AN BORD PLEANÁLA
LDG- 068937-23
ABP-
15 DEC 2023
Fee: € 220 Type: PMS
Time: By: Reg Post

From:Dara Canavan

Knockranny Moycullen Wind Farm Action Group,

Pillagh,

Moycullen,

Co. Galway

To: The Secretary, An Bord Pleanála, 64 Marlborough Street, Dublin 1, D01 V902

Date: 12 December 2023

Subject: Comprehensive Objection to Planning Application 23225, Knockranny Windfarm

Dear Sir/Madam,

I am writing on behalf of the Knockranny Moycullen Wind Farm Action Group to express our vehement objection to the proposed increase in turbine height from 130 meters to 150 meters at the Knockranny Windfarm development in Moycullen, County Galway. This objection encompasses a range of concerns, all of which profoundly affect the local community, environment, and the general well-being of the area's residents.

Key Points of Objection:

Location Appropriateness:
The proposed site is situated in an area classified as "Not Normally Permissible" for wind energy development in the current Galway County Development Plan 2022-28. The grant of a new planning application in this classification suggests a fundamental planning oversight that contradicts the current Galway County Development plan and raises critical concerns about the suitability of the location for such a large-scale development. The designation of areas as "Not Normally Permissible" typically stems from a variety of factors including, but not limited to, environmental sensitivity, proximity to residential areas, and potential impact on the natural and cultural heritage of the region.

The decision to propose a windfarm in such an area contradicts established planning principles and guidelines, which are designed to ensure that developments are appropriately sited to minimise negative impacts on the environment and local communities. It also raises questions about the thoroughness of the site selection process undertaken by the developers and whether alternative sites, more suitable for wind energy development, were adequately considered.

In light of these concerns, it is imperative for An Bord Pleanála to scrutinize the rationale behind the site selection, especially considering the potential for significant and irreversible impacts on the local environment and community. This scrutiny should include a detailed examination of the site's environmental sensitivity, its proximity to residential areas, and any potential conflicts with local planning and development policies.

Furthermore, the selection of a site classified as "Not Normally Permissible" for wind energy development sets a concerning precedent for future renewable energy projects. It undermines the integrity of the planning process and could lead to a scenario where unsuitable sites are routinely considered for development, to the detriment of environmental protection and community well-being.

The objection to the proposed site is not just a matter of local concern but speaks to broader issues of sustainable development and responsible planning. It is crucial for An Bord Pleanála to consider these broader implications and ensure that the principles of sustainable development are upheld in the decision-making process.

Visual Impact:

The increased height of the turbines will significantly mar the natural beauty of the region, detrimentally impacting the visual landscape. The visual impact of the proposed increase in turbine height at the Knockranny Windfarm is a significant concern. The augmentation from 130 meters to 150 meters represents a substantial change in the landscape, with the turbines becoming more dominating and intrusive elements in the scenic views of the region. This increase in size has the potential to transform the character of the landscape dramatically, affecting not only the immediate vicinity of the windfarm but also distant views, as these larger structures become visible from greater distances.

The visual impact extends beyond mere aesthetic considerations. It affects the sense of place and connection that local residents have with their environment. The area's natural beauty, which contributes to the community's identity and quality of life, is at risk of being overshadowed by industrial structures that are out of scale with the surrounding landscape. This can lead to a diminished sense of well-being among residents, who value the visual harmony of their natural surroundings.

Additionally, the visual impact has implications for local tourism, a vital part of the regional economy. The attractiveness of the area as a destination for visitors, who come to appreciate its unspoiled natural beauty, could be significantly compromised. This could result in economic repercussions for businesses and services that rely on tourism.

The assessment of visual impact in the developer's report must be critically evaluated. It is essential to ensure that the assessment adequately considers the cumulative visual impact of

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the turbines, taking into account not only the immediate visual effects but also the broader landscape and visual amenity implications. Photomontages and visual simulations should be carefully analyzed to ascertain their accuracy in depicting the real impact of the turbines.

In conclusion, the visual impact of the taller turbines is not a superficial concern but a substantial one that affects the community's quality of life, sense of place, and economic well-being. It is a critical aspect that An Bord Pleanála must consider in evaluating the suitability of this development.

Shadow Flicker:
The projected shadow flicker from the taller turbines poses a risk to the health and comfort of nearby residents. Shadow flicker remains a significant concern, now underscored by the developer's own admission that six properties will be directly impacted by this effect due to the proposed increase in turbine height (Please see enclosed MWP Shadow Flicker Assessment report and referenced Appendix A on Shadow Flicker Model Output Data for shadow times on each house due to all turbines). This acknowledgment highlights the tangible and adverse consequences of the development on local residents. The shadow flicker caused by the rotating blades of the taller turbines can be a source of considerable annoyance and discomfort, and in some cases, may lead to more severe health implications, such as headaches or exacerbation of conditions like epilepsy or autism.

The inclusion of this admission in the developer's submission warrants a critical examination of the proposed mitigation strategies. It raises questions about the extent to which these measures can effectively minimize the impact on the affected properties. The analysis of shadow flicker effects must consider not only the quantitative aspects, such as the duration and frequency of flicker, but also the qualitative experience of those living in the shadow paths.

Furthermore, the community needs reassurance that the mitigation strategies will be enforced and monitored for their effectiveness over the lifespan of the windfarm. This includes a commitment to ongoing assessment and adaptation of mitigation measures to ensure they remain effective under changing conditions and feedback from impacted residents.

In light of this, the potential increase in shadow flicker caused by taller turbines is not just a theoretical concern but a confirmed impact that requires serious consideration. Ensuring the well-being of residents, their right to enjoy their properties without undue disturbance, and addressing the potential health implications must be central to the decision-making process.

Noise Pollution:
The anticipated increase in noise levels due to the larger turbines is a major concern, with potential health implications for the local population. The noise impact of wind turbines is a critical issue, particularly with the proposed increase in turbine height at the Knockranny Windfarm. Taller turbines can produce more noise, both in terms of volume and frequency range. This increase in noise pollution can have significant adverse effects on the quality of life for nearby residents, potentially leading to sleep disturbance, stress, and other health issues.

The noise impact assessment in the developer's report must be questioned and further information sought on why the environmental noise study has not been updated since 2013 for the current 2023 planning application? The assessment needs to consider not only the increased decibel levels but also the character of the noise, such as low-frequency sound, which can be particularly disturbing. The methodology used for predicting noise levels, including the model assumptions and parameters, should be transparent and robust. Residents noted in prior objections that the baseline level was raised deliberately by bringing in loud excavating machines during the specific two-week period the baseline was being measured in 2013. This has resulted in artificially raising the noise level in the area to give the perception the wind turbines proposed will not materially impact noise levels when that is not the case.

It should be noted in compliance reports in relation to noise monitoring submitted by nearby windfarms (Knockalough) they observed levels of sound reaching 89% of the maximum threshold. The maximum tip blade height of the proposed turbines would be 15% greater than those in operation at Knockalough, with the increase in height proposed it would seem highly likely the noise levels would breach the permitted levels. The recent noise survey conducted at Knockalough by AWN Consulting did not adhere to the planning conditions in place as only two locations were surveyed rather than the four stipulated in planning as noted and communicated by Galway County Council. It should also be noted the Knockalough windfarm and other nearby windfarms are subsidiaries of the same group that this proposed windfarm is also a subsidiary of, Craydel Holdings, with many of the same consultant partners engaged. Their track record of failing to comply with the noise level monitoring requirements on the last two compliance reports submitted in relation to Knockalough windfarm demonstrates adhering to planning conditions and welfare of local residents is not a priority.

Moreover, the cumulative noise impact, considering other existing or planned wind farms in the area, must be immediately evaluated. Residents might be subjected to compounded noise levels from multiple sources, which can exacerbate the overall impact.

Mitigation strategies proposed by the developer, such as setbacks from residential areas and noise-reducing technologies, need to be scrutinized for their efficacy. The residents require assurances that these strategies will be effectively implemented and monitored to ensure compliance with noise regulations and standards.

In essence, the increased noise pollution potential from taller turbines is a serious concern that demands a comprehensive and rigorous assessment. The health and well-being of the community, their right to a peaceful living environment, and the adherence to noise standards are paramount considerations in the evaluation of this project.

Health Impacts:
The overall health impact, particularly in terms of stress, sleep disturbance, and quality of life, has not been adequately addressed. The health impacts of the proposed Knockranny Windfarm, especially with the increase in turbine height, are a critical concern. While the developer's

report may address health impacts, the depth and comprehensiveness of this assessment are questionable. Health impacts from wind farms can include sleep disturbance, stress, and potential exacerbation of certain medical conditions due to factors like noise pollution and shadow flicker. The proximity of turbines to residential areas can intensify these effects.

A thorough, evidence-based analysis is necessary to evaluate the potential health impacts adequately. This analysis must consider not only the direct effects of noise and shadow flicker but also the cumulative and long-term health implications on the local population. Studies have shown that prolonged exposure to certain aspects of wind farms can have a detrimental effect on mental and physical health. The assessment should be inclusive, considering vulnerable groups such as children, the elderly, and those with pre-existing health conditions.

Furthermore, the developer's assessment of health impacts should be scrutinized for its reliance on current research and adherence to international health guidelines, such as those issued by the World Health Organization. Any gaps or limitations in the methodology used to assess health impacts should be highlighted, and the need for independent health impact studies should be considered.

In conclusion, the assessment of health impacts in the EIAR needs a rigorous and independent review to ensure that the well-being of the community is not compromised. The responsibility lies with the decision-makers to ensure that public health considerations are given the utmost priority in evaluating this development.

Environmental Impacts:
The development poses significant risks to local wildlife and biodiversity, which has not been thoroughly assessed and mitigated. The environmental impacts of the proposed Knockranny Windfarm, particularly with the increase in turbine height, encompass a broad range of concerns. These include potential effects on local wildlife and biodiversity, landscape integrity, and the natural ecosystem. The developer's Environmental Impact Assessment Report (EIAR) must be critically analyzed to ensure that it accurately reflects the potential environmental implications of the project.

Key areas of focus in the environmental impact assessment should include the impact on avian and bat populations, local flora and fauna, and sensitive ecological areas. The potential for habitat disruption and fragmentation, as well as the impact on local water bodies and soil, must be carefully evaluated. The cumulative impact of the wind farm, in conjunction with other existing or proposed developments in the area, should also be a major consideration.
The methodology used in the EIAR to assess environmental impacts should be scrutinized for its comprehensiveness and scientific rigor. This includes the adequacy of baseline data, the scope of impact studies, and the effectiveness of proposed mitigation measures. Independent environmental studies may be necessary to validate or challenge the findings of the developer's report.

The findings and recommendation of refusal by An Bord Pleanála's own inspector when this development was originally submitted, with specific concerns raised on impact to Golden Plover, remain valid.

In essence, a thorough and unbiased assessment of the environmental impacts is essential to ensure that the development does not cause irreversible harm to the local ecosystem. The preservation of the area's natural heritage and biodiversity should be a key consideration in the decision-making process.

Inadequate Consultation:
The developer's approach to community consultation regarding the Knockranny Windfarm project is a matter of significant concern. Effective consultation is fundamental in such developments, ensuring community concerns are heard and addressed. In this case, the consultation process appears to have been insufficient, raising questions about the legitimacy of the project's community engagement efforts.

A meaningful consultation process involves transparent communication, active engagement with local residents, and a genuine consideration of their feedback. This process should not be a mere formality but an integral part of the planning and development process. The lack of comprehensive consultation undermines the trust between the developer and the community and may lead to a feeling of disenfranchisement among local residents.

The impact of inadequate consultation extends beyond community relations. It can result in key concerns being overlooked, such as local knowledge about environmental and social aspects, which are crucial in assessing the project's true impact. The developer's failure to engage meaningfully with the community also suggests a potential gap in understanding the local context, which could lead to misjudgments about the suitability and sustainability of the project.
The same developer has completed other wind turbines in the area and has a demonstrated track record of ignoring residents and failing to adhere to flicker impact time limits or submit required noise monitoring reports. This blatant disregard for both the impact to residents and adherence to the planning conditions on previous applications needs to be factored into any decision for this development.

In addition, Galway County Council refused to meet with local residents despite requests to do so and there is no evidence anyone from Galway County Council conducted any adequate onsite inspection before making a decision on this development.

In this context, An Bord Pleanála should consider the adequacy of the consultation process in its evaluation of the project. The board should ensure that the concerns of the local community are not just heard but are also given substantial weight in the decision-making process. The fundamental right of the community to be involved in decisions that affect their environment and well-being must be upheld.

As local residents we would very much welcome meeting with the An Bord Pleanála's Inspector in due course when on any site visit to provide any additional information required for the full evaluation of sensitive site receptors and impact on residents of the proposed development.

Community Benefits and Impacts:

The proposal fails to offer substantial benefits to the local community while imposing significant adverse impacts. The balance of community benefits against the impacts of the Knockranny Windfarm development is a critical consideration. While renewable energy projects often provide broader environmental benefits, these should not overshadow the specific impacts on the local community. In this case, it appears that the development may impose significant adverse impacts on the community, without offering proportionate benefits.

The assessment of community benefits and impacts should include a detailed analysis of the economic, social, and environmental implications for the local area. This includes evaluating the potential for job creation, infrastructure development, and contributions to local services against the negative aspects such as visual intrusion, noise pollution, and potential property devaluation.

Additionally, the developer's commitment to the community should be scrutinized. This involves examining any proposed community benefit schemes for their adequacy and fairness. It is important to assess whether these schemes are substantial enough to offset the impacts of the development and whether they align with the community's needs and priorities. There are no specific details provided by the developer on anything in this regard. The planning application merely makes a reference to community benefit within a 20km radius (which would include for example Galway City with a population of 80,000). Likewise Condition #15 of Galway County Council decision for 23/225 on 22/11/23 simply states as an afterthought *"Prior to the commencement of development, the community gain proposals shall be submitted to and agreed in writing with the Planning Authority"*. An Bord Pleanála must question why is there a glaring lack of commitment to this piece in the planning proposal and also why further information was not requested by Galway Council in advance of any decision?

An Bord Pleanála's decision should reflect a holistic understanding of the project's impact on the local community. It is crucial that benefits are required from the developer that are not only tangible and significant but also equitably distributed among those most affected by the development.

Decommissioning and Disposal:

The issue of decommissioning and disposal is a critical aspect of the Knockranny Windfarm project, often overlooked in its long-term implications. Proper decommissioning plans are essential to ensure that once the windfarm reaches the end of its operational life, it does not leave a lasting negative impact on the landscape and the community. The process involves dismantling the turbines, restoring the site, and responsibly disposing of or recycling the materials.

The developer's plan for decommissioning and disposal should be thoroughly evaluated for its feasibility, environmental soundness, and financial viability. This includes an analysis of the environmental impact of dismantling the turbines and a detailed plan for waste management. It's crucial to ensure that sufficient financial provisions are made for these activities, preventing the burden from falling on the community or local authorities.

Additionally, the potential environmental impact of the disposal process, especially concerning non-recyclable materials and the possible contamination of land and water resources, must be considered. The developer should demonstrate a commitment to sustainable practices in every aspect of the decommissioning process.

In conclusion, An Bord Pleanála should scrutinize the decommissioning and disposal plan to ensure that it meets the highest environmental standards and adequately protects the interests of the local community and the natural landscape.

Study Area Considerations:

The study area for the project seems insufficiently expansive to understand the full impact of the development. The adequacy of the study area defined in the Environmental Impact Assessment Report (EIAR) for the Knockranny Windfarm is of paramount importance. A considerable portion of the immediately adjacent Ardderroo windfarm is not within the study area boundary, and Knockalough, Lettergunnet, Letterpeak, Inverin windfarms along with a portion of the Galway Wind Park windfarms are also omitted. The applicant has not adequately assessed the cumulative impact. A comprehensive study area is crucial to understand the full range of impacts of the development. This includes assessing the environmental, social, and economic effects both within the immediate vicinity of the windfarm and in the broader regional context. The study area should be sufficiently large to capture all potential direct and indirect impacts. This includes considering the cumulative impacts of the windfarm in conjunction with other existing or proposed developments in the region. A narrow or limited study area can lead to an underestimation of the project's true impact, particularly in terms of environmental and social effects.

The methodology used to define the study area should be transparent and scientifically sound. It should take into account the specific characteristics of the region, such as ecological connectivity, population distribution, and socio-economic factors. An independent review of the study area may be necessary to ensure that it comprehensively covers all relevant impacts.

In essence, the determination of the study area is not just a technical issue but one that has significant implications for the accuracy and credibility of the environmental impact assessment. An Bord Pleanála should ensure that the study area is appropriately defined to capture the full scope of the project's impact.

Property Devaluation:

Property devaluation is a significant concern for residents living near the proposed Knockranny Windfarm. The presence of large wind turbines can impact property values due to factors such as visual intrusion, noise pollution, and shadow flicker. These effects can make properties less desirable to potential buyers, leading to a decrease in market value.

An objective assessment of the potential impact on property values is crucial. This assessment should be based on robust data and analysis, considering the experiences of similar developments in other areas. It's important to understand not only the immediate impact on property values but also the long-term trends as the windfarm becomes operational.

The developer's responsibility to address this issue should be emphasized. Compensation mechanisms or other forms of redress should be considered for those whose property values are adversely affected by the development. This approach is essential to ensure fairness and to mitigate the economic impacts on the local community. To date this has been ignored by the developer and concerns raised by residents have not been addressed.

In conclusion, the potential for property devaluation is a tangible concern that requires careful consideration. An Bord Pleanála should consider the economic implications for local residents and ensure that appropriate measures are in place to address any negative impacts on property values.

We also wish to highlight the lack of onsite inspection by Galway County Council and their refusal to meet with residents to discuss these concerns. This absence of direct engagement and assessment is highly concerning and suggests a gap in the understanding of the local impact of the project.

We request a comprehensive review by An Bord Pleanála, considering all these points and the cumulative impact on our community and environment. We would also like to meet with an inspector from An Bord Pleanála onsite. It is crucial for the decision-making process to be transparent, inclusive, and reflective of the residents' concerns.

This letter is supported by detailed information and evidence, as outlined on our Facebook page (https://www.facebook.com/people/Knockranny-Moycullen-Wind-Farm-Action-Group/100091372336092/) and YouTube channel, (https://www.youtube.com/@KnockrannyWindfarmAction-qo9og) where we have made our objections and concerns publicly available, as well as provided the findings of our own independent expert on assessing the extent of the cumulative wind developments in the area that has been ignored in the developers application and the decision making process to date.

In accordance with relevant planning laws and regulations, this objection raises several critical issues. These include the proposed development's non-compliance with local zoning and land-use designations, which classify the area as "Not normally permissible" for wind energy development. Additionally, the project raises significant concerns about environmental protection, as mandated by national and EU directives, particularly regarding biodiversity, landscape integrity, and the cumulative environmental impact. The inadequacy of community consultation and engagement in the planning process also contravenes principles of participatory planning and decision-making enshrined in planning law. Furthermore, the potential negative impacts on residential amenity, such as increased noise pollution, shadow flicker, and visual intrusion, are contrary to the objectives of sustainable development and proper planning, as outlined in planning legislation. These legal grounds form the basis of our objection, underscoring the need for a comprehensive review by An Bord Pleanála to ensure compliance with all statutory requirements.

Thank you for your attention to this matter. We trust that An Bord Pleanála will make a decision that prioritizes the well-being of our community, the integrity of our environment, and the principles of responsible and sustainable development by refusing to allow this development proceed.

Sincerely,

Knockranny Moycullen Wind Farm Action Group

Group Members:

Aine Bohan

Raymond Cooley

Dara Canavan

Trisha Canavan

Matthew O'Connor

Jason Bohan

Lorraine Bohan

Michael Murphy

Agnes Murphy

Stephen Murphy

James Caulfield

Richard Bohan

Elizabeth Bohan

Ann Malcolm

Michaela Parker

Siobhan O'Connor

Seán O'Connor

Tommy Keady

Fidelma Keady

Orla O'Connor

Martin O'Connor

Sally Faherty

Matthew Faherty

Frank Faherty

05/07/2023

Dara Canavan
Knockranny moycullen wind farm action group
Pillagh
Moycullen
Co Galway

Comhairle Chontae na Gaillimhe
Galway County Council

TAG: Uimh. Thag. Pleanála: **RE:** Planning ref. no.:	23/225 - PERMISSION for the following: (1) Alterations to the Cnoc Raithní (Knockranny) Wind Farm (Galway County Council Planning Ref. No. 13/829 and An Bord Pleanála Ref: 07.243094 comprising 11 no. wind turbines with an overall ground to blade tip height of 150m (an increase of 19.5m & 9.5m from 130.5m & 140.5m, as previously permitted), a rotor blade length of 68m or 69m & a hub height of 81m or 82m; associated increase in turbine foundations; & omission of permitted on-site 110kV substation & underground cabling; (2) Provision of underground electrical (33kV) & communications cabling connecting the 11 no. wind turbines to the Ardderroo wind farm substation for the purposes of connection to the national grid, including a new cable service track (with watercourse/culvert crossings) & widening of an existing access road; extension of the Ardderroo substation within the existing substation compound, including control building extension, new 110kV transformer & electrical plant & apparatus; (3) All associated site development & ancillary works above & below ground in support of the above, including site drainage & tree felling. (4) An operational period & planning permission duration to align with the existing permission (An Bord Pleanála Ref: 07.243094) is sought. An Environmental Impact Assessment Report (EIAR) & Natura Impact Statement (NIS) have been prepared & will be submitted to the Planning Authority with the application i mbaile fearainn / in the townland of : Knockranny, Ardderroo, Letter

RIALACHÁIN PLEANÁLA AGUS FORBARTHA, 2001-2002	PLANNING AND DEVELOPMENT REGULATIONS, 2001-2002
ADMHÁIL ar AIGHNEACHT nó TUAIRIM atá FAIGHTE ar IARRATAS PLEANÁLA	**ACKNOWLEDGEMENT of RECEIPT of SUBMISSION or OBSERVATION on a PLANNING APPLICATION**

IS DOICIMÉAD THÁBHACHTACH É SEO!	THIS IS AN IMPORTANT DOCUMENT!
COINNIGH AN DOICIMÉAD SEO GO SÁBHÁILTE. BEIDH ORT AN ADMHÁIL SEO A THAISPEÁINT DON BHORD PLEANÁLA MÁS MIAN LEAT ACHOMHAIRC A DHÉANAMH AR CHINNEADH AN ÚDARÁIS PLEANÁLA	KEEP THIS DOCUMENT SAFELY. YOU WILL BE REQUIRED TO PRODUCE THIS ACKNOWLEDGEMENT TO AN BORD PLEANÁLA IF YOU WISH TO APPEAL THE DECISION OF THE PLANNING AUTHORITY

Tá aighneacht/tuairim faighte i scríbhinn ó Knockranny moycullen wind farm action group ar an 05/07/2023 maidir leis an iarratas pleanála thuas.

Tá an táille cuí de €20 íoctha.

Tá an t-aighneacht/tuairim de réir na forálacha cuí de na Rialacháin um Pleanáil agus Forbairt, 2001 agus cuirfidh an tÚdarás Pleanála san áireamh iad nuair atá cinneadh dhá dhéanamh ar an iarratas pleanála.

AIRE

Tabhair faoi deara gur é an dáta is déanaí do chinneadh ar an gcomhad seo ná 26/07/2023

Má tharlaíonn sé **nach bhfaigheann tú fógra** maidir leis an gcinneadh seo laistigh de **3 – 5 lá den dáta thuas**, déan teagmháil leis an oifig seo ar an bpointe ag 091 509 308 nó ar ríomhphost ag planning@galwaycoco.ie, chun a chinntiú go gcloíonn tú le sprioc amanna achomharc an Bhord Pleanála.

A submission/observation in writing has been received from Knockranny moycullen wind farm action group on 05/07/2023 in relation to the above planning application

The appropriate fee of € 20 has been paid

The submission/observation is in accordance with the appropriate provisions of the Planning and Development Regulations 2001 and will be taken into account by the planning authority in its determination of the planning application

N.B

Please note that the latest date for decision on this file is 26/07/2023

Should you **not receive notification** of this decision within **3 – 5 days of the above date**, please contact this office immediately at 091 509 308 or email at planning@galwaycoco.ie, in order to ensure that you meet an Bord Pleanála appeal deadlines

AN BORD PLEANÁLA
LDG-
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Fee: € ______ Type: ______
Time: ______ By: ______

E. [signature]
Administrative Officer, Planning

Received
- 5 JUL 2023
Planning & Development Section
Galway County Council

Ed O
R.453613

Knockranny Moycullen Wind Farm Action Group
Pillagh,
Moycullen,
Co. Galway

5th July 2023

To: Galway County Council

Subject: Objection to Planning Application 23225, Knockranny Windfarm

Dear Sir/Madam,

A significant number of Pillagh residents are members of the Knockranny Moycullen Windfarm Action Group. As a group we strongly object to the proposed increase in turbine height from 130 meters to 150 meters at the Knockranny Windfarm development in Moycullen, Galway.

The group has made information publicly available that we would request the Council review and include in their decision-making process:

- Group Facebook page: https://www.facebook.com/people/Knockranny-Moycullen-Wind-Farm-Action-Group/100091372336092/
- Information Videos on Group YouTube channel including work commissioned with a consultant to illustrate the impact of the proposed development including context of surrounding windfarms: https://www.youtube.com/@KnockrannyWindfarmAction-go9og

Individually group members have lodged detailed objections to this proposal that cover a range of reasons the proposal should be refused including:

- Located in an area marked as "Not normally permissible" for wind energy development
- Visual Impact
- Shadow Flicker
- Noise
- Health Impacts
- Environmental Impacts
- Inadequate consultation
- Community Benefits and Impacts
- Decommissioning and Disposal
- Study Area
- Property Devaluation

We request Galway County Council visit the area to in person to observe the impact of wind energy developments to date as part of the decision-making process.

We would also appreciate it if the Group were afforded a meeting prior to final decision as there was no meaningful consultation effort by the developer with the local community prior to the application.

Sincerely,

Knockranny Moycullen Wind Farm Action Group

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Ann Malcolm

Michaela Parker

Siobhan O'Connor

Sean O'Connor

Tommy Keady

Fidelma Keady

Orla O'Connor

Martin O'Connor

Sally Faherty

Matthew Faherty

Frank Faherty

MWP

Shadow Flicker Assessment

Cnoc Raithní (Knockranny) Wind Farm proposed variation.

May 2023

Contents

MWP

Project No.	Doc. No.	Rev.	Date	Prepared By	Checked By	Approved By	Status
22854	6007	A	08/05/2023	CF	PB	CF	Final

MWP, Engineering and Environmental Consultants
Address: Reen Point, Blennerville, Tralee, Co. Kerry, V92 X2TK
www.mwp.ie

NSAI Certified NSAI Certified NSAI Certified

Engineers Ireland CPD Accredited Employer

1. Introduction

Shadow flicker is an effect that can occur when the shadow of a moving wind turbine blade passes over a small opening (e.g. a window) causing a flickering effect to be perceived. The likelihood and duration of this effect occurring depends upon certain combinations of relative sun, turbine and window locations, turbine orientation, times of day, days of the year and weather conditions. The flickering may have the potential to cause disturbance and annoyance to residents if it affects occupied rooms of a property.

In February 2016, An Bord Pleanála granted planning permission for an 11 turbine wind farm development in Cnoc Raithní (Knockranny), Co. Galway (An Bord Pleanála Ref. No.: PL 07.243094). Condition 9(a) of the planning consent stipulates the following:

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

A shadow flicker assessment had been undertaken for the Permitted Development[1] and the potential Shadow Flicker impact was determined to be not significant and would be compliant with the thresholds set out in the 2006 Wind Energy Development Guidelines as set out in Section 1.3.1 below.

The current proposal is now seeking to amend the turbine dimensions.

This report provides an assessment of the potential shadow flicker effect on residential amenity resulting from the Proposed Development. The specific objectives of the report are to:

- summarise the assessment methodology used in completing the assessment;
- describe the potential shadow flicker impact of the Proposed Wind Farm Development;
- compare the effects to the previously Permitted Development; and
- describe the mitigation measures proposed to address likely significant effects;

1.1 Assessment Methodology

1.1.1 Scope of the Assessment

In general, the shadow flicker assessment methodology involves the identification of houses within a defined study area, which have the potential to be adversely impacted by shadow flicker. The Wind Energy Development Guidelines (2006) provide that *"At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low"*. In line with best practice guidance, the study area is usually limited to a distance (between a house and wind turbine) equivalent in length to 10 of the proposed wind turbine rotor diameters. Determining shadow flicker based on using the 10 rotor diameter rule has been widely accepted across different European countries and is deemed to be an appropriate assessment area (Parsons Brinckerhoff, 2011).

[1] As defined in Chapters 1 and 2 of the submitted Environmental Impact Assessment Report

Computer software is then used to predict the occurrence of shadow flicker at each house within the study area, which is known to over-estimate the possible impact. This is explained in more detail in **section 1.1.3.4**.

The results are compared against the criteria in the existing 2006 Wind Energy Development Guidelines. Consideration was also given to the 2019 Draft Revised Wind Energy Development Guidelines.

1.1.2 Study Area

The study area for the Proposed Development was calculated with respect to two proposed candidate turbines, one with a 136m rotor diameter and the other with a 138m rotor diameter, resulting in a study area of 1.36km and 1.38km from each turbine.

1.1.3 Factors relating to Shadow Flicker Occurrence

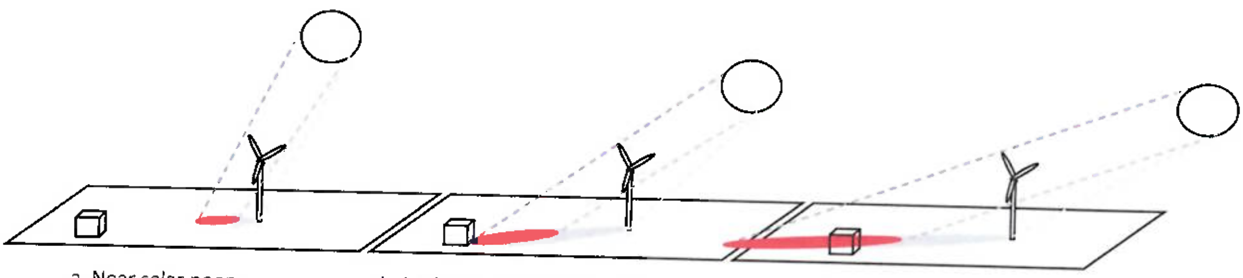
The key factors related to shadow flicker occurrence are discussed below.

1.1.3.1 Spatial Relationships

It is generally considered that the occurrence of shadow flicker is very low "at distances greater than 10 rotor diameters from a turbine" or at a distance greater than 1 kilometre (km). This is because at such separation distance the rotor of a wind turbine will not appear to be chopping light, but the turbine will be regarded as an object with the sun behind it.

Figure 1 shows an approximation of the shadow cast by a turbine at various times during the day, where the red shading represents the area where shadow flicker may occur.

Figure 1 Shadow prone area as function of time of day

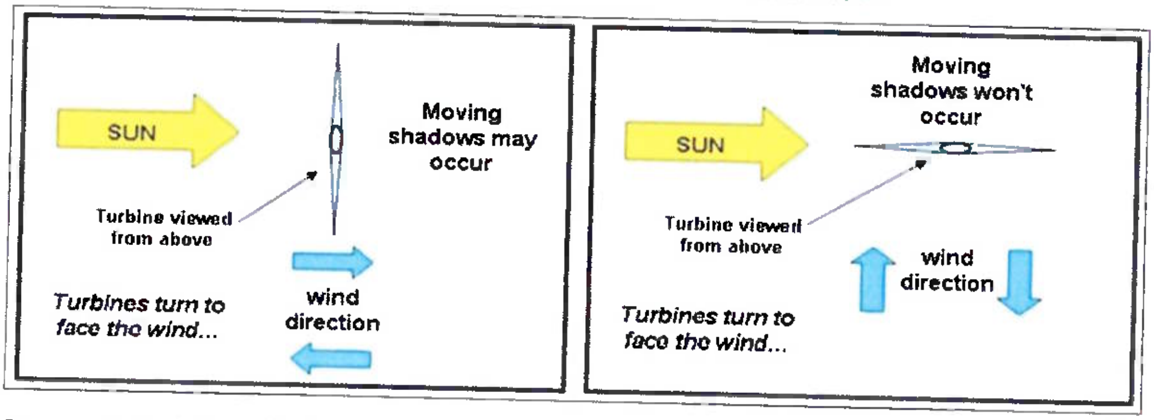


Source: Shadow Flicker Assessment Helimax Energy, Dec 2008

1.1.3.2 Wind Direction

The angle between the sun and the rotor plane also plays a determining role for both shadow flicker occurrence and intensity. The rotor plane is determined by the direction of the wind: because the turbine rotor continuously yaws to face the wind, the rotor plane will always be perpendicular to the wind direction. Shadow flicker will be most pronounced when the rotor plane is perpendicular to the sun-receptor line of sight.

Figure 2 Turbine Blade Position and Shadow Flicker Impact



Source: Wind Fact Sheet: Shadow Flicker, Noise Environment Power LLC

1.1.3.3 Sunshine Hours

The shadow flicker analysis assumes the sun is always shining, which in Ireland is certainly not the case. It is reasonable to factor any results by the percentage of time the sun is actually shining. Ireland normally gets between 1100 and 1600 hours of sunshine each year. The sunniest months are May and June. During these months, sunshine duration averages between 5 and 6.5 hours per day over most of the country. The extreme southeast gets the most sunshine, averaging over 7 hours a day in early summer. December is the dullest month, with an average daily sunshine ranging from about 1 hour in the north to almost 2 hours in the extreme southeast. Over the year as a whole, most areas get an average of between 3 1/4 and 3 3/4 hours of sunshine each day[2].

1.1.3.4 Theoretical Model Assumptions

Shadow flicker was calculated for the proposed wind turbines using industry-standard simulation software *WindFarm*, a tool which has been successfully applied to similar studies around the world. This software identifies the study area for the assessment based on the candidate turbine dimensions. Two models were carried out for both the proposed candidate turbines, namely

- wind turbine tip height of 150m and rotor diameter of 136m
- wind turbine tip height of 150m and rotor diameter of 138m

The model uses Ordnance Survey Ireland digital 10m height contour data as its only topographical reference. Simulations are run on a 'bare earth scenario' without allowing for the obscuring effect of vegetation or other

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obstacles between the location of the residence and the position of the sun in the sky. Nor does the model consider any obscuring features around residences itself, which would minimise views of the site and hence further reduce the potential for shadow flicker, thus the *WindFarm* model uses a conservative assessment scenario when reporting shadow flicker results for the existing environment. The model assumes that:

1. The sun will always be shining during daylight hours, with no cloud cover or fog i.e. bright sunshine every day.
2. The wind will blow continuously throughout the day and always above cut-in speed, i.e. the turbine will always be rotating.
3. The wind will always be blowing from a direction such that the turbine rotor is aligned with the sun-receptor line. In other words, the rotor will yaw in parallel with the sun such that the rotor blades are always perpendicular to the sun-receptor view line.
4. There will be no screening by intervening structures, vegetation or trees (other than topography), i.e. a bare earth scenario.
5. Assumed a North, South, East, and West facing façade window of dimensions 1m x 1m for each dwelling with a 2 m height above ground.

An assumption is also made that the windows of the rooms, where the effects may occur, (i) directly face the development, (ii) that the rooms are occupied and (iii) that the curtains or blinds, if present, are open.

A more realistic simulation would use the following assumptions:

1. The sun will not always be shining; therefore, it is only necessary to calculate shadow flicker for the fraction of time when the sun would be shining.
2. The rotor will not be turning all the time. For example, a turbine would not be rotating during maintenance works or low wind conditions.
3. The rotor blades will not always be perpendicular to the sun-receptor view line.
4. Trees, vegetation, local topography and buildings in the vicinity of the receptor will reduce shadow flicker or eliminate shadow flicker.

1.2 Assessment Criteria

Current assessment criteria are described in the Department of the Environment, Heritage and Local Government, Wind Energy Development Guidelines, 2006. These guidelines are currently under review and replacement Draft Wind Energy Development Guidelines were published in December 2019, which at the time of writing remain under review. See EIAR Appendix 1-3.

Until the revised guidelines are published in final form, the Government has advised that the current 2006 guidelines remain in force. However the criteria in both documents are considered.

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1.2.1 Wind Energy Development Guidelines (2006)

The current 2006 Wind Energy Development Guidelines recommend that shadow flicker at offices and dwellings within 500m of a turbine should not exceed 30 hours per year or 30 minutes per day and also that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

1.2.2 Draft Wind Energy Development Guidelines (2019)

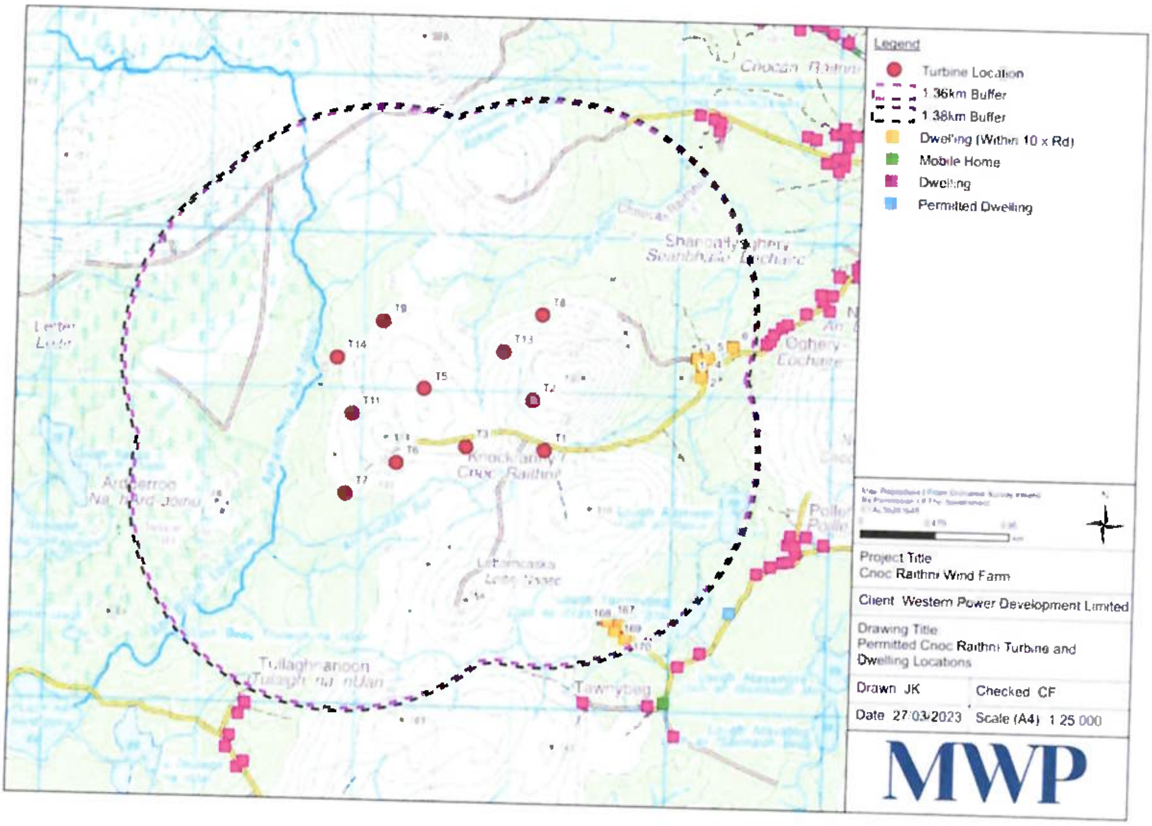
The shadow flicker criteria described in the 2019 Draft Wind Energy Guidelines is as follows:

The planning authority or An Bord Pleanála should impose condition(s) to ensure that no existing dwelling or other affected property will experience shadow flicker as a result of the wind energy development subject of the planning application and the wind energy development shall be installed and operated in accordance with the shadow flicker study submitted to accompany the planning application, including any mitigation measures required.

1.3 Receiving Environment

In line with best practice, the scope of this assessment extends to a distance of 10 times the maximum rotor diameter (1.38km for the 138m rotor and 1.36km for the 136m rotor) where shadow flicker could theoretically occur. There are 10 No. properties within the 10 x rotor diameter study area for both scenarios (H1-H6, H167-H170)). These locations are illustrated on **Figure 3**.

Figure 3 Residential Receptors within 10 Rotor Diameters of a Turbine



1.4 Assessment of Shadow Flicker

1.4.1 Permitted Cnoc Raithní (Knockranny) wind turbines

The maximum rotor diameter assessed for the Permitted Development Cnoc Raithní (Knockranny) wind turbines was 101m. As there were no residential receptors with 1010m (10 rotor diameters) of the proposed turbines, an assessment area of 1.2km was considered for the zone of potential shadow flicker influence. This was to ensure that the closest residential receptors were included in the assessment.

The output from the previous shadow flicker model for the Permitted Development Cnoc Raithní (Knockranny) wind turbines identified that there were 3 residences within the assessment zone of potential shadow flicker influence. On assessment it was determined however that these residential dwellings within the zone of influence in reality would be unlikely to experience shadow flicker due to local screening and topography.

1.4.2 Proposed Wind Turbines

There are no dwellings or commercial facilities within 500m of a turbine. Therefore, the Proposed Development would be compliant with the 2006 Wind Energy Development Guidelines recommendation that shadow flicker at offices and dwellings within 500m of a turbine should not exceed 30 hours per year or 30 minutes per day.

The summary of the results of the shadow flicker model output for all houses within 1.36 km (10 rotor diameters) and 1.38 km (10 rotor diameters) are presented in Table **1 and Table 2** below.

The output from the Shadow Flicker model determines that Shadow flicker could theoretically occur at up to 6 properties, under theoretical conservative conditions, within both the 1.36km and 1.38km 10 rotor diameter study areas. The predicted times of day/year occurrence for each dwelling are attached as Appendix A. House No.s 167, 168, 169 and 170 would not experience any shadow flicker as they are due south of the wind turbines.

Table 1 Summary of Predicted Shadow Flicker Results for 136m Rotor Diameter Turbines

House	Easting	Northing	Days per year	Max hours per day	Mean hours per day	Total hours per year
1	517135	734153	128	0.53	0.38	48.6
2	517137	734235	121	0.53	0.38	46.3
3	517107	734271	131	0.55	0.39	51.6
4	517166	734306	115	0.52	0.37	42.7
5	517175	734278	111	0.52	0.37	41.2
6	517332	734352	59	0.46	0.35	20.9
167	516575	732593	0	0	0	0
168	516621	732540	0	0	0	0
169	516648	732568	0	0	0	0
170	516685	732484	0	0	0	0

Table 2 Summary of Predicted Shadow Flicker Results for 138m Rotor Diameter Turbines

House	Easting	Northing	Days per year	Max hours per day	Mean hours per day	Total hours year
1	517135	734153	128	0.54	0.38	49.2
2	517137	734235	122	0.54	0.38	46.9
3	517107	734271	132	0.56	0.4	52.4
4	517166	734306	115	0.53	0.38	43.3
5	517175	734278	111	0.53	0.38	41.7
6	517332	734352	94	0.47	0.35	32.8
167	516575	732593	0	0	0	0
169	516621	732540	0	0	0	0
168	516648	732568	0	0	0	0
170	516685	732484	0	0	0	0

While National Guidelines would be adhered to, as there are no dwellings within 500m of a turbine, the results of the model presented in the Tables 1 and 2 show that best practice shadow flicker thresholds may potentially be exceeded in theory. These results however can be considered a very conservative overestimate. As outlined earlier this is because the model does not take into account the hours when the wind is blowing in the direction needed to orient the turbine perpendicular to the residential dwelling. Furthermore, when this does happen it will not always coincide with a sunny period. An assumption has also been made that there is a clear line of sight between all dwellings and a wind turbine and that there is a window on the potentially affected wall/gable.

A more realistic simulation would be that the sun will not always be shining; therefore, it is only necessary to calculate shadow flicker for the proportion of time when the sun would be shining.

It was possible using the 30 year average sunshine data available from Met Eireann to determine the percentage of time shadow flicker could actually occur. Average sunshine hours used in this assessment are based on average monthly figures from the years 1971 to 2000, from the Claremorris National Meteorological Station. These are presented in Table 3.

Table 3 Average hours of Sunshine and Average hours of daylight for Galway (Claremorris Meteorological Station 1971-2000)

Month	Mean Daily Duration (hours)	Average length of day (hours)	Portion of daylight hours with sunshine (%)
January	1.65	8.26	20
February	2.28	9.85	26
March	3.38	11.87	28
April	4.96	13.95	35
May	5.80	15.78	37
June	5.06	16.77	30
July	4.63	16.30	28
August	4.53	14.68	27
September	3.69	12.75	29
October	2.73	10.62	26
November	2.00	8.75	23
December	1.17	7.70	15
MONTHLY AVERAGE	3.49	YEARLY AVERAGE	27

From the data in Table 3, it can be determined that the conditions necessary for shadow flicker (sunshine hours) are only predicted to be present at approximately 27% of the maximum theoretical hours predicted by the *WindFarm* software. Therefore, using the data from Table 3, the theoretical maximum shadow flicker as predicted by *WindFarm* is multiplied by 0.27 (27 percent) to evaluate the more realistic potential shadow flicker impacts from the Cnoc Raithní (Knockranny) Wind Farm. The results are presented in Tables 4 and 5. When sunshine hours are accounted for, the potential shadow flicker reduces to well below the 30 hours per year threshold value at all locations.

Again, this methodology is conservative in that it does not account for times when the turbine blades are not spinning, or when the flicker is blocked from view at a given receptor, or when the rotor is not perpendicular to the sun.

Table 4 Annual Shadow Flicker Results adjusted for Annual Regional Sunshine Hours (136m Rotor Diameter Turbines)

House	Easting	Northing	Total hours per year (Theoretical Conservative Scenario)	Total hours per year (Adjusted Annual Regional Sunshine Scenario)
1	517135	734153	48.6	13.12
2	517137	734235	46.3	12.5
3	517107	734271	51.6	13.9
4	517166	734306	42.7	11.5
5	517175	734278	41.2	11.1
6	517332	734352	20.9	5.6
167	516575	732593	0	0
168	516621	732540	0	0
169	516648	732568	0	0
170	516685	732484	0	0

Table 5 Annual Shadow Flicker Results adjusted for Annual Regional Sunshine Hours (138m Rotor Diameter Turbines)

House	Easting	Northing	Total hours per year (Theoretical Conservative Scenario)	Total hours per year (Adjusted Annual Regional Sunshine Scenario)
1	517135	734153	49.2	13.3
2	517137	734235	46.9	12.7
3	517107	734271	52.4	14.2
4	517166	734306	43.3	11.7
5	517175	734278	41.7	11.3
6	517332	734352	32.8	8.9
167	516575	732593	0	0
168	516621	732540	0	0
169	516648	732568	0	0
170	516685	732484	0	0

1.5 Cumulative Impact

The Shadow Flicker models were also run to consider the cumulative effect of the proposed wind turbines along with the nearby Ardderroo wind turbines. As can be seen in the image below there are no residential receptors which would potentially experience in combination Shadow Flicker effects by both wind farm developments. The Galway Park turbines further to the west and the Knockalough Wind Farm wind turbines were also reviewed and confirmed to have no potential for in combination effects with the Proposed Development.

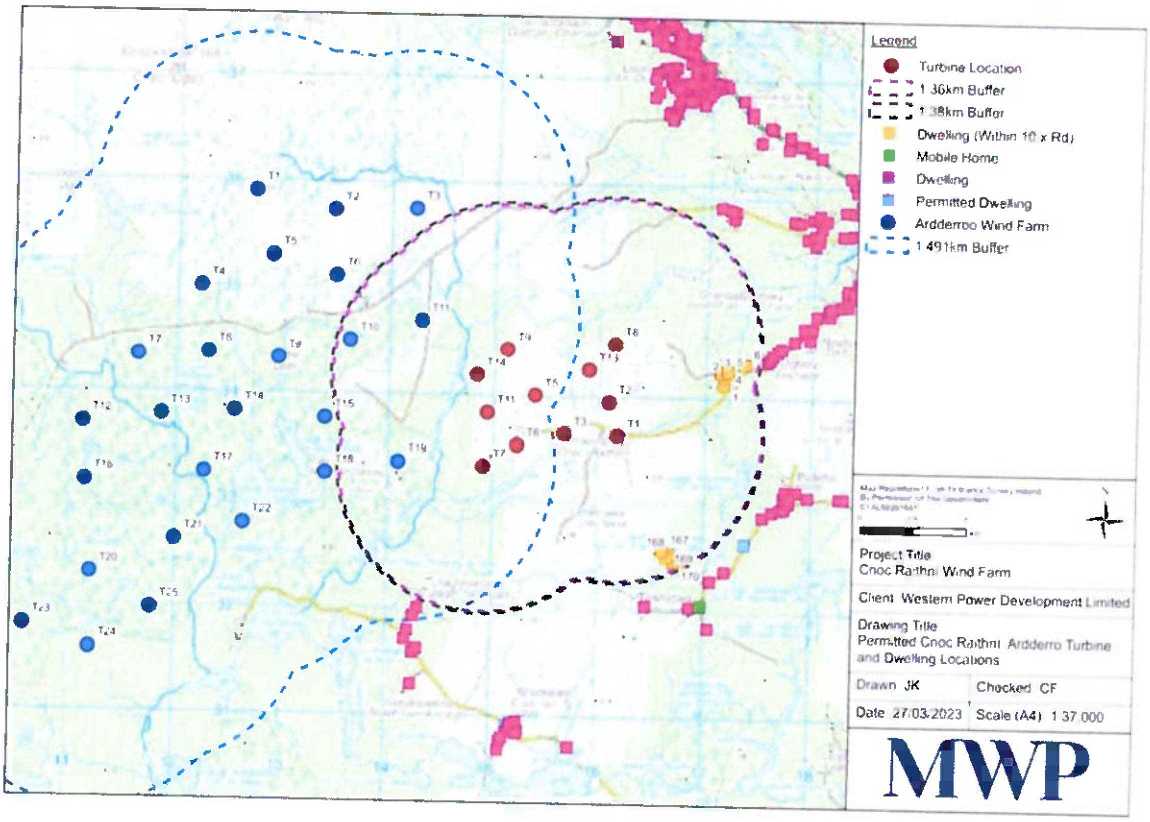


Figure 4 Zone of Potential Cumulative Shadow Flicker

1.6 Mitigation Strategy

1.6.1 Pre and Post-Mitigation Effects

As outlined in Section 1.4.2 above, of the properties modelled, it is predicted that 6 no. properties may experience daily shadow flicker levels above the Guidelines threshold of 30 minutes per day (0.5 hours). The annual figure is compliant once adjusted for the regional sunshine average. Shadow flicker mitigation strategies are commonplace across Ireland and internationally, supported where necessary by technical hardware and software measurement and verification equipment. The mitigation strategy outlined in Table 6 below is based on the theoretical precautionary scenario insofar that it discounts sunshine hours and other conditions discussed in preceding sections of this report which may naturally reduce the pre-mitigation rate of potential shadow flicker at the residential properties in question. It confirms that when any required turbine control measures are deployed, these will ensure the Guideline 30 minutes per day shadow flicker is not exceeded at all houses post mitigation.

Table 6 Shadow Flicker Mitigation Strategy – Pre and Post Mitigation

House	136m Rotor Diameter Turbines		138m Rotor Diameter Turbines	
	Predicted Pre-Mitigation Scenario (max hours per day)	Post Mitigation Scenario (max hours per day)	Predicted Pre-Mitigation Scenario (max hours per day)	Post Mitigation Scenario (max hours per day)
1	0.53	≤ 0.50	0.54	≤ 0.50
2	0.53	≤ 0.50	0.54	≤ 0.50
3	0.55	≤ 0.50	0.56	≤ 0.50
4	0.52	≤ 0.50	0.53	≤ 0.50
5	0.52	≤ 0.50	0.53	≤ 0.50
6	0.46	≤ 0.50	0.47	≤ 0.50

The developer commits to installing mitigation measures that will eliminate any potential shadow flicker duration greater that the accepted guideline limits.

In the first year of operation, the shadow flicker at these dwellings will be monitored to determine if shadow flicker occurring is exceeding the guideline limits and if so a strategy will be devised with the resident on how best to address this, having regard to the following:

1.6.2 Screening Measures

In the event of an occurrence of shadow flicker exceeding guideline threshold values of 30 minutes per day at residential receptor locations, mitigation options will be discussed with the affected homeowner, including:

- Installation of appropriate window blinds in the affected rooms of the residence;
- Planting of screening vegetation;
- Other site-specific measures which might be agreeable to the affected party and may lead to the desired mitigation.

If agreement can be reached with the homeowner, then it would be arranged for the required mitigation to be implemented in cooperation with the affected party as soon as practically possible and for the full costs to be borne by the wind farm operator.

1.6.3 Wind Turbine Control Measures

If it is not possible to mitigate any identified shadow flicker limit exceedance locally using the measures detailed in Section 1.6.1 above, wind turbine control measures will be implemented.

Shadow Flicker Control Modules (SFCM) is a standard element of commercial wind turbine packages which requires the identified dates and times of day of potential occurrence at dwellings within the shadow flicker study area to be inserted into the SFCM computer program. This software considers factors such as weather conditions, which will then automatically stop each wind turbine at times when shadow flicker would otherwise occur within any of the houses. Once the conditions for shadow flicker to occur no longer apply (e.g. when the sun has passed the relevant position in the sky or once it has been clouded over), the wind turbine is restarted

The shadow flicker computer model assessment provides very detailed information, down to the exact times of day when shadow flicker is predicted to occur and from which turbine for each receptor. This information will be used to program the shadow flicker modules to assist in eliminating shadow flicker making sure it does not occur at any property. Should the draft 2019 Wind Energy Development Guidelines be adopted this curtailment measure would be capable of satisfying the recommended requirements concerning Shadow Flicker.

1.7 Summary

The current 2006 Wind Energy Development Guidelines recommend that shadow flicker at offices and dwellings within **500m** of a turbine should not exceed 30 hours per year or 30 minutes per day. There are no dwellings within **500m** of a proposed turbine, therefore the development would comply with the recommended threshold criteria.

These guidelines also state that at distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

The output from the Shadow Flicker model determines that Shadow flicker could theoretically occur at up to 6 properties, under theoretical conservative conditions, within the 10 rotor diameter study area.

The likelihood and duration of this effect occurring however depends upon certain combinations of factors namely sunshine, turbine and window locations, turbine orientation, weather conditions and intervening structures or vegetation. When average annual sunshine data is taken into account, the potential annual shadow flicker at all dwellings falls well below the best practice threshold of 30 hours per day.

Condition 9(a) of the Permitted Development stipulates that "***Shadow flicker arising from the proposed development, by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed 30 hours per year or 30 minutes per day at existing or permitted dwellings or other sensitive receptors***"

The computer model provides very detailed information, down to the times of day when shadow flicker is predicted to occur and from which turbine for each receptor. Should it be required, this information will be used to programme shadow flicker control modules on turbines to pause turbine operation where necessary when shadow flicker is predicted to occur. The correct operation of the installed shadow flicker control measures will ensure that there will be no shadow flicker impact.

Therefore there would be no difference in the residual shadow flicker effects associated with the Proposed Development when compared to the Permitted Development.

The Shadow Flicker model was also run to consider the cumulative effect of the varied Cnoc Raithní (Knockranny) wind farm development along with the nearby consented Ardderroo wind farm. The results provide that there are no residential receptors which would potentially experience in combination Shadow Flicker effects by both wind farm developments.

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APPENDIX A

SHADOW FLICKER MODEL OUTPUT DATA

Project : 22854 Cnoc Raithní Wind Farm
Run Name V136 2023-02-22.WFK
Title : Permitted (V136)
Time : 22/02/2023 12:01

MERGED SHADOW TIMES ON EACH HOUSE DUE TO ALL TURBINES
Please note, this does not account for daylight savings

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
1	517135	734153	15-Feb	16:56:55	17:00:48	00:03:53	100
1	517135	734153	16-Feb	16:55:24	17:07:41	00:12:17	100
1	517135	734153	17-Feb	16:54:11	17:15:02	00:20:51	100
1	517135	734153	18-Feb	16:53:13	17:19:59	00:26:47	100
1	517135	734153	19-Feb	16:52:26	17:20:37	00:28:11	100
1	517135	734153	20-Feb	16:51:48	17:21:03	00:29:15	100
1	517135	734153	21-Feb	16:51:20	17:21:19	00:29:59	100
1	517135	734153	22-Feb	16:51:00	17:21:25	00:30:25	100
1	517135	734153	23-Feb	16:50:48	17:21:22	00:30:34	100
1	517135	734153	24-Feb	16:50:44	17:21:09	00:30:25	100
1	517135	734153	25-Feb	16:50:47	17:20:46	00:29:59	100
1	517135	734153	26-Feb	16:50:59	17:20:13	00:29:14	100
1	517135	734153	27-Feb	16:51:21	17:19:29	00:28:09	100
1	517135	734153	28-Feb	16:51:54	17:18:33	00:26:39	100
1	517135	734153	01-Mar	16:52:40	17:17:23	00:24:43	100
1	517135	734153	02-Mar	16:53:42	17:15:55	00:22:13	100
1	517135	734153	03-Mar	16:55:09	17:14:03	00:18:54	100
1	517135	734153	04-Mar	16:57:17	17:11:29	00:14:13	83.9
1	517135	734153	05-Mar	17:01:31	17:06:47	00:05:15	10.9
1	517135	734153	18-Mar	17:39:09	18:07:22	00:28:13	100
1	517135	734153	19-Mar	17:38:20	18:07:37	00:29:18	100
1	517135	734153	20-Mar	17:37:42	18:07:41	00:29:59	100
1	517135	734153	21-Mar	17:37:13	18:07:35	00:30:21	100
1	517135	734153	22-Mar	17:36:54	18:07:18	00:30:24	100
1	517135	734153	23-Mar	17:36:44	18:06:51	00:30:07	100
1	517135	734153	24-Mar	17:36:44	18:06:14	00:29:29	100
1	517135	734153	25-Mar	17:36:55	18:05:26	00:28:30	100
1	517135	734153	26-Mar	17:37:18	18:04:26	00:27:07	100
1	517135	734153	27-Mar	17:37:55	18:03:12	00:25:17	100
1	517135	734153	28-Mar	17:38:48	18:01:42	00:22:54	100
1	517135	734153	29-Mar	17:40:04	17:59:50	00:19:47	100
1	517135	734153	30-Mar	17:41:55	17:57:23	00:15:28	99.71
1	517135	734153	31-Mar	17:45:13	17:53:29	00:08:15	26.93
1	517135	734153	10-Apr	18:52:45	18:53:27	00:00:42	100
1	517135	734153	11-Apr	18:41:58	18:52:57	00:10:59	100
1	517135	734153	12-Apr	18:32:09	18:52:11	00:20:01	100
1	517135	734153	13-Apr	18:27:45	18:51:12	00:23:27	100
1	517135	734153	14-Apr	18:28:26	18:49:59	00:21:34	100
1	517135	734153	15-Apr	18:29:26	18:48:31	00:19:05	100
1	517135	734153	16-Apr	18:30:53	18:46:36	00:15:43	100
1	517135	734153	17-Apr	18:33:11	18:43:52	00:10:41	51.06

1	517135	734153	27-Apr	19:29:45	19:35:36	00:05:51	100
1	517135	734153	28-Apr	19:24:21	19:36:14	00:11:53	100
1	517135	734153	29-Apr	19:19:17	19:36:44	00:17:27	100
1	517135	734153	30-Apr	19:14:30	19:37:05	00:22:35	100
1	517135	734153	01-May	19:09:59	19:37:19	00:27:19	100
1	517135	734153	02-May	19:06:07	19:37:28	00:31:21	100
1	517135	734153	03-May	19:05:52	19:37:30	00:31:38	100
1	517135	734153	04-May	19:05:44	19:37:28	00:31:44	100
1	517135	734153	05-May	19:05:39	19:37:20	00:31:41	100
1	517135	734153	06-May	19:05:41	19:37:07	00:31:26	100
1	517135	734153	07-May	19:05:49	19:36:50	00:31:01	100
1	517135	734153	08-May	19:06:02	19:36:28	00:30:26	100
1	517135	734153	09-May	19:06:22	19:36:01	00:29:40	100
1	517135	734153	10-May	19:06:47	19:35:30	00:28:43	100
1	517135	734153	11-May	19:07:18	19:34:53	00:27:35	100
1	517135	734153	12-May	19:07:56	19:34:10	00:26:14	100
1	517135	734153	13-May	19:08:41	19:33:22	00:24:41	100
1	517135	734153	14-May	19:09:35	19:32:27	00:22:53	100
1	517135	734153	15-May	19:10:38	19:31:24	00:20:46	100
1	517135	734153	16-May	19:11:54	19:30:08	00:18:14	100
1	517135	734153	17-May	19:13:29	19:28:36	00:15:07	81.96
1	517135	734153	18-May	19:15:36	19:26:32	00:10:55	41.12
1	517135	734153	19-May	19:19:52	19:22:21	00:02:29	2.11
1	517135	734153	24-Jul	19:28:20	19:34:03	00:05:43	11.18
1	517135	734153	25-Jul	19:25:13	19:37:13	00:12:00	49.91
1	517135	734153	26-Jul	19:23:18	19:39:09	00:15:51	90.43
1	517135	734153	27-Jul	19:21:50	19:40:37	00:18:48	100
1	517135	734153	28-Jul	19:20:37	19:41:49	00:21:12	100
1	517135	734153	29-Jul	19:19:35	19:42:49	00:23:14	100
1	517135	734153	30-Jul	19:18:41	19:43:40	00:24:59	100
1	517135	734153	31-Jul	19:17:54	19:44:22	00:26:29	100
1	517135	734153	01-Aug	19:17:12	19:44:59	00:27:46	100
1	517135	734153	02-Aug	19:16:36	19:45:28	00:28:52	100
1	517135	734153	03-Aug	19:16:05	19:45:52	00:29:47	100
1	517135	734153	04-Aug	19:15:38	19:46:09	00:30:31	100
1	517135	734153	05-Aug	19:15:16	19:46:21	00:31:05	100
1	517135	734153	06-Aug	19:14:58	19:46:26	00:31:29	100
1	517135	734153	07-Aug	19:14:44	19:46:26	00:31:42	100
1	517135	734153	08-Aug	19:14:36	19:46:21	00:31:44	100
1	517135	734153	09-Aug	19:14:31	19:46:09	00:31:38	100
1	517135	734153	10-Aug	19:14:30	19:45:50	00:31:20	100
1	517135	734153	11-Aug	19:18:19	19:45:26	00:27:07	100
1	517135	734153	12-Aug	19:22:28	19:44:54	00:22:26	100
1	517135	734153	13-Aug	19:26:52	19:44:14	00:17:22	100
1	517135	734153	14-Aug	19:31:32	19:43:25	00:11:53	100
1	517135	734153	15-Aug	19:36:29	19:42:27	00:05:57	100
1	517135	734153	25-Aug	18:36:26	18:45:45	00:09:19	38.09
1	517135	734153	26-Aug	18:33:22	18:48:14	00:14:52	100
1	517135	734153	27-Aug	18:31:18	18:49:44	00:18:26	100
1	517135	734153	28-Aug	18:29:42	18:50:44	00:21:02	100

1	517135	734153	29-Aug	18:28:24	18:51:26	00:23:02	100
1	517135	734153	30-Aug	18:29:37	18:51:54	00:22:17	100
1	517135	734153	31-Aug	18:38:24	18:52:08	00:13:44	100
1	517135	734153	01-Sep	18:48:04	18:52:11	00:04:07	100
1	517135	734153	12-Sep	17:35:22	17:47:38	00:12:17	60.56
1	517135	734153	13-Sep	17:32:20	17:49:58	00:17:38	100
1	517135	734153	14-Sep	17:30:09	17:51:25	00:21:16	100
1	517135	734153	15-Sep	17:28:26	17:52:26	00:23:59	100
1	517135	734153	16-Sep	17:27:02	17:53:08	00:26:06	100
1	517135	734153	17-Sep	17:25:52	17:53:36	00:27:44	100
1	517135	734153	18-Sep	17:24:55	17:53:51	00:28:56	100
1	517135	734153	19-Sep	17:24:08	17:53:55	00:29:46	100
1	517135	734153	20-Sep	17:23:32	17:53:48	00:30:16	100
1	517135	734153	21-Sep	17:23:06	17:53:32	00:30:26	100
1	517135	734153	22-Sep	17:22:49	17:53:07	00:30:18	100
1	517135	734153	23-Sep	17:22:41	17:52:32	00:29:50	100
1	517135	734153	24-Sep	17:22:43	17:51:46	00:29:03	100
1	517135	734153	25-Sep	17:22:57	17:33:26	00:10:30	100
1	517135	734153	08-Oct	16:37:39	16:42:52	00:05:13	10.64
1	517135	734153	09-Oct	16:32:56	16:47:03	00:14:07	82.06
1	517135	734153	10-Oct	16:30:20	16:49:07	00:18:47	100
1	517135	734153	11-Oct	16:28:25	16:50:31	00:22:06	100
1	517135	734153	12-Oct	16:26:55	16:51:31	00:24:36	100
1	517135	734153	13-Oct	16:25:43	16:52:15	00:26:32	100
1	517135	734153	14-Oct	16:24:44	16:52:47	00:28:02	100
1	517135	734153	15-Oct	16:23:58	16:53:07	00:29:09	100
1	517135	734153	16-Oct	16:23:22	16:53:18	00:29:56	100
1	517135	734153	17-Oct	16:22:56	16:53:19	00:30:23	100
1	517135	734153	18-Oct	16:22:39	16:53:13	00:30:34	100
1	517135	734153	19-Oct	16:22:30	16:52:58	00:30:29	100
1	517135	734153	20-Oct	16:22:30	16:52:36	00:30:06	100
1	517135	734153	21-Oct	16:22:40	16:52:05	00:29:25	100
1	517135	734153	22-Oct	16:22:59	16:51:26	00:28:27	100
1	517135	734153	23-Oct	16:23:29	16:50:37	00:27:08	100
1	517135	734153	24-Oct	16:24:11	16:47:04	00:22:53	100
1	517135	734153	25-Oct	16:25:07	16:39:31	00:14:24	100
1	517135	734153	26-Oct	16:26:22	16:32:28	00:06:06	100

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
2	517137	734235	11-Feb	16:42:48	16:46:17	00:03:29	100
2	517137	734235	12-Feb	16:41:53	16:52:25	00:10:32	100
2	517137	734235	13-Feb	16:41:09	16:58:56	00:17:46	100
2	517137	734235	14-Feb	16:40:35	17:05:51	00:25:16	100
2	517137	734235	15-Feb	16:40:09	17:09:10	00:29:01	100
2	517137	734235	16-Feb	16:39:50	17:09:22	00:29:32	100
2	517137	734235	17-Feb	16:39:40	17:09:25	00:29:46	100
2	517137	734235	18-Feb	16:39:37	17:09:20	00:29:43	100
2	517137	734235	19-Feb	16:39:40	17:09:05	00:29:24	100
2	517137	734235	20-Feb	16:39:52	17:08:40	00:28:48	100

2	517137	734235	21-Feb	16:40:12	17:08:04	00:27:52	100
2	517137	734235	22-Feb	16:40:43	17:07:18	00:26:35	100
2	517137	734235	23-Feb	16:41:25	17:06:17	00:24:52	100
2	517137	734235	24-Feb	16:42:22	17:05:02	00:22:40	100
2	517137	734235	25-Feb	16:43:39	17:03:26	00:19:47	100
2	517137	734235	26-Feb	16:45:27	17:01:17	00:15:50	100
2	517137	734235	27-Feb	16:48:25	16:57:58	00:09:34	37.67
2	517137	734235	13-Mar	17:26:53	17:50:52	00:23:59	100
2	517137	734235	14-Mar	17:26:17	17:55:52	00:29:36	100
2	517137	734235	15-Mar	17:25:50	17:55:46	00:29:56	100
2	517137	734235	16-Mar	17:25:33	17:55:29	00:29:56	100
2	517137	734235	17-Mar	17:25:25	17:55:02	00:29:37	100
2	517137	734235	18-Mar	17:25:27	17:54:24	00:28:57	100
2	517137	734235	19-Mar	17:25:41	17:53:35	00:27:54	100
2	517137	734235	20-Mar	17:26:07	17:52:33	00:26:26	100
2	517137	734235	21-Mar	17:26:47	17:51:16	00:24:29	100
2	517137	734235	22-Mar	17:27:45	17:49:42	00:21:58	100
2	517137	734235	23-Mar	17:29:08	17:47:43	00:18:35	100
2	517137	734235	24-Mar	17:31:15	17:44:59	00:13:45	79.34
2	517137	734235	25-Mar	17:35:59	17:39:39	00:03:40	5.34
2	517137	734235	04-Apr	18:39:10	18:43:11	00:04:01	100
2	517137	734235	05-Apr	18:24:10	18:42:38	00:18:28	100
2	517137	734235	06-Apr	18:16:41	18:41:54	00:25:13	100
2	517137	734235	07-Apr	18:17:02	18:40:57	00:23:55	100
2	517137	734235	08-Apr	18:17:38	18:39:46	00:22:08	100
2	517137	734235	09-Apr	18:18:33	18:38:18	00:19:46	100
2	517137	734235	10-Apr	18:19:53	18:36:26	00:16:33	100
2	517137	734235	11-Apr	18:21:59	18:33:49	00:11:50	64.12
2	517137	734235	18-Apr	19:18:33	19:20:27	00:01:54	100
2	517137	734235	19-Apr	19:10:58	19:21:37	00:10:39	100
2	517137	734235	20-Apr	19:03:55	19:22:30	00:18:35	100
2	517137	734235	21-Apr	18:57:21	19:23:09	00:25:48	100
2	517137	734235	22-Apr	18:54:10	19:23:38	00:29:28	100
2	517137	734235	23-Apr	18:53:29	19:23:58	00:30:29	100
2	517137	734235	24-Apr	18:52:57	19:24:10	00:31:13	100
2	517137	734235	25-Apr	18:52:32	19:24:15	00:31:43	100
2	517137	734235	26-Apr	18:52:14	19:24:13	00:31:59	100
2	517137	734235	27-Apr	18:52:02	19:24:05	00:32:03	100
2	517137	734235	28-Apr	18:51:57	19:23:51	00:31:53	100
2	517137	734235	29-Apr	18:51:59	19:23:31	00:31:31	100
2	517137	734235	30-Apr	18:52:08	19:23:04	00:30:56	100
2	517137	734235	01-May	18:52:24	19:22:32	00:30:08	100
2	517137	734235	02-May	18:52:47	19:21:54	00:29:06	100
2	517137	734235	03-May	18:53:18	19:21:08	00:27:50	100
2	517137	734235	04-May	18:53:57	19:20:15	00:26:18	100
2	517137	734235	05-May	18:54:46	19:19:14	00:24:28	100
2	517137	734235	06-May	18:55:47	19:18:03	00:22:16	100
2	517137	734235	07-May	18:57:03	19:16:38	00:19:35	100
2	517137	734235	08-May	18:58:41	19:14:52	00:16:11	95.37
2	517137	734235	09-May	19:00:58	19:12:28	00:11:29	45.76

2	517137	734235	02-Aug	19:14:50	19:18:20	00:03:30	4.19
2	517137	734235	03-Aug	19:10:26	19:22:35	00:12:08	51.12
2	517137	734235	04-Aug	19:08:08	19:24:43	00:16:35	100
2	517137	734235	05-Aug	19:06:24	19:26:16	00:19:52	100
2	517137	734235	06-Aug	19:04:59	19:27:28	00:22:28	100
2	517137	734235	07-Aug	19:03:49	19:28:25	00:24:37	100
2	517137	734235	08-Aug	19:02:48	19:29:12	00:26:24	100
2	517137	734235	09-Aug	19:01:55	19:29:50	00:27:55	100
2	517137	734235	10-Aug	19:01:10	19:30:19	00:29:10	100
2	517137	734235	11-Aug	19:00:31	19:30:41	00:30:10	100
2	517137	734235	12-Aug	18:59:58	19:30:55	00:30:57	100
2	517137	734235	13-Aug	18:59:31	19:31:02	00:31:32	100
2	517137	734235	14-Aug	18:59:09	19:31:03	00:31:54	100
2	517137	734235	15-Aug	18:58:53	19:30:56	00:32:03	100
2	517137	734235	16-Aug	18:58:43	19:30:43	00:32:00	100
2	517137	734235	17-Aug	18:58:38	19:30:23	00:31:45	100
2	517137	734235	18-Aug	18:58:38	19:29:55	00:31:16	100
2	517137	734235	19-Aug	18:58:46	19:29:19	00:30:33	100
2	517137	734235	20-Aug	18:58:59	19:28:35	00:29:35	100
2	517137	734235	21-Aug	19:01:12	19:27:41	00:26:29	100
2	517137	734235	22-Aug	19:07:08	19:26:36	00:19:27	100
2	517137	734235	23-Aug	19:13:31	19:25:18	00:11:47	100
2	517137	734235	24-Aug	19:20:23	19:23:43	00:03:19	100
2	517137	734235	31-Aug	18:22:18	18:32:09	00:09:52	43.36
2	517137	734235	01-Sep	18:19:15	18:34:33	00:15:18	100
2	517137	734235	02-Sep	18:17:09	18:35:59	00:18:50	100
2	517137	734235	03-Sep	18:15:32	18:36:56	00:21:24	100
2	517137	734235	04-Sep	18:14:14	18:37:35	00:23:21	100
2	517137	734235	05-Sep	18:13:11	18:37:59	00:24:48	100
2	517137	734235	06-Sep	18:14:38	18:38:10	00:23:32	100
2	517137	734235	07-Sep	18:27:54	18:38:09	00:10:16	100
2	517137	734235	18-Sep	17:21:36	17:30:29	00:08:53	31.72
2	517137	734235	19-Sep	17:17:51	17:33:31	00:15:40	100
2	517137	734235	20-Sep	17:15:25	17:35:14	00:19:49	100
2	517137	734235	21-Sep	17:13:33	17:36:23	00:22:50	100
2	517137	734235	22-Sep	17:12:03	17:37:11	00:25:08	100
2	517137	734235	23-Sep	17:10:49	17:37:43	00:26:54	100
2	517137	734235	24-Sep	17:09:49	17:38:02	00:28:14	100
2	517137	734235	25-Sep	17:09:00	17:38:10	00:29:09	100
2	517137	734235	26-Sep	17:08:22	17:38:06	00:29:44	100
2	517137	734235	27-Sep	17:07:55	17:37:53	00:29:58	100
2	517137	734235	28-Sep	17:07:37	17:37:31	00:29:54	100
2	517137	734235	29-Sep	17:07:28	17:36:58	00:29:31	100
2	517137	734235	30-Sep	17:07:29	17:26:06	00:18:37	100
2	517137	734235	14-Oct	16:22:15	16:30:51	00:08:36	30.05
2	517137	734235	15-Oct	16:18:42	16:33:57	00:15:16	99.75
2	517137	734235	16-Oct	16:16:26	16:35:47	00:19:21	100
2	517137	734235	17-Oct	16:14:45	16:37:04	00:22:19	100
2	517137	734235	18-Oct	16:13:26	16:37:59	00:24:34	100
2	517137	734235	19-Oct	16:12:23	16:38:42	00:26:19	100

2	517137	734235	20-Oct	16:11:33	16:39:13	00:27:40	100
2	517137	734235	21-Oct	16:10:54	16:39:33	00:28:39	100
2	517137	734235	22-Oct	16:10:25	16:39:44	00:29:19	100
2	517137	734235	23-Oct	16:10:05	16:39:46	00:29:41	100
2	517137	734235	24-Oct	16:09:54	16:39:41	00:29:48	100
2	517137	734235	25-Oct	16:09:51	16:39:29	00:29:38	100
2	517137	734235	26-Oct	16:09:57	16:39:09	00:29:12	100
2	517137	734235	27-Oct	16:10:11	16:37:41	00:27:30	100
2	517137	734235	28-Oct	16:10:36	16:30:37	00:20:01	100
2	517137	734235	29-Oct	16:11:10	16:23:59	00:12:49	100
2	517137	734235	30-Oct	16:11:56	16:17:45	00:05:50	100

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
3	517107	734271	03-Feb	16:42:54	16:43:26	00:00:32	15.03
3	517107	734271	04-Feb	16:39:27	16:48:22	00:08:55	71.62
3	517107	734271	05-Feb	16:37:27	16:53:33	00:16:06	100
3	517107	734271	06-Feb	16:35:59	16:56:42	00:20:43	100
3	517107	734271	07-Feb	16:34:51	16:57:59	00:23:09	100
3	517107	734271	08-Feb	16:33:55	16:59:02	00:25:07	100
3	517107	734271	09-Feb	16:33:11	16:59:52	00:26:41	100
3	517107	734271	10-Feb	16:32:35	17:00:31	00:27:55	100
3	517107	734271	11-Feb	16:32:08	17:00:59	00:28:52	100
3	517107	734271	12-Feb	16:31:48	17:01:20	00:29:32	100
3	517107	734271	13-Feb	16:31:35	17:01:31	00:29:56	100
3	517107	734271	14-Feb	16:31:29	17:01:34	00:30:05	100
3	517107	734271	15-Feb	16:31:30	17:01:28	00:29:58	100
3	517107	734271	16-Feb	16:31:38	17:01:13	00:29:36	100
3	517107	734271	17-Feb	16:31:52	17:00:49	00:28:57	100
3	517107	734271	18-Feb	16:32:16	17:00:15	00:27:59	100
3	517107	734271	19-Feb	16:32:49	16:59:29	00:26:40	100
3	517107	734271	20-Feb	16:33:33	16:58:31	00:24:57	100
3	517107	734271	21-Feb	16:34:32	16:57:18	00:22:46	100
3	517107	734271	22-Feb	16:35:50	16:55:44	00:19:53	100
3	517107	734271	23-Feb	16:37:39	16:53:38	00:15:59	100
3	517107	734271	24-Feb	16:40:34	16:50:25	00:09:51	39.56
3	517107	734271	10-Mar	17:19:59	17:26:14	00:06:15	100
3	517107	734271	11-Mar	17:19:22	17:49:21	00:29:59	100
3	517107	734271	12-Mar	17:18:54	17:49:19	00:30:25	100
3	517107	734271	13-Mar	17:18:36	17:49:05	00:30:28	100
3	517107	734271	14-Mar	17:18:27	17:48:40	00:30:13	100
3	517107	734271	15-Mar	17:18:28	17:48:05	00:29:38	100
3	517107	734271	16-Mar	17:18:39	17:47:20	00:28:41	100
3	517107	734271	17-Mar	17:19:02	17:46:21	00:27:20	100
3	517107	734271	18-Mar	17:19:38	17:45:09	00:25:31	100
3	517107	734271	19-Mar	17:20:31	17:43:41	00:23:10	100
3	517107	734271	20-Mar	17:21:45	17:41:51	00:20:06	100
3	517107	734271	21-Mar	17:23:35	17:39:26	00:15:50	100
3	517107	734271	22-Mar	17:26:47	17:35:38	00:08:51	31.26
3	517107	734271	02-Apr	18:30:41	18:38:30	00:07:49	100

3	517107	734271	03-Apr	18:13:40	18:37:55	00:24:15	100
3	517107	734271	04-Apr	18:11:30	18:37:09	00:25:39	100
3	517107	734271	05-Apr	18:11:53	18:36:10	00:24:17	100
3	517107	734271	06-Apr	18:12:31	18:34:57	00:22:27	100
3	517107	734271	07-Apr	18:13:27	18:33:27	00:20:00	100
3	517107	734271	08-Apr	18:14:49	18:31:31	00:16:42	100
3	517107	734271	09-Apr	18:16:59	18:28:49	00:11:50	62.76
3	517107	734271	16-Apr	19:12:16	19:16:05	00:03:49	100
3	517107	734271	17-Apr	19:04:06	19:17:12	00:13:06	100
3	517107	734271	18-Apr	18:56:32	19:18:03	00:21:31	100
3	517107	734271	19-Apr	18:49:31	19:18:41	00:29:10	100
3	517107	734271	20-Apr	18:48:39	19:19:08	00:30:29	100
3	517107	734271	21-Apr	18:47:57	19:19:27	00:31:30	100
3	517107	734271	22-Apr	18:47:24	19:19:38	00:32:14	100
3	517107	734271	23-Apr	18:46:59	19:19:42	00:32:43	100
3	517107	734271	24-Apr	18:46:39	19:19:39	00:32:59	100
3	517107	734271	25-Apr	18:46:27	19:19:29	00:33:02	100
3	517107	734271	26-Apr	18:46:22	19:19:14	00:32:52	100
3	517107	734271	27-Apr	18:46:23	19:18:52	00:32:29	100
3	517107	734271	28-Apr	18:46:32	19:18:25	00:31:53	100
3	517107	734271	29-Apr	18:46:47	19:17:51	00:31:04	100
3	517107	734271	30-Apr	18:47:10	19:17:11	00:30:01	100
3	517107	734271	01-May	18:47:41	19:16:23	00:28:43	100
3	517107	734271	02-May	18:48:20	19:15:28	00:27:08	100
3	517107	734271	03-May	18:49:09	19:14:24	00:25:15	100
3	517107	734271	04-May	18:50:11	19:13:10	00:22:59	100
3	517107	734271	05-May	18:51:28	19:11:42	00:20:14	100
3	517107	734271	06-May	18:53:07	19:09:52	00:16:45	99.4
3	517107	734271	07-May	18:55:27	19:07:23	00:11:56	48
3	517107	734271	04-Aug	19:09:22	19:12:38	00:03:16	3.54
3	517107	734271	05-Aug	19:04:42	19:17:08	00:12:26	52.09
3	517107	734271	06-Aug	19:02:17	19:19:20	00:17:03	100
3	517107	734271	07-Aug	19:00:29	19:20:55	00:20:26	100
3	517107	734271	08-Aug	18:59:00	19:22:08	00:23:08	100
3	517107	734271	09-Aug	18:57:46	19:23:07	00:25:21	100
3	517107	734271	10-Aug	18:56:42	19:23:54	00:27:11	100
3	517107	734271	11-Aug	18:55:47	19:24:32	00:28:45	100
3	517107	734271	12-Aug	18:54:59	19:25:02	00:30:02	100
3	517107	734271	13-Aug	18:54:19	19:25:23	00:31:04	100
3	517107	734271	14-Aug	18:53:44	19:25:37	00:31:53	100
3	517107	734271	15-Aug	18:53:15	19:25:44	00:32:29	100
3	517107	734271	16-Aug	18:52:52	19:25:44	00:32:52	100
3	517107	734271	17-Aug	18:52:34	19:25:37	00:33:03	100
3	517107	734271	18-Aug	18:52:22	19:25:23	00:33:01	100
3	517107	734271	19-Aug	18:52:16	19:25:02	00:32:46	100
3	517107	734271	20-Aug	18:52:15	19:24:33	00:32:18	100
3	517107	734271	21-Aug	18:52:21	19:23:57	00:31:36	100
3	517107	734271	22-Aug	18:52:34	19:23:13	00:30:39	100
3	517107	734271	23-Aug	18:52:55	19:22:18	00:29:23	100
3	517107	734271	24-Aug	18:58:31	19:21:14	00:22:42	100

3	517107	734271	25-Aug	19:05:21	19:19:56	00:14:35	100
3	517107	734271	26-Aug	19:12:43	19:18:22	00:05:39	100
3	517107	734271	02-Sep	18:16:19	18:25:48	00:09:29	39.19
3	517107	734271	03-Sep	18:13:06	18:28:21	00:15:15	100
3	517107	734271	04-Sep	18:10:55	18:29:51	00:18:56	100
3	517107	734271	05-Sep	18:09:14	18:30:51	00:21:36	100
3	517107	734271	06-Sep	18:07:54	18:31:32	00:23:38	100
3	517107	734271	07-Sep	18:06:48	18:31:57	00:25:09	100
3	517107	734271	08-Sep	18:06:02	18:32:10	00:26:08	100
3	517107	734271	09-Sep	18:16:40	18:32:11	00:15:30	100
3	517107	734271	21-Sep	17:11:42	17:23:13	00:11:31	53.36
3	517107	734271	22-Sep	17:08:29	17:25:43	00:17:14	100
3	517107	734271	23-Sep	17:06:14	17:27:16	00:21:02	100
3	517107	734271	24-Sep	17:04:29	17:28:19	00:23:50	100
3	517107	734271	25-Sep	17:03:03	17:29:04	00:26:00	100
3	517107	734271	26-Sep	17:01:53	17:29:33	00:27:41	100
3	517107	734271	27-Sep	17:00:55	17:29:50	00:28:55	100
3	517107	734271	28-Sep	17:00:09	17:29:56	00:29:47	100
3	517107	734271	29-Sep	16:59:34	17:29:52	00:30:18	100
3	517107	734271	30-Sep	16:59:08	17:29:38	00:30:30	100
3	517107	734271	01-Oct	16:58:52	17:29:15	00:30:24	100
3	517107	734271	02-Oct	16:58:44	17:27:00	00:28:16	100
3	517107	734271	03-Oct	16:58:48	17:02:39	00:03:51	100
3	517107	734271	17-Oct	16:13:30	16:21:54	00:08:24	28.35
3	517107	734271	18-Oct	16:09:56	16:25:05	00:15:09	96.91
3	517107	734271	19-Oct	16:07:42	16:26:58	00:19:16	100
3	517107	734271	20-Oct	16:06:02	16:28:17	00:22:15	100
3	517107	734271	21-Oct	16:04:44	16:29:16	00:24:33	100
3	517107	734271	22-Oct	16:03:41	16:30:01	00:26:20	100
3	517107	734271	23-Oct	16:02:52	16:30:35	00:27:43	100
3	517107	734271	24-Oct	16:02:14	16:30:58	00:28:44	100
3	517107	734271	25-Oct	16:01:45	16:31:13	00:29:28	100
3	517107	734271	26-Oct	16:01:26	16:31:20	00:29:54	100
3	517107	734271	27-Oct	16:01:14	16:31:20	00:30:05	100
3	517107	734271	28-Oct	16:01:11	16:31:12	00:30:01	100
3	517107	734271	29-Oct	16:01:15	16:30:58	00:29:42	100
3	517107	734271	30-Oct	16:01:28	16:30:36	00:29:08	100
3	517107	734271	31-Oct	16:01:50	16:30:08	00:28:18	100
3	517107	734271	01-Nov	16:02:21	16:29:31	00:27:11	100
3	517107	734271	02-Nov	16:03:01	16:28:47	00:25:45	100
3	517107	734271	03-Nov	16:03:53	16:27:52	00:23:59	100
3	517107	734271	04-Nov	16:04:59	16:26:45	00:21:46	100
3	517107	734271	05-Nov	16:06:22	16:25:19	00:18:57	100
3	517107	734271	06-Nov	16:08:12	16:20:12	00:12:01	95.26
3	517107	734271	07-Nov	16:10:52	16:15:22	00:04:30	39.2

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
4	517166	734306	08-Feb	16:35:13	16:37:21	00:02:08	100
4	517166	734306	09-Feb	16:34:23	16:43:01	00:08:38	100

4	517166	734306	10-Feb	16:33:43	16:49:01	00:15:18	100
4	517166	734306	11-Feb	16:33:12	16:55:22	00:22:10	100
4	517166	734306	12-Feb	16:32:50	17:00:38	00:27:49	100
4	517166	734306	13-Feb	16:32:35	17:00:53	00:28:18	100
4	517166	734306	14-Feb	16:32:27	17:00:57	00:28:29	100
4	517166	734306	15-Feb	16:32:28	17:00:52	00:28:25	100
4	517166	734306	16-Feb	16:32:34	17:00:38	00:28:03	100
4	517166	734306	17-Feb	16:32:49	17:00:14	00:27:25	100
4	517166	734306	18-Feb	16:33:13	16:59:39	00:26:26	100
4	517166	734306	19-Feb	16:33:47	16:58:52	00:25:05	100
4	517166	734306	20-Feb	16:34:34	16:57:52	00:23:18	100
4	517166	734306	21-Feb	16:35:36	16:56:36	00:20:59	100
4	517166	734306	22-Feb	16:37:01	16:54:55	00:17:54	100
4	517166	734306	23-Feb	16:39:05	16:52:34	00:13:30	80.96
4	517166	734306	24-Feb	16:43:07	16:48:14	00:05:07	11.01
4	517166	734306	09-Mar	17:18:06	17:27:54	00:09:48	100
4	517166	734306	10-Mar	17:17:32	17:46:08	00:28:36	100
4	517166	734306	11-Mar	17:17:09	17:46:01	00:28:52	100
4	517166	734306	12-Mar	17:16:54	17:45:43	00:28:49	100
4	517166	734306	13-Mar	17:16:50	17:45:14	00:28:25	100
4	517166	734306	14-Mar	17:16:55	17:44:34	00:27:39	100
4	517166	734306	15-Mar	17:17:13	17:43:42	00:26:29	100
4	517166	734306	16-Mar	17:17:44	17:42:36	00:24:52	100
4	517166	734306	17-Mar	17:18:31	17:41:14	00:22:44	100
4	517166	734306	18-Mar	17:19:39	17:39:32	00:19:54	100
4	517166	734306	19-Mar	17:21:19	17:37:17	00:15:58	100
4	517166	734306	20-Mar	17:24:08	17:33:52	00:09:44	40.27
4	517166	734306	31-Mar	18:12:00	18:33:10	00:21:10	100
4	517166	734306	01-Apr	18:07:21	18:32:32	00:25:10	100
4	517166	734306	02-Apr	18:07:36	18:31:41	00:24:06	100
4	517166	734306	03-Apr	18:08:04	18:30:36	00:22:33	100
4	517166	734306	04-Apr	18:08:49	18:29:15	00:20:26	100
4	517166	734306	05-Apr	18:09:57	18:27:33	00:17:35	100
4	517166	734306	06-Apr	18:11:41	18:25:14	00:13:33	88.46
4	517166	734306	07-Apr	18:15:02	18:21:19	00:06:17	17.93
4	517166	734306	13-Apr	18:58:16	19:08:14	00:09:58	100
4	517166	734306	14-Apr	18:49:15	19:09:12	00:19:57	100
4	517166	734306	15-Apr	18:42:32	19:09:54	00:27:21	100
4	517166	734306	16-Apr	18:41:36	19:10:23	00:28:48	100
4	517166	734306	17-Apr	18:40:50	19:10:43	00:29:53	100
4	517166	734306	18-Apr	18:40:13	19:10:53	00:30:40	100
4	517166	734306	19-Apr	18:39:45	19:10:56	00:31:10	100
4	517166	734306	20-Apr	18:39:24	19:10:50	00:31:26	100
4	517166	734306	21-Apr	18:39:12	19:10:38	00:31:27	100
4	517166	734306	22-Apr	18:39:06	19:10:19	00:31:12	100
4	517166	734306	23-Apr	18:39:09	19:09:52	00:30:43	100
4	517166	734306	24-Apr	18:39:20	19:09:19	00:29:59	100
4	517166	734306	25-Apr	18:39:38	19:08:38	00:28:59	100
4	517166	734306	26-Apr	18:40:06	19:07:49	00:27:43	100
4	517166	734306	27-Apr	18:40:44	19:06:50	00:26:07	100

4	517166	734306	28-Apr	18:41:33	19:05:42	00:24:09	100
4	517166	734306	29-Apr	18:42:36	19:04:21	00:21:45	100
4	517166	734306	30-Apr	18:43:58	19:02:42	00:18:43	100
4	517166	734306	01-May	18:45:51	19:00:34	00:14:43	80.14
4	517166	734306	02-May	18:48:52	18:57:19	00:08:28	25.89
4	517166	734306	10-Aug	18:57:11	19:05:49	00:08:38	26.82
4	517166	734306	11-Aug	18:53:58	19:08:44	00:14:45	80.13
4	517166	734306	12-Aug	18:51:50	19:10:33	00:18:43	100
4	517166	734306	13-Aug	18:50:09	19:11:52	00:21:43	100
4	517166	734306	14-Aug	18:48:47	19:12:53	00:24:06	100
4	517166	734306	15-Aug	18:47:38	19:13:41	00:26:03	100
4	517166	734306	16-Aug	18:46:38	19:14:17	00:27:39	100
4	517166	734306	17-Aug	18:45:48	19:14:44	00:28:56	100
4	517166	734306	18-Aug	18:45:05	19:15:01	00:29:56	100
4	517166	734306	19-Aug	18:44:30	19:15:11	00:30:41	100
4	517166	734306	20-Aug	18:44:01	19:15:12	00:31:11	100
4	517166	734306	21-Aug	18:43:39	19:15:05	00:31:26	100
4	517166	734306	22-Aug	18:43:24	19:14:51	00:31:28	100
4	517166	734306	23-Aug	18:43:15	19:14:29	00:31:14	100
4	517166	734306	24-Aug	18:43:12	19:13:59	00:30:47	100
4	517166	734306	25-Aug	18:43:17	19:13:20	00:30:03	100
4	517166	734306	26-Aug	18:43:30	19:12:32	00:29:03	100
4	517166	734306	27-Aug	18:43:52	19:11:34	00:27:42	100
4	517166	734306	28-Aug	18:48:24	19:10:23	00:21:59	100
4	517166	734306	29-Aug	18:56:30	19:08:58	00:12:28	100
4	517166	734306	30-Aug	19:05:22	19:07:13	00:01:51	100
4	517166	734306	05-Sep	18:09:05	18:20:29	00:11:24	60.69
4	517166	734306	06-Sep	18:06:22	18:22:31	00:16:10	100
4	517166	734306	07-Sep	18:04:25	18:23:47	00:19:22	100
4	517166	734306	08-Sep	18:02:54	18:24:37	00:21:43	100
4	517166	734306	09-Sep	18:01:41	18:25:09	00:23:29	100
4	517166	734306	10-Sep	18:00:42	18:25:27	00:24:45	100
4	517166	734306	11-Sep	17:59:56	18:25:31	00:25:35	100
4	517166	734306	12-Sep	18:14:45	18:25:24	00:10:39	100
4	517166	734306	23-Sep	17:08:03	17:19:52	00:11:49	59.74
4	517166	734306	24-Sep	17:05:03	17:22:09	00:17:06	100
4	517166	734306	25-Sep	17:02:56	17:23:35	00:20:39	100
4	517166	734306	26-Sep	17:01:17	17:24:32	00:23:15	100
4	517166	734306	27-Sep	16:59:57	17:25:12	00:25:15	100
4	517166	734306	28-Sep	16:58:52	17:25:37	00:26:45	100
4	517166	734306	29-Sep	16:57:59	17:25:49	00:27:49	100
4	517166	734306	30-Sep	16:57:20	17:25:50	00:28:31	100
4	517166	734306	01-Oct	16:56:50	17:25:41	00:28:51	100
4	517166	734306	02-Oct	16:56:30	17:25:22	00:28:52	100
4	517166	734306	03-Oct	16:56:20	17:24:54	00:28:34	100
4	517166	734306	04-Oct	16:56:20	17:04:20	00:07:59	100
4	517166	734306	17-Oct	16:17:48	16:17:59	00:00:11	0.01
4	517166	734306	18-Oct	16:11:26	16:23:58	00:12:31	68.57
4	517166	734306	19-Oct	16:08:55	16:26:07	00:17:13	100
4	517166	734306	20-Oct	16:07:07	16:27:34	00:20:27	100

4	517166	734306	21-Oct	16:05:45	16:28:37	00:22:52	100
4	517166	734306	22-Oct	16:04:40	16:29:24	00:24:44	100
4	517166	734306	23-Oct	16:03:50	16:29:59	00:26:09	100
4	517166	734306	24-Oct	16:03:11	16:30:23	00:27:12	100
4	517166	734306	25-Oct	16:02:42	16:30:38	00:27:56	100
4	517166	734306	26-Oct	16:02:23	16:30:44	00:28:21	100
4	517166	734306	27-Oct	16:02:12	16:30:43	00:28:31	100
4	517166	734306	28-Oct	16:02:10	16:30:34	00:28:24	100
4	517166	734306	29-Oct	16:02:16	16:30:18	00:28:01	100
4	517166	734306	30-Oct	16:02:32	16:27:04	00:24:32	100
4	517166	734306	31-Oct	16:02:56	16:20:38	00:17:42	100
4	517166	734306	01-Nov	16:03:31	16:14:35	00:11:04	100
4	517166	734306	02-Nov	16:04:16	16:08:53	00:04:37	100

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
5	517175	734278	12-Feb	16:38:30	16:43:38	00:05:08	100
5	517175	734278	13-Feb	16:37:57	16:50:04	00:12:07	100
5	517175	734278	14-Feb	16:37:33	16:56:56	00:19:23	100
5	517175	734278	15-Feb	16:37:17	17:04:14	00:26:57	100
5	517175	734278	16-Feb	16:37:09	17:05:43	00:28:34	100
5	517175	734278	17-Feb	16:37:08	17:05:36	00:28:28	100
5	517175	734278	18-Feb	16:37:14	17:05:19	00:28:05	100
5	517175	734278	19-Feb	16:37:29	17:04:53	00:27:23	100
5	517175	734278	20-Feb	16:37:54	17:04:15	00:26:21	100
5	517175	734278	21-Feb	16:38:29	17:03:24	00:24:56	100
5	517175	734278	22-Feb	16:39:17	17:02:20	00:23:04	100
5	517175	734278	23-Feb	16:40:22	17:00:58	00:20:37	100
5	517175	734278	24-Feb	16:41:51	16:59:11	00:17:19	100
5	517175	734278	25-Feb	16:44:05	16:56:37	00:12:32	69.04
5	517175	734278	11-Mar	17:22:30	17:41:58	00:19:28	100
5	517175	734278	12-Mar	17:21:56	17:50:32	00:28:36	100
5	517175	734278	13-Mar	17:21:33	17:50:24	00:28:50	100
5	517175	734278	14-Mar	17:21:19	17:50:04	00:28:45	100
5	517175	734278	15-Mar	17:21:15	17:49:34	00:28:19	100
5	517175	734278	16-Mar	17:21:22	17:48:52	00:27:30	100
5	517175	734278	17-Mar	17:21:41	17:47:58	00:26:18	100
5	517175	734278	18-Mar	17:22:13	17:46:50	00:24:37	100
5	517175	734278	19-Mar	17:23:02	17:45:26	00:22:24	100
5	517175	734278	20-Mar	17:24:13	17:43:40	00:19:27	100
5	517175	734278	21-Mar	17:25:58	17:41:19	00:15:21	100
5	517175	734278	22-Mar	17:29:04	17:37:37	00:08:34	30.89
5	517175	734278	01-Apr	18:32:11	18:37:08	00:04:57	100
5	517175	734278	02-Apr	18:13:37	18:36:38	00:23:00	100
5	517175	734278	03-Apr	18:11:11	18:35:55	00:24:44	100
5	517175	734278	04-Apr	18:11:30	18:35:00	00:23:30	100
5	517175	734278	05-Apr	18:12:03	18:33:51	00:21:47	100
5	517175	734278	06-Apr	18:12:56	18:32:23	00:19:28	100
5	517175	734278	07-Apr	18:14:14	18:30:31	00:16:17	100

5	517175	734278	08-Apr	18:16:20	18:27:54	00:11:34	63.2
5	517175	734278	14-Apr	19:10:53	19:11:18	00:00:24	100
5	517175	734278	15-Apr	19:01:56	19:12:33	00:10:38	100
5	517175	734278	16-Apr	18:53:40	19:13:29	00:19:48	100
5	517175	734278	17-Apr	18:46:53	19:14:09	00:27:16	100
5	517175	734278	18-Apr	18:45:59	19:14:38	00:28:39	100
5	517175	734278	19-Apr	18:45:15	19:14:56	00:29:41	100
5	517175	734278	20-Apr	18:44:41	19:15:06	00:30:26	100
5	517175	734278	21-Apr	18:44:15	19:15:09	00:30:54	100
5	517175	734278	22-Apr	18:43:56	19:15:04	00:31:08	100
5	517175	734278	23-Apr	18:43:44	19:14:52	00:31:07	100
5	517175	734278	24-Apr	18:43:40	19:14:33	00:30:52	100
5	517175	734278	25-Apr	18:43:44	19:14:07	00:30:23	100
5	517175	734278	26-Apr	18:43:56	19:13:34	00:29:39	100
5	517175	734278	27-Apr	18:44:15	19:12:55	00:28:39	100
5	517175	734278	28-Apr	18:44:43	19:12:07	00:27:23	100
5	517175	734278	29-Apr	18:45:21	19:11:10	00:25:48	100
5	517175	734278	30-Apr	18:46:10	19:10:04	00:23:53	100
5	517175	734278	01-May	18:47:13	19:08:45	00:21:32	100
5	517175	734278	02-May	18:48:34	19:07:10	00:18:35	100
5	517175	734278	03-May	18:50:24	19:05:07	00:14:43	80.81
5	517175	734278	04-May	18:53:16	19:02:03	00:08:47	28.1
5	517175	734278	08-Aug	19:01:58	19:11:08	00:09:10	30.51
5	517175	734278	09-Aug	18:58:59	19:13:52	00:14:53	82.34
5	517175	734278	10-Aug	18:56:56	19:15:37	00:18:41	100
5	517175	734278	11-Aug	18:55:20	19:16:55	00:21:35	100
5	517175	734278	12-Aug	18:54:01	19:17:55	00:23:54	100
5	517175	734278	13-Aug	18:52:54	19:18:42	00:25:48	100
5	517175	734278	14-Aug	18:51:57	19:19:19	00:27:22	100
5	517175	734278	15-Aug	18:51:08	19:19:46	00:28:38	100
5	517175	734278	16-Aug	18:50:27	19:20:04	00:29:37	100
5	517175	734278	17-Aug	18:49:52	19:20:14	00:30:21	100
5	517175	734278	18-Aug	18:49:25	19:20:16	00:30:51	100
5	517175	734278	19-Aug	18:49:03	19:20:11	00:31:07	100
5	517175	734278	20-Aug	18:48:49	19:19:58	00:31:09	100
5	517175	734278	21-Aug	18:48:40	19:19:37	00:30:57	100
5	517175	734278	22-Aug	18:48:38	19:19:09	00:30:31	100
5	517175	734278	23-Aug	18:48:43	19:18:32	00:29:49	100
5	517175	734278	24-Aug	18:48:55	19:17:46	00:28:51	100
5	517175	734278	25-Aug	18:49:17	19:16:50	00:27:33	100
5	517175	734278	26-Aug	18:54:18	19:15:41	00:21:23	100
5	517175	734278	27-Aug	19:01:44	19:14:19	00:12:35	100
5	517175	734278	28-Aug	19:09:48	19:12:37	00:02:49	100
5	517175	734278	03-Sep	18:15:05	18:24:14	00:09:08	38.36
5	517175	734278	04-Sep	18:11:55	18:26:43	00:14:48	100
5	517175	734278	05-Sep	18:09:47	18:28:10	00:18:23	100
5	517175	734278	06-Sep	18:08:09	18:29:06	00:20:57	100
5	517175	734278	07-Sep	18:06:52	18:29:44	00:22:53	100
5	517175	734278	08-Sep	18:05:49	18:30:06	00:24:17	100
5	517175	734278	09-Sep	18:04:59	18:30:15	00:25:15	100

5	517175	734278	10-Sep	18:16:28	18:30:12	00:13:44	100
5	517175	734278	21-Sep	17:14:00	17:25:11	00:11:11	53.22
5	517175	734278	22-Sep	17:10:53	17:27:36	00:16:43	100
5	517175	734278	23-Sep	17:08:42	17:29:04	00:20:22	100
5	517175	734278	24-Sep	17:07:01	17:30:03	00:23:02	100
5	517175	734278	25-Sep	17:05:39	17:30:44	00:25:05	100
5	517175	734278	26-Sep	17:04:33	17:31:09	00:26:37	100
5	517175	734278	27-Sep	17:03:39	17:31:22	00:27:43	100
5	517175	734278	28-Sep	17:02:58	17:31:24	00:28:26	100
5	517175	734278	29-Sep	17:02:27	17:31:15	00:28:48	100
5	517175	734278	30-Sep	17:02:06	17:30:56	00:28:50	100
5	517175	734278	01-Oct	17:01:54	17:30:27	00:28:33	100
5	517175	734278	02-Oct	17:01:53	17:18:09	00:16:16	100
5	517175	734278	16-Oct	16:17:05	16:28:46	00:11:40	59.01
5	517175	734278	17-Oct	16:14:22	16:31:05	00:16:44	100
5	517175	734278	18-Oct	16:12:28	16:32:36	00:20:09	100
5	517175	734278	19-Oct	16:11:01	16:33:41	00:22:41	100
5	517175	734278	20-Oct	16:09:52	16:34:29	00:24:37	100
5	517175	734278	21-Oct	16:08:59	16:35:05	00:26:06	100
5	517175	734278	22-Oct	16:08:17	16:35:29	00:27:12	100
5	517175	734278	23-Oct	16:07:46	16:35:44	00:27:58	100
5	517175	734278	24-Oct	16:07:25	16:35:49	00:28:24	100
5	517175	734278	25-Oct	16:07:12	16:35:47	00:28:35	100
5	517175	734278	26-Oct	16:07:08	16:35:36	00:28:28	100
5	517175	734278	27-Oct	16:07:13	16:28:47	00:21:35	100
5	517175	734278	28-Oct	16:07:27	16:21:47	00:14:21	100
5	517175	734278	29-Oct	16:07:50	16:15:13	00:07:23	100
5	517175	734278	30-Oct	16:08:24	16:09:03	00:00:40	100

House	Easting	Northing	Date	Start Time	End Time	Duration	% Cover
6	517332	734352	07-Mar	17:22:49	17:34:50	00:12:01	100
6	517332	734352	08-Mar	17:22:09	17:47:05	00:24:56	100
6	517332	734352	09-Mar	17:21:40	17:47:04	00:25:24	100
6	517332	734352	10-Mar	17:21:22	17:46:51	00:25:29	100
6	517332	734352	11-Mar	17:21:15	17:46:26	00:25:11	100
6	517332	734352	12-Mar	17:21:20	17:45:49	00:24:29	100
6	517332	734352	13-Mar	17:21:38	17:44:57	00:23:20	100
6	517332	734352	14-Mar	17:22:11	17:43:50	00:21:40	100
6	517332	734352	15-Mar	17:23:02	17:42:25	00:19:22	100
6	517332	734352	16-Mar	17:24:21	17:40:32	00:16:11	100
6	517332	734352	17-Mar	17:26:28	17:37:50	00:11:22	63.64
6	517332	734352	05-Apr	18:54:33	18:55:32	00:00:59	93.88
6	517332	734352	06-Apr	18:40:36	18:57:19	00:16:43	100
6	517332	734352	07-Apr	18:37:16	18:58:30	00:21:15	100
6	517332	734352	08-Apr	18:35:55	18:59:19	00:23:25	100
6	517332	734352	09-Apr	18:34:50	18:59:52	00:25:02	100
6	517332	734352	10-Apr	18:33:59	19:00:12	00:26:12	100
6	517332	734352	11-Apr	18:33:20	19:00:20	00:26:59	100
6	517332	734352	12-Apr	18:32:51	19:00:18	00:27:27	100

6	517332	734352	13-Apr	18:32:31	19:00:07	00:27:36	100
6	517332	734352	14-Apr	18:32:20	18:59:46	00:27:26	100
6	517332	734352	15-Apr	18:32:20	18:59:17	00:26:57	100
6	517332	734352	16-Apr	18:32:29	18:58:38	00:26:09	100
6	517332	734352	17-Apr	18:32:50	18:57:48	00:24:59	100
6	517332	734352	18-Apr	18:33:22	18:56:47	00:23:25	100
6	517332	734352	19-Apr	18:34:09	18:55:33	00:21:23	100
6	517332	734352	20-Apr	18:35:16	18:54:01	00:18:45	100
6	517332	734352	21-Apr	18:36:50	18:52:02	00:15:12	100
6	517332	734352	22-Apr	18:39:20	18:49:09	00:09:49	41.05
6	517332	734352	20-Aug	18:44:42	18:53:38	00:08:56	33.59
6	517332	734352	21-Aug	18:41:35	18:56:15	00:14:39	93.65
6	517332	734352	22-Aug	18:39:30	18:57:49	00:18:19	100
6	517332	734352	23-Aug	18:37:53	18:58:55	00:21:02	100
6	517332	734352	24-Aug	18:36:35	18:59:42	00:23:07	100
6	517332	734352	25-Aug	18:35:31	19:00:14	00:24:44	100
6	517332	734352	26-Aug	18:34:38	19:00:35	00:25:57	100
6	517332	734352	27-Aug	18:33:55	19:00:44	00:26:49	100
6	517332	734352	28-Aug	18:33:21	19:00:43	00:27:22	100
6	517332	734352	29-Aug	18:32:56	19:00:32	00:27:36	100
6	517332	734352	30-Aug	18:32:40	19:00:12	00:27:32	100
6	517332	734352	31-Aug	18:32:33	18:59:43	00:27:10	100
6	517332	734352	01-Sep	18:32:34	18:59:03	00:26:29	100
6	517332	734352	02-Sep	18:32:45	18:58:11	00:25:27	100
6	517332	734352	03-Sep	18:33:08	18:57:08	00:24:00	100
6	517332	734352	04-Sep	18:33:45	18:55:49	00:22:04	100
6	517332	734352	05-Sep	18:34:42	18:54:10	00:19:29	100
6	517332	734352	06-Sep	18:44:54	18:52:03	00:07:08	100
6	517332	734352	25-Sep	17:13:37	17:17:27	00:03:50	6.86
6	517332	734352	26-Sep	17:08:51	17:21:31	00:12:40	79.66
6	517332	734352	27-Sep	17:06:22	17:23:19	00:16:57	100
6	517332	734352	28-Sep	17:04:34	17:24:26	00:19:52	100
6	517332	734352	29-Sep	17:03:10	17:25:11	00:22:00	100
6	517332	734352	30-Sep	17:02:04	17:25:38	00:23:33	100
6	517332	734352	01-Oct	17:01:13	17:25:50	00:24:37	100
6	517332	734352	02-Oct	17:00:35	17:25:50	00:25:16	100
6	517332	734352	03-Oct	17:00:09	17:25:39	00:25:30	100
6	517332	734352	04-Oct	16:59:53	17:25:17	00:25:24	100
6	517332	734352	05-Oct	16:59:49	17:24:43	00:24:54	100
6	517332	734352	06-Oct	16:59:58	17:10:53	00:10:56	100

House	Easting	Northing
167	516575	732593

There are no shadows cast on this window

House	Easting	Northing
168	516621	732540

There are no shadows cast on this window

House	Easting	Northing
169	516648	732568

There are no shadows cast on this window

House	Easting	Northing
170	516685	732484

There are no shadows cast on this window

CNOC RAITHNÍ (KNOCKRANNY) WIND FARM

CHAPTER 12

Noise and Vibration

VOLUME II EIAR

CHAPTER 12 - Noise and Vibration

Contents

Chapter12

1. NOISE AND VIBRATION

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impacts associated with the Proposed Development. This application seeks to amend the Permitted Development comprising alterations to the dimensions of the 11 no. wind turbines permitted as part of the Cnoc Raithní (Knockranny) Wind Farm (, omission of the permitted onsite substation, whilst seeking permission for proposed underground electrical and communications cabling connecting the 11 no. wind turbines to the Ardderroo substation, as well as extension to substation control building and new step up transformer. A full description of the Proposed Development is provided in Chapter 2 of this EIAR. There are 270 no. noise sensitive locations (NSLs) within 3.3 km of the proposed turbine locations.

An environmental noise survey to quantify the existing baseline noise environment at NSLs was previously conducted by Malachy Walsh and Partners as part of the planning assessment for the Permitted Development. The details of the environmental baseline noise survey are presented Section 12.4.

Existing, permitted and proposed wind farm developments have been identified in the wider EIAR Study Area and the cumulative impact of these developments has been considered in this assessment in line with guidance set out in the Institute of Acoustics (IOA) document A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) (IOA GPG). Further details on each of these developments is provided in Chapter 2 of this EIAR.

12.1.1 Fundamentals of Acoustics

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. To take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels (SPL) is 0dB (for the threshold of hearing) to 120dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3 dB.

The frequency of sound is the rate at which a sound wave oscillates is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz. In order to rank the SPL of various noise sources, the measured level has to be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. The 'A-weighting' system defined in the international standard, BS ISO 226:2003 Acoustics Normal Equal-loudness Level Contours has been found to provide the best correlations with human response to perceived loudness. SPL's measured using 'A-weighting' are expressed in terms of dB(A).

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 12.1. Appendix 12-1 contains a glossary of acoustic terminology used throughout this chapter.

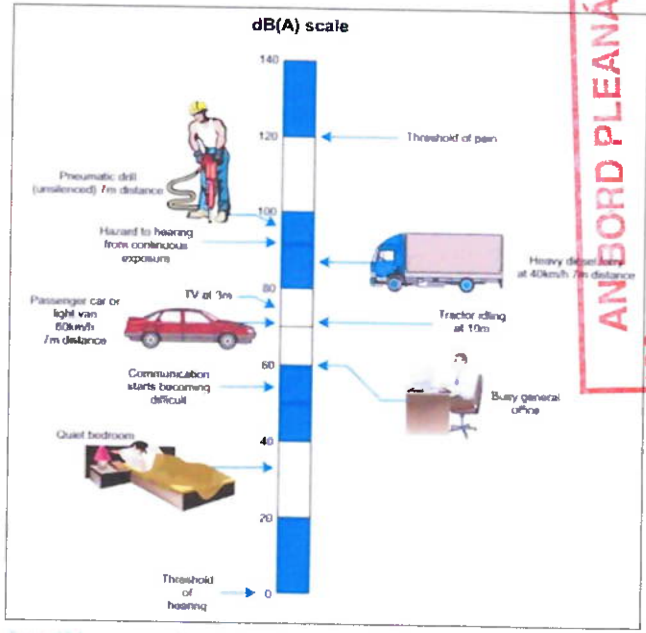

Figure 12.1

The assessment of impacts has been undertaken with reference to the most appropriate guidance documents relating to noise and vibration for both the operational and construction phases of the Proposed Development, which are set out within the relevant sections of this chapter.

In addition to the specific guidance documents outlined below, the Environmental Impact Assessment (EIA) guidelines listed in Section 1.4.1 of Chapter 1 were considered and consulted for the purposes of preparing this EIAR chapter.

The methodology adopted for this noise impact assessment is summarised as follows:

- Review of appropriate guidance to identify appropriate noise and vibration criteria for both the construction and operational phases
- Characterise the receiving environment through baseline noise surveys at various NSLs surrounding the proposed development.
- Undertake predictive calculations to assess the potential impacts associated with the construction phase of the proposed development at NSLs.

- Undertake predictive calculations to assess the potential impacts associated with the operational phase of the Proposed Development at NSLs, evaluate the potential noise and vibration impacts and effects;
- Specify mitigation measures to reduce, where necessary, the identified potential outward impacts relating to noise and vibration from the Proposed Development; and,
- Describe the significance of the residual noise and vibration effects associated with the Proposed Development.

12.2.1 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

12.2.1.1. Construction Phase

Construction Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities normally control construction activities by imposing limits on the hours of construction works and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the *British Standard 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Noise*.

The approach adopted here calls for the designation of a NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded (construction noise only) at the façade of residential, noise sensitive locations, indicates a potential significant noise impact is associated with the construction activities.

Table 12.1 sets out the values which, when exceeded, potentially signify a significant effect at the facades of residential receptors as recommended by BS 5228-1. These levels relate to construction noise only.

Table 12.1 Example Threshold of Potential Significant Effect at Noise Sensitive Locations

Assessment category and threshold value period (T)	Threshold values, LAeq,T dB		
	Category A Note A	Category B Note B	Category C Note C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends Note D	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 - 13:00hrs)	65	70	75

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values

Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values

Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values

Note D 19:00 - 23:00 weekdays, 13:00 - 23:00 Saturdays and 07:00 - 23:00 Sundays

The following assessment method is only valid for residential properties.

For the appropriate period (e.g. daytime) the ambient noise level is determined and rounded to the nearest 5dB. In this instance, with the rural nature of the site, properties near the development have daytime ambient noise levels that typically range from 40 to 50 dB $L_{Aeq,1hr}$. Therefore, as a precautionary approach all properties will be afforded a Category A designation.

See Section 12.4.2 for the detailed assessment in relation to this site. If the specific construction noise level exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,12hr}$ during weekday daytime periods) then a significant effect is deemed to have occurred.

Additional Vehicular Activity on Public Roads

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the construction of the Proposed Development will make use of existing roads already carrying traffic volumes, it is appropriate to assess the calculated increase in traffic noise levels that will arise because of vehicular movements associated with construction works.

In order to assist with the assessment of construction traffic noise, reference is made to the Design Manual for Roads and Bridges LA 111 (DMRB), Highways England Company Limited, Transport Scotland, The Welsh Government and The Department for Regional Development (Northern Ireland), (hereafter referred to as DMRB). The DMRB has been used to assess the likely magnitude of effect associated with changes in traffic noise levels along an existing road. Table 12.2 below presents the likely effects associated with change in traffic noise level and is adapted from Table 3.17 of the DMRB to include a column on the significance of effects in EPA/EIAR terms.

Table 12.2 Likely Impacts Associated with Change in Traffic Noise Level (Source DMRB, 2020)

Change in Sound Level	Subjective Reaction	Magnitude of Impact	EPA Significance of Effect
Less than 1 dB	Inaudible	Negligible	Imperceptible
1.0 – 2.9	Barely Perceptible	Minor	Not significant
3.0 - 4.9	Perceptible	Moderate	Slight, Moderate
5+	Up to a doubling of loudness	Major	Significant

In accordance with the DMRB, construction noise and construction traffic noise effects shall constitute a significant effect where it is determined that a major or moderate magnitude of effect will occur for a duration exceeding:

- Ten or more days or nights in any 15 consecutive day or nights, or

- A total number of days exceeding 40 in any six consecutive months

The guidance outlined in Table 12.2 will be used to assess the predicted increases in traffic levels on public roads associated with the construction of the Proposed Development. Where an impact is identified due to the change in traffic noise level, reference will be made to the overall predicted noise level from construction traffic in the context of the construction noise criteria outlined in Section 12.4.1.1.

Construction Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to this development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- BS 7385 - Evaluation and measurement for vibration in buildings - Part 2. Guide to damage levels from groundborne vibration (1993); and
- BS 5228 - Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration (2009+A1 2014)

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above.

BS 5228 recommends that, for soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above than 15 Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is generated the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (TII, 2014) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 12.3.

Table 12.3 Transient Vibration Guide Values for Cosmetic Building Damage

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

12.2.1.2. Operational Phase

Noise

The noise assessment summarised in the following sections has been based on guidance in relation to acceptable levels of noise from wind farms as contained in the document "Wind Energy Development Guidelines" published by the Department of the Environment, Heritage and Local Government in 2006 (hereafter referred to as WEDG). These guidelines are in turn based on detailed recommendations set out in the Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) publication "The Assessment and Rating of Noise from Wind Farms" (1996). The ETSU document has been used to supplement the guidance contained within the WEDG publication where necessary.

Commentary on the current planning condition applicable to the Permitted Development is provided in Section 12.4.3.

Wind Energy Development Guidelines

Section 5.6 of the WEDG addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

The following extracts from this document should be considered:

'An appropriate balance must be achieved between power generation and noise impact.'

While this comment is noted it should be stated that the Guidelines give no specific advice in relation to what constitutes an 'appropriate balance'. In the absence of this, guidance will be taken from alternative and appropriate publications.

"In the case of wind energy development, a noise sensitive location includes any occupied house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational importance. Noise limits should apply only to those areas frequently used for relaxation of activities for which a quiet environment is highly desirable. Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

As can be seen from the calculations presented later in this chapter the various issues identified in this extract have been incorporated into our assessment.

'In general, a lower fixed limit of 45dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours.'

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

"However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development be limited to an absolute level within the range of 35 - 40dB(A)."

In relation to night-time periods the following guidance is given:

'A fixed limit of 43dB(A) will protect sleep inside properties during the night.'

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ABP-
15 DEC 2023
Fee: € Type:
Time: By:

This limit is defined in terms of the $L_{A90,10min}$ parameter. This represents the commonly adopted night-time lower limit noise criterion curve in relation to wind farm developments.

In summary, the Wind Energy Development Guidelines outlines the following guidance to identify appropriate wind turbine noise criteria curves at noise sensitive locations:

- An appropriate absolute limit level for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ for daytime environments with background noise levels of greater than 30 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), and;
- 43 dB $L_{A90,10min}$ for night time periods.

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála, including the current planning permission for the Permitted Development. Therefore, a night-time allowance for 5dB(A) above background has also been adopted for this assessment.

This set of criteria has been chosen as it is in line with the intent of the relevant Irish guidance. The proposed operational noise criteria curves for wind turbine noise at various noise sensitive locations are presented in Section 12.4.2.

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

As stated previously the core of the noise guidance contained within the Wind Energy Development Guidelines is based on the 1996 ETSU publication The Assessment and Rating of Noise from Wind Farms (ETSU-R-97).

ETSU-R-97 calls for the control of wind turbine noise by the application of noise limits at the nearest noise sensitive properties. ETSU-R-97 considers that absolute noise limits applied at all wind speeds are not suited to wind turbine developments and recommends that noise limits should be set relative to the existing background noise levels at noise sensitive locations. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site noise surveys.

ETSU-R-97 states on page 58, "...absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question...". Therefore, the noise contribution from all wind turbine developments in the area should be included in the assessment.

Institute of Acoustics Good Practice Guide

The guidance contained within the institute of Acoustics (IOA) document A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) (IOA GPG) and Supplementary Guidance Notes are considered to represent best practice and have been adopted for this assessment. The IOA GPG states, that at a minimum continuous baseline noise monitoring should be carried out at the nearest noise sensitive locations for typically a two-week period and should capture a representative sample of wind speeds in the area (i.e. cut in speeds to wind speed of rated sound power of the proposed turbine). Background noise measurements (i.e. LA90,10min) should be related to wind speed measurements that are collated at the site of the wind turbine development. Regression analysis is then conducted on the data sets to derive background noise levels at various wind speeds to establish the appropriate day and night-time noise criterion curves.

Noise emissions associated with the wind turbine can be predicted in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (1996). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

Where noise predictions indicate that reductions in noise emissions are required in order to satisfy any adopted criteria, consideration can be given to detailed downwind analysis and operating turbines in low noise modes, which is typically offered by modern wind turbine units.

Reference has been made to the IOA GPG for guidance on the methodology for the background noise survey and operation impact assessment for wind turbine noise.

World Health Organisation (WHO) Noise Guidelines for the European Region)

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'. A strong recommendation, "can be adopted as policy in most situations" whereas a conditional recommendation, "requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply".

The objective of the World Health Organisation (WHO) Environmental Noise Guidelines for the European Region that was published in October 2018 is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of Lden and Lnight levels above which there is potential for adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

> *"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB Lden, as wind turbine noise above this level is associated with adverse health effects.*
>
> *No recommendation is made for average night noise exposure Lnight of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.*
>
> *To reduce health effects, the GDG conditionally recommends that policymakers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."*

The quality of evidence used for the WHO research is stated as being 'Low', the recommendations are therefore conditional.

The WHO Environmental Noise Guidelines aim to support the legislation and policy-making process on local, national and international level thus shall be considered by Irish policy makers for any future revisions of Irish National Wind Energy Guidelines.

There is potential increased uncertainty due to the parameter used by the WHO for assessment of exposure (i.e. Lden), which it is acknowledged may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes, as stated below.

> *"Even though correlations between noise indicators tend to be high (especially between LAeq like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in Lden is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of Lden or Lnight may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes ...*
>
> *...Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region."*

Based upon the review set out above, it is concluded that the conditional WHO recommended average noise exposure level (i.e. 45dB Lden) should not currently be applied as target noise criteria for an existing or proposed wind turbine development in Ireland.

Future Potential Guidance Change

In December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 (referred to here as the Draft Guidelines) were published for consultation and therefore have yet to be finalised. It is important to note that as part of the public consultation a number of concerns in relation to the proposed approach have been expressed by various parties and it is the opinion of the authors' of this assessment that the Draft Guidelines document does not outline a best practice approach in terms of the assessment of wind turbine noise. Specific concerns expressed by a cross party group of interested professionals can be reviewed at:

> https://www.ioa.org.uk/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community-and

The following statement is of note from the above submission:

> *"a number of acousticians working in the field have raised serious concerns over the significant amount of technical errors, ambiguities and inconsistencies in the content of the draft WEDG and these were highlighted during the consultation process by a group of acousticians".*

It is also noted that the Department has sought to commission a review of the guidelines.

Therefore, in line with best practice, which includes ESTU and IOA methodologies as described above the assessment presented in the EIAR is based on the current best practice guidance outlined in Section 5.6 of the WEDG

The original ETSU-R-97 concepts on which the WEDG is based underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics publication of the A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including 6 Supplementary Guidance Notes, all of which bring together the combined experience of acoustic consultants in the UK and Ireland in the application of these methods. Numerous improvements in the accuracy and robustness are described, in particular the treatment of wind shear and the general adaptation to larger wind turbines. The assessment in the EIAR takes cognisance of these amendments and is therefore in full accordance with the latest best-practice methods.

In the event that updated Wind Energy Development Guidelines are published during the application process for the Proposed Development it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

Permitted Development Planning Condition

Condition 8 of the grant of planning permission relates to noise and is as follows:

> *8 Noise mitigation measures outlined in the environmental impact statement and in the further information submitted to the planning authority shall be carried out in full. The following conditions shall be complied with.*
>
> *(a) Wind turbine noise arising from the proposed development by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed the greater of*
>
> - *5 dB(A) above background noise levels or*
> - *43 dB(A) L90,10min*
>
> *when measured externally at dwellings or other sensitive receptors.*
>
> *(b) Prior to commencement of development, the developer shall submit to and agree in writing with the planning authority a noise compliance monitoring programme for the subject development including any mitigation measures such as the de-rating of particular turbines. All noise measurements shall be carried out in accordance with ISO Recommendation R 1996 "Assessment of Noise with Respect to Community Response," as amended by ISO Recommendations R 1996-1. The results of the initial noise compliance monitoring shall be submitted to, and agreed in writing with, the planning authority within six months of commissioning of the wind farm.*
>
> *Reason: In the interest of residential amenity.*

The noise condition refers to cumulative wind turbine noise levels. The wording of the noise limits is such that if it can be demonstrated that the cumulative wind turbine noise level at a noise-sensitive location is 43 dB $L_{A90,10min}$ or less, then the noise level is compliant with the condition, without reference to the background noise levels.

12.2.2 Special Characteristics of Turbine Noise

12.2.2.1. Infrasound/Low Frequency Noise

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200Hz whereas Infrasound is typically described as sound at frequencies below 20Hz. In relation to Infrasound, the following extract from the EPA document Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) (EPA, 2011) is noted here.

"There is similarly no significant infrasound from wind turbines. Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature."

With respect to infrasonic noise levels below the hearing threshold, the World Health Organisation (WHO) document Community Noise (WHO, 1995) has stated that:

> *"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects."*

In 2010, the UK Health Protection Agency published a report entitled Health Effects of Exposure to Ultrasound and Infrasound, Report of the independent Advisory Group on Non-ionising Radiation. The exposures considered in the report related to medical applications and general environmental exposure. The report notes

> *"Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects."*

The UK Institute of Acoustics Bulletin in March 2009 included a statement of agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments (IAO JS2009). The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. In relation to the issue of infrasound, the article states the following:

> *"Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.*
>
> *Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low-frequency sound. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view."*

The article concludes that:

> *"from examination of reports of the studies referred to above and other reports widely available on internet sites, we conclude that there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, generally has adverse effects on wind farm neighbours".*

A report released in January 2013 by the South Australian Environment Protection Authority[1] namely, Infrasound levels near windfarms and in other environments (EPA, 2013) found that the level of infrasound from wind turbines is insignificant and no different to any other source of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people.

The study included several houses in rural and urban areas, both adjacent to and away from a wind farm, and measured the levels of infrasound with the wind farms operating and switched off.

There were no noticeable differences in the levels of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building.

The EPA's study concluded that the level of infrasound at houses near wind turbines was no greater than in other urban and rural environments, and stated that:

> *"The contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."*

A German report[2], titled "Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources" presents the details of a measurement project which ran from 2013. The report was published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016 and concluded the following in relation to infrasound from wind turbines:

> *"The measured infrasound levels (G levels) at a distance of approx. 150 m from the turbine were between 55 and 80 dB(G) with the turbine running. With the turbine switched off, they were between 50 and 75 dB(G). At distances of 650 to 700 m, the G levels were between 55 and 75 dB(G) with the turbine switched on as well as off."*

[1] EPA South Australia, 2013. Wind farms https://www.epa.sa.gov.au/files/477912_infrasound.pdf

[2] Report available at https://www4.lubw.baden-wuerttemberg.de/servlet/is/262445/low-frequency_noise_incl_infrasound.pdf?command=downloadContent&filename=low-frequency_noise_incl_infrasound.pdf

"For the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013 Draft)[1]

"The results of this measurement project comply with the results of similar investigations on a national and international level."

In conclusion, there is a significant body of evidence to show that the infrasound associated with wind turbines will be below perceptibility thresholds and typically in line with existing baseline levels of infrasound within the environment.

12.2.2.2. Amplitude Modulation

In the context of this assessment, amplitude modulation (AM) is defined in the IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document A Method for Rating Amplitude Modulation in Wind Turbine Noise (IOA, 2016) as:

"Periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency (BPF) of the turbine rotor(s)."

It is now generally accepted that there are two mechanisms which can cause amplitude modulation.

- 'Normal' AM, and,
- 'Other' AM (sometimes referred to 'Excessive' AM).

In both cases, the result is a regular fluctuation in amplitude at the Blade Passing Frequency (BPF) of the wind turbine blades (the rate at which the blades of the turbine pass a fixed point). For a three-bladed turbine rotating at 20 rpm, this equates to a modulation frequency of 1 Hz.

'Normal' AM — An observer at ground level close to a wind turbine will experience 'blade swish' because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from the observer.

This effect is reduced for an observer on or close to the turbine axis, and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

The RenewableUK AM project (RenewableUK, 2013) has coined the term 'normal' AM (NAM) for this inherent characteristic of wind turbine noise, which has long been recognised and was discussed in ETSU-R-97 in 1996.

'Other' AM — In some cases AM is observed at large distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' at relatively low frequencies.

On sites where it has been reported, occurrences appear to be occasional, although they can persist for several hours under some conditions, dependent on atmospheric factors, including wind speed and direction.

It was proposed in the RenewableUK 2013 study that the fundamental cause of this type of AM is transient stall conditions occurring as the blades rotate, giving rise to the periodic thumping at the blade passing frequency.

Transient stall represents a fundamentally different mechanism from blade swish and can be heard at relatively large distances, primarily downwind of the rotor blade.

The RenewableUK AM project report adopted the term 'Other AM' (OAM) for this characteristic. The terms 'enhanced' or 'excess' AM (EAM) have been used by others, although such definitions do not distinguish between the source mechanisms and presuppose a 'normal' level of AM, presumably relating back to blade swish as described in ETSU-R-97.

Frequency of Occurrence of AM

Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report Research into Aerodynamic Modulation of Wind Turbine Noise (2007). The broad conclusions of this report were that aerodynamic modulation was only considered to be an issue at 4, and a possible issue at a further 8, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the 4 sites where AM was confirmed as an issue, it was considered that conditions associated with AM might occur between about 7 and 15% of the time. It also emerged that for three out of the four sites the complaints have subsided, in one case due to the introduction of a turbine control system. The research has shown that AM is a rare and unlikely occurrence at operational wind farms.

It should be noted that AM is associated with wind turbine operation and it is not possible to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule.

RenewableUK Research Document states the following in relation to matter:

Page 68 Module F	"even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."
Page 6 Module F	"It has also been the experience of the project team that, even at those wind farm sites where AM has been reported or identified to be an issue, its occurrence may be relatively infrequent. Thus, the capture of time periods when subjectively significant AM occurs may involve elapsed periods of several weeks or even months."

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[1] DIN 45680 2013-09 – Draft 'Measurement and Assessment of Low-frequency Noise Emissions' November 2013

Page 61 Module F "There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."

Assessment of AM

Research and Guidance in the area is ongoing with recent publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016) (The Reference Method). The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation.

The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work and is currently the subject of a separate UK Government funded study. In the absence of published guidance to date, it is considered best practice to adopt the penalty an article published in the Institute of Acoustics publication Acoustics Bulletin (Vol. 42 No. 2 March/April 2017) titled. Perception and Control of Amplitude Modulation in Wind Turbines Noise rating and assessment scheme contained in

Where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements during the operational phase of the proposed development. The 'Reference Method' for measuring AM outlined in the IOA AMWG document will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

12.2.2.3. Comments on Human Health Impacts

Health effects of wind turbine noise are discussed in Chapter 14, Population and Human Health. The peer reviewed research outlined in Chapter 14 supports that there are no negative health effects on people with long term exposure to wind turbine noise.

12.2.3 Vibration

A report published in Germany by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Wurttemberg in 2016, "Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources". Conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

Considering the distances from nearest NSLs to any of the turbines in the Proposed Development (>500m) the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria have not been specified for the operational phase of the Proposed Development.

12.2.4 Turbine Noise Calculations

A series of computer-based prediction models have been prepared to quantify the noise level associated with the operation of the Proposed Development. This section discusses the methodology for the noise modelling process.

12.2.4.1. Noise Modelling Software

Proprietary noise calculation software was used for the purposes of this impact assessment. The selected software DGMR iNoise Enterprise, calculates noise levels in accordance with ISO 9613 Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, (ISO, 1996).

iNoise is a proprietary noise calculation package for computing noise levels and propagation of noise sources. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated considering a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (LWA);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m)

12.2.4.2. Input Data and Assumptions

The calculation settings, input data and any assumptions made in the assessment are described in the following sections. Additional information relating to the noise model inputs and calculation settings is provided in Appendix 12-2.

12.2.4.3. Turbine Details

Table 12.4 details the co-ordinates of the 11 no. proposed turbines that are being considered in this assessment.

Table 12.4 Proposed Development Turbine Co-ordinates

Turbine Ref.	Coordinates - Irish Transverse Mercator (ITM)	
	Easting	Northing
T01	516,137	733,670
T02	516,053	733,980
T03	515,637	733,678
T05	515,363	734,036

Turbine Ref	Coordinates - Irish Transverse Mercator (ITM)	
	Easting	Northing
T06	515,199	733,570
T07	514,875	733,361
T08	516,103	734,530
T09	515,090	734,468
T11	514,908	733,868
T13	515,865	734,285
T14	514,806	734,228

For the purposes of this assessment, two turbine technologies have been selected:

- the Enercon E138 with a hub height of 81m, and
- the Vestas V136 with a hub height of 82m.

Tables 12.5 and 12.6 detail the noise spectra used for noise modelling purposes for the Proposed Development.

Table 12.5 Sound Power Level Spectra Used for Enercon E138 at a hub height of 81m

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
4	76.3	83.5	89.2	91.6	93.8	90.5	80.4	73.6	97.9
5	81.3	87.9	92.8	95.8	97.6	94.2	85.2	67.4	101.8
6	85.3	91.6	95.9	99.3	100.7	97.5	89.0	71.6	105.1
7	86.8	92.7	96.3	99.7	101.8	98.2	89.8	72.7	105.9
8	87.8	93.3	96.2	99.4	102.0	98.5	90.4	73.5	106.0
9	88.2	93.4	96.0	99.2	102.0	98.7	90.9	73.5	106.0

Table 12.6 Sound Power Level Spectra Used for Vestas V136 at a hub height of 82m

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
4	75.2	83.2	88.0	89.9	88.7	84.5	77.3	67.0	94.7
5	80.2	88.1	93.0	94.8	93.6	89.4	82.2	71.9	99.6
6	84.1	91.8	96.5	98.3	97.2	93.1	86.2	76.1	103.2
7	84.9	92.5	97.2	99.0	97.9	93.8	86.9	76.9	103.9
8	85.0	92.6	97.2	99.0	97.9	93.9	87.0	77.3	103.9
9	85.2	92.6	97.2	99.0	97.9	93.9	87.2	77.5	103.9

An appraisal of the surrounding area around the site identified the potential for cumulative impacts from the operation of the Proposed Development in combination with other wind farms. The wind farms which are included in the noise assessment are listed below:

- Cloosh - Operational development of 22 turbines with an associated HH of 90m.
- Letterpeak - Operational development of 7 turbines with an associated HH of 78m.
- Uggool - Operational development of 16 turbines with an associated HH of 90m.
- Seecon - Operational development of 16 turbines with an associated HH of 90m.
- Lettercraffroe - Operational development of 8 turbines with an assumed HH of 80m.
- Knockalough - Operational of 11 turbines with an associated HH of 77.5m.
- Cloosh Extension - Proposed development of 9 turbines with assumed HH of 99m.
- Ardderroo - Proposed development of 25 turbines with HH of 103.5m.

The sound power levels for the wind farms listed above are presented in Appendix 12-3. The manufacturer's turbine sound power levels in the Table 12.5 and Table 12.6 are derived based on measurements in terms of the L_{Aeq} acoustic parameter[4]. In accordance with best practice guidance contained within the Institute of Acoustics

[4] For details, see IEC 61400 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques

Good Practice Guide (IOA GPG), an allowance for uncertainty in the measurement of turbine source levels of +2dB is added to all turbine sound power levels presented in the tables above.

Moreover, as explained in Section 12.2.1.2, appropriate guidance is couched in terms of a L_{A90} parameter. Best practice guidance in the IOA GPG states that "L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB". Therefore, a 2dB reduction has been applied to the noise model output. All predicted noise levels in this chapter are presented in terms of L_{A90}, i.e. this reduction of 2dB is included the values presented. In the interest of clarity, the levels presented in the tables above are the corrected levels following the adding and subtracting of 2dB.

Finally, best practice specifies that should any tonal component be present, a penalty shall be added to the predicted noise levels. The level of this penalty is described in ETSU-R-97[5] and is related to the level by which any tonal components exceed audibility. For the purposes of this assessment a tonal penalty has not been included within the predicted noise levels. A warranty will be provided by the manufacturers of the selected turbine to ensure that the noise output will not require a tonal noise correction under best practice guidance.

The predicted cumulative turbine noise level from the Proposed Development and contributing permitted and proposed developments in the area will be compared against the current planning conditions and any exceedances of the limits will be identified and assessed. Where necessary, appropriate mitigation measures will be outlined.

12.2.5 Study Area for Environmental Noise

The IOA GPG states the following in relation to the extent of the study area, in section 2.2:

> *The 'study area' for background noise surveys (and noise assessment) should, as a minimum, be the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35 dB L_{A90} at up to 10 m/s wind speed. (Note: unless stated in this document the wind speed reference for noise data is the 10 metre standardised wind speed, derived from the wind speed at turbine hub height as explained in Section 2.6).*

If there were no other wind farms to be considered, the study area is simply the 35 dB L_{A90} noise contour at maximum sound power level for the turbine, due to the proposed development only. The inclusion of other wind farms in the noise model has the potential to increase predicted noise levels to above 35dB L_{A90} at a wider set of NSLs. In this instance, NSLs within the 25 dB contour for the proposed development only are included in the assessment; this reaches to approximately 3.3 km from any Proposed Development turbine.

The coordinates of the resulting 270 NSLs are presented in Appendix 12-4.

An environmental noise survey to quantify the existing baseline noise environment at NSLs was conducted by Malachy Walsh Partners as part of the planning assessment for the Permitted Development. The details of the environmental baseline noise survey are presented in the following sections.

12.3.1 Wind Speed Measurement

In this instance, wind speeds were measured at 10m height above ground level. The IOA GPG, published at in the same year as the survey, formalised a number of emerging best practices in relation to the measurement and analysis of baseline noise levels for wind turbine noise assessments. One of the main recommendations was the derivation of the 'standardised 10m wind speed' based on wind speeds measured at stipulated heights above ground in order to give due consideration to the issue of wind shear. Up to that time, it was common practice, including in Ireland, to obtain this specific wind speed dataset by the measurement of wind speed directly at 10 m above ground with no correction of the issue of wind shear typically being applied.

The IOA GPG states that wind speeds measured directly at 10 m above ground can be used once an appropriate correction is applied, as follows:

> 4.5.4 *The following simplified method is proposed for ease of use: applying a fixed correction by subtracting the following factors from the wind speed reference used for the turbine predictions: 1 m/s for turbine hub heights of up to 30 m, 2 m/s for hub heights of up to 60 m and 3 m/s for hub heights of more than 60 m. Such a generic approach would be suitable in the context of a study made using a 10 m mast to limit costs in the absence of site-specific data.*
>
> 4.5.5 *If it can be demonstrated that the predicted levels are below the applicable lower fixed limits regardless of wind speed, it can be seen that wind shear would not have an effect on the assessment, and this may form the basis of a suitable planning condition.*

In Chapter 10 of the submitted EIS for the Permitted Development a correction of 3 m/s was applied to the predicted noise levels in the noise assessment, in accordance with Section 4.5.4 of the IOA GPG. The parameters and findings of the noise surveys summarised in the following sections.

12.3.2 Choice of Measurement Locations

Coordinates for the two noise monitoring locations are detailed in Table 12.7 and illustrated in Figure 12.2.

Table 12.7 Measurement Location Coordinates

Location	Coordinates - Irish Transverse Mercator (ITM)	
	Easting	Northing
H002	517139	734232
H157	514269	732026

[5] UK Department of Trade and Industry, ETSU-R-97 The assessment of rating of noise from wind farms, 1996

Figure 12.2

12.3.3 Measurement Periods

Noise measurements were conducted at each of the monitoring locations over the periods outlined in

Table 12.8 Measurement Periods

Location	Start Date	End Date
H002 (N1 in EIS)	14 May 2013	23 May 2013
H157 (N2 in EIS)	14 May 2013	23 May 2013

A variety of wind speed and weather conditions were encountered over the survey periods in question.

12.3.4 Background Noise Levels

12.3.4.1. Location H002

Daytime Periods

The background noise levels measured at H002, which was named N1 in the original EIS, are presented in Figure 12.3 or daytime periods

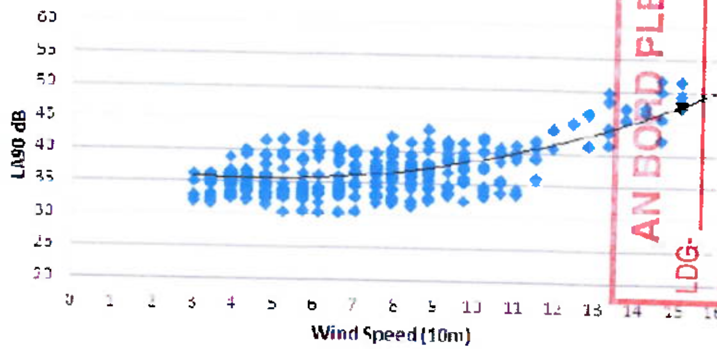

Figure 12.3

Night-time Periods

The background noise levels measured at H002 are presented in Figure 12.4 for night-time periods.

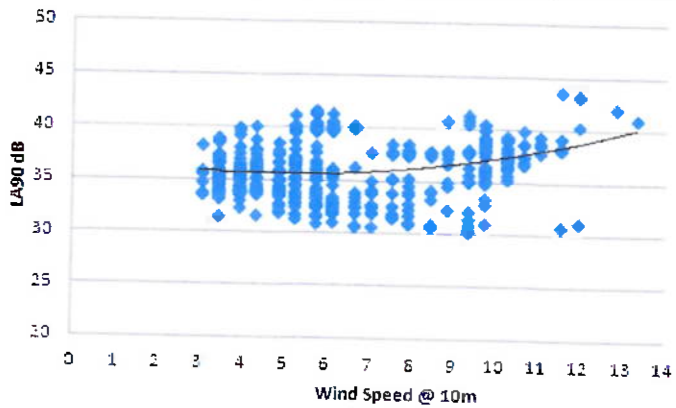

Figure 12.4

12.3.4.2. Location H157

Daytime Periods

The background noise levels measured at H157, which was named N2 in the original EIS, are presented in Figure 12.5 for daytime periods.

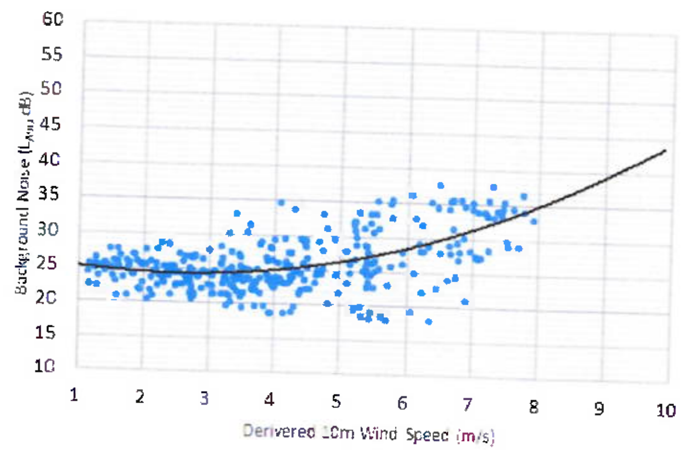

Figure 12.5

Night-time Periods

The background noise levels measured at H157 are presented in Figure 12.6 for night-time periods.

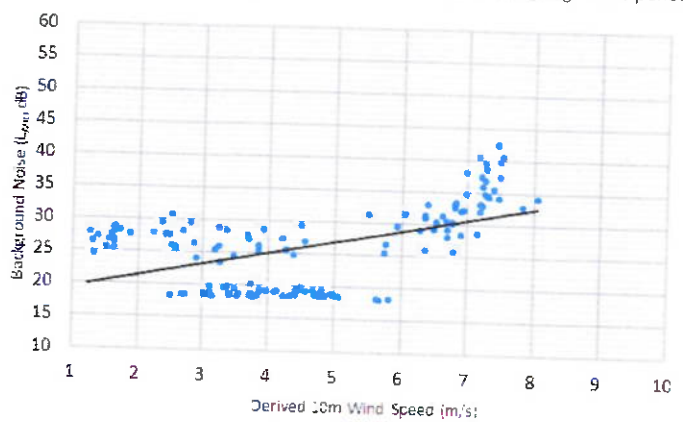

Figure 12.6

12.3.4.3. Wind Turbine Noise Criteria

The noise condition for the Permitted Development (See Section 12.2.1.2) are stated as "the greater of 43 dB L_{A90} or background + 5 dB". On review of the measured background noise levels, it is clear if predicted noise levels are 43 dB L_{A90} or less, then compliance with this planning condition is demonstrated. The wind turbine noise criteria are, therefore, for both day and night-time periods:

Table 12.9 Wind Turbine Noise Criteria

Wind Turbine Noise Criteria (dB L_{A90}) at standardised Wind Speed at 10 m above ground level						
3	4	5	6	7	8	9
43	43	43	43	43	43	43

Moreover, as the noise criterion is constant with respect to wind speed, the effect of wind shear does not have an effect on the assessment, and the fact that wind speeds were measured directly at 10m in the baseline noise survey, is not at concern.

12.4.1 Do Nothing Scenario

If the Proposed Development were not to proceed the already permitted 11-turbine layout will proceed under the terms of the Galway County Council Planning Ref. No. 13/829 and An Bord Pleanála Ref. 07.243094 planning permissions. The opportunity to increase the energy output from County Galway's valuable renewable energy resource would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

12.4.2 Assessment of Effects During Construction

The construction phase noise impacts of the Permitted Development were assessed in the EIS submitted with that planning application. This Proposed Development seeks to increase the overall height of the permitted 11 no. wind turbines from a combination of 130.5m and 140.5m to 150m with associated turbine foundation alteration, omission of the permitted on-site substation, alteration to the underground cabling connection including road upgrade and provision of a new cable service track, and extension to the Ardderroo Substation to facilitate the revised grid connection.

The EIS for the Permitted Development fully assessed the likely significant effects of the 11 no. turbine layout and proposed mitigation measures to avoid or reduce these effects. The findings of the assessment and proposed mitigation measures will not be altered as a result of the Proposed Development.

12.4.2.1. Turbines and Hardstands

The construction phase noise impacts of the Permitted Development were assessed in the EIS submitted with that planning application. The EIS for the Permitted Development fully assessed the likely significant effects of the 11-turbine layout and proposed mitigation measures to avoid or reduce these effects. The findings of the assessment and proposed mitigation measures will not be altered as a result of the Proposed Development.

In terms of these the construction activities, the overall associated effects remain negative, not significant and short-term.

12.4.2.2. Grid Connection Route

The Proposed Development includes underground electrical and communications cabling connecting the 11 no wind turbines to the Ardderroo substation, as well as extension to substation control building and new step up transformer. The underground cabling will be provided from within the wind farm roads, widened forestry road, and the new cable service track along the southern verge of the road serving Ardderroo substation

The nearest noise-sensitive location to this element of the works are H152 and H154 at a distance of the order of 2.6 km.

Due to the nature of construction activities, it is difficult to calculate the actual magnitude of noise emissions to the local environment. However, the standard best practice approach used to predict typical noise levels at the nearest sensitive receptor is by using guidance set out in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Noise.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra from BS 5228 at various distances from these works.

The noise levels referred to in this section are indicative only and are intended to assess whether it is likely that the contractor can comply with current best practice guidance. The predicted levels are expected to occur for only short periods of time at a very limited number of properties. Construction noise levels will be lower than these levels for most of the time at most properties in the vicinity of the Proposed Development site.

Several indicative sources that would be expected on a site of this nature have been identified and noise predictions of their potential impacts prepared to nearby houses.; construction noise levels will be lower at properties located further from the works.

Table 12.10 details the noise levels associated with typical construction noise sources assessed in this instance along with typical sound pressure levels and spectra from BS 5228 - 1: 2009. Calculations have assumed an on-time of 66% for each item of plant i.e. 8 hours over a 12-hour assessment period.

Table 12.10 Noise Levels due to grid connection construction

Item (BS5228 Ref)	Plant Noise Level at 10m Distance (dB $L_{Aeq,T}$) 6	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,T}$)			
		1000 m	1500 m	2000 m	2500 m
HGV Movement (C.2.30)	79	31	27	24	22
Tracked Excavator (C.4.64)	77	29	25	22	20
Dumper Truck (C.4.4)	76	28	24	21	19
Vibrating Rollers (D.8.29)	77	29	25	22	20
Generator (C.2.44)	77	29	25	22	20
Total Construction Noise (cumulative for all activities)		36	32	29	27

These levels of noise are well within the construction noise criterion outlined in Table 12.1, therefore it is concluded that there will be no significant noise impact associated with the construction of the grid connection, therefore no specific mitigation measures are required.

12.4.2.3. Substation

The Proposed Development proposes to omit the permitted on-site substation and instead connect the proposed wind turbines to the electrical grid at Ardderroo substation, as discussed in the previous section. An extension of the Ardderroo substation will be constructed to accommodate grid connection to Knockranny wind farm. The overall noise emission from the substation will be similar to the permitted substation therefore no significant noise or vibration effects due to the substation extension are likely.

12.4.2.4. Additional Traffic along Turbine Delivery Route

In respect of the potential noise effects of additional traffic of surrounding roads, the following comments are made for the construction phase, the assessment and findings in the EIS for the Permitted Development remain applicable and valid with the exception of traffic during the concrete pouring phase.

6 All plant noise levels are derived from BS 5228 Part 1

However, as a result of the increased size of the foundations due to the increase in size of the turbines as part of the Proposed Development, additional concrete deliveries will be made to the site. The information presented in Chapter 5 has been used to inform the assessment of the updated traffic flows for this phase of the construction.

Changes in traffic noise levels along the proposed route have been estimated and presented in Table 12.11.

Table 12.11 Estimated Changes in Traffic Noise Levels during Construction Phase

Link	Change in noise levels due to permitted development dB $L_{Aeq,12hr}$	Change in noise levels due to proposed development dB $L_{Aeq,12hr}$	Significance of Effect for Proposed Development
N59 National Secondary Road - Southeast	0.4	0.5	Imperceptible
N59 National Secondary Road - Northwest	0.3	0.4	Imperceptible
L-53453	4	4.4	Slight to Moderate

Based on the criteria in Table 12.2, the associated effect with the Proposed Development is negative, slight to moderate and short-term, just as it is for the Permitted Development.

In respect of the remaining phases, which are delivery of large equipment and other deliveries, the traffic flows are the same as those for the Permitted Development. The effects remain negative, slight and short-term.

12.4.3 Assessment of Effects During Operation

The noise levels for the Proposed Development site have been calculated for all noise sensitive receivers identified within the EIAR Study Area for noise as described in Section 12.2.5.

Note that this assessment refers to a cumulative situation as required by the IOA GPG:

> 5.1.4 *During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.*

As such a noise impact assessment considering the Proposed Development in isolation is not included. The results of the cumulative assessment are presented in the sections below, where two scenarios are considered, each representing one of the two candidate turbine technologies (E138 and V136).

12.4.3.1. Enercon E138

Using the sound power levels in Table 12.5, the cumulative noise levels at all 270 NSLs have been calculated in accordance with the guidance in section 12.2.1.2. The full set of predicted noise levels is presented in Appendix 12-5. For brevity, the noise levels are presented in Table 12.12 for a subset of locations, being the closest NSLs in different directions from the Proposed Development.

Table 12.12 Review of Cumulative Predicted Turbine Noise Levels against Relevant Criteria (E138)

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
H001 (1099m)	Predicted	29.7	33.7	37.1	37.9	38.0	38.0
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	
H002 (1073m)	Predicted	29.6	33.6	37.0	37.9	38.0	38.0
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H003 (1034m)	Predicted	29.9	33.9	37.3	38.1	38.2	38.2
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H065 (1627m)	Predicted	25.8	29.9	33.4	34.4	34.5	34.5
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H066 (1672m)	Predicted	24.9	28.9	32.4	33.4	33.5	33.5
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H067 (1660m)	Predicted	25.7	29.8	33.3	34.3	34.4	34.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H068	Predicted	25.9	30.0	33.5	34.5	34.6	34.6

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
(1623m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H152 (2226m)	Predicted	23.3	27.5	31.1	32.2	32.4	32.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H154 (2178m)	Predicted	23.5	27.6	31.2	32.3	32.5	32.5
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H156 (2352m)	Predicted	23.2	27.4	31.1	32.2	32.4	32.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H157 (1467m)	Predicted	29.7	34.1	38.0	39.4	39.6	39.6
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H158 (1550m)	Predicted	29.4	33.8	37.7	39.2	39.4	39.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H159 (1697m)	Predicted	28.9	33.3	37.2	38.8	39.0	39.0
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H160	Predicted	28.6	33.0	37.0	38.5	38.7	38.7

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
(1778m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H167 (1161m)	Predicted	28.2	32.3	35.9	36.9	37.1	37.1
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H168 (1214m)	Predicted	27.8	31.9	35.5	36.6	36.7	36.7
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H169 (1226m)	Predicted	27.9	32.0	35.6	36.6	36.8	36.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H170 (1305m)	Predicted	27.3	31.4	35.1	36.2	36.4	36.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H173 (1572m)	Predicted	25.3	29.4	33.1	34.2	34.4	34.4
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H174 (1629m)	Predicted	25.0	29.1	32.8	34.0	34.2	34.2
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H175	Predicted	25.1	29.2	32.8	34.0	34.2	34.2

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
(1686m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--

Contours of noise levels for E138 standard mode operation rated power wind speed (i.e. highest noise emission) have been presented in Appendix 12-6. The predicted noise levels for all turbines operating in standard mode shows that all predicted noise levels are within the planning criterion of 43 dB L_{A90}.

With respect to the EPA criteria for description of effects, the potential predicted effects at the nearest noise sensitive locations associated with the operation of the wind turbines is negative, moderate and long-term.

12.4.3.2. Vestas V136

Using the sound power levels in Table 12.6, the cumulative noise levels at all 270 NSLs have been calculated in accordance with the guidance in section 12.2.1.2. The full set of predicted noise levels is presented in Appendix 12-7. For brevity, the noise levels are presented in Table 12.6 for a subset of locations, being the closest NSLs in different directions from the Proposed Development.

Table 12.13 Review of Cumulative Predicted Turbine Noise Levels against Relevant Criteria (V136)

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
H001 (1099m)	Predicted	27.4	32.3	35.9	36.8	36.8	36.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H002 (1073m)	Predicted	27.4	32.2	35.9	36.7	36.8	36.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
	Predicted	27.6	32.5	36.1	36.9	37.0	37.0

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
H003 (1034m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H065 (1627m)	Predicted	24.2	29.0	32.7	33.7	33.8	33.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H066 (1672m)	Predicted	23.2	28.0	31.7	32.7	32.8	32.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H067 (1660m)	Predicted	24.1	28.9	32.6	33.6	33.7	33.7
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H068 (1623m)	Predicted	24.3	29.1	32.8	33.8	33.9	33.9
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H152 (2226m)	Predicted	22.3	27.1	30.9	32.0	32.1	32.1
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H154 (2178m)	Predicted	22.3	27.1	30.9	32.0	32.2	32.2
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H156	Predicted	22.1	26.9	30.7	31.9	32.1	32.1

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
(2352m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H157 (1467m)	Predicted	28.9	33.7	37.6	39.1	39.3	39.3
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H158 (1550m)	Predicted	28.6	33.4	37.4	38.9	39.1	39.1
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H159 (1697m)	Predicted	28.2	33.0	37.0	38.5	38.8	38.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H160 (1778m)	Predicted	28.0	32.7	36.7	38.3	38.5	38.5
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H167 (1161m)	Predicted	26.4	31.2	35.0	36.1	36.3	36.3
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H168 (1214m)	Predicted	26.1	30.9	34.7	35.8	36.0	36.0
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H169	Predicted	26.0	30.8	34.7	35.8	36.0	36.0

House (at distance, m)	Parameter	Predicted Noise Level dB LA90 at Standardised Wind Speed at 10m A.G.L.					
		4	5	6	7	8	9
(1226m)	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H170 (1305m)	Predicted	25.6	30.4	34.3	35.5	35.7	35.7
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H173 (1572m)	Predicted	23.8	28.5	32.4	33.6	33.8	33.8
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H174 (1629m)	Predicted	23.6	28.3	32.2	33.4	33.6	33.6
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--
H175 (1686m)	Predicted	23.6	28.3	32.2	33.4	33.6	33.6
	Criterion	43	43	43	43	43	43
	Excess	--	--	--	--	--	--

Contours of noise levels the V136 for standard mode operation rated power wind speed (i.e. highest noise emission) have been presented in Appendix 12-8. The predicted noise levels for all turbines operating in standard mode shows that all predicted noise levels are within the planning criterion of 43 dB L_{A90}.

With respect to the EPA criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with the operation of the wind turbines is negative, moderate and long-term.

12.4.3.3. Comparison of Proposed Development with Permitted Development

Table 12.14 compares the predicted cumulative noise levels due to the Permitted Development with the proposed development. Note that the values in the 'Permitted' column have been calculated with the GE 2.85 MW turbine at a hub heights of 80 and 90 m, and that the calculations include the other wind farms as listed in Section

12.2.4.3. Therefore the predicted noise levels differ slightly from those in the EIS associated with the Permitted Development.

In the case of the E138, the predicted changes in noise levels are -0.6 to -0.1 dB and for the V136, the changes are 0.0 to +0.2 dB. In both cases, the differences in predicted noise levels between the Permitted Development and either scenario for the Proposed Development are imperceptible.

Table 12.14 Review of differences in predicted noise levels at 8 m/s wind speed at standardised 10m height

Name	Predicted noise levels at 8 m/s wind speed at standardised 10m height				
	Permitted	E138	E138 vs Permitted	V136	V136 Vs Permitted
H001	36.8	38.0	+1.2	36.8	0.0
H002	36.7	38.0	+1.3	36.8	+0.1
H003	37.0	38.2	+1.2	37.0	0.0
H065	33.8	34.5	+0.7	33.8	0.0
H066	32.7	33.5	+0.8	32.8	+0.1
H067	33.6	34.4	+0.8	33.7	+0.1
H068	33.8	34.6	+0.8	33.9	+0.1
H152	32.2	32.4	+0.2	32.1	-0.1
H154	32.2	32.5	+0.3	32.2	0.0
H156	32.2	32.4	+0.2	32.1	-0.1
H157	39.6	39.6	0.0	39.3	-0.3
H158	39.4	39.4	0.0	39.1	-0.3
H159	39.0	39.0	0.0	38.8	-0.2
H160	38.8	38.7	-0.1	38.5	-0.3
H167	36.3	37.1	+0.8	36.3	0.0
H168	36.0	36.7	+0.7	36.0	0.0
H169	36.0	36.8	+0.8	36.0	0.0
H170	35.7	36.4	+0.7	35.7	0.0
H173	33.7	34.4	+0.7	33.8	+0.1
H174	33.5	34.2	+0.7	33.6	+0.1
H175	33.6	34.2	+0.6	33.6	0.0

12.5.1 Construction Phase

As the wind turbine construction methods will be the same as those for the Permitted Development, the mitigation measures presented in the previous EIS apply also to the Proposed Development, re-iterated here:

Reference will be made to British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Noise, which offers detailed guidance on the control of noise & vibration from demolition and construction activities. The following best practices will be employed:

- limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- establishing channels of communication between the contractor/developer, Local Authority and residents;
- appointing a site representative responsible for matters relating to noise and vibration;
- monitoring typical levels of noise and vibration during critical periods and at sensitive locations;
- keeping site access roads even to mitigate the potential for vibration from lorries
- selection of plant with low inherent potential for generation of noise and/ or vibration;
- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints; and,
- regular maintenance and servicing of plant items

12.5.1.1. Noise

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Noise. The following list of measures will be considered, where necessary, to ensure compliance with the relevant construction noise criteria:

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.

- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate outside of general construction hours will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 12.1 using methods outlined in British Standard BS 5228-1:2009+A1 2014 Code of practice for noise and vibration control on construction and open sites - Noise.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 17:00hrs Monday to Saturday. However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (i.e., concrete pours, rotor blade lifting) it could occasionally be necessary to work out of these hours.

Where rock breaking is employed, the following are examples of measures that will be employed, to mitigate noise emissions from these activities:

- Fit suitably designed muffler or sound reduction equipment to the rock breaking tool to reduce noise without impairing machine efficiency.
- Ensure all leaks in air lines are sealed.
- Use a dampened bit to eliminate ringing.
- Erect acoustic screen between compressor or generator and noise sensitive area. When possible, line of sight between top of machine and reception point needs to be obscured.
- Enclose breaker or rock drill in portable or fixed acoustic enclosure with suitable ventilation.

12.5.2 Operational Phase

An assessment of the operational noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 12.2.1.2 of this Chapter. The findings of the assessment confirmed that the predicted operational noise levels will be within the relevant best practice noise criteria curves for wind farms at all locations and therefore no mitigation measures are required.

If alternative turbine technologies are considered for the site an updated noise assessment will be prepared to confirm that the noise emissions associated with the selected turbines will comply with the relevant operational criteria associated with the grant of planning for the Proposed Development. If necessary, suitable curtailment strategies will be designed and implemented for alternative technologies to ensure compliance with the relevant noise criteria curves, should detailed assessment conclude that this is necessary.

In the unlikely event that an issue with low frequency noise is associated with the Proposed Development, it is recommended that an appropriate detailed investigation be undertaken. Due consideration should be given to guidance on conducting such an investigation which is outlined in Appendix VI of the EPA document entitled Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (EPA, 2016). This guidance is based on the threshold values outlined in the Salford University document Procedure for the assessment of low frequency noise complaints, Revision 1, December 2011.

In the unlikely event that a complaint is received which indicates potential amplitude modulation (AM) associated with turbine operation, the operator shall employ an independent acoustic consultant to assess the level of AM in accordance with the methods outlined in the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016) or subsequent revisions.

The measurement method outlined in the IOA AMWG document, known as the 'Reference Method', will provide an indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

12.5.2.1. Monitoring

Commissioning noise surveys are recommended to ensure compliance with any noise conditions applied to the Proposed Development. In the unlikely instance that an exceedance of these noise criteria is identified, the assessment guidance outlined in the IOA GPG and *Supplementary Guidance Note 5: Post Completion Measurements (July 2014)* should be followed and relevant corrective actions will be taken if deemed necessary. For example, implementation of noise operational modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure predicted noise levels are within the relevant noise criterion curves/planning conditions.

Post-commissioning of the Proposed Development turbines, it is recommended that the noise monitoring detailed in the relevant section of this report be repeated with consideration of the guidance outlined in the IOA GPG and Supplementary Guidance Note 5.

12.5.3 Decommissioning Phase

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will be used. The noise and vibration impacts associated with any decommissioning of the wind turbines are considered to be comparable to those outlined in relation to the construction of the Permitted Development. With reference to the Construction Environmental Management Plan, there is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the levels outlined in Section 12.2.1.1.

Considering that in all aspects of the construction and decommissioning the predicted noise levels are expected to be below the appropriate Category A value (i.e., 65dB $L_{Aeq,T}$) at current noise sensitive locations for the decommissioning phase, therefore the noise and vibration effects are not significant.

12.5.3.1. Decommissioning Phase Mitigation

The mitigation measures that will be considered in relation to any decommissioning of the site are the same as those proposed for the construction phase of the development, i.e., as per Section 12.4.2.

12.6.1 Construction Phase

During the construction phase of the project there will be some effect on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby NSLs and the fact that the construction phase of the development is short-term in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that the noise and vibration effect is kept to a minimum.

With respect to the EPA's criteria for description of effects, in terms of these construction activities, the potential worst-case associated effects at the nearest NSLs associated with the various elements of the construction phase are negative, not significant and short-term.

12.6.2 Operational Phase

The predicted noise levels associated with the Proposed Development will be within best practice noise criteria curves recommended in Irish guidance '*WEDG*' therefore, it is not considered that a significant effect is associated with the Proposed Development.

The predicted residual operational noise effects are summarised as follows: negative, moderate and long-term

12.7.1 Wind Farm Developments

12.7.1.1. Construction Phase

In general, potential construction noise impacts may occur if other developments are constructed at the same time as the proposed development. In this instance, the closest other wind farm included in the cumulative assessment is Ardderroo, which is already partially constructed; similarly, the next nearest wind farms, Uggool and Cloosh and Knockalough are also operational.

Due to the distances between NSLs considered here and the other wind farms yet to be constructed, is not considered that significant cumulative noise and vibration effects are likely.

Forestry operations on the site will be concurrent with the construction phase but are not expected to have a significant cumulative noise effect.

12.7.1.2. Operational Phase

The noise assessment presented in this EIAR chapter is inherently an assessment of cumulative wind turbine noise, as required by the IOA GPG.

12.7.2 Other Developments

Development other than wind farms are considered here are as follows:

- The proposed N59 Maigh Cullinn (Moycullen) Bypass Road Project
- The Connemara Greenway

12.7.2.1. N59 Maigh Cullinn (Moycullen) Bypass

Due to the distances between the NSLs considered in this assessment and the proposed Moycullen bypass, it is considered that cumulative effects are not significant for either the construction or operational phases.

12.7.2.2. Connemara Greenway

The Connemara Greenway passes to the east of the NSLs used in this assessment. NSLs along the N59 are at distances of the order of 2.5 km from the proposed development; similarly, distances are such that there is no likelihood of a significant cumulative impact due to the construction of the greenway. In the operational phase, the greenway is not expected to generate any significant noise and cannot therefore lead to a significant cumulative noise impact with the proposed development.

None.

EPA Guidelines on the Information to be contained in Environmental Impact Statements, (EPA, 2022);

EPA Advice Notes for Preparing Environmental Impact Statements, (Draft, September 2015);

BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2 – Vibration.

BS 7385-2:1993 Evaluation and measurement for vibration in buildings. Guide to damage levels from groundborne vibration;

Design Manual for Roads and Bridges LA 111 Sustainability & Environmental Appraisal. Noise and Vibration Rev 2 (2020);

ISO 1996: 2017: Acoustics – Description, measurement and assessment of environmental noise.

World Health Organisation Environmental Noise Guidelines for the European Region, 2018

Institute of Acoustics: A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013)

Wind Energy Development Guidelines" published by the Department of the Environment, Heritage and Local Government 2006

Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) "The Assessment and Rating of Noise from Wind Farms" (1996).

Appendix 12.1 - Glossary of Acoustic Terms

A variety of acoustic parameters and terminology are used throughout this chapter. Significant definitions are identified at this stage to inform the reader.

A - Weighting	The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing.
Background Noise	The noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods. The LA90,10min is the parameter that is used to define the background noise level in this instance. LA90 is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.
dB (decibel)	The unit normally employed to measure the magnitude of sound. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 μ Pa).
dB(A)	An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz - 20 kHz) with A-frequency weighting (i.e. A - Weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Hub Height Wind Speed	The wind speed at the centre of the turbine rotor.
Hertz (Hz)	The unit of sound frequency in cycles per second.
$L_{Aeq,T}$	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).The closer the L_{Aeq} value is to either the L_{AF10} or L_{AF90} value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.

L_{AF90} — Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.

L_{den} — Refers to the L_{Aeq} noise levels over a whole day, but with a penalty of 10 dB(A) for night-time noise (23:00-07:00) and 5 dB(A) for evening noise (19:00-23:00), also known as the day evening night noise indicator.

Low Frequency Noise — LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.

Noise — Sound that evokes a feeling of displeasure in the environment in which it is heard and is therefore unwelcomed by the receiver.

Noise Sensitive Location (NSL) — Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.

octave band — A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.

Pascal (Pa) — Pascal is a unit of pressure and so sound pressures are measured in Pascals.

Sound Power Level (L_W) — The sound power level radiated by a source is defined as:

$$L_W = 10\log_{10}\frac{W}{W_0} \quad dB$$

Where W is the acoustic power of the source in Watts (W) and W_0 is a reference sound power chosen in air to be 10^{-12}W.

Sound Pressure Level (Lp) — The sound pressure level at a point is defined as:

$$L_P = 20\log_{10}\frac{P}{P_0} \quad dB$$

Where P is the sound pressure and P_0 is a reference pressure for propagation of sound in air and has a value of 2×10^{-5}Pa.

Tonal	Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.
10 Minute Average Wind Speed (m/s)	The wind speed measured by an anemometer at a specified height above ground level, averaged over a 10-minute period.
Wind Shear	The increase of wind speed with height above ground.

Appendix 12.2 – Calculation Parameters and Settings for Noise Model

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, 1996. Guidance in terms of the calculation settings has been obtained from the Institute of Acoustics (IoA) Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) (IoA GPG) and its associated supplementary guidance notes. The following are the main aspects that have been considered in terms of the noise predictions presented in this instance.

Directivity Factor:

The directivity factor (D) 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 this case appropriate consideration is given to the issue of wind directivity as detailed in the relevant sections of the chapter.

Ground Effect:

Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on source height receiver height propagation height between the source and receiver and the ground conditions.

The ground conditions are described according to a variable defined as G, which varies between 0.0 for hard ground (including paving, ice concrete) and 1.0 for soft ground (includes ground covered by grass trees or other vegetation) Predictions have been carried out using a source height corresponding to the hub height of the proposed turbines, a receiver height of 4m and a ground effect factor of G=0.5.

Geometrical Divergence

This term relates to the spherical spreading in the free-field from a point sound source resulting in an attenuation depending on distance according to the following equation:

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

where d = distance from the source

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

Atmospheric Adsorption

Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies.

In these predictions, a temperature of 10°C and a relative humidity of 70% have been used, which give relativity low levels of atmosphere attenuation and corresponding worst case noise predictions.

Barrier Attenuation

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 ISO9613 model have been shown to be significantly greater than that measured in practice under down wind conditions. 3D ground topography data supplied by MKO was used in the noise prediction modelling. Attenuation from topography screening has been limited to a maximum of 2 dB in the tabulated results in accordance with the IoA GPG.

Wind Turbine Valley Correction

The IOA GPG recommends a correction of +3 dB 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:

$$hm \geq 1.5 \times (abs\,(hs - hr)\,/2)$$

where h_m is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver, respectively. The recommended Valley correction has been incorporated into the turbine prediction calculations.

Table 3: Sound Power Level Spectra Used for Letterpeak wind farm with a Hub Height of 78 m.

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB LWA
	63	125	250	500	1000	2000	4000	8000	
4	70.0	81.9	88.6	91.9	88.6	80.7	69.8	66.5	95.2
5	75.6	82.1	86.8	92.3	94.7	89.5	78.6	71.3	98.0
6	79.4	85.9	90.6	96.1	98.5	93.3	82.4	75.1	101.8
7	82.5	89.0	93.7	99.2	101.6	96.4	85.5	78.2	104.9
≥8	83.6	90.1	94.8	100.3	102.7	97.5	86.6	79.3	106.0

Table 4: Sound Power Level Spectra Used for Cloosh Wind Farm Extension with a Hub Height of 99 m.

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB LWA
	63	125	250	500	1000	2000	4000	8000	
4	77.8	83.2	86.5	89.3	92.1	92.5	88.6	75.5	97.6
5	83.1	88.5	91.8	94.6	97.4	97.8	93.9	80.8	102.9
6	86.6	92.0	95.3	98.1	100.9	101.3	97.4	84.3	106.4
7	87.2	92.6	95.9	98.7	101.5	101.9	98.0	84.9	107.0
≥8	87.2	92.6	95.9	98.7	101.5	101.9	98.0	84.9	107.0

Appendix 12.3 – Sound Power Levels

Table 1: Sound Power Level Spectra Used for Cloosh, Seecon, Uggool wind farms with a Hub Height of 90 m.

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
4	70.3	82.2	88.9	92.2	88.9	81.0	70.1	66.8	95.5
5	75.0	86.9	93.6	96.9	93.6	85.7	74.8	71.5	100.2
6	79.6	91.5	98.2	101.5	98.2	90.3	79.4	76.1	104.8
7	81.4	93.3	100.0	103.3	100.0	92.1	81.2	77.9	106.6
≥8	81.8	93.7	100.4	103.7	100.4	92.5	81.6	78.3	107.0

Table 2: Sound Power Level Spectra Used for Lettercraffroe with a hub height of 80 m and Knockalough with a Hub Height of 79.5 m.

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
4	70.0	81.9	88.6	91.9	88.6	80.7	69.8	66.5	95.2
5	74.6	86.5	93.2	96.5	93.2	85.3	74.4	71.1	99.8
6	79.3	91.2	97.9	101.2	97.9	90.0	79.1	75.8	104.5
7	81.3	93.2	99.9	103.2	99.9	92.0	81.1	77.8	106.5
≥8	81.8	93.7	100.4	103.7	100.4	92.5	81.6	78.3	107.0

Table 5: Sound Power Level Spectra Used for Ardderroo wind farm with a Hub Height of 103.5 m.

Wind Speed (m/s)	Sound Power Level, dB at Octave Band Centre Frequency, Hz								dB L_{WA}
	63	125	250	500	1000	2000	4000	8000	
4	78.1	84.7	87.6	88.6	89	87.2	81.5	72.3	95.0
5	81.6	88.2	91.9	94.0	95.3	93.4	83.8	75.9	100.3
6	85.6	92.2	95.9	98.0	99.3	97.4	87.8	79.9	104.3
7	87.5	94.0	97.7	99.8	101.1	99.3	89.7	81.8	106.1
≥8	87.8	94.0	97.7	100.3	101.0	98.5	90.9	82.9	106.1