for candidate turbine

Turbine	Sound power level, dB L_{WA}, per octave band centre frequency, Hz, at standardised windspeed at 10 m of 8 ms^{-1}							
	63	125	250	500	1k	2k	4k	8k
Vestas V117 STE	88.3	95.5	100.3	102.6	102.4	99.7	94.5	86.8

13.4.10 Data has also been collected for turbines to be considered within the cumulative assessment. Whilst the study area is 10km from the Proposed Development, there are a number of single turbines between 5 to 10km. Given the distances, and the relatively negligible contribution from the single turbines as compared to the multi-turbine sites, both within the 5km buffer and the 10km buffer, two single turbine sites near the 10km buffer (Gelli-wen Farm and Tir-y-Ferch-Gryno Farm) have not been included in the cumulative assessment.

13.4.11 **Table 13.12** presents the sites which are included in the cumulative assessment, along with the turbine type and sound power levels by wind speed. Octave sound power levels for each turbine type are presented in **Table 13.13**. Where details are not available about the turbine type, a reasonable worst-case turbine has been assumed. The numbers listed in the tables are corrected to a standardised 10m height and include corrections for uncertainty, in line with best practice.

Table 13.12 Broadband sound power data for other turbines

Wind Farm Site	Turbine	Sound power levels, dB L_{WA}, per wind speed at standardised 10 m, ms^{-1}								
		4	5	6	7	8	9	10	11	12
Abertillery Wind Farm	Envelope*	103.5	107.4	110.9	112	112.4	112.4	112.4	112.4	112.4
Bryn Ysgawen Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Mynydd Carn y Cefn	Vestas V150 STE*	97.7	102.6	106.4	106.9	106.9	106.9	106.9	106.9	106.9
Coed y Gilfach	Vestas V27 225kW	97.6	97.6	98.1	98.5	98.9	99.3	99.7	99.7	99.7
Mynydd Maen	Gamesa G128-4.5MW*	100.6	105.3	108.9	109.5	109.2	108.9	108.6	108.6	108.6
Mynydd Llanhilleth	Vestas V150 STE*	97.7	102.6	106.4	106.9	106.9	106.9	106.9	106.9	106.9
Oakdale Business Park	Senvion MM100 2MW	98.8	103.9	105.2	105.8	105.8	105.8	105.8	105.8	105.8
Pen y Fan Ganol Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Pen-y-Fan Industrial Estate	Vestas V66 1.5MW	104.6	104.6	104.6	104.6	105.6	105.6	105.6	105.6	105.6
Penyfan Leisure Park	Ropatec T30 ProS	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.5
Trecelyn	Vestas V117 STE*	97.8	102.0	105.7	107.8	108.0	108.0	108.0	108.0	108.0
Tyle Crwth	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5

* - Assumed turbine type

Table 13.13 Octave band sound power data for other turbines

Turbine	Sound power level, dB L_{WA}, per octave band, Hz, at standardised wind speed at 10 m of 8 ms^{-1}							
	63	125	250	500	1k	2k	4k	8k
Envelope	97.4	102.2	104.1	104.1	105.7	105.3	102.6	99.5
Enercon E53	85.3	92.1	94.3	96.3	98.6	96.6	88.3	77.7

Turbine	Sound power level, dB L_{WA}, per octave band, Hz, at standardised wind speed at 10 m of 8 ms^{-1}							
	63	125	250	500	1k	2k	4k	8k
Vestas V150 STE	87.9	95.6	100.2	102.0	100.9	96.8	89.9	80.0
Vestas V27	73.4	82.5	88.3	93.6	95.1	91.0	78.3	67.1
Gamesa G128	85.0	94.5	100.6	104.3	103.5	100.4	97.7	93.8
Senvion MM100	87.9	94.1	98.1	100.7	100.5	96.1	91.3	77.0
Vestas V66	88.2	95.6	100.2	102.0	100.9	97.0	90.2	80.6
Ropatec T30 ProS			78.5					
Nordex N117	85.5	92.5	97.3	98.9	101.8	100.7	98.3	88.2

13.5 Overall baseline

Current baseline

Wind Farm development and grid connection

13.5.1 The Proposed Development is located in a rural area east of Newbridge. In the vicinity of the nearest NSRs the local acoustic environment consists primarily of distant road noise from the A467 and A472, local vehicle movements, farming activities and naturogenic sounds of flora and fauna.

Future baseline

13.5.2 It is reasonable to assume that, over time, background noise levels in the vicinity of the Proposed Development would generally remain the same, with possible slight increases in road traffic noise in line with normal growth of flows of road traffic.

13.6 Embedded measures

13.6.1 A range of environmental measures have been embedded into the Proposed Development as outlined in **Section 4.9**. **Table 13.14** outlines how these embedded measures will influence the noise assessment.

Table 13.14 Summary of the embedded environmental measures

Receptor	Potential changes and effects	Embedded measures	Compliance mechanism
Construction			

Receptor	Potential changes and effects	Embedded measures	Compliance mechanism
All	Construction noise and vibration effects from site works	All construction activities undertaken in accordance with good practice as set out in BS5228-1:2009+A1:2014[21].	Construction Environmental Management Plan (CEMP)
All	Construction noise and vibration effects from site works	All employees on the construction site will be advised of quieter methods of operating plant and tools. Noise control measures (silencers, mufflers, any noise barriers, etc.) are to be subject to regular inspection and maintenance.	CEMP
All	Construction noise and vibration effects from site works	Where practicable, for any particular activity, suitable plant, machinery and working practices will be adopted.	CEMP
All	Construction noise and vibration effects from site works	Construction plant capable of generating significant noise and vibration levels will be operated in a manner to minimise noise emissions.	CEMP

13.7 Scope of the assessment

The Proposed Development

13.7.1 Wind farm noise assessment is part of an iterative design process, the aim of which is to achieve a design from which cumulative turbine noise emissions meet limits derived following the approach given in ETSU-R-97[6]. Consequently, the design of the scheme is such that relevant operational noise limits are met, and no additional environmental mitigation measures are necessary. By way of separation between receptors and turbines resulting from this process, construction noise is also limited, thus only general good-practice noise control measures are required, and no specific mitigation is necessary.

13.7.2 The EIA Regulations 2017 require that all 'significant' effects be identified. The majority of noise related guidance and standards (including ETSU-R-97[6]) are not directly related to the concepts of 'significant' and 'not significant' that underpin the EIA process. However, for the purposes of this assessment, the determination of effect significance is based upon compliance with the applicable noise limits; i.e., breach of the cumulative turbine noise limits indicates a 'significant' effect, whereas compliance with the cumulative turbine noise limits indicates a 'not significant' effect.

13.7.3 The agreed approach and scope for this chapter (in accordance with the noise and vibration chapter within the Scoping Report and subsequent Scoping Direction) is that construction noise and vibration (piling only, if required), operational noise, and construction traffic will be assessed.

13.7.4 On the basis of the information provided in **Chapter 4: Project Description Section 4.5: Construction Activities**, the only construction activity that may be required with the potential to generate significant levels of vibration is piling for the wind turbine

foundations. It is noted that the nearest dwelling to any potential piling activities is R5, located approximately 400m west of proposed turbine 1. Due to the separation distances involved, it is considered that the potential for significant effects due to vibration during construction and operation of the Proposed Development is negligible. Therefore, based on the above, quantitative assessment of construction vibration has not been carried out, and potential vibration effects have been assessed qualitatively.

13.7.5 It is assumed that decommissioning noise would be generally less than, or at most, similar to, that experienced during the construction period. It is therefore considered that noise impacts relating to the decommissioning of wind turbines would be no worse than those experienced during construction, provided similar restrictions on working hours and transport routes are applied. Noise from decommissioning has therefore been scoped out of further assessment.

Spatial scope

13.7.6 The spatial scope of the assessment of noise covers the area of the Proposed Development contained within the red line boundary, together with the Zones of Influence (ZoIs) that have formed the basis of the study area described in **Section 13.4**.

13.7.7 Receptors have been identified using the screening approach outlined within ETSU-R-97[6]. The screening approach can be adopted where noise at receptors from proposed and existing wind turbines does not exceed 35 dB $L_{A90,10min}$ in wind speeds of 10 ms^{-1} at a standardised height of 10 m. Receptors that are predicted to experience wind turbine noise levels higher than 35 dB $L_{A90,10min}$ have been included in the assessment.

13.7.8 Initial noise modelling of the Proposed Development indicated that properties to the west and southwest would likely fall within the 35 dB $L_{A90,10min}$ contour and thus are considered further within this chapter.

Temporal scope

13.7.9 The temporal scope of the assessment of noise is consistent with the period over which the Project would be carried out and therefore covers the 30 years of operation.

Potential receptors

13.7.10 The principal noise receptors that have been identified as being potentially subject to effects are summarised in **Table 13.15**.

Table 13.15 Noise receptors subject to potential effects

Receptor	Reason for consideration
Residential receptors	Considered of high sensitivity in respect to noise.
Ecological receptors	Have the potential to be affected by changes in the ambient noise level. These receptors are considered further in **Chapter 9: Ornithology.**

13.7.11 The residential receptors considered further in this assessment are detailed in **Table 13.16** and shown in **Figure 13.1**.

Table 13.16 Potential residential receptors

Reference	Receptor Location	Approximate Easting	Approximate Northing	Representative monitoring location
R1	Rhyswg-ganol	323737	194800	M1
R2	Bwthyn Mamgu	322624	194633	M1
R3	Graigwen Bungalow, Gwyddon Rd	322501	195274	M1
R4	Roxburgh Bungalow	322411	195552	M1
R5	Glan Shon Farm	322464	195969	M1
R6	Blaendwrney Farm Dwelling	322973	197807	M2
R7	Old Pant Road, Newbridge	322186	198053	M3
R8	Cefn-rhos-y-bedd-uchaf	322543	198178	M3
R9	Ty Oakley	322840	198311	M3
R10	Pen-y-Caeau	323259	198280	M3
R11	Ty-hir, Cefn-Crib Rd	323635	199278	M4
R12	Tir Shon Shenkin	324079	199177	M4
R13	Bwthyn Yr Ysgol, Blaen-y-cwm Rd	324453	199614	M4
R14	Cefn-y-Crib Farm, Blaen-y-Cwm Rd	324295	199851	M4

Likely significant effects

13.7.12 The effects on noise receptors which have the potential to be significant and are being taken forward for detailed assessment are summarised in **Table 13.17**.

Table 13.17 Summary of effects scoped in for further assessment

Activity	Likely significant effects
Piling noise	Noise disturbance to receptors in the area of activities
Construction traffic movements	Disturbance to receptors on the construction traffic route
Operational turbine noise	Noise disturbance from wind turbines

13.7.13 In addition to the above, noise and vibration effects from the operation of the grid connection are considered qualitatively, as described in **Chapter 4: Project Description**.

13.7.14 The receptors/effects detailed in **Table 13.18** have been scoped out from being subject to further assessment because the potential effects are not considered likely to be significant.

Table 13.18 Summary of effects scoped out of the noise assessment

Activity	Justification
Blasting	Blasting would be very unlikely to be undertaken as part of the construction of the Proposed Development, however if any blasting is to occur it would be controlled via a blasting management plan as part of a planning condition requirement.
Construction vibration	The only activity likely to be required with the potential to generate significant construction vibration is impact piling for the turbine foundations. However the distances to the nearest receptors is such (the closest receptor to a turbine is approximately 400 m away) that it is unlikely there would be any significant effects due to construction vibration.
Construction activities other than piling	Noise emissions from construction activities other than piling (including vehicles on haul routes, but not on existing roads) are unlikely to be high enough, given the distance of the Proposed Development to NSRs, to warrant a noise assessment. Therefore, construction activities other than piling have been scoped out from further assessment. However, planning conditions regarding standard times of work should apply.
Operational traffic	Operational traffic noise during the operation of the Proposed Development is scoped out as the amount of traffic associated during the operational phase would be minimal. See **Chapter 12: Traffic and Transport** for further details.
Decommissioning	The effects of decommissioning on any NSRs are likely to be similar in nature but of a lower magnitude than those during the construction phase. As a result, it is not proposed to assess the decommissioning phase of the development in addition to that of the construction phase.
Construction of the grid connection	Whilst there would be some construction noise associated with the grid connection at nearby residences, this would be temporary in nature. It is unlikely that the construction works associated with these connections would last for more than 10 days within any consecutive 15 or for a total number of days exceeding 40 in any 6 consecutive months, and therefore noise effects due to the construction at the grid connection has been scoped out from further assessment.

13.8 Assessment methodology

13.8.1 The generic project-wide approach to the assessment methodology is set out in **Chapter 2: Approach to Environmental Impact Assessment** and specifically in **Sections 2.5 to 2.8**. However, whilst this has informed the approach that has been used in this noise assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this noise assessment.

Construction noise assessment methodology

Construction traffic

13.8.2 The assessment of increases in road traffic noise during the construction phase is undertaken based on the available traffic flow data with reference to CRTN[Error! Bookmark not defined.] and DMRB[23].

13.8.3 Generally, it is anticipated that additional vehicle movements generated by the construction phase would be negligible compared to baseline flows of vehicles.

13.8.4 DMRB[23] states that, for the definition of the study area for construction traffic noise, road links *'with the potential for an increase in the baseline noise level of 1 dB(A) or more'* should be included. As a guide it takes an increase of 25% in traffic flows to have an increase in noise levels of 1 dB, though a higher proportion of HGVs would require less of an increase to give rise to an increase of 1 dB. The criteria for magnitude of impact due to short term increases of road noise provided in Table 3.54a of DMRB[23] indicates that any increase less than 1.0 dB is equivalent to an impact of negligible magnitude.

Construction activities

13.8.5 BS 5228-1:2009+A1:2014[21] includes guidelines relating to the acceptability of noise from construction sites. The appropriate noise limit for a project in an area such as the Proposed Development would be 65 dB $L_{Aeq,T}$ during the daytime (from 07:00 to 19:00 hrs on weekdays and from 07:00 to 13:00 hrs on Saturdays).

13.8.6 The precise construction methodology for the Site would not be finalised until such a time as a contractor is commissioned to build the development and as such the actual plant to be used is not yet known. The plant list provided in **Table 13.19** is based upon experience of other wind farm construction projects. The noise emission data quoted is taken from BS 5228-1:2009+A1:2014[21].

Table 13.19 Construction plant source data (piling only)

Plant	dB $L_{Aeq,T}$ at 10m	Number of plant	% on time	Typical sound power level dBA	Data source
Large rotary bored piling rig	83	1	100	112	BS 5228-1:2009+A1:2014[2121] Table C.3 Reference 14

13.8.7 Estimates of piling noise are undertaken in accordance with Annex F of BS 5228-1:2009+A1:2014[21].

Proposed Development operation assessment methodology

13.8.8 Planning Policy Wales (PPW) refers to ETSU-R-97[6] for guidance on the assessment of noise from wind farms.

13.8.9 Consequently, the assessment methodology adopted is that found in ETSU-R-97[6]. The advice presented in the document was produced by The Working Group on Noise from Wind Turbines, a body comprising a number of interested parties including, amongst others, wind farm operators, environmental health officers, acoustic consultants and legal

experts. The assessment approach was developed to address the shortcomings of other methods used to assess wind farm noise.

Noise limits

13.8.10 Acceptable limits for wind turbine operational noise are defined in ETSU-R-97[6]. The test for operational noise is therefore whether or not the cumulative wind turbine noise levels at noise sensitive properties lie at or below the noise limits derived in accordance with ETSU-R-97[6]. The key assessment is the cumulative assessment as ETSU-R-97[6] requires all wind farm noise to be assessed against a baseline free of wind farm noise. However, an assessment of the Proposed Development on its own has also been included for information, but does not affect the significance of effect from the Proposed Development.

13.8.11 Preliminary modelling for the Proposed Development indicated that operational noise was likely to exceed this threshold at a number of surrounding properties. The ETSU-R-97[6] Guidance therefore recommends that wind farm noise limits should be set relative to existing background noise levels, subject to a fixed minimum limit, and that these limits should reflect the variation in background noise with wind speed. The wind speeds that should be considered range from the cut-in speed up to 12 ms^{-1}, the point at which turbines are usually at or above 95% of their rated power and thus no significant increases in noise emissions are expected. Wind speeds are referenced to a 10-metre measurement height (V10) on the wind farm site.

13.8.12 The daytime noise limit is derived from background noise data measured at residential properties during the 'quiet daytime', as defined in ETSU-R-97[6], which comprises:

- Weekday evenings (from 18:00 to 23:00 hrs);
- Saturday afternoons and evenings (from 13:00 to 23:00 hrs); and
- All Sunday daytime (from 07:00 to 23:00 hrs).

13.8.13 The noise measurements are plotted against the concurrent wind speed data measured at the application site and a 'best fit' correlation is established.

13.8.14 In low noise environments (i.e. where background noise levels are less than 30 to 35 dBA, the ETSU-R-97[6] Guidance recommends that wind farm noise for quiet daytime periods should be limited to a lower fixed level within the range 35 to 40 dB $L_{A90,10min}$ or 5 dB above the prevailing background, whichever is the greater. The choice of which lower fixed level to use within the range is based upon a number of factors as outlined in Paragraph 22 of the ETSU-R-97[6] Guidance. These include:

- The number of dwellings in the neighbourhood of the wind farm;
- The effect of noise limits on the amount of electricity generated; and
- The duration and level of exposure.

13.8.15 The Scoping Report states that the cumulative assessment will be based on a daytime lower fixed noise limit of 40 dB $L_{A90,10min}$, based on the cumulative level of power provided by all the wind farms together, an approach advocated within ETSU-R-97[6]. Consideration of noise from the Proposed Development on its own is based upon a lower fixed limit of 35 dB $L_{A90,10min}$ for the daytime, to provide an indicative assessment of the potential impact from the Proposed Development alone.

13.8.16 The night-time noise limit is derived from the background noise data measured during the night-time period (23:00 to 07:00 hrs) every day. As with the daytime data, this is plotted against the concurrent wind speed data and a 'best fit' correlation established. For night-

time periods, the ETSU-R-97[6] recommended limits are 43 dB $L_{A90,10min}$ or 5 dB above prevailing background, whichever is the greater.

13.8.17 The only exception to the daytime and night-time limits outlined above is for properties with a financial involvement in the development where ETSU-R-97[6] limits can be increased to 45 dB $L_{A90,10min}$ (or 5 dB above the prevailing background, whichever is greater). Receptor 5 - Glan Shon Farm is considered as having a financial benefit from the Proposed Development, therefore the higher noise limits have been adopted for this location.

13.8.18 The ETSU-R-97[6] noise criteria assumes that the wind turbine noise contains no audible tones. Where tones are present, a correction is added to the measured or predicted noise level before comparison with the recommended limits. The level of correction will depend on how audible the tone is. A warranty would be sought from the manufacturers of the turbine selected for the Proposed Development such that the noise output would either not require a tonal correction (under the ETSU-R-97[6] Guidance) or, where tonal corrections are required, the noise criteria would be met having made the appropriate correction for any tonal component.

13.8.19 The ETSU-R-97[6] Guidance states the $L_{A90,10min}$ descriptor should be used for both the background noise and wind farm noise when setting limits.

Research background

13.8.20 The Institute of Acoustics (IOA) published 'A Good Practice Guide to the Application of ETSU-R-97[6] for the Assessment and Rating of Wind Turbine Noise'11. The use of the IOA GPG[14] in the assessment of wind turbine noise has been endorsed by Welsh Government. Carl Sargeant, Minister for Housing and Regeneration, Welsh Government, stated in a letter to the IOA on 22 May 2013:

"The assumptions listed in the section below are all confirmed within the IOA GPG as the correct approach to modelling wind turbine noise emissions."

13.8.21 In line with the IOA GPG[14], the model used in this assessment is based upon that found in ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors[36]. The model takes account of:

- Geometric divergence (attenuation with distance);
- Air absorption;
- Barriers (including buildings or topography);
- Screening (including vegetation); and
- Ground absorption and reflection.

13.8.22 The ISO 9613-2[36] algorithm has been chosen as being the most robust prediction method, based on the findings of a joint European Commission research project into wind farm noise propagation over large distances. According to this research, this model (like all others considered in the research) tends to over-estimate noise levels at nearby dwellings, rather than under-estimate them. The conclusion of the study was that the ISO 9613-2[36] algorithm tended to predict noise levels that would generally occur under downwind propagation conditions.

[36] International Standards Organization (1996). *ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*. ISO, Geneva.

13.8.23 Another important outcome of the research demonstrated that under upwind propagation conditions between a given receiver and the wind farm, the wind farm noise level at that receiver will be as much as 10 to 15 dB lower than the level predicted using the ISO 9613-2[36] algorithm.

Operational noise modelling

13.8.24 For the purposes of the present assessment, noise level predictions have been based upon the following assumed model parameters:

- A receiver height of 4.0 metres above local ground level – to represent the height of a typical bedroom window;
- Mixed ground (G = 0.5) – this represents a ground cover that has equal amounts of fully reflective and fully absorptive character. For the purposes of this assessment, mixed ground represents a ground cover that is as equally absorptive of noise as it is reflective;
- Air absorption based on a temperature of 10°C and 70% relative humidity;
- $L_{A90,10min}$ is 2 dB less than $L_{Aeq,10min}$ for wind farm noise; and
- Predicted turbine noise levels are inclusive of any 'valley effect' penalty (discussed below).

Valley effect

13.8.25 The IOA GPG[14] recommends that a noise correction is applied in circumstances where the intervening terrain height between a proposed wind development and sensitive receptors drops away significantly. Where a 'valley effect' is shown to occur, a penalty of 3 dB (or 1.5 dB if a ground absorption factor of 0 is being used) is applied to the overall predicted noise level at receptors.

Significance evaluation methodology

13.8.26 The assessment of significant operational noise effects is based upon compliance with the ETSU-R-97[6] derived cumulative turbine noise limits, i.e., a breach of the cumulative turbine noise limits indicates a 'significant' effect, whereas compliance with cumulative turbine noise limits indicates a 'not significant' effect. It is acknowledged that the ETSU-R-97[6] approach does not directly aim to determine significance in an EIA context, rather it represents a balance between the need for wind energy and the need to protect residential amenities. Since the purpose of identifying significant effects during EIA is to ensure they are taken into account in the 'planning balance', for the purposes of this assessment it is assumed that noise effects up to the ETSU-R-97[6] noise limits have already been taken into account and thus only noise levels exceeding the ETSU-R-97[6] noise limits are deemed to be 'significant' and require further consideration.

13.9 Preliminary assessment of noise effects

Construction of Proposed Development (piling only)

13.9.1 Predictions of the noise levels from piling have been undertaken to find the distance at which 65 dB $L_{Aeq,T}$ would no longer be experienced as summarised in **Table 13.20**.

Table 13.20 Predicted noise levels during construction phase (piling only)

Plant item	dB $L_{Aeq,T}$ @ 10m	Distance at which resultant $L_{Aeq,T}$ is below 65 dB, m
Large rotary bored piling rig	84	80

13.9.2 As no NSRs fall within 80m of the construction area where piling could take place, it is considered highly unlikely that an exceedance of 65 dB $L_{Aeq,T}$ would be experienced at the NSRs due to piling. Therefore, the noise effects as a result of construction are considered to be **not significant**.

Construction traffic

13.9.3 Information on likely construction traffic routes and movements provided in **Chapter 12: Traffic and Transport** states that construction traffic would take one of two possible routes:

- Route 1: Hafod Quarry (directly to the east of the Site);
- Route 2: Trefil Quarry (to the North of the Site via the A4046);

13.9.4 Traffic flow data has been assessed, which assumes an equal split of traffic on both Route 1 and Route 2. The prediction of the change in the Basic Noise Level (BNL) due to construction traffic during the peak of vehicle movements is provided in **Table 13.21** below.

Table 13.21 Construction road traffic noise change prediction

Link	Baseline 2026			Baseline 2026 plus construction traffic			Predicted increase in BNL, dB
	18hr AAWT	%HGV	BNL, dB L_{A10}	18hr AAWT	%HGV	BNL, dB L_{A10}	
A4046	17264	1.0	72	17288	1.2	72	0.0
A467	14789	2.8	72	14814	2.9	72	0.0
A467	22992	3.2	74	23016	3.3	74	0.0

13.9.5 The results in **Table 13.21** indicate that predicted noise increases due to construction traffic are less than 1 dB. Even if all construction traffic used the same route, predicted noise increases would still be below 1 dB. On this basis, impacts to road traffic noise due to construction traffic would be negligible and would result in effects which are **not significant**.

Operation of Proposed Development

13.9.6 Noise levels have been predicted for the closest residential properties to the wind farm, as shown in **Figure 13.1** and listed in **Table 13.16**. As per the IOA GPG[14], to account for the use of 10m wind speeds, the turbine noise results at residential receptors have been

shifted to the left along the wind speeds (e.g. the prediction results for 10 ms^{-1} are compared against the baseline and criteria for 7 ms^{-1}). This is to account for the potentially much higher wind shear gradient on the Site than would normally be specified with turbine noise corrections at 10m height. This correction is already embedded in the results tables below.

13.9.7 **Table 13.22** and **Table 13.23** present the following information for each wind speed for each of the properties for daytime and night-time respectively:

- The noise limits derived from the ETSU-R-97[6] Guidance and IOA GPG[14] based on background noise levels measured;
- The predicted turbine noise levels (as corrected) from the Proposed Development, based on worst-case downwind noise propagation and inclusive of any 'valley effect' penalty at receptors and assuming turbines are operating simultaneously; and
- The margin by which the predicted turbine noise, inclusive of any 'valley effect' penalty, meets the noise limits at each wind speed using the worst-case downwind noise predictions (negative values indicate the predicted noise levels are lower than the noise limits).

13.9.8 It should be noted, as outlined in **paragraph 13.8.10**, that the assessments presented in **Table 13.22** and **Table 13.23** are for information only. In accordance with ETSU-R-97[6] Guidance and IOA GPG[14] it is the cumulative assessment which determines the significance of wind turbine noise at each receptor.

Table 13.22 Noise assessment – daytime

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
R1 - Rhyswg-ganol									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	23.0	27.2	31.0	32.9	33.2	33.2	33.2	33.2	33.2
Difference wrt noise limit	-18.3	-15.1	-12.7	-12.8	-15.1	-18.5	-22.6	-27.6	-27.6
R2 - Bwthyn Mamgu									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	25.0	29.2	33.0	34.9	35.2	35.2	35.2	35.2	35.2
Difference wrt noise limit	-16.3	-13.1	-10.7	-10.8	-13.1	-16.5	-20.6	-25.6	-25.6
R3 - Graigwen Bungalow, Gwyddon Rd									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	26.4	30.6	34.4	36.3	36.6	36.6	36.6	36.6	36.6
Difference wrt noise limit	-14.9	-11.7	-9.3	-9.4	-11.7	-15.1	-19.2	-24.2	-24.2
R4 - Roxburgh Bungalow									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	29.2	33.4	37.2	39.1	39.4	39.4	39.4	39.4	39.4

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
Difference wrt noise limit	-12.1	-8.9	-6.5	-6.6	-8.9	-12.3	-16.4	-21.4	-21.4
R5 - Glan Shon Farm									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	45.0	45.0	45.0	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	33.3	37.5	41.3	43.2	43.5	43.5	43.5	43.5	43.5
Difference wrt noise limit	-11.7	-7.5	-3.7	-2.5	-4.8	-8.2	-12.3	-17.3	-17.3
R6 - Blaengawney Farm Dwelling									
Background noise curve	30.7	32.3	34.1	36.3	38.9	41.7	45.0	48.5	51.8
ETSU-R-97 derived noise limit	35.7	37.3	39.1	41.3	43.9	46.7	50.0	53.5	53.5
Wind Farm turbine noise	27.0	31.2	35.0	36.9	37.2	37.2	37.2	37.2	37.2
Difference wrt noise limit	-8.7	-6.1	-4.1	-4.4	-6.7	-9.5	-12.8	-16.3	-16.3
R7 - Old Pant Road, Newbridge									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	37.5	39.4	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	22.7	26.9	30.7	32.6	32.9	32.9	32.9	32.9	32.9
Difference wrt noise limit	-14.8	-12.5	-10.9	-11.5	-14.0	-16.9	-19.9	-23.1	-23.1
R8 - Cefn-rhos-y-bedd-uchaf									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	37.5	39.4	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	23.2	27.4	31.2	33.1	33.4	33.4	33.4	33.4	33.4
Difference wrt noise limit	-14.3	-12.0	-10.4	-11.0	-13.5	-16.4	-19.4	-22.6	-22.6
R9 - Ty Oakley									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	37.5	39.4	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	24.1	28.3	32.1	34.0	34.3	34.3	34.3	34.3	34.3
Difference wrt noise limit	-13.4	-11.1	-9.5	-10.1	-12.6	-15.5	-18.5	-21.7	-21.7
R10 - Pen-y-Caeau									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	37.5	39.4	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	27.0	31.2	35.0	36.9	37.2	37.2	37.2	37.2	37.2
Difference wrt noise limit	-10.5	-8.2	-6.6	-7.2	-9.7	-12.6	-15.6	-18.8	-18.8
R11 - Ty-hir, Cefn-Crib Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	35.0	37.5	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	24.6	28.8	32.6	34.5	34.8	34.8	34.8	34.8	34.8
Difference wrt noise limit	-10.4	-8.7	-7.7	-8.5	-10.3	-11.4	-11.4	-11.4	-11.4
R12 - Tir Shon Shenkin									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	35.0	37.5	40.3	43.0	45.1	46.2	46.2	46.2	46.2

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
Wind Farm turbine noise	26.1	30.3	34.1	36.0	36.3	36.3	36.3	36.3	36.3
Difference wrt noise limit	-8.9	-7.2	-6.2	-7.0	-8.8	-9.9	-9.9	-9.9	-9.9
R13 - Bwthyn Yr Ysgol, Blaen-y-cwm Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	35.0	37.5	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	22.2	26.4	30.2	32.1	32.4	32.4	32.4	32.4	32.4
Difference wrt noise limit	-12.8	-11.1	-10.1	-10.9	-12.7	-13.8	-13.8	-13.8	-13.8
R14 - Cefn-y-Crib Farm, Blaen-y-Cwm Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	35.0	37.5	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	20.3	24.5	28.3	30.2	30.5	30.5	30.5	30.5	30.5
Difference wrt noise limit	-14.7	-13.0	-12.0	-12.8	-14.6	-15.7	-15.7	-15.7	-15.7

Table 13.23 Noise assessment – night-time

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
R1 - Rhyswg-ganol									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	23.0	27.2	31.0	32.9	33.2	33.2	33.2	33.2	33.2
Difference wrt noise limit	-20.0	-15.8	-12.0	-10.1	-10.7	-14.3	-18.6	-23.6	-23.6
R2 - Bwthyn Mamgu									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	25.0	29.2	33.0	34.9	35.2	35.2	35.2	35.2	35.2
Difference wrt noise limit	-18.0	-13.8	-10.0	-8.1	-8.7	-12.3	-16.6	-21.6	-21.6
R3 - Graigwen Bungalow, Gwyddon Rd									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	26.4	30.6	34.4	36.3	36.6	36.6	36.6	36.6	36.6
Difference wrt noise limit	-16.6	-12.4	-8.6	-6.7	-7.3	-10.9	-15.2	-20.2	-20.2
R4 - Roxburgh Bungalow									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	29.2	33.4	37.2	39.1	39.4	39.4	39.4	39.4	39.4
Difference wrt noise limit	-13.8	-9.6	-5.8	-3.9	-4.5	-8.1	-12.4	-17.4	-17.4
R5 - Glan Shon Farm									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	45.0	45.0	45.0	45.0	45.0	47.5	51.8	56.8	56.8

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
Wind Farm turbine noise	33.3	37.5	41.3	43.2	43.5	43.5	43.5	43.5	43.5
Difference wrt noise limit	-11.7	-7.5	-3.7	-1.8	-1.5	-4.0	-8.3	-13.3	-13.3
R6 - Blaengawney Farm Dwelling									
Background noise curve	26.1	28.2	30.8	33.6	36.6	39.4	41.9	44.0	44.0
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	44.4	46.9	49.0	49.0
Wind Farm turbine noise	27.0	31.2	35.0	36.9	37.2	37.2	37.2	37.2	37.2
Difference wrt noise limit	-16.0	-11.8	-8.0	-6.1	-5.8	-7.2	-9.7	-11.8	-11.8
R7 - Old Pant Road, Newbridge									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	22.7	26.9	30.7	32.6	32.9	32.9	32.9	32.9	32.9
Difference wrt noise limit	-20.3	-16.1	-12.3	-10.4	-11.6	-14.7	-17.6	-20.2	-20.2
R8 - Cefn-rhos-y-bedd-uchaf									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	23.2	27.4	31.2	33.1	33.4	33.4	33.4	33.4	33.4
Difference wrt noise limit	-19.8	-15.6	-11.8	-9.9	-11.1	-14.2	-17.1	-19.7	-19.7
R9 - Ty Oakley									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	24.1	28.3	32.1	34.0	34.3	34.3	34.3	34.3	34.3
Difference wrt noise limit	-18.9	-14.7	-10.9	-9.0	-10.2	-13.3	-16.2	-18.8	-18.8
R10 - Pen-y-Caeau									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	27.0	31.2	35.0	36.9	37.2	37.2	37.2	37.2	37.2
Difference wrt noise limit	-16.0	-11.8	-8.0	-6.1	-7.3	-10.4	-13.3	-15.9	-15.9
R11 - Ty-hir, Cefn-Crib Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	24.6	28.8	32.6	34.5	34.8	34.8	34.8	34.8	34.8
Difference wrt noise limit	-18.4	-14.2	-10.4	-8.5	-8.2	-10.8	-10.8	-10.8	-10.8
R12 - Tir Shon Shenkin									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	26.1	30.3	34.1	36.0	36.3	36.3	36.3	36.3	36.3
Difference wrt noise limit	-16.9	-12.7	-8.9	-7.0	-6.7	-9.3	-9.3	-9.3	-9.3
R13 - Bwthyn Yr Ysgol, Blaen-y-cwm Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	22.2	26.4	30.2	32.1	32.4	32.4	32.4	32.4	32.4
Difference wrt noise limit	-20.8	-16.6	-12.8	-10.9	-10.6	-13.2	-13.2	-13.2	-13.2
R14 - Cefn-y-Crib Farm, Blaen-y-Cwm Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	20.3	24.5	28.3	30.2	30.5	30.5	30.5	30.5	30.5
Difference wrt noise limit	-22.7	-18.5	-14.7	-12.8	-12.5	-15.1	-15.1	-15.1	-15.1

13.9.9 The results show that predicted turbine noise levels are below the ETSU-R-97[6] derived noise limits at all receptors during the daytime and night-time. The results indicate that the potential for significant effects due to noise emissions from the Proposed Development is low.

13.9.10 Potentially significant effects are considered further in the cumulative assessment in **Section 13.10**.

Other operational noise issues

Infrasound and low frequency noise

13.9.11 Infrasound is generally defined as pressure waves with a frequency below 20 Hz. The human hearing threshold is much reduced below 20 Hz compared to higher frequencies. The exact definition of low frequency noise varies, but generally spans the infrasonic and audible ranges from around 10 Hz to 200 Hz.

13.9.12 Information published by the British Wind Energy Association (BWEA, now RenewableUK) 'Low Frequency Noise and Wind Turbines'[37] presents a review of a number of sources of information on low frequency noise. Based upon these sources, it is concluded that levels for wind turbines lie below the threshold of perception even for those who are particularly sensitive to such noise.

13.9.13 The report 'The Measurement of Low Frequency Noise at three UK Wind Farms'[38] presents the results of a number of measurements taken at wind farm sites throughout the UK. The study concluded that modern wind turbines are not sources of infrasound at levels which could be injurious to the health of a wind farm neighbour. At all of the measurement sites, low frequency noise associated with traffic movement along local roads was greater than that associated with the wind farm.

13.9.14 Furthermore, in its discussions of wind farm noise, TAN 8 states in paragraph 2.17:

"There is no evidence that ground transmitted low frequency from wind turbines is at a sufficient level to be harmful to human health."

[37] The British Wind Energy Association (2005). *Low Frequency Noise and Wind Turbines*. [online] Available at: http://www.windmeasurementinternational.com/Info/bwea_low_frequency_noise_report.pdf [Accessed 30 October 2023].
[38] Hayes McKenzie Partnership (2006). *The Measurement of Low Frequency Noise at Three UK Wind Farms.* Department of Trade and Industry, London.

Other Amplitude Modulation (OAM)

13.9.15 Amplitude Modulation (AM) is a normal characteristic of noise from a rotating turbine when stood close to it. AM is a variation in noise level over time, often described by observers as a repeating 'blade swish' noise. The AM of the aerodynamic noise observed close to the turbine is principally caused by trailing-edge noise from the rotating blades and is termed 'Normal' Amplitude Modulation (NAM).

13.9.16 The noise limits derived following the procedure recommended by the ETSU-R-97[6] Guidance takes into account the phenomenon of NAM and thus afford receptors some protection. However, in unusual and rare occurrences where AM occurs outside the definition and mechanisms of NAM, this is known as 'Other' Amplitude Modulation (OAM). Examples of OAM include circumstances where AM is detected in the far-field downwind from the wind turbines or resulting in greater than expected variations in magnitude. Observers of OAM often describe the noise as a 'thump' in character rather than a 'swish'.

13.9.17 The DTI (Department of Trade and Industry), now Department for Business, Energy and Industrial Strategy (BEIS)) study undertaken by Hayes McKenzie into low frequency noise[39] referred to above also investigated the phenomenon of OAM. It was found that internal noise levels associated with aerodynamic modulation were above the threshold of audibility at some properties. While measurements within the report indicated these were not high enough to wake occupiers of a room, they could result in difficulties returning to sleep once awoken.

13.9.18 Following publication of the report[40] in 2005, the DTI published a guidance note in 2006 to advise planning authorities on the issue[41]. It states that concerns apparently relating to the phenomenon have been expressed at five out of the (then) 126 operational wind farms throughout the UK. It is categorically stated that the ETSU-R-97[6] Guidance should continue to be used for the assessment of noise from wind farms and it was not considered necessary to further consider the issue of OAM for the Proposed Development.

13.9.19 The DTI Noise Working Group commissioned Salford University to investigate the occurrence of the phenomenon in more detail. A survey was conducted of local authorities to investigate the extent of OAM, and complaint histories were analysed to determine the number of complainants. The phenomenon was considered to be a factor in four of the sites at which there had been complaints and a possible factor at eight further sites. It was found that meteorological conditions were such that the effect would prevail for between 7 – 15% of the time and could persist for several days. The report concluded that given the low incidence of OAM and the low numbers of people involved it is difficult to justify further research; however, they do state it may be prudent to attempt to improve our understanding as the phenomenon cannot be predicted at present.

13.9.20 Following publication of the report in 2007, BERR released a statement as follows:

"Based on these findings, Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time; however, it will continue to keep the issue under review."

[39] Department of Trade and Industry (2006). *Advice on findings of the Hayes McKenzie report on noise arising from wind farms*. DTI, London.
[40] University of Salford (2007). *Research into aerodynamic modulation of wind turbine noise.* Department of Business Enterprise and Regulatory Reform, Salford.
[41] RenewableUK (2013). *Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects*. [online] Available at: https://cdn.ymaws.com/www.renewableuk.com/resource/collection/4E7CC744-FEF2-473B-AF2B-135FF2AA3A43/ruk_wind_turbine_amplitude_modulation_dec_2013_v2_(1).pdf [Accessed 30 October 2023].

13.9.21 It is noted that the Institute of Acoustics Nosie Working Group (IOA NWG) tasked with putting together the IOA GPG[14] at the time of publication were unwilling to propose a method for predicting OAM. In relation to OAM, the IOA GPG states:

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

13.9.22 In December 2013, RenewableUK published Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects. The RenewableUK report comprises detailed scientific research into the identification of occurrence and mitigation of OAM. The mechanisms for the occurrence of OAM were found to be generally site specific therefore any proposed mitigation would likely have to be tailored on a site by site basis. As part of the research, members of the Institute of Acoustics developed a proposed planning condition that could be used by Local Authorities and tools for confirming its detection.

13.9.23 More recently, BS 8233:2014 Guide on sound insulation and noise reduction for buildings[42] states:

"Excess AM can sometimes occur. However, it cannot be predicted at the planning stage with the current state of the art."

13.9.24 Given that the current understanding of the mechanisms of OAM are still in development and that an exact choice of turbine is yet to be determined for the Proposed Development, accurate predictions of the likelihood of its occurrence are not possible. It has therefore been determined that it is not necessary to apply a penalty for OAM at the planning stage.

13.9.25 Should an occurrence of OAM occur that gives rise to a Statutory Nuisance, then remedies remain available to the Local Authority under the Environmental Protection Act 1990.

13.10 Assessment of cumulative (inter-project) effects

13.10.1 A Cumulative Effects Assessment (CEA) has been undertaken for the Proposed Development which considers the combined impacts with other developments on the same single receptor or resource (inter-project effects) and constitutes the significance of effect from the development.

13.10.2 **Table 13.24** and **Table 13.25** present the information summarised in the modelling approach for all wind farms contributing to the noise levels at the receptors listed in **Table 13.16**.

13.10.3 The modelling results assume all wind turbines are acting directly downwind of all receptors at the same time, showing an absolute worst-case scenario.

Table 13.24 Noise assessment – cumulative daytime

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
R1 - Rhyswg-ganol									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8

[42] British Standards Institution (2014). *BS 8233:2014 Guide on sound insulation and noise reduction for buildings*. BSI, London.

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	26.1	30.5	34.1	35.6	35.3	35.0	34.8	34.8	34.8
Difference wrt noise limit	-15.2	-11.8	-9.6	-10.1	-13.0	-16.7	-21.0	-26.0	-26.0
R2 - Bwthyn Mamgu									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	27.3	31.6	35.2	36.9	36.7	36.5	36.4	36.4	36.4
Difference wrt noise limit	-14.0	-10.7	-8.5	-8.8	-11.6	-15.2	-19.4	-24.4	-24.4
R3 - Graigwen Bungalow, Gwyddon Rd									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	27.6	31.8	35.5	37.4	37.4	37.2	37.2	37.2	37.2
Difference wrt noise limit	-13.7	-10.5	-8.2	-8.3	-10.9	-14.5	-18.6	-23.6	-23.6
R4 - Roxburgh Bungalow									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	41.3	42.3	43.7	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	30.0	34.2	37.9	39.8	39.9	39.8	39.8	39.8	39.8
Difference wrt noise limit	-11.3	-8.1	-5.8	-5.9	-8.4	-11.9	-16.0	-21.0	-21.0
R5 - Glan Shon Farm									
Background noise curve	36.3	37.3	38.7	40.7	43.3	46.7	50.8	55.8	55.8
ETSU-R-97 derived noise limit	45.0	45.0	45.0	45.7	48.3	51.7	55.8	60.8	60.8
Wind Farm turbine noise	33.7	37.9	41.6	43.7	43.8	43.7	43.7	43.7	43.7
Difference wrt noise limit	-11.3	-7.1	-3.4	-2.0	-4.5	-8.0	-12.1	-17.1	-17.1
R6 - Blaengawney Farm Dwelling									
Background noise curve	30.7	32.3	34.1	36.3	38.9	41.7	45.0	48.5	51.8
ETSU-R-97 derived noise limit	40.0	40.0	40.0	41.3	43.9	46.7	50.0	53.5	53.5
Wind Farm turbine noise	29.6	33.9	37.4	39.1	38.9	38.7	38.5	38.5	38.5
Difference wrt noise limit	-10.4	-6.1	-2.6	-2.2	-5.0	-8.0	-11.5	-15.0	-15.0
R7 - Old Pant Road, Newbridge									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	40.0	40.0	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	27.9	32.0	35.2	36.6	36.3	36.0	35.9	35.9	35.9
Difference wrt noise limit	-12.1	-8.0	-6.4	-7.5	-10.6	-13.8	-16.9	-20.1	-20.1
R8 - Cefn-rhos-y-bedd-uchaf									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	40.0	40.0	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	27.8	32.1	35.5	36.9	36.5	36.2	36.0	36.0	36.0
Difference wrt noise limit	-12.2	-7.9	-6.1	-7.2	-10.4	-13.6	-16.8	-20.0	-20.0
R9 - Ty Oakley									

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	40.0	40.0	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	28.9	33.1	36.5	37.9	37.6	37.2	37.0	37.0	37.0
Difference wrt noise limit	-11.1	-6.9	-5.1	-6.2	-9.3	-12.6	-15.8	-19.0	-19.0
R10 - Pen-y-Caeau									
Background noise curve	32.5	34.4	36.6	39.1	41.9	44.8	47.8	51.0	51.0
ETSU-R-97 derived noise limit	40.0	40.0	41.6	44.1	46.9	49.8	52.8	56.0	56.0
Wind Farm turbine noise	31.3	35.7	39.3	40.6	40.3	40.0	39.7	39.7	39.7
Difference wrt noise limit	-8.7	-4.3	-2.3	-3.5	-6.6	-9.8	-13.1	-16.3	-16.3
R11 - Ty-hir, Cefn-Crib Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	40.0	40.0	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	32.5	37.0	40.6	41.6	41.0	40.5	40.0	40.0	40.0
Difference wrt noise limit	-7.5	-3.0	+0.3	-1.4	-4.1	-5.7	-6.2	-6.2	-6.2
R12 - Tir Shon Shenkin									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	40.0	40.0	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	34.6	39.2	42.8	43.8	43.2	42.5	42.0	42.0	42.0
Difference wrt noise limit	-5.4	-0.8	+2.5	+0.8	-1.9	-3.7	-4.2	-4.2	-4.2
R13 - Bwthyn Yr Ysgol, Blaen-y-cwm Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	40.0	40.0	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	35.0	39.7	43.3	44.1	43.4	42.8	42.3	42.3	42.3
Difference wrt noise limit	-5.0	-0.3	+3.0	+1.1	-1.7	-3.4	-3.9	-3.9	-3.9
R14 - Cefn-y-Crib Farm, Blaen-y-Cwm Rd									
Background noise curve	29.9	32.5	35.3	38.0	40.1	41.2	41.2	41.2	41.2
ETSU-R-97 derived noise limit	40.0	40.0	40.3	43.0	45.1	46.2	46.2	46.2	46.2
Wind Farm turbine noise	33.9	38.6	42.2	43.0	42.4	41.9	41.5	41.5	41.5
Difference wrt noise limit	-6.1	-1.4	+1.9	0.0	-2.7	-4.3	-4.7	-4.7	-4.7

Table 13.25 Noise assessment – cumulative night-time

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
R1 - Rhyswg-ganol									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	26.1	30.5	34.1	35.6	35.3	35.0	34.8	34.8	34.8
Difference wrt noise limit	-16.9	-12.5	-8.9	-7.4	-8.6	-12.5	-17.0	-22.0	-22.0
R2 - Bwthyn Mamgu									

Noise parameter,	Standardised 10 m wind speed quoted by manufacturer (m/s)								
dB $L_{A90,10\ m}$	4	5	6	7	8	9	10	11	12
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	27.3	31.6	35.2	36.9	36.7	36.5	36.4	36.4	36.4
Difference wrt noise limit	-15.7	-11.4	-7.8	-6.1	-7.2	-11.0	-15.4	-20.4	-20.4
R3 - Graigwen Bungalow, Gwyddon Rd									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	27.6	31.8	35.5	37.4	37.4	37.2	37.2	37.2	37.2
Difference wrt noise limit	-15.4	-11.2	-7.5	-5.6	-6.5	-10.3	-14.6	-19.6	-19.6
R4 - Roxburgh Bungalow									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.9	47.5	51.8	56.8	56.8
Wind Farm turbine noise	30.0	34.2	37.9	39.8	39.9	39.8	39.8	39.8	39.8
Difference wrt noise limit	-13.0	-8.8	-5.1	-3.2	-4.0	-7.7	-12.0	-17.0	-17.0
R5 - Glan Shon Farm									
Background noise curve	30.6	31.8	33.6	35.9	38.9	42.5	46.8	51.8	51.8
ETSU-R-97 derived noise limit	45.0	45.0	45.0	45.0	45.0	47.5	51.8	56.8	56.8
Wind Farm turbine noise	33.7	37.9	41.6	43.7	43.8	43.7	43.7	43.7	43.7
Difference wrt noise limit	-11.3	-7.1	-3.4	-1.3	-1.2	-3.8	-8.1	-13.1	-13.1
R6 - Blaengawney Farm Dwelling									
Background noise curve	26.1	28.2	30.8	33.6	36.6	39.4	41.9	44.0	44.0
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	44.4	46.9	49.0	49.0
Wind Farm turbine noise	29.6	33.9	37.4	39.1	38.9	38.7	38.5	38.5	38.5
Difference wrt noise limit	-13.4	-9.1	-5.6	-3.9	-4.1	-5.7	-8.4	-10.5	-10.5
R7 - Old Pant Road, Newbridge									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	27.9	32.0	35.2	36.6	36.3	36.0	35.9	35.9	35.9
Difference wrt noise limit	-15.1	-11.0	-7.8	-6.4	-8.2	-11.6	-14.6	-17.2	-17.2
R8 - Cefn-rhos-y-bedd-uchaf									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	27.8	32.1	35.5	36.9	36.5	36.2	36.0	36.0	36.0
Difference wrt noise limit	-15.2	-10.9	-7.5	-6.1	-8.0	-11.4	-14.5	-17.1	-17.1
R9 - Ty Oakley									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	28.9	33.1	36.5	37.9	37.6	37.2	37.0	37.0	37.0
Difference wrt noise limit	-14.1	-9.9	-6.5	-5.1	-6.9	-10.4	-13.5	-16.1	-16.1

Noise parameter, dB $L_{A90,10\ m}$	Standardised 10 m wind speed quoted by manufacturer (m/s)								
	4	5	6	7	8	9	10	11	12
R10 - Pen-y-Caeau									
Background noise curve	28.3	30.6	33.3	36.4	39.5	42.6	45.5	48.1	48.1
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	44.5	47.6	50.5	53.1	53.1
Wind Farm turbine noise	31.3	35.7	39.3	40.6	40.3	40.0	39.7	39.7	39.7
Difference wrt noise limit	-11.7	-7.3	-3.7	-2.4	-4.2	-7.6	-10.8	-13.4	-13.4
R11 - Ty-hir, Cefn-Crib Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	32.5	37.0	40.6	41.6	41.0	40.5	40.0	40.0	40.0
Difference wrt noise limit	-10.5	-6.0	-2.4	-1.4	-2.0	-5.1	-5.6	-5.6	-5.6
R12 - Tir Shon Shenkin									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	34.6	39.2	42.8	43.8	43.2	42.5	42.0	42.0	42.0
Difference wrt noise limit	-8.4	-3.8	-0.2	+0.8	+0.2	-3.1	-3.6	-3.6	-3.6
R13 - Bwthyn Yr Ysgol, Blaen-y-cwm Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	35.0	39.7	43.3	44.1	43.4	42.8	42.3	42.3	42.3
Difference wrt noise limit	-8.0	-3.3	+0.3	+1.1	+0.4	-2.8	-3.3	-3.3	-3.3
R14 - Cefn-y-Crib Farm, Blaen-y-Cwm Rd									
Background noise curve	25.4	28.2	31.2	34.4	37.5	40.6	40.6	40.6	40.6
ETSU-R-97 derived noise limit	43.0	43.0	43.0	43.0	43.0	45.6	45.6	45.6	45.6
Wind Farm turbine noise	33.9	38.6	42.2	43.0	42.4	41.9	41.5	41.5	41.5
Difference wrt noise limit	-9.1	-4.4	-0.8	0.0	-0.6	-3.7	-4.1	-4.1	-4.1

13.10.4 The results of the cumulative noise assessment show compliance at the majority of receptors during the daytime and night-time periods, resulting in a **not significant** effect.

13.10.5 Exceedances of the daytime limits of up to 3.0 dB are indicated at receptors R11 to R14 and wind speeds between 6 to 7 ms^{-1} resulting in a potential **significant** effect. Exceedances of the night-time limits of up to 1.1 dB are indicated at receptors R12 and R13 at wind speeds between 6 to 8 ms^{-1} resulting in a potential **significant** effect.

13.10.6 It should be noted that directivity effects may have a significant influence at the receptor locations where exceedances are predicted due north of the proposed turbines. The cumulative noise at these receptors is dominated by turbines forming part of the proposed Mynydd Maen Wind Farm (noting that sound power levels for Mynydd Maen Wind Farm have been assumed at this stage). The receptors where exceedances are predicted lie approximately 1 km north west of the proposed Mynydd Maen Wind Farm, and hence the prevailing wind direction would tend not to aid the propagation of sound from the turbines to these receptors, which in turn would reduce the cumulative noise at these receptors. If further analysis indicates that these turbines still contribute to an exceedance of the limits, then reduced power operating modes can be specified for these turbines to ensure

compliance with the limits. Where the information is available, the sound levels predicted from the proposed Mynydd Maen Wind Farm will be updated in order to review where reduced power modes may be required from that wind farm, assuming it would be under the same planning constraints.

13.11 Significance conclusions

13.11.1 The results of the assessment of operational noise indicates that the ETSU-R-97[6] derived noise limits are likely to be exceeded at R11 to R14 during the daytime and at receptors R12 and R13 during the night-time, resulting in potential significant effects.

13.11.2 At all receptors where exceedances are identified, noise from turbines associated with the proposed Mynydd Maen Wind Farm is dominant. Assuming this proposed wind farm would be under the same planning constraints, the contribution from the Mynydd Maen turbines could be significantly reduced by specifying reduced power operating modes, which would significantly reduce the cumulative turbine sound levels.

13.11.3 Based on the above, i.e. that operational noise from proposed turbines would be controlled appropriately to avoid significant effects at the nearest receptor locations, it is considered that the identified exceedances would be avoided. On this basis, the effect of operational noise on residences would be **not significant**.

13.11.4 A summary of the results of the preliminary noise assessment is provided in **Table 13.26**.

Table 13.26 Summary of significance of effects

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Construction noise daytime: All NSRs	High	Negligible	Not Significant	BS 5228-1:2009+A1:2014 limits are not exceeded during the daytime period due to piling noise.
Construction traffic	High	Negligible	Not significant	Predicted increases of road traffic noise on the local highway network indicate negligible increases of road traffic noise due to construction traffic.
Operational daytime: R11 to R14 inclusive	High	High	Significant	ETSU-R-97 noise limits may be exceeded during the daytime period due to cumulative wind turbine noise, which is dominated by sound from the proposed Mynydd Maen Wind Farm. Reduced power operating modes for specific turbines can be specified to ensure compliance with the limits and reduce residual effects such that they are not significant, as indicated below in **Table 13.27**.
Operational daytime: All other NSRs	High	Negligible	Not Significant	ETSU-R-97 noise limits are unlikely to be exceeded during the daytime period.
Operational night-time: R12 and R13	High	High	Significant	ETSU-R-97 noise limits may be exceeded during the daytime period due to cumulative wind turbine noise, which is dominated by sound from the proposed Mynydd Maen Wind Farm. Reduced power operating modes for specific turbines can be specified to ensure compliance with the limits and reduce residual effects such that they are not significant, as indicated below in **Table 13.27**.
Operational night-time: All other NSRs	High	Negligible	Not Significant	ETSU-R-97 noise limits are unlikely to be exceeded during the night-time period.

1. The sensitivity/importance/value of a receptor is defined using the criteria set out in Section 13.7 and is defined as low, medium, or high.
2. The magnitude of change on a receptor resulting from activities relating to the development is defined using the criteria set out in Section 13.8 and is defined as negligible or high.
3. The significance of the environmental effects is based on the combination of the sensitivity/importance/value of a receptor and the magnitude of change and is expressed as major (significant), moderate (potentially significant) or minor/negligible (not significant), subject to the evaluation methodology outlined in Section 13.8. The significance is based on the residual effects post mitigation assumed to be included into the design.

Implementation of environmental measures

13.11.5 Whilst the candidate turbine may change, the residential amenity of surrounding areas would be protected by an appropriately worded planning condition based on ETSU-R-97[6] limits as outlined in **Section 13.10**. Compliance with these limits can be proven with measurements taken at residential receptor locations once the wind farm is operational.

13.11.6 As discussed above, the exceedances identified are primarily due to noise from the proposed Mynydd Maen Wind Farm. As such, the design of the proposed Mynydd Maen Wind Farm would need to respond to this, to ensure that the ETSU-R-97[6] derived noise limits are not exceeded. On this basis, through the implementation of appropriate mitigation measures to ensure that cumulative wind turbine noise levels would not exceed the ETSU-R-97[6] derived noise limits, resulting effects due to cumulative turbine noise would be **not significant**.

13.11.7 An initial investigation into the attenuations required to ensure compliance with the ETSU-R-97[6] derived noise limits has been undertaken, based on the predictions of cumulative turbine noise presented here. The turbine sound level attenuations provided in **Table 13.27** would reduce turbine noise such that they do not exceed the identified limits, without taking directivity into account.

Table 13.27 Summary of turbine attenuations to meet limits (without directivity)

Scenario	Day 6 ms-1	Night 6 ms-1	Day 7 ms-1	Night 7 ms-1	Night 8 ms-1
Max exceedance, dB	3.0	0.3	1.1	1.1	0.4
Max attenuation achieved, dB	3.2	0.3	1.4	1.3	0.5
Attenuations per turbine, dB					
Mynydd Maen - T10	-3				
Mynydd Maen - T3	-0.5				
Mynydd Maen - T4	-5		-2	-2	
Mynydd Maen - T5	-2.5				
Mynydd Maen - T6	-3.5		-1	-1	
Mynydd Maen - T7	-7	-1	-4	-3.5	-2
Mynydd Maen - T8	-5	-0.5	-2.5	-2	-0.5
Trecelyn - T2	-0.5				

13.12 Further work

13.12.1 When preparing the Final ES, the latest information on other proposed and consented wind farms will be considered in the assessment, particularly any information relating to the Proposed Mynydd Maen Wind Farm.

13.12.2 If, following further analysis, exceedances of the ETSU-R-97[6] derived noise limits are still indicated, then reduced power operating modes will be determined that would ensure compliance with the limits and reduce residual effects such that they are not significant.