

Volume 1: SUBMISSION ON COOLOO WINDFARM

Planning Reference: 323761

Date for Submission: 21st November 2025

Cooloo Wind Farm, Co. Galway Assessment of Non-Technical Summary

[Note: Non-Technical Summary in Blue Font, Abstracts from EIAR Chapters & Appendices in Black Font, Martin Lavelle comments in Red Font & Yellow Highlight.]

Chapter 1: Introduction

This EIAR, along with a NIS will accompany the planning application for the Proposed Project which will be made to ACP. Both the EIAR and NIS contain the information necessary for ACP to complete the Environmental Impact Assessment (EIA) and Appropriate Assessment as required for this planning application. The Proposed Grid Connection is an integral part of the Proposed Project and is assessed in this EIAR, however, it will be subject to a separate, future application. The future, application for consent for the Proposed Grid Connection will be made to ACP in accordance with the provisions of 182A of the Planning and Development Act 2000, as amended.

Chapter 1: EIAR

Due to the nature of the proposed renewable energy development, which will have a potential generating capacity of greater than 50 megawatts (MW) and requires the provision of 110 kV infrastructure which will form part of the national electricity transmission network, two separate planning applications are required.

Response: Note "potential generating capacity" & not "output". Note no mention of Battery storage facility.

Brief Description of the Proposed Project

The Proposed Project will comprise the construction of 9 no. wind turbines with an overall blade tip height of 180 metres and all associated works, and a 110kV substation and associated works, including underground 110kV cabling to connect to the national grid at Cloon 110kV substation. The full description of the Proposed Project is detailed in Chapter 4 of this EIAR.

The development will consist of the provision of the following:

i. 9 no. wind turbines with the following parameters:

Total turbine tip height of 180 metres;

A rotor blade diameter of 150 to 162 metres;

A hub height of 99 to 105 metres;

ii. Permanent turbine foundations, hard-standing and assembly areas;

iii. Underground electrical (33kV) and communications cabling;

iv. 1 no. temporary construction compound (including site offices and welfare facilities);

v. A meteorological mast with a height of 100 metres, security fencing and associated foundation and hard-standing area;

vi. 1 no. new site entrance on the R332 in the townland Lisavally;

vii. 1 no. new access and egress point off the L6056 Local Road in the townland of Dangan Eighter;

viii. 1 no. new access and egress point on to an existing access track in the townland of Dangan Eighter;

ix. 2 no. new access and egress points off the L6301 Local Road in the townland of Cooloo and Lecarrow;

x. Upgrade of existing site tracks/roads and provision of new site access roads, clear span crossings, junctions and hard-standing areas;

xi. A new temporary access road from N63 national road and to R332 Regional Road in the townland of Slievegorm to facilitate the delivery of turbine components and other abnormal sized loads;

xii. Demolition of an existing derelict house and adjacent outbuilding in the townland of Cooloo;

xiii. Peat and Spoil Management Areas;

- xiv. Tree felling and hedgerow removal;
 - xv. Biodiversity Management and Enhancement measures;
 - xvi. Site Drainage;
 - xvii. Operational Stage site signage; and
 - xviii. All ancillary apparatus and site development works above and below ground, including soft and hard landscaping.
- The application is seeking a ten-year planning permission. Current and future wind turbine generator technology will ensure that the wind turbine model, chosen for the Proposed Project, will have an operational lifespan greater than the 35-year operational life that is being sought as part of the planning application.

Modern wind turbine generators currently have a potential generating capacity in the 4 to 8 MW range, with the generating capacity continuing to evolve upwards as technology improvements are achieved by the turbine manufacturers. For the purposes of this application, **it is assumed that the wind turbine Wind Farm, Co. Galway model installed as part of the Proposed Project will have a generating capacity of between 6 and 7.2 MW**. Therefore, on this basis, the proposed 9 no. wind turbines would have a combined generating capacity of between **54 to 64.8 MW**. The actual turbine procured as part of a competitive tender process may have a generating potential that is lower or greater than the turbines described in the EIAR. Irrespective of the power output of the actual turbine procured, the conclusions of the EIAR will not be materially affected.

The chapters of this EIAR are as follows:

1. Introduction
2. Background to the Proposed Project
3. Considerations of Reasonable Alternatives
4. Description of the Proposed Project
5. Population and Human Health
6. Biodiversity
7. Birds
8. Land, Soils and Geology
9. Hydrology and Hydrogeology
10. Air Quality
11. Climate
12. Noise and Vibration
13. Landscape and Visual
14. Cultural Heritage
15. Material Assets (including Traffic and Transport, Telecommunications and Aviation)
16. Major Accidents and Natural Disasters
17. Interactions of the Foregoing
18. Schedule of Mitigation Measures

Chapter 2: Background to the Proposed Project

The Proposed Wind Farm comprises the provision of 9 no. wind turbines with an overall tip height of 180 meters and an estimated installed generating capacity of between c.54MW and 64.8MW, and associated infrastructure.

Table 2.5 Opportunities and Sensitivities of the Proposed Wind Farm site

Opportunities		Sensitivities	
Energy Network (High priority)	Proximity to the Cloon 110kV Substation	Pop. Density (High priority)	>20 and <= 50 (Second lowest population category)
Road Network (High priority)	Within 3km of the National Road Network (N63)	Settlements (High priority)	Not situated in the excluded settlement areas
Land use (Medium priority)	Pasture and Peat bogs (both identified as opportunity areas)	Slope (Medium priority)	Lowest rating (less than 10 degrees)
Elevation (High priority)	65.5-83.5 mAOD	Protected Areas (High priority)	Not located within the excluded landscape, geological, natura 2000 or natural heritage area sites
Wind Speed (High priority)	<=8 (m/s)	Flooding (Medium priority)	Does not overlap with fluvial & Coastal flood areas
		Landslide (High priority)	Low (inferred)

Response: For a wind speed of 7-8m/s as stated by Applicant, the Vesta Power Curve below indicates an output of 2.501Mw. For 9 turbines the output is 22.509Mw & not 63Mw. This proposal does not meet SID Threshold.

Altitude [ft (m)]	Temperature [°F (°C)]	Pressure [psi (hPa)]	Air density [lb / cu ft (kg / m³)]
sea level	59 (15)	14.7 (1,013.25)	0.077 (1.23)
2,000 (610)	51.9 (11.1)	13.7 (941.7)	0.072 (1.16)
4,000 (1,219)	44.7 (7.1)	12.7 (873.3)	0.068 (1.09)
6,000 (1,829)	37.6 (3.1)	11.7 (808.2)	0.064 (1.02)
8,000 (2,438)	30.5 (-0.8)	10.8 (746.2)	0.06 (0.95)
10,000 (3,048)	23.3 (-4.8)	10 (687.3)	0.056 (0.9)
12,000 (3,658)	16.2 (-8.8)	9.2 (631.6)	0.052 (0.84)
14,000 (4,267)	9.1 (-12.8)	8.4 (579)	0.048 (0.77)
16,000 (4,877)	1.9 (-16.7)	7.7 (530.9)	0.045 (0.72)

Table 2.7 Scoping List and Responses

Ref	Consultee	Date of Response
1	An Taisce	8th May 2023
2	Bat Conservation Ireland	19th April 2023
3	Bird Watch Ireland	No Response
4	Broadcasting Authority Ireland	1st Aug 2025
5	Commission for Regulation for Utilities, Water and Energy	No Response
6	Department for Agriculture, Food and the Marine	2nd May 2023
7	Department for Defence	5th May 2023
8	Department of Environment, Climate and Communications	8th May 2023
9	Department of Tourism, Culture, Arts, Gaeltacht, Sport, and Media	No Response
10	Department of Transport	11th May 2023
11	EirGrid	No Response
12	ESB Networks	28th Aug 2025
13	Faillte Ireland	20th Aug 2025
14	Forest Service	10th May 2023
15	Galway Airport	No Response
16	Galway County Council - Environment Department	No Response
17	Galway County Council - Heritage Officer	No Response
18	Galway County Council - Roads Department	No Response
19	Galway County Council - Planning Department	No Response
20	Geological Survey of Ireland	12th Aug 2025
21	Health Service Executive	28th Aug 2025
22	Iarróid Éireann	18th May 2023
23	Inland Fisheries Ireland	No Response
24	Ireland West Airport (Knock)	No Response
25	Irish Aviation Authority	31st Jul 2025
26	Irish Peatland Conservation Council	No Response
27	Irish Raptor Study Group	No Response
28	Irish Red Grouse Association	No Response
29	Irish Sport Council	No Response
30	Irish Water/ Uisce Éireann	5th Sept 2025
31	Irish Wildlife Trust	18th Apr 2023
32	Lawpro	11th May 2023
33	National Parks and Wildlife Service	29th May 2023
34	Northern & Western Regional Assembly	18th May 2023
35	Office of Public Works	2nd Jun 2023
36	Sustainable Energy Authority of Ireland	No Response
37	The Heritage Council	No Response
38	Transport Infrastructure Ireland	6th Aug 2025
39	Waterways Ireland	No Response
40	Western RBD Project Office	No Response

2.8 Other Consultations

2.8.1 Pre-Planning Meetings

2.8.1.1 An Coimisiún Pleanála: First Pre-Application Meeting- Section 37B

Following this presentation, there was further discussion held between the project team and the representatives of ACP. Matters discussed included:

- Requirement of clear justification for the location of three turbines outside the area open to consideration.
- Potential impacts due of the Proposed Wind Farm due to the presence of peat on the Site.
- Requirement of constraints mapping of rural dwellings illustrated with buffers overlapping with proposed turbines.
- Further consultation with Local Authorities.

- Forestry felling and the potential for impacts on bats.
- The potential for impacts on the river catchment and sub catchment.
- Recommended engagement with National Park and Wildlife Service (NPWS).
- Haul routes for turbine delivery should be identified and align with standard road approaches.
- Assessment of Natura 2000 sites.

Table 7 – 5 – 1 Turbine specifications Wind Farm Component Scenario Modelled	
Turbine model	V162
Number of turbines	9
Blades per turbine rotor	3
Rotor diameter (m)	162
Rotor radius (m)	81
Hub height (m)	99
Swept height (m)	18-180
Pitch of blade (degrees)	6
Maximum chord (m) (i.e. depth of blade)	4.7
Rotational period (s)	6
*Turbine operational time	85
Turbine model	SG155
Number of turbines	9
Blades per turbine rotor	3
Rotor diameter (m)	155
Rotor radius (m)	77.5
Hub height (m)	102.5
Swept height (m)	25-180
Pitch of blade (degrees)	6
Maximum chord (m) (i.e. depth of blade)	4.2
Rotational period (s)	7.1
*Turbine operational time	85
Turbine model	V150
Number of turbines	9
Blades per turbine rotor	3
Rotor diameter (m)	150
Rotor radius (m)	75
Hub height (m)	105
Swept height (m)	30-180
Pitch of blade (degrees)	6
Maximum chord (m) (i.e. depth of blade)	4.2
Rotational period (s)	7.1
*Turbine operational time	85

Response: Note Survival speed not provided

Conditions for Power Curve and C_p Values (at Hub Height)	
Wind Shear, α	0.00-0.30 (10-minute average)
Turbulence Intensity, I	6-12% (10-minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 \pm 2°
Grid Voltage	Nominal Voltage \pm 2.5%
Grid Frequency	Nominal Frequency \pm 0.5 Hz
Grid Active Power (LV-side)	Per tabulated values in Section 6 and following sections
Grid Reactive Power (LV-side)	Power Factor 1.0

Response: The Applicant does not include the Modelling Software in accordance with EU Lacunae Directive. Therefore, constraints are not known with non-compliant separation distances, rain/ICE/Snow/detritus on blades & their effect on Wake & Noise are not provided.

Vestas V164-8.0

[Pictures](#) [Datasheet](#) [Power curve](#) [Marketplace](#) [Service](#) [Models](#)

8 MW



- ✓ Power data
- ✓ 28 Pictures
- ✓ 2 Models

Datasheet

Power

Rated power:	8.000.0 kW
Flexible power ratings:	-
Cut-in wind speed:	4.0 m/s
Rated wind speed:	13.0 m/s
Cut-out wind speed:	25.0 m/s
Survival wind speed:	50.0 m/s
Wind zone (DIE):	-
Wind class (IEC):	-

Rotor

Diameter:	164.0 m
Swept area:	21.124.0 m ²
Number of blades:	3
Rotor speed, max:	12.1 U/min
Tip speed:	104 m/s
Type:	80
Material:	-
Manufacturer:	Vestas
Power density 1:	378.7 W/m ²
Power density 2:	2.6 m ² /kW

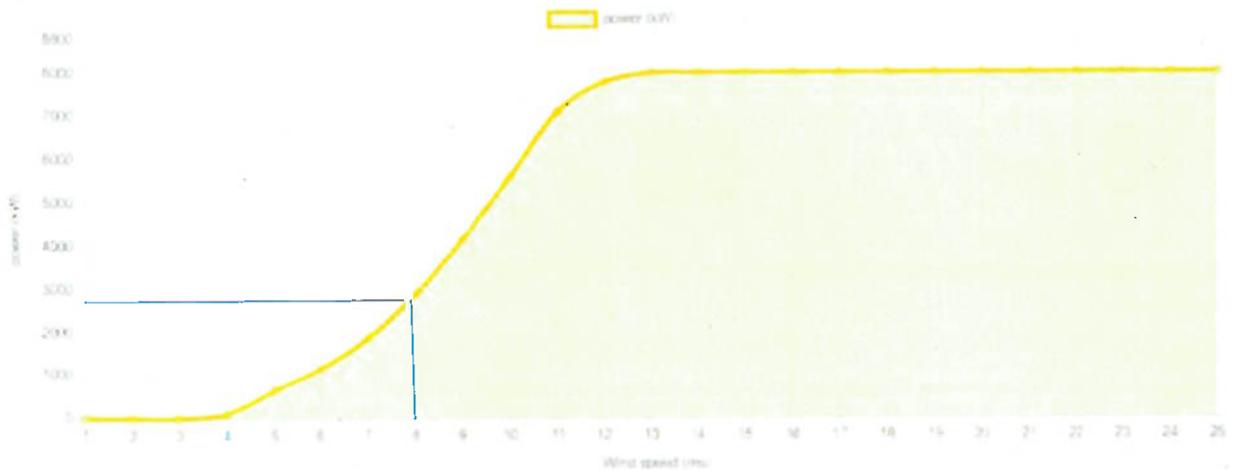
Weight

Single blade:	35.0 t
Hub:	-
Rotor:	-
Nacelle:	375.0 t
Tower, max:	-
Total weight:	-

Note: [Data was not available for V162-7Mw model, but it is assumed that the V164-8Mw model would be similar.

- Survival Speed of 50m/s. Note Wind Speed from Birr Met Station in Volume 1 of this Submission.
- Single Blade Weight of 35.01tonnes & Nacelle Weight of 375.01tonnes. Note no assessment of bridges, culverts, roads provided to cater for these weights.

Power curve



Response: ACP Decision in relation to Ballinla Windfarm

As clarified by the prospective applicant following the pre-application consultation meetings the proposed development will comprise of 7 turbines each with an output of 7.2 MW giving a range of between 50.4 MW.

This results in the nominal output exceeding the MW output by 0.4 MW. It is also noted that turbines have an output range, however, the applicant in its final letter does not mention this and cites a capacity of 7.2 MW only. On this basis of a maximum output it meets the threshold. The legislation does not set out or reference a minimum or maximum range for MW output. I note precedent ABP Ref: 312224 had the same MW output as Ballinla Wind Farm and was considered SID.

Local Authority Renewable Energy Strategy

When the Galway County Development Plan 2022 – 2028 was adopted, parts of the Proposed Wind Farm site were classified as “Generally to be Discouraged”. This classification was prescribed under the County Galway’s Local Authority Renewable Energy Strategy (LARES) which is included as Appendix 1 of the GCDP. The majority of the site remained classified as “Open to Consideration”.

6 no. turbines are located in areas classified as “Open to Consideration”, 2 no turbines are located in areas classified as “Generally to be Discouraged”.

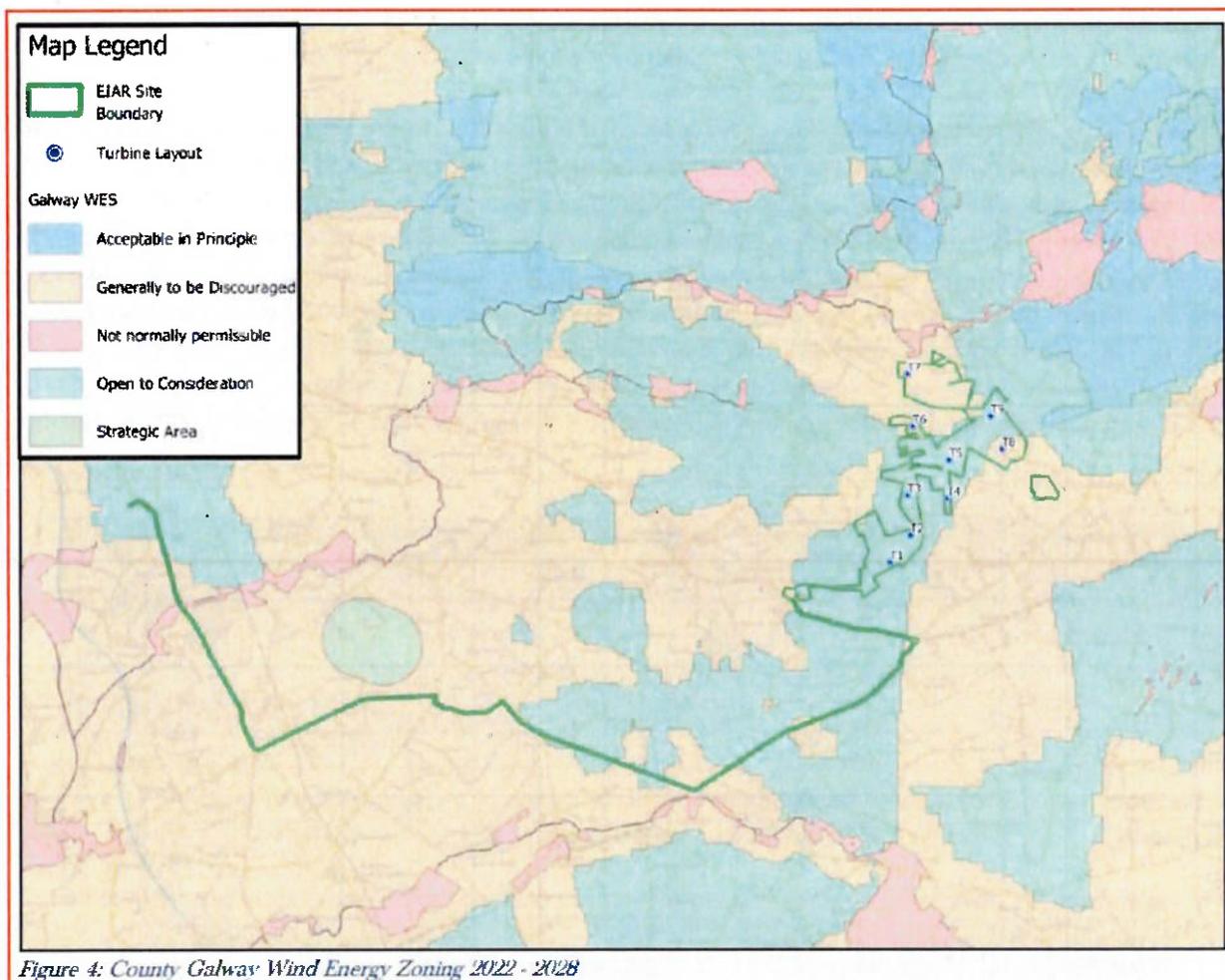


Figure 4: County Galway Wind Energy Zoning 2022 - 2028

This classification for “Open to Consideration” is defined as follows in the LARES: ‘Areas where Wind Energy development is likely to be favourably considered - subject to the results of more detailed assessment of policies and potential effects.’

This classification for “Generally to be Discouraged” areas is defined as follows in the LARES: ‘Areas where Wind Energy development is unlikely to be favourably considered on account of potential to adversely effect protected landscape, water, ecological resources and residential amenity.’

The associated LARES Policy Objective associated with the ‘Generally to be Discouraged’ wind energy zoning classification is as follows:

‘Wind energy development proposals in areas that are identified as ‘Generally to be Discouraged’ for wind energy development will be considered in accordance with the LARES and the proper planning and sustainable development of the area.’

Whilst the modification of the wind energy classification was acknowledged, the decision was made to advance with the Proposed Wind Farm through the planning process. This decision was based on detailed site surveys and a comprehensive constraints analysis concluding in the site retaining its suitability for wind energy development. It should be noted that the wind energy classification in the LARES does not restrict wind turbines within the “Generally to be Discouraged” but rather, they are assessed on the principles of proper planning and sustainable development, in accordance with the LARES. Section 7.2 of the Planning Report, included as part of this EIAR and Planning Application demonstrates the Proposed Wind Farm’s compliance with the relevant policies of the CDP and the LARES.

Wind Energy Development Guidelines

The relevant considerations under the ‘Wind Energy Development Guidelines for Planning Authorities’ (Department of the Environment, Heritage and Local Government (DOEHLG, 2006) hereafter referred to as ‘the Guidelines’, have been taken into account during the preparation of this EIAR.

The aim of these guidelines is to assist with the proper planning of wind energy projects in appropriate locations around Ireland. The Guidelines highlight general considerations in the assessment of all planning applications for wind energy. They set out advice to planning authorities on planning for wind energy through the development plan process

and in determining applications for planning permission. They contain guidelines to ensure consistency of approach throughout the country in the identification of suitable locations for wind energy development.

The Proposed Wind Farm adheres to the Guidelines in its design and preparation. In this regard this EIAR considers all relevant potential environmental impacts that could arise (Chapter 5 of the Guidelines), and the design of the Proposed Wind Farm has followed the design principles established in Chapter 6 of the Guidelines.

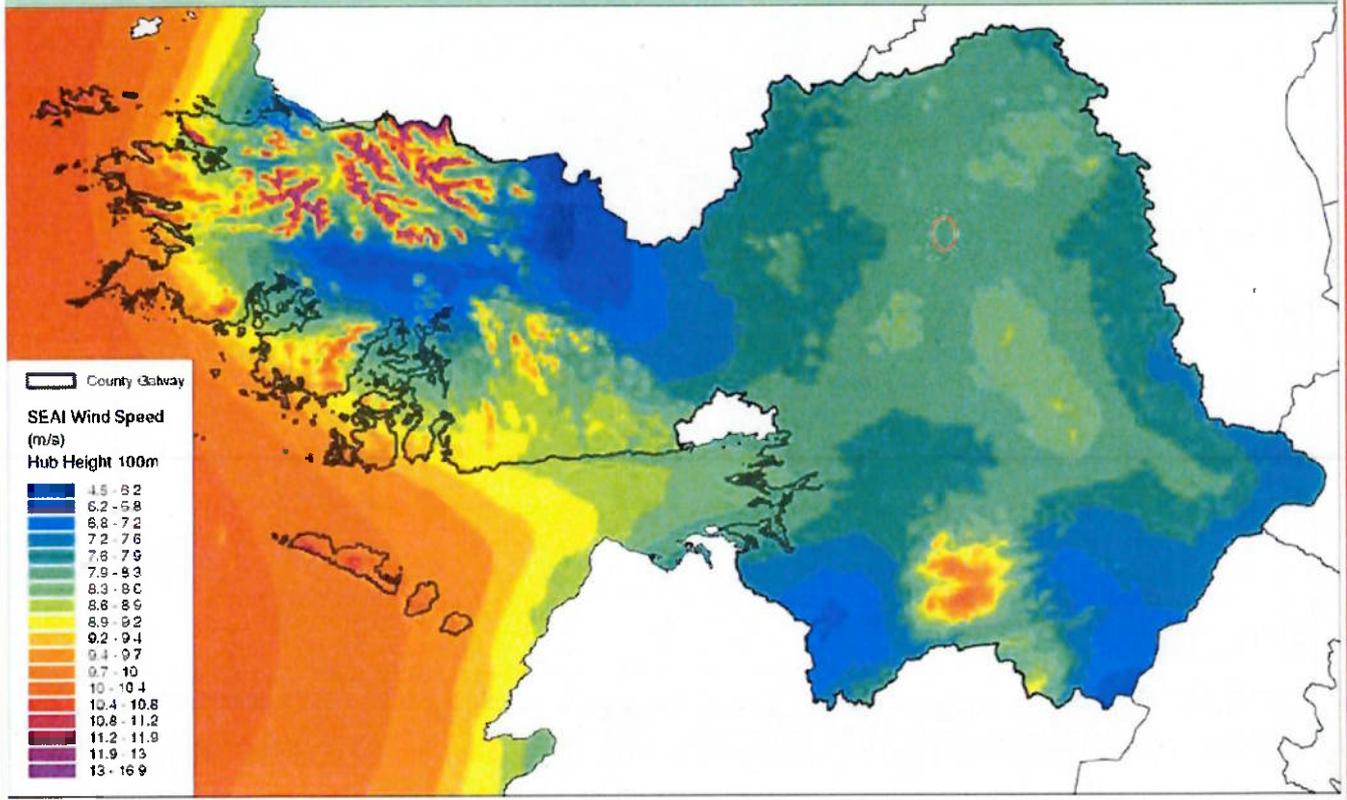
The Department of Housing, Planning and Local Government published the Draft Revised Wind Energy Development Guidelines (Draft Guidelines) in December 2019, and they remain in draft at the time of writing. The Draft Guidelines note that potential impacts of wind energy development proposals on the landscape, including the natural and built environment, must be considered along with the legitimate concerns of local communities. The design of the Proposed Wind Farm has been designed in accordance with the Guidelines and has also been developed with the provisions of the Draft Guidelines in mind (for example in relation to 4 times turbine tip height set back distance from sensitive receptors).

Table 8: Assessment of factors against the Application Site

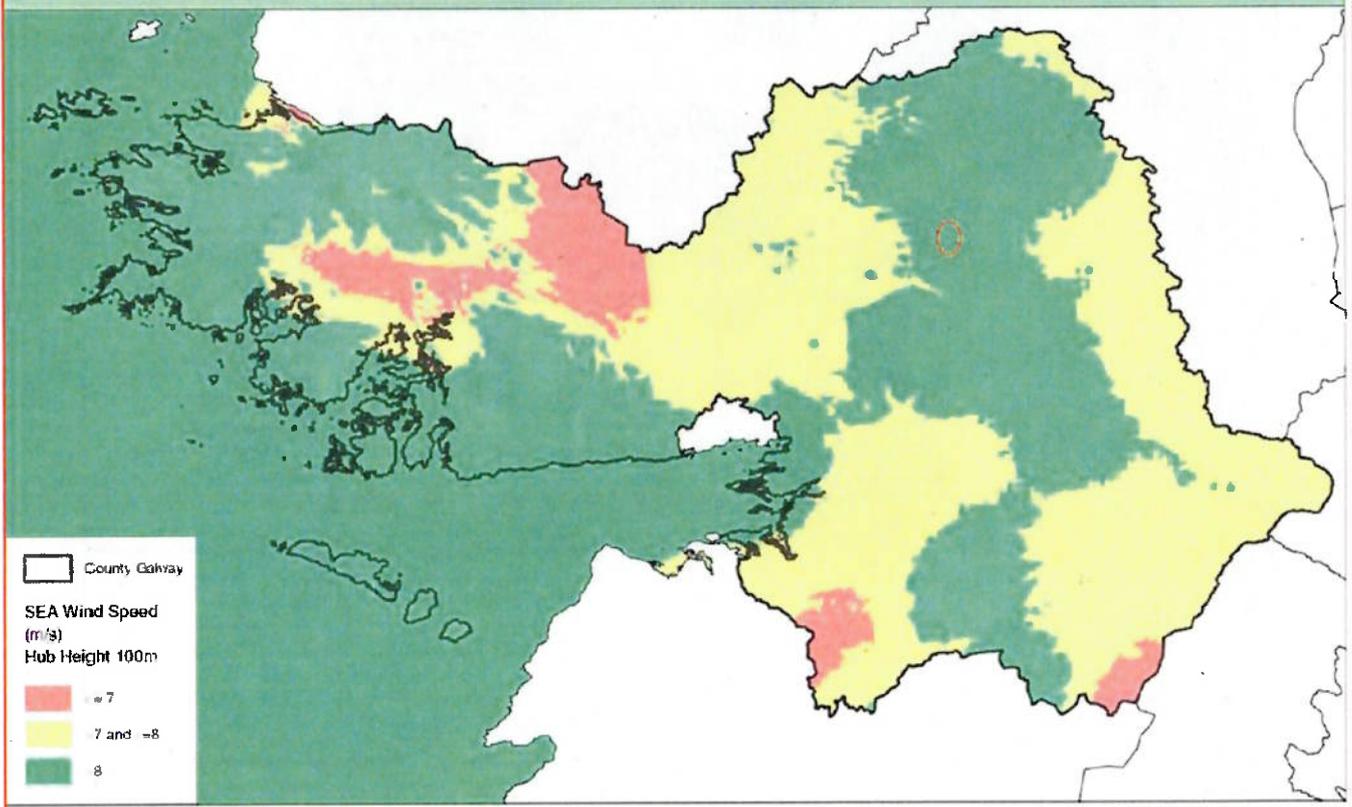
Opportunities	Assessment of Subject Site	Sensitivities	Assessment of Subject Site
Energy Network (High priority)	Proximity to the Cloon 110kV Substation	Pop. Density (High priority)	>20 and <= 50 persons per sq. km (Second lowest population category)
Road Network (High priority)	Proximity to the National Road Network (N63)	Settlements (High priority)	Not situated in the excluded settlement areas

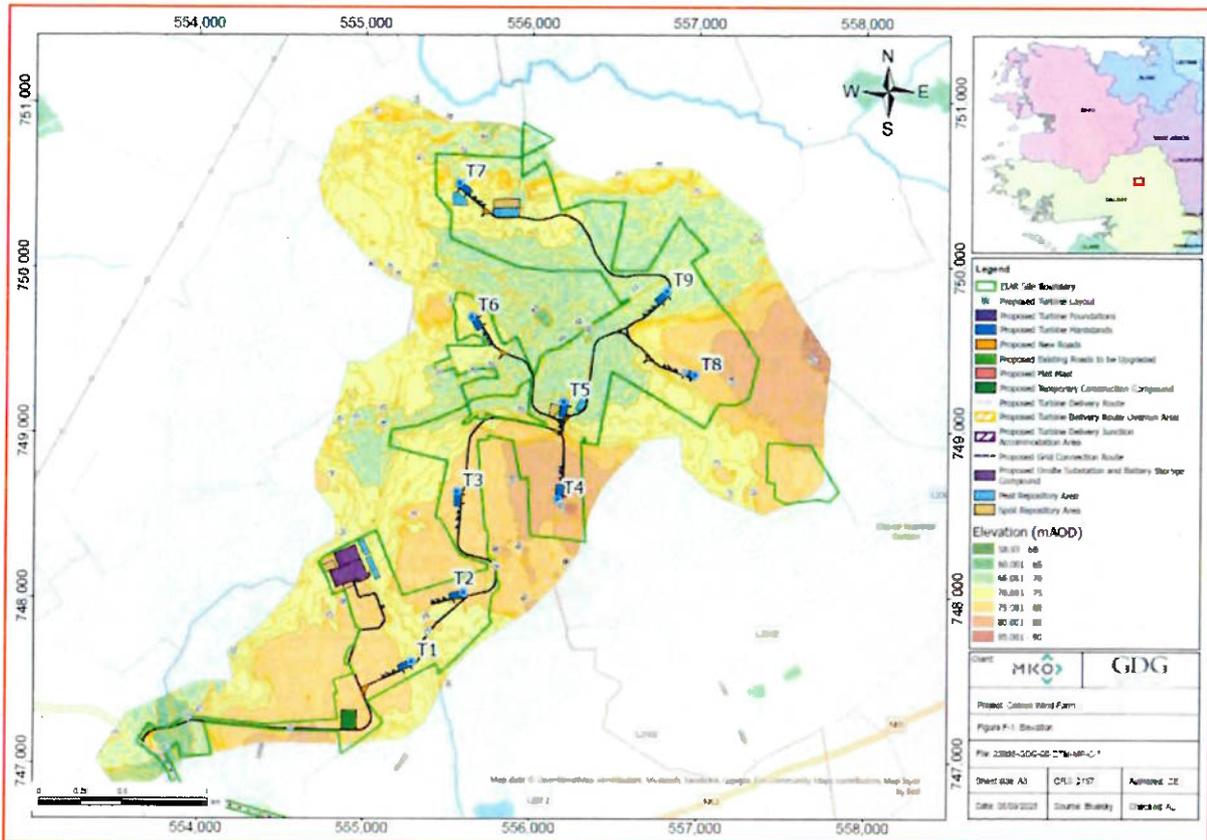
Land use (Medium priority)	Pasture and Peat bogs (both identified as opportunity areas)	Slope (Medium priority)	Lowest rating (less than 10 degrees)
Elevation (High priority)	65.5 - 83.5 mAOD	Protected Areas (High priority)	Not located within the excluded landscape, geological, natura 2000 or natural heritage area sites
Wind Speed (High priority)	>7 and <=8 (m/s)	Flooding (Medium priority)	Does not overlap with fluvial & coastal flood areas
		Landslide (High priority)	Low (inferred)

Wind Opportunity - Wind Speed

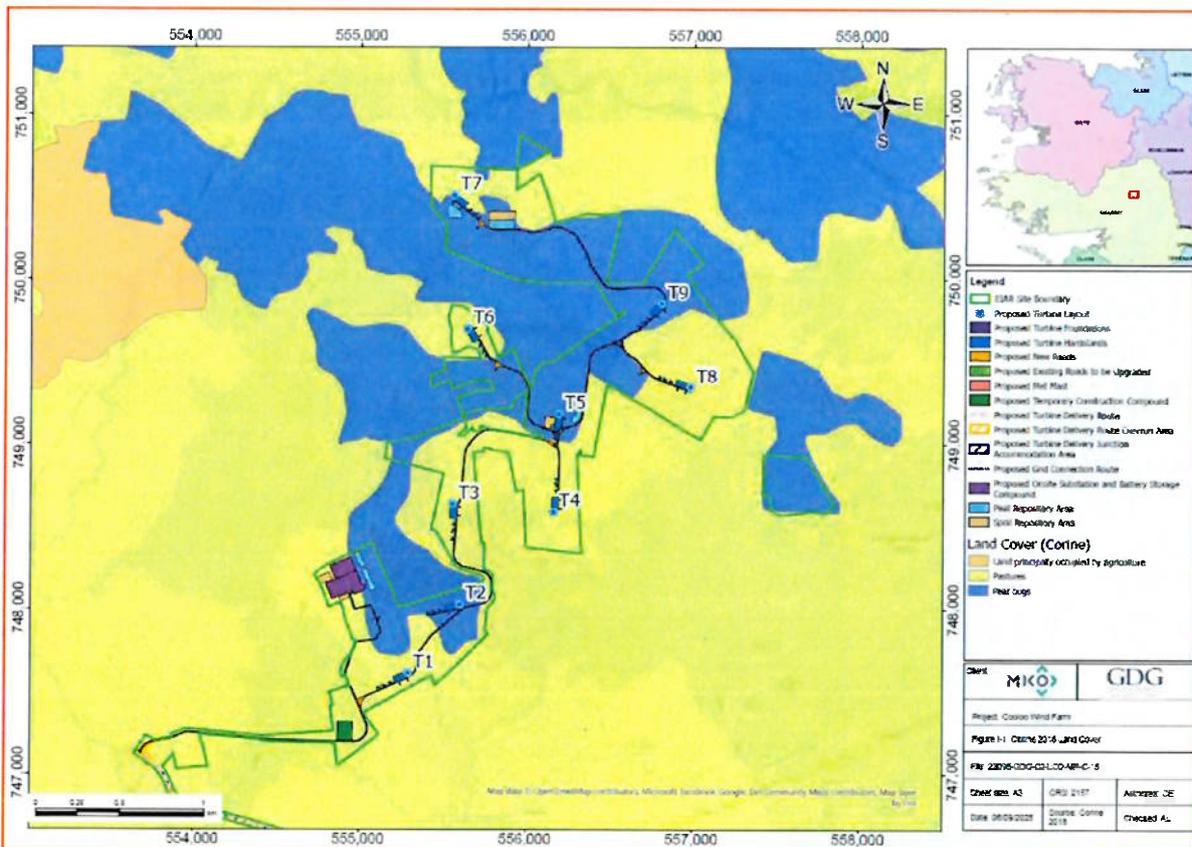


Wind Opportunity - Wind Speed



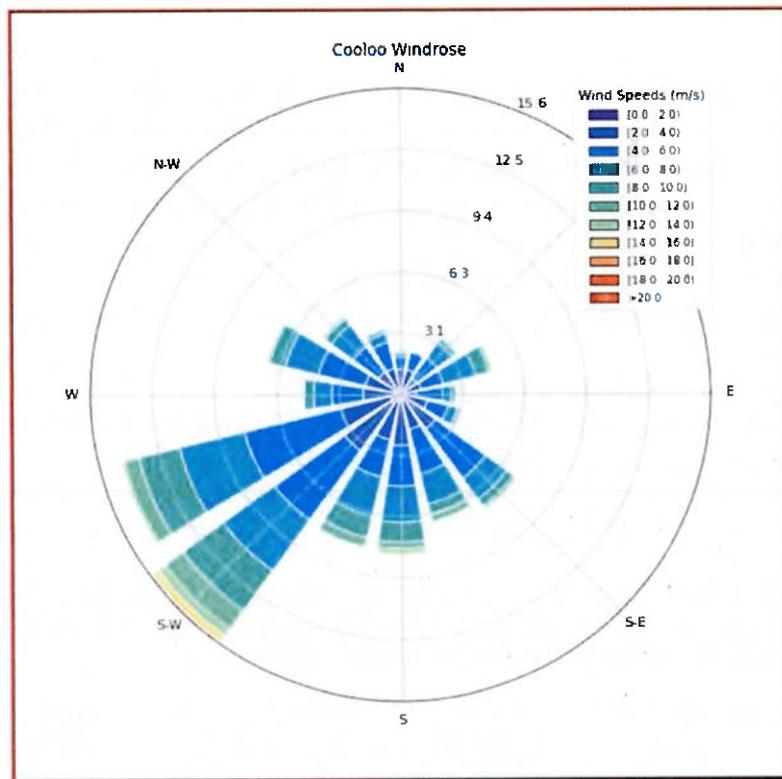


Response: This contoured map indicates ground levels of 59 – 85m OD. & this reinforces the air density factor used above.



Response: Note the surrounding pasture lands that will be affected by the Climatic change on foot of the Wake 3rd Centigrade drop in soil & household temperature. This temperature extends up to 40km radius. The Irish Constitution protects the property rights of its citizens as does the ECHR Protocols 1 & 8 [Verein Klimasenioren]

Schweiz And Others V. Switzerland ECHR]. It is unconstitutional to impose such a temperature drop without property owner consent.



Cumulative Impact Assessment

The potential for cumulative impacts arising from other plans and/or projects has therefore been fully considered within this EIAR. The cumulative impact assessment of projects has three principle aims:

- To establish the range and nature of existing and approved plans and/or projects within the cumulative impact study area of the Proposed Project Wind Farm, Co. Galway
- To summarise the relevant plans and/or projects which have a potential to create cumulative impacts.
- To identify the plans and/or projects that hold the potential for cumulative interaction within the context of the Proposed Project and discard plans and/or projects that will neither directly or indirectly contribute to cumulative impacts.

Chapter 3: Considerations of Reasonable Alternatives

Do Nothing Alternative

An alternative land-use option to the development of a renewable energy project at the Site would be to leave it as it is, with no changes made to the current land-use practices. Predominantly agricultural fields with areas in the north occupied by active raised blanket bog would continue. In doing so, the environmental effects in terms of emissions are likely to be neutral.

Alternative Site Locations

The process of identifying a suitable wind farm site is influenced by a number of factors, while wind speeds, the area of suitable or available land, proximity to a grid connection point and planning policy are all very important, a wind farm project must be commercially viable/competitive, as otherwise it will never attract the necessary project finance required to build it.

Site selection for the development of a wind farm must be suitable for consideration under a number of criteria, such as:

- Local Policy: Site location relative to Galway County Development Plan Wind Energy Capacity's classification of areas considered that have capacity for wind farm development from a planning policy perspective;
- Environmental Sensitivities: Located outside areas designated for protection of ecological species and habitats;
- Grid Connection: Access to the national electricity grid possible within a viable distance;

- Sensitive Receptors: Capable of complying with required setbacks from sensitive receptors;
- Site Scale: Sufficient area of unconstrained land that could potentially accommodate a wind farm development and turbine spacing requirements.

The constraints maps for the Site encompasses the following constraints and associated buffers:

- Sensitive Receptors: Residential dwellings plus a minimum 720 metre buffer (meeting the requirement of 4 x maximum tip height separation distance as required by the draft 2019 Guidelines. Although not adopted, the developer has applied the setback in this instance as it is considered best practice.) (Refer to Chapter 5 Population and Human Health of EIA);
- Designated Sites: Natura 2000 sites plus 100 metre buffer
- Habitats and Biodiversity: Siting of infrastructure so as to minimise loss of habitats of Local Importance (higher value) and higher.
- Hydrology: Watercourses and waterbodies plus 50 metre buffer
- Archaeology: Recorded Archaeological Sites and Monuments/Protected Structures plus 50 metre buffer
- Telecommunications: Telecommunication Links plus operator specific buffer

The final proposed turbine layout was then developed to take account of all the constraints mentioned above including their associated buffer zones and the separation distance required between them. All constraints considered can be seen in Figure 3-2 below.

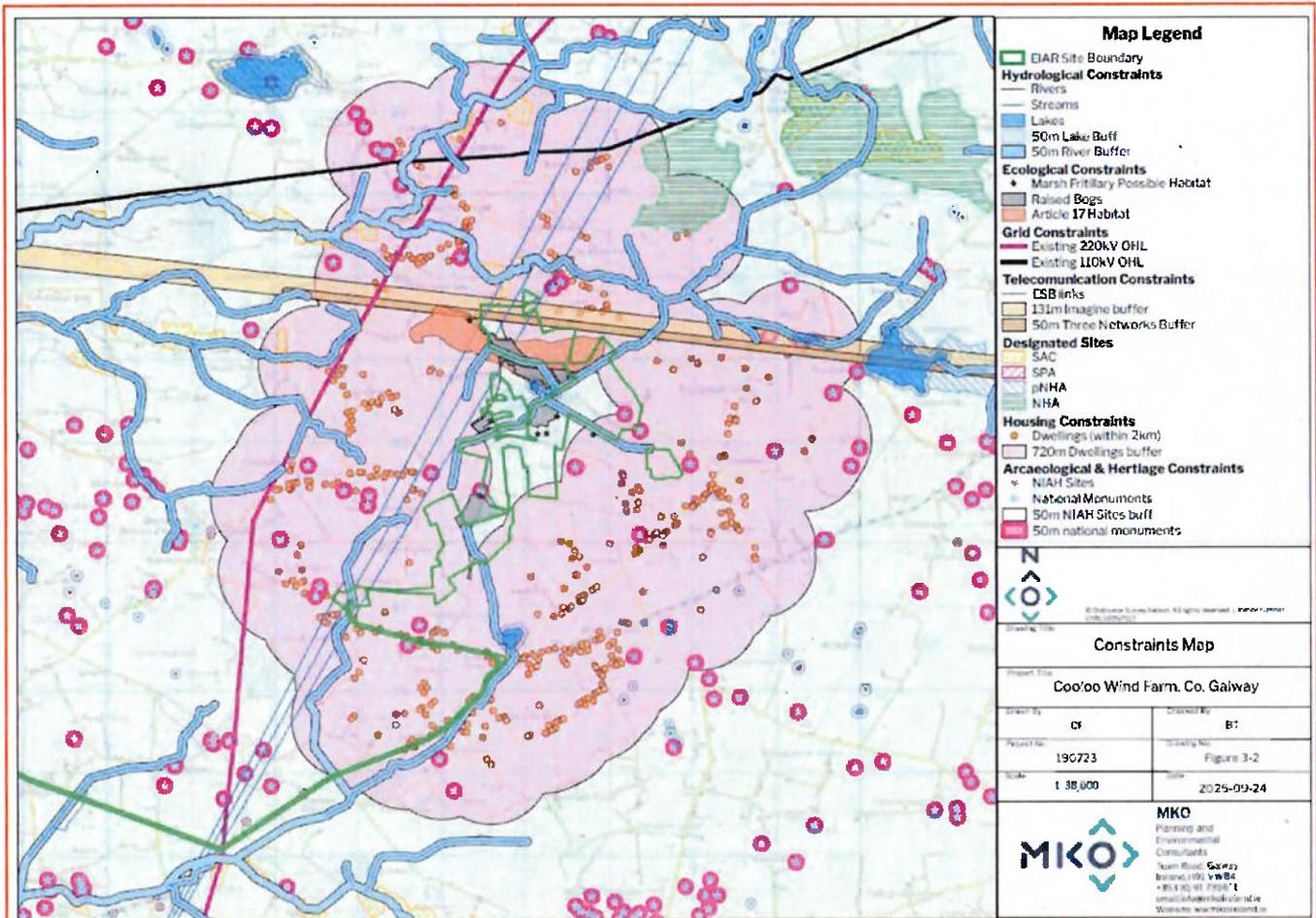
Response: This is not correct. The separation distances do not comply with the 2006 or 2019 Wind Energy Guidelines of 7x rotor diameter downwind (7x162 = 1,134m) as outlined in Column 9 For a 150m rotor diameter, the minimum separation distance is 1050m & for 162m rotor diameter, the minimum separation distance is 1,134m.

Turbine No.	Easting Coordinate	Difference	Square	Northing Coordinate	Difference	Square	Sum of Squares	Sq root of sum of squares
1	555297			747613				
2	555608	311	96721	748030	417	173889	270610	520.2
3	555563	-45	2025	748640	610	372100	374125	611.7
4	556167	604	364816	748591	49	2401	367217	606.0
5	556198	31	961	749183	592	350464	351425	592.8
6	555648	-550	302500	749699	516	266256	568756	754.2
7	555568	-80	6400	750508	809	654481	660881	812.9
8	556986	1418	2010724	749348	-1160	1345600	3356324	1832.0
9	556813	-173	29929	749855	507	257049	286978	535.7
3	555563			748640				
5	556198	635	403225	749183	543	294849	698074	835.5
3	555563			748640				
6	555648	85	7225	749699	1059	1121481	1128706	1062.4
5	556198			749183				
8	556986	788	620944	749348	165	27225	648169	805.1

3.5.2.1.3 Proposed Turbine Layout Iteration No. 3

The final Proposed Wind Farm layout takes account of all site constraints (e.g. ecology, ornithology, hydrology, archaeology, material assets, etc) and design constraints (e.g. setback distances from houses and distances between turbines on site etc). The layout also takes account of the results of all site investigations and baseline assessments that have been carried out during the EIA process.

Response: No mention of Separation distances between turbines as required by WEG 2006 & 2019. These statements are simply untrue.

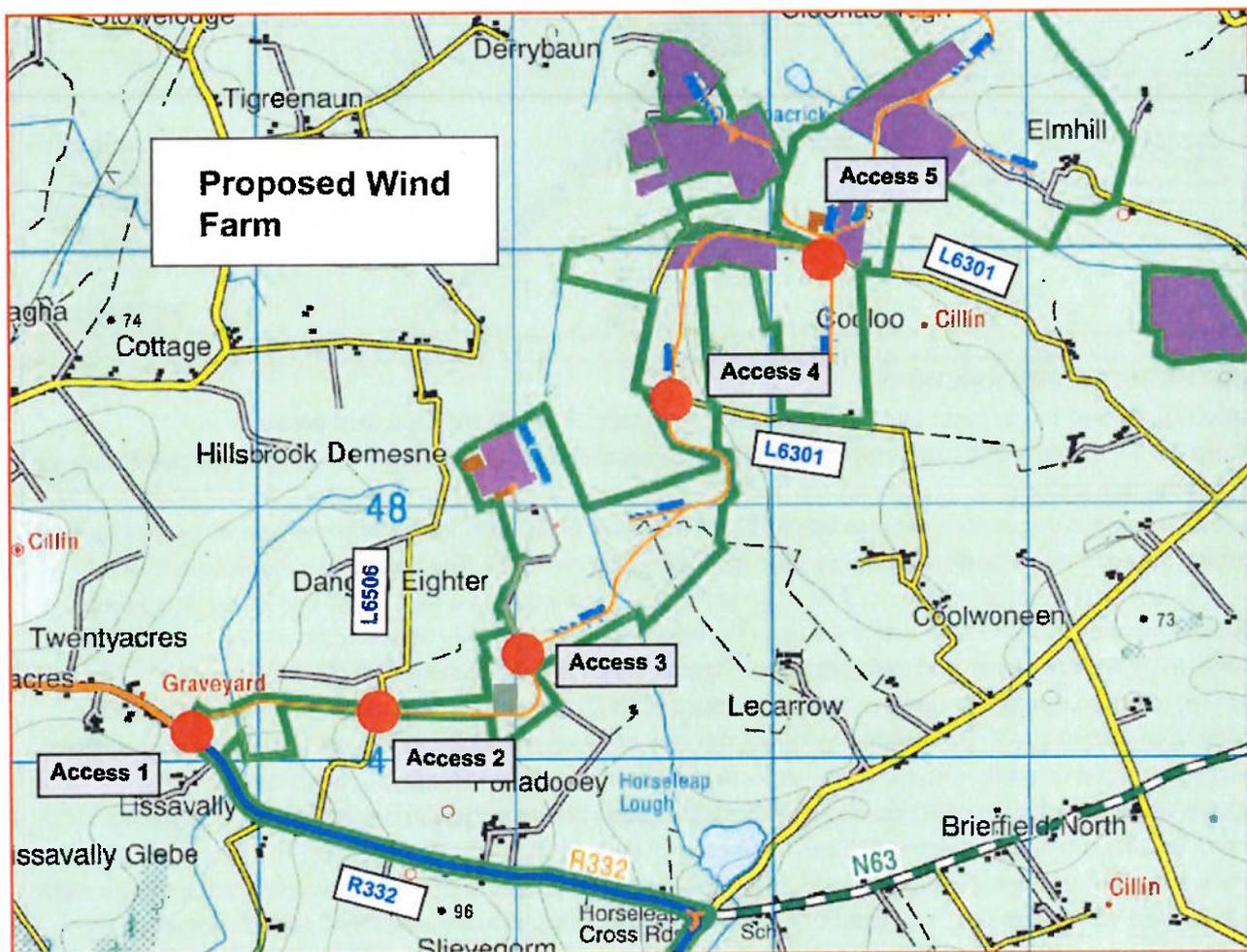


The nearest Natura 2000 site to the Proposed Wind Farm site is the Lough Corrib SAC, which is located approximately 0.5km to the north of the Proposed Wind Farm site at its closest point (i.e., T07). Natural Heritage Area (NHA) or proposed Natural Heritage Area (pNHA) to the Proposed Wind Farm site is the Summerville Lough NHA which is located approximately 3.1km east of the Proposed Wind Farm site at its closest point (i.e., T08). The nearest Natura 2000 site to the Proposed Grid Connection is the Lough Corrib SAC, which the Proposed Grid Connection crosses within the existing public road corridor approx. 1.8km south of the Cloon 110kV for approx. 95m. The nearest Natural Heritage Area (NHA) or proposed Natural Heritage Area (pNHA) to the Proposed Grid Connection is the Belclare Turlough pNHA which is located approximately 5.3km west of the Proposed Grid Connection at its closest point.

Response: Where is the Belclare Turlough pNHA?

Considering that residential density may be an underlying wind energy zoning factor to northeast of the Application Site where T8 is located, it should be noted that the Proposed Development has been designed to reduce potential impacts on residential amenity. The Proposed Development achieves a 4x tip height set back from all Sensitive Receptors to protect residential visual amenity, as recommended in the Draft Guidelines. Shadow Flicker analysis demonstrates that of the 218 no. Sensitive Receptors modelled, when the regional sunshine average (i.e. the mean amount of sunshine hours throughout the year) of 24.44% is taken into account, the total annual guideline limit of 30 hours is predicted as to being potentially exceeded at 76 No. Sensitive Receptors. Mitigation measures, outlined in Chapter 5 of the EIAR, will ensure that no significant effect will arise in relation to shadow flicker and to ensure daily/annual limits will not be exceeded. Noise analysis results conclude that no significant effects will occur on Sensitive receptors during the operational phase of the Proposed Wind Farm.

Response: Rather than conditioning a software package to control shadow flicker in morning & evening, the Wind turbines could be required to shut down daily for 1hr after dawn & 1hr before dusk



APPENDIX 4-5

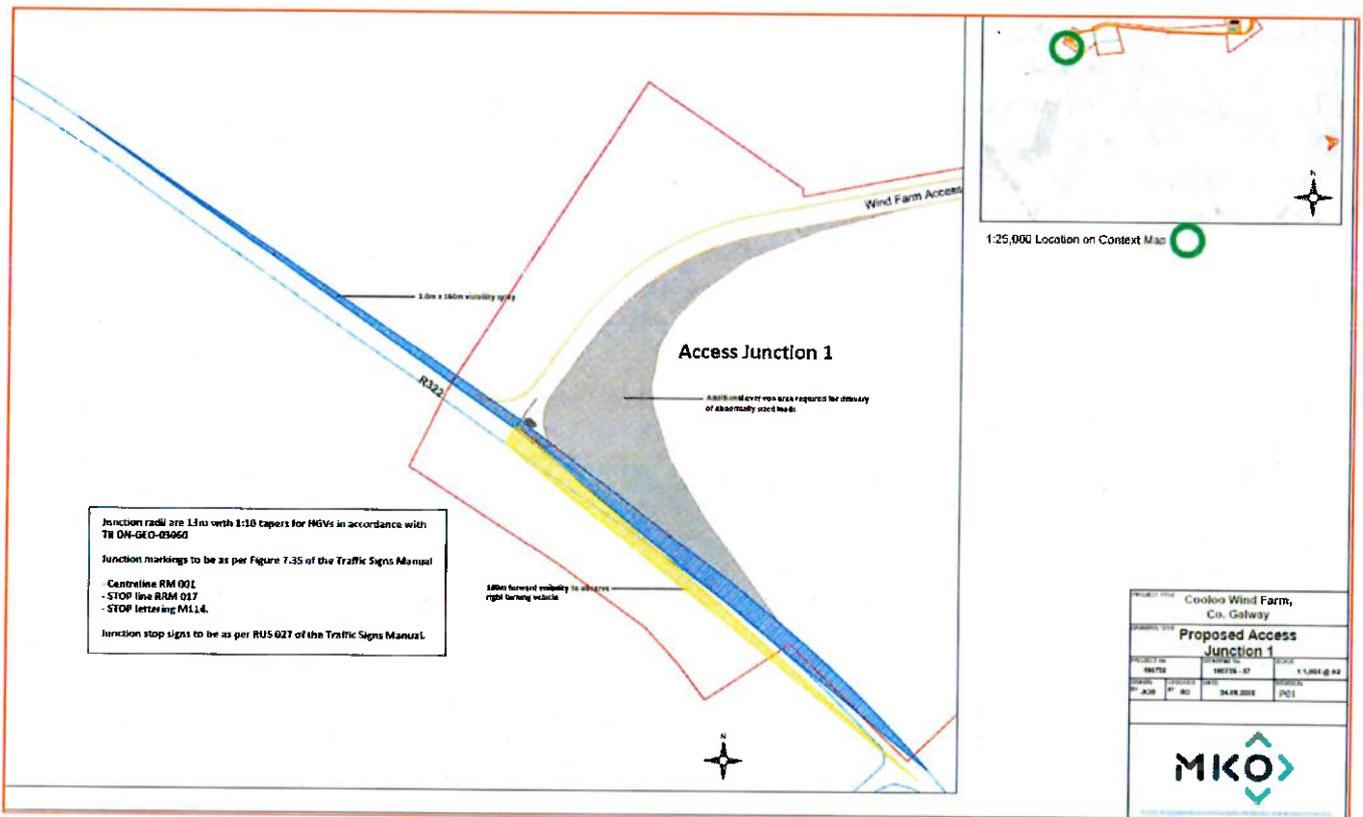
Construction and Environmental Management Plan

3.4.1.2 Abnormal Load Route Assessment

While the proposed turbine delivery route from the port of entry is discussed in Section 15.1.2.2 the route assessment discussed in this section includes all locations on the proposed 3 turbine delivery route from the right turn off Junction 19 of the M17 onto the double roundabout junctions with the N63, to the Proposed Wind Farm site access junction located on the R332, with the route and assessment locations shown in Figure 15-1b.

A swept path analysis was undertaken at **all locations** using Autotrack in order to establish the locations where the wind turbine transporter vehicles will be accommodated, and the locations where some form of remedial measure may be required.

Response: The swept path analysis submitted is totally inadequate. It only deals with a few locations & not "all locations".



PROPOSED PROJECT ACCESS JUNCTIONS

The location of the site access junctions 1 to 5 are shown in Figure 15-3 and are described below.

Access junction 1 – Construction access junction on R332 – Proposed temporary access for abnormally sized loads and general construction traffic

The proposed temporary access junction on the R332 for the abnormally sized loads, which will be accompanied by a Garda escort, standard HGVs and construction staff, is shown in Figure 15-17. The access is in the townland of Lissavally, Co Galway is situated on the northern side of the R332 at a location where an 80 kph speed limit applies. The proposed junction radii are 13m with 1:10 tapers provided for standard HGV access in accordance with TII DN-GEO-03060. STOP road markings and signs are as per Figure 7.35 of the Traffic Signs Manual.

The proposed junction includes a run-over area at the northeastern corner in order to facilitate the delivery of the abnormally sized turbine loads. On completion of the delivery of the abnormally sized loads the temporary run-over areas will be closed off to traffic with the layout resorting to the standard junction layout described above.

The required visibility splays for an 80 kph speed limit, 160m along the nearside carriageway edge taken from a setback of 3.0m, are available along the R332 to the west and east, as shown in Figure 15-18. The figure also shows the full forward 160m forward visibility for traffic approaching from the east to observe a vehicle waiting to turn right into the Proposed Wind Farm site. It is noted that there are existing shrubs and bushes that partially constrain the forward visibility splay. In mitigation it is proposed that the following measures are implemented;

- The bush / shrubs on the south side of the R332 are trimmed in order to maximise forward visibility. It is estimated that a forward visibility of approximately 140m may be achieved by trimming the roadside bushes alone.

Response: Was landowner consent provided to trim the bushes?

The Galway County Development Plan requires Vertical sections of the SDT, Forward Sight Distance for right-turning vehicles, Road Safety Audits & Traffic Impact Assessments, where traffic increases by more than 5%. It should also be noted that the adjoining Briarfield N.S. was closed on the 8th July, when the 1-day traffic count was taken. The use of a 3m setback for HGV's in a SID is not adequate & should be increased to 4.5m.

- An application to Galway County Council for a temporary reduction of the speed limit on this section of the R328 to 60 km/h during the 18 month construction phase of the Proposed Project,

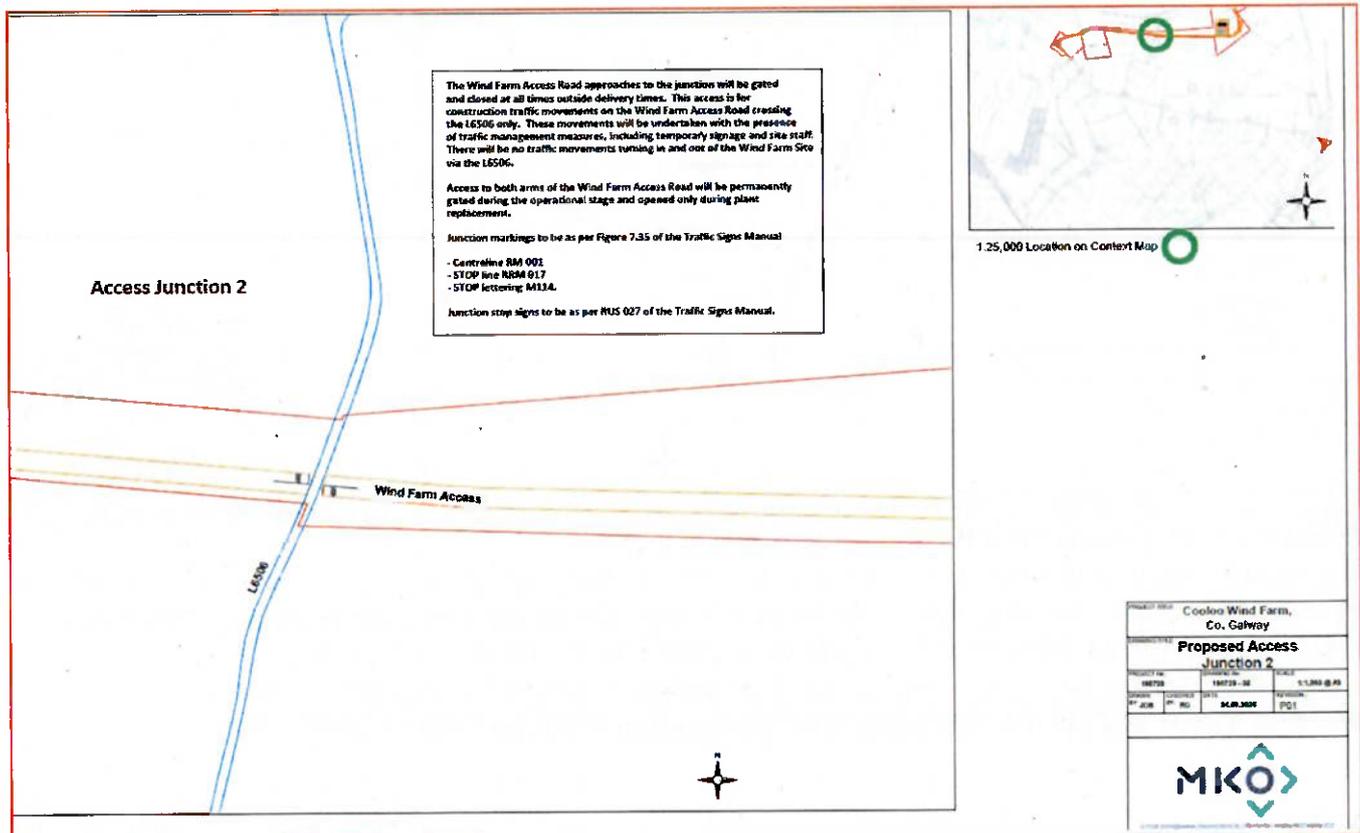
Response: Why were they not submitted for approval before the application was submitted? The developer has referenced the R328, this road has no connection with this project!

- The introduction of Traffic signs in accordance with the "Traffic Signs Manual, Section 8 – Temporary Traffic Measures and Signs for Road Works" (DoT now DoTT&S) and "Guidance for the Control and Management of Traffic at

Roadworks" (DoTT&S). The proposed traffic management measures will be submitted to Galway County Council's Roads section for agreement prior to the construction phase.

Response: Why were they not submitted for approval before the application was submitted?

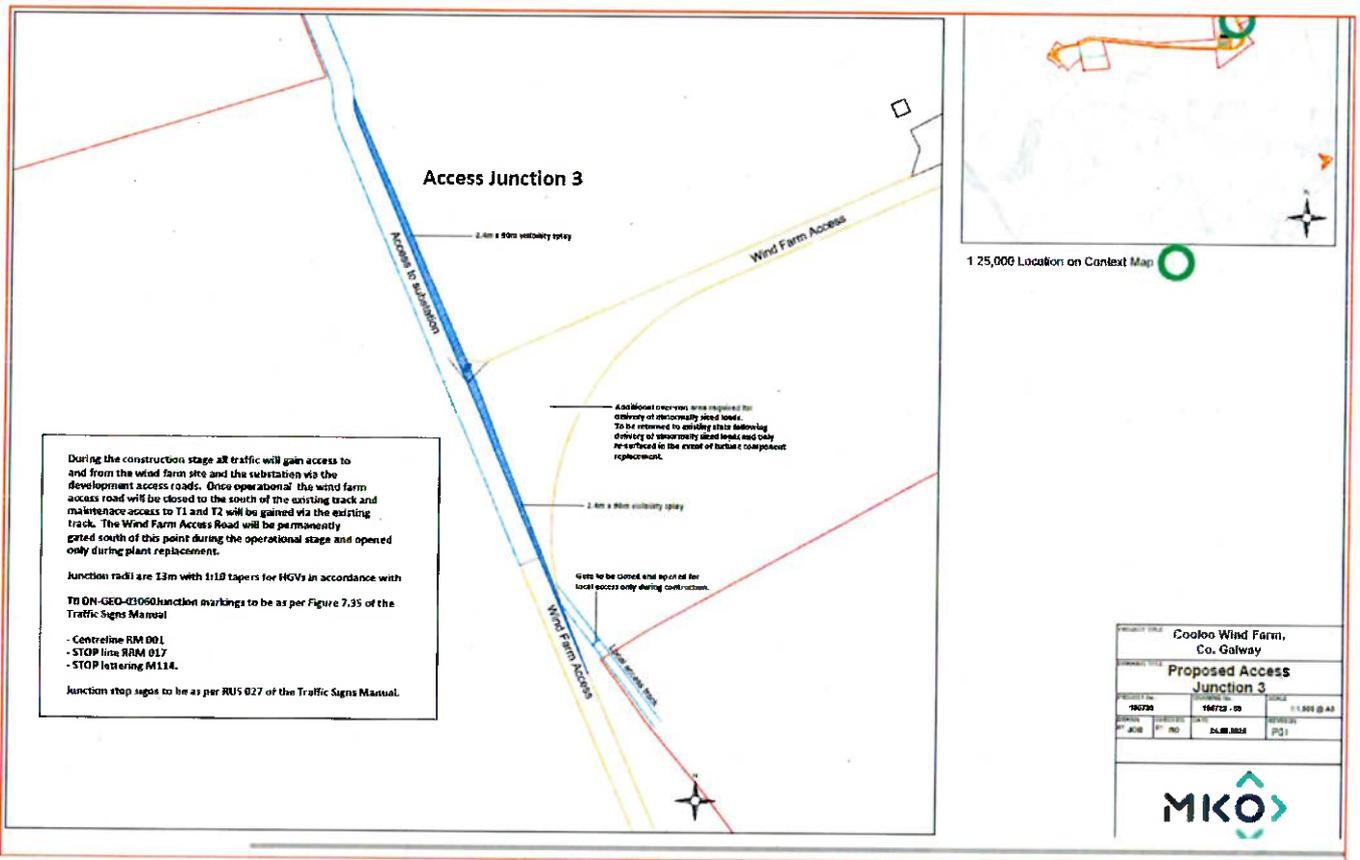
- The provision of a flagman at all times that the proposed access junction is in use during the construction phase.
- The closure of the site access by means of temporary fencing and gates during periods when the access is not in use, including evenings during the construction phase.
- The permanent closure of the site access junction on completion of the construction phase. This junction will only be opened for the purpose of the replacement of large component parts.



Access junction 2 – Crossing of the L6506

This crossing point of the Proposed Wind Farm access road over the L6506 local road together with the 90m visibility splays taken from a 2.4m setback from the carriageway edge, appropriate for a 60 kph speed limit, are shown in Figure 15-22. It is proposed that construction traffic will cross the local road at this location during the construction phase of the Proposed Wind Farm, which will be low in frequency, once the Proposed Wind Farm is operational. There will be no turning movements between the local road and the access junction at this junctions and the site accesses will be gated when not in use. All abnormally sized loads will be accompanied by a Garda escort and a Flagman will be present at these junctions on busy days during the construction period.

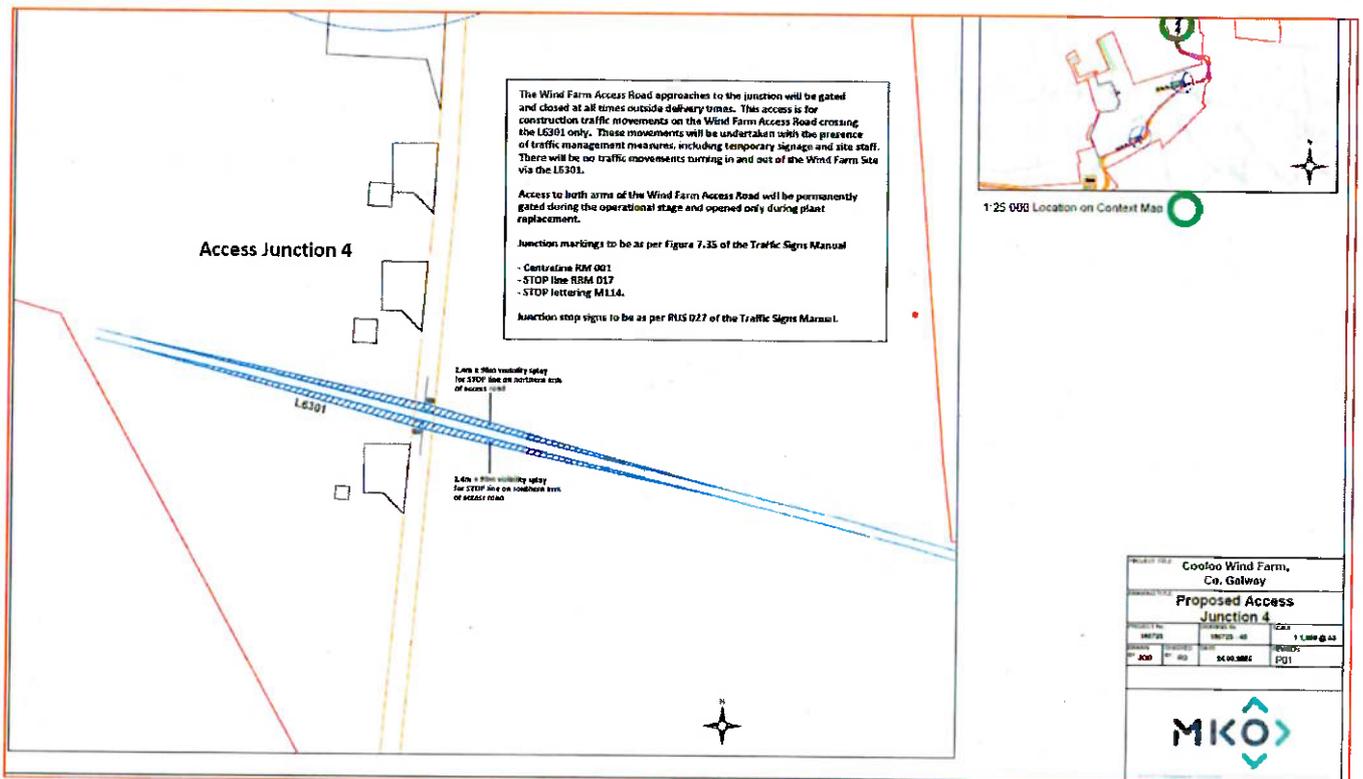
Response: The use of a 2.4m setback for HGV's in a SID is not adequate & should be increased to 4.5m.



Access junction 3 – Connection with local track for access to substation

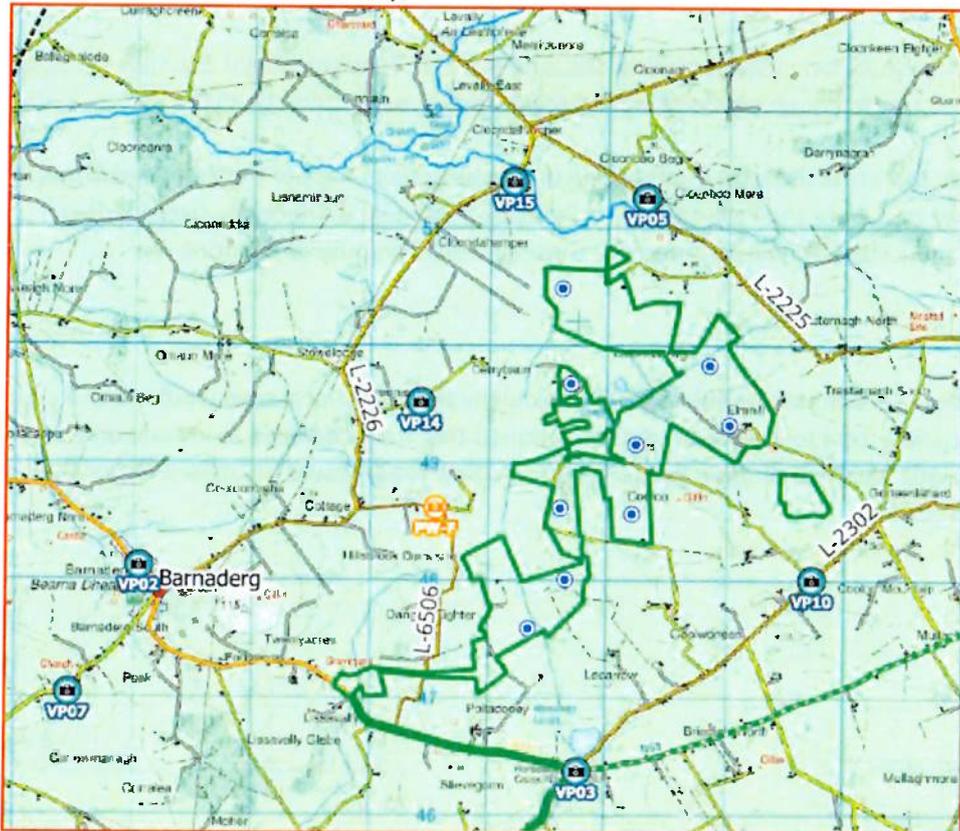
The proposed layout for this junction that connect a local track to the access proposed or the substation is shown in Figure 15.23. Visibility splays taken from a 2.4m setback from the carriageway edge, appropriate for a 60 kph speed limit, are provided. It is proposed that this access will be gated and closed at all times apart from during the construction of the substation and during maintenance visits when the Proposed Project is operational.

Response: The use of a 3m setback for HGV's in a SID is not adequate & should be increased to 4.5m.

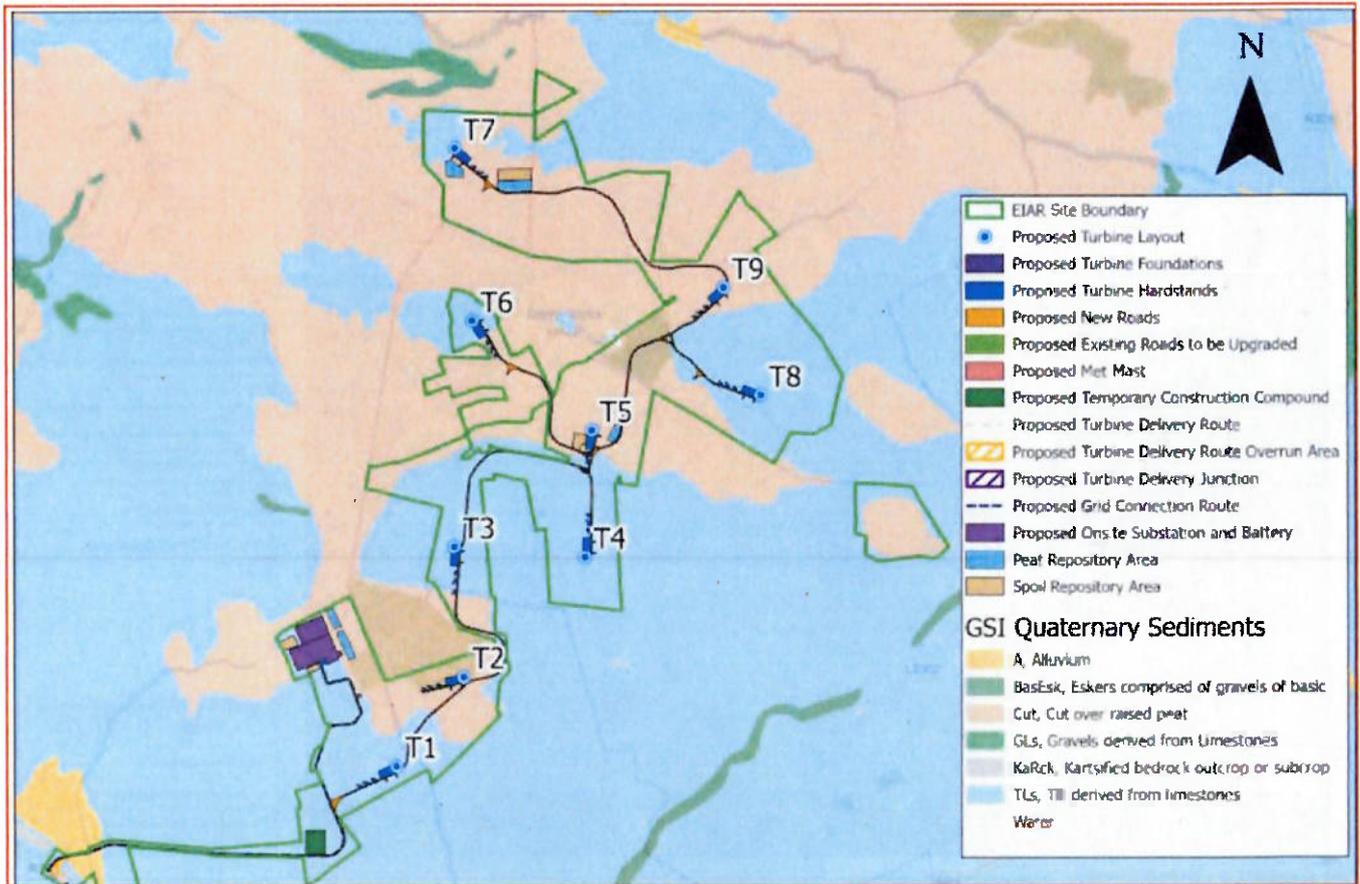


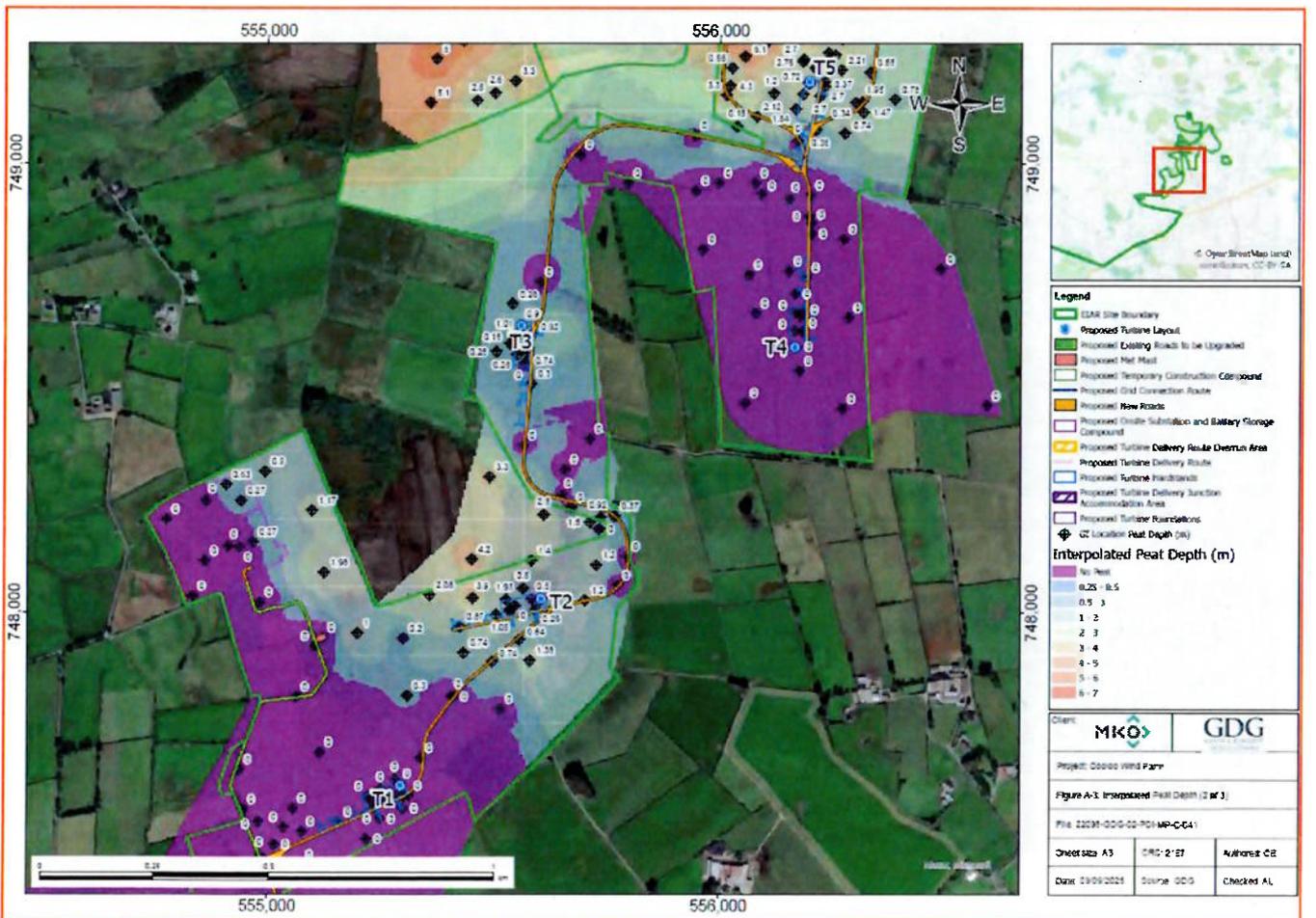
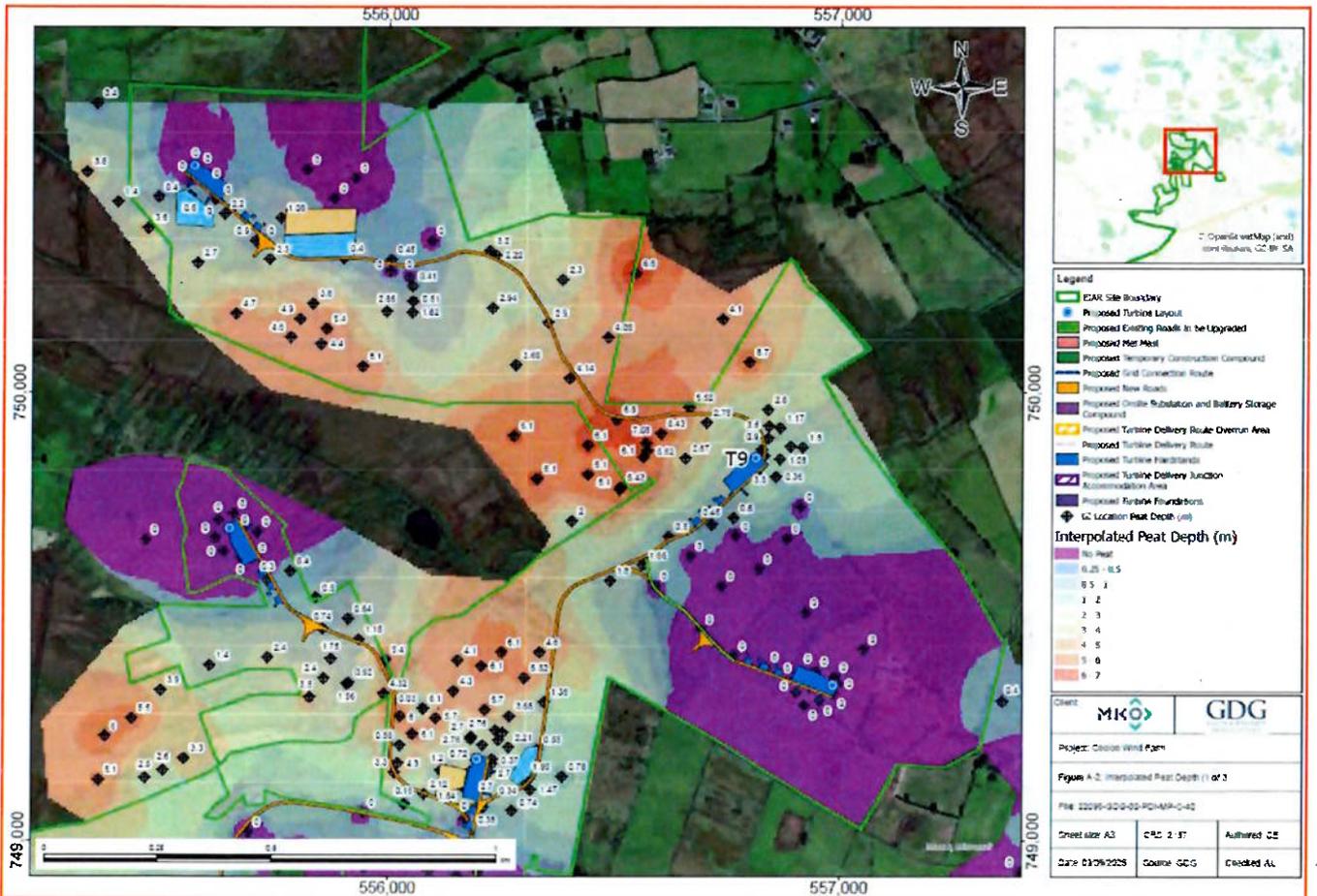
Access junctions 4 and 5 -- Crossings of the L6301

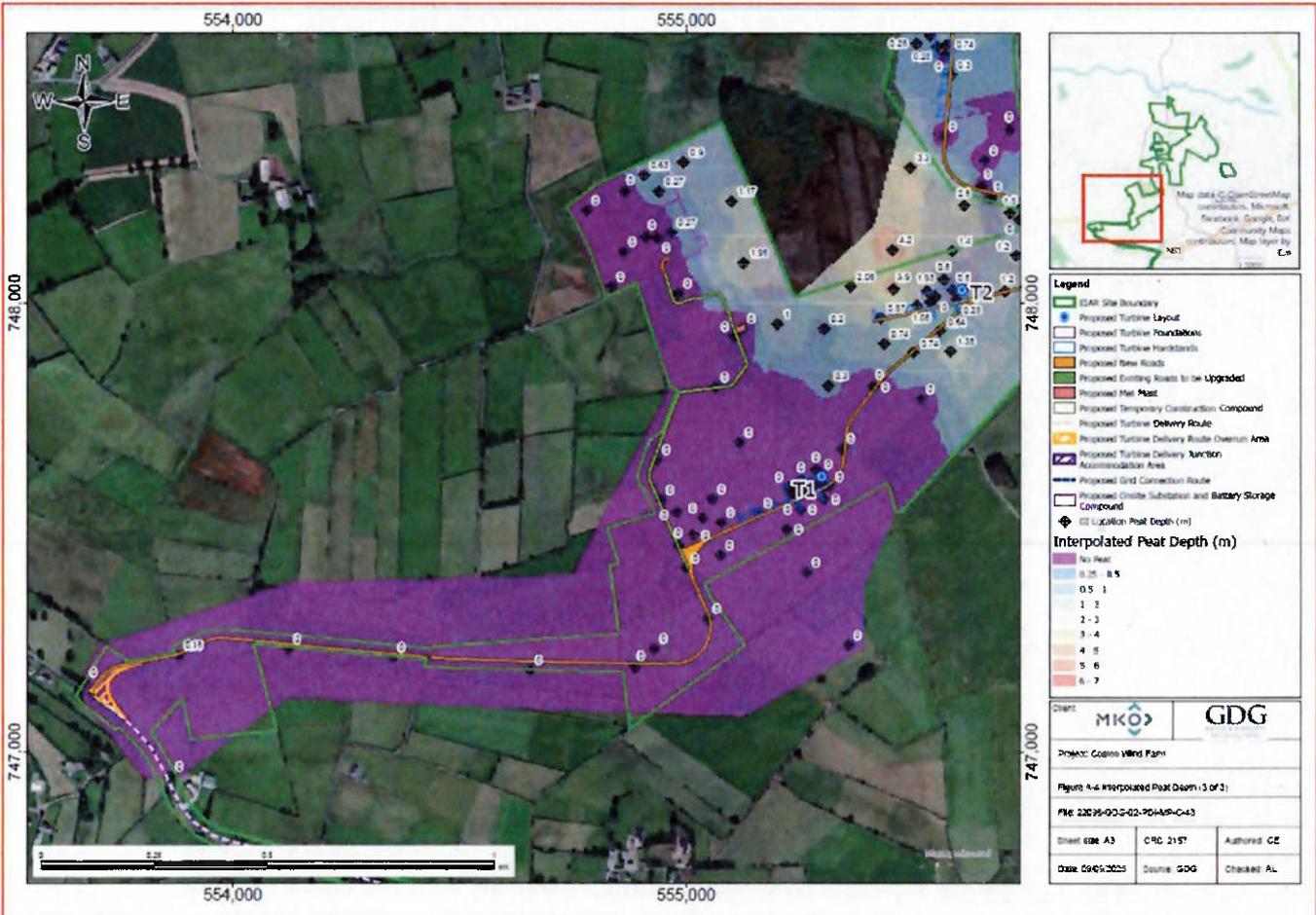
APPENDIX 13-4: LVIA Baseline Map

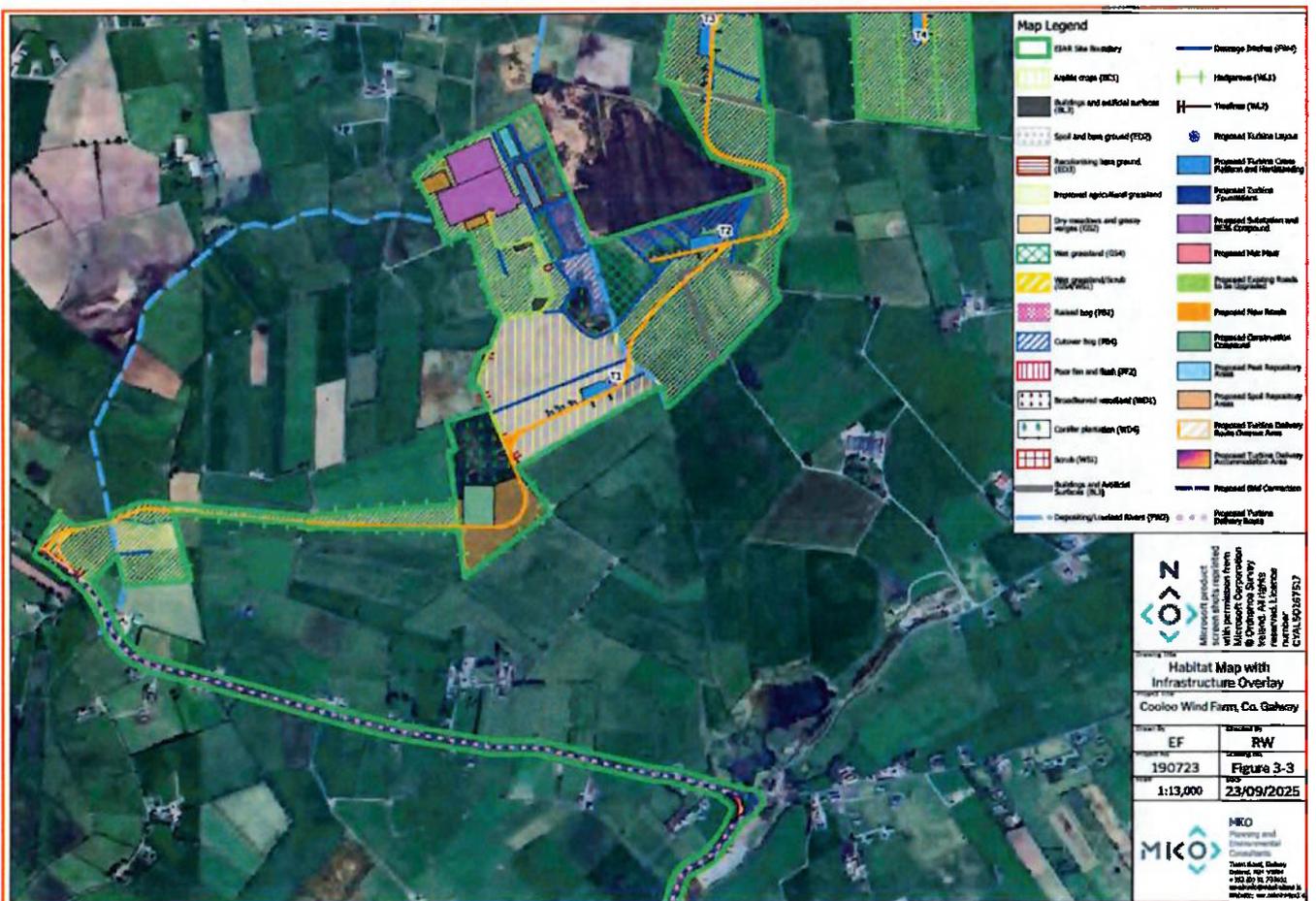
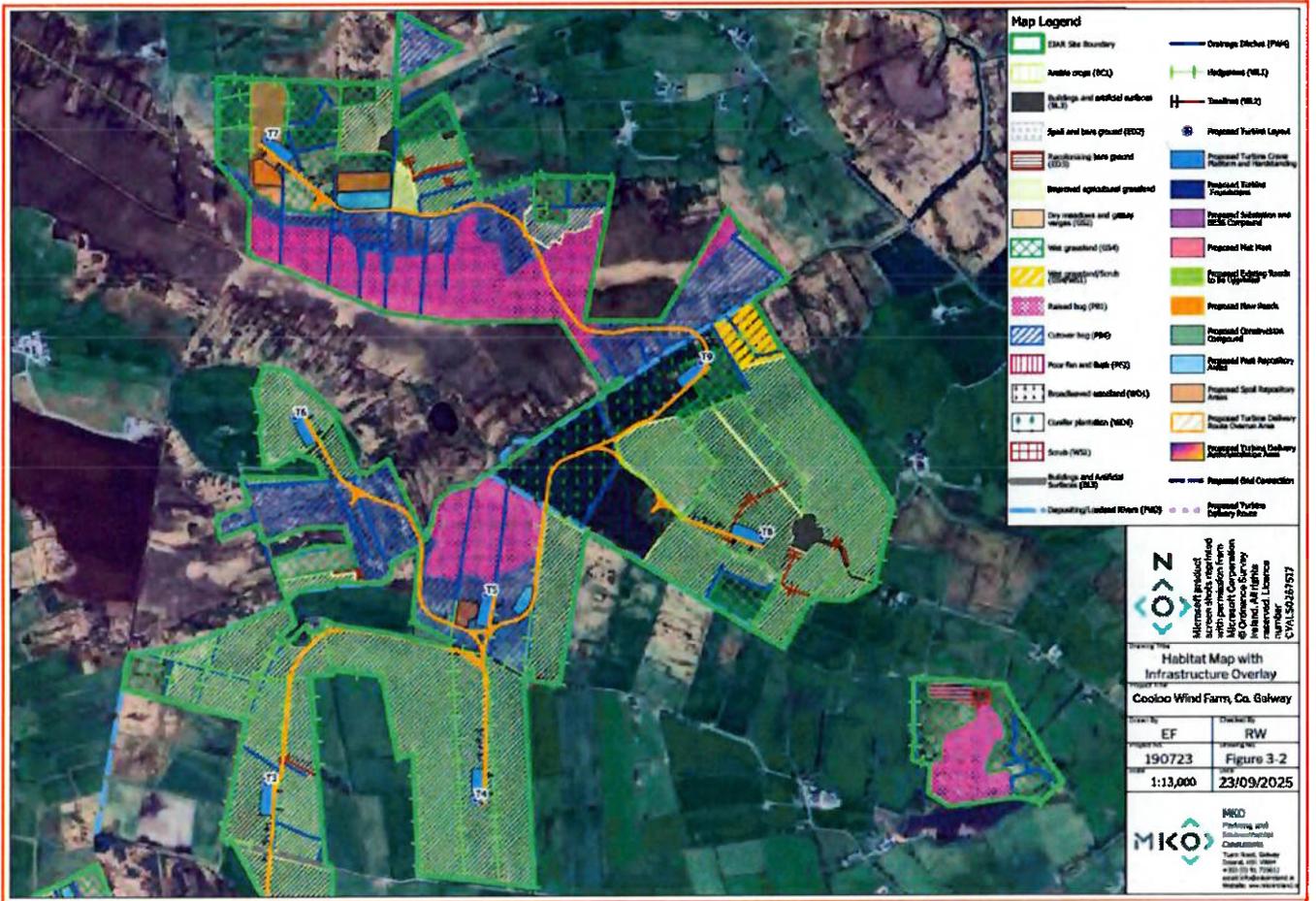


Response: The Vantage Points (except for VP05) are all greater than 1km from the nearest turbine. Why are houses nearer not included?









The Proposed Project intends to connect to the national grid via underground electrical cabling within the local and regional road network along the Proposed Grid Connection to the existing Cloon 110kV substation, in the townland of Cloonascragh, Co. Galway.

Response: No landowner consents provided for the laying of the grid connection. Without such consents this involves trespass as per Cremins v Dromada Windfarm 2023, Constitutional Property Rights & ECHR Protocol 1 & 8, where ACP cannot facilitate illegal approvals.

The site comprises a mix of pastoral agriculture, peatlands, low-density residential, and small-scale commercial forestry. The Proposed Wind Farm site will be easily accessible via new temporary construction site entrance of the R332 regional road to the south of the Proposed Wind farm site and for the operational phase via L6301 local road in the centre of the Proposed Wind Farm site.

Alternative Renewable Energy technologies

The Proposed Project will be located on a site where small-scale pastoral agriculture and peat cutting practices will continue to be carried out around the footprint of the Proposed Project.

Response: Will wake climatic effects require landowner consent? Will potential bog fires create a major risk for windfarm?

Alternative Turbine Layout and Development Design

The design of the Proposed Wind Farm has been an informed and collaborative process from the outset, involving the designers, developers, engineers, environmental, ecological, hydrological and geotechnical, archaeological specialists and traffic consultants. The design process has also taken account of the recommendations and comments of the relevant statutory and non-statutory organisations, near neighbours / the local community and local authorities. Throughout the preparation of this EIAR, the layout of the Proposed Wind Farm has been revised and refined to take account of the findings of all site investigations and baseline assessments, which have brought the design from its first initial layout iteration to the Proposed Wind Farm layout.

Constraints and Facilitators Mapping

An initial 9 no. turbine layout was proposed following a preliminary desk-based constraints assessment. A more detailed constraints mapping exercise was then carried out to inform the final proposed turbine layout. The constraints mapping process involved applying buffer zones around various environmental and technical constraints to clearly define areas where no development will occur. These buffers were established based on relevant standards and best practice guidelines. Key constraints included sensitive receptors, such as residential dwellings, which were assigned a 720 metre buffer in line with the draft 2019 Guidelines recommending a separation distance of four times the maximum turbine tip height. Designated Natura 2000 sites were given a 100 metre buffer, while a 50 metre buffer was applied to watercourses, waterbodies, and recorded archaeological sites or protected structures. Infrastructure was carefully sited to avoid the loss of habitats of Local Importance (higher value) or greater. Additionally, telecommunication links were protected with operator-specific buffers to avoid interference.

Turbine Layout

The design of the Proposed Wind Farm evolved through multiple iterations, starting with an initial layout of nine turbines based on preliminary constraints mapping and viability analysis.

Early desk-based assessments led to adjustments, such as relocating Turbine 1 to avoid a telecommunications link. In Iteration 2, turbines were renumbered, and preliminary infrastructure siting and site investigations including habitat, ecological, hydrological, and geotechnical surveys prompted further relocations of several turbines to avoid deep peat, maintain setbacks, and optimise wind capture.

Iteration 3 maintained the nine turbines, incorporating additional detailed investigations and a telecoms impact assessment, which led to a minor relocation of Turbine 7.

The final layout is considered optimal, balancing technical efficiency with minimal environmental impact. It integrates all site and design constraints, site investigation results, and includes biodiversity enhancement measures such as native replanting and habitat restoration. Peat and spoil management areas were also refined based on multidisciplinary surveys to avoid ecological and hydrological constraints.

Response: The lacunae of the Windpro software design has not been provided as per EEC Directive.

CJEU Case 258/11 at 44

“So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned.”

Judgement of the Court Case 258/11

Article 6(3) of Council Directive 92/43/EEC of 23rd May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of sites of Community importance, in accordance with the Directive. The precautionary principle should be applied for the purposes of that appraisal.

Alternative Design of Ancillary Infrastructure

The ancillary structures required for the Proposed Project include roads, temporary construction compound, meteorological (met) mast, peat and spoil repository areas, onsite 110kV substation, battery energy storage system (BESS) compound, and associated underground cabling.

Response: This Battery Storage System is not included in the application.

3.5.3.5 Onsite 110kV Substation and Battery Storage Compound

The proposed onsite 110kV substation and BESS compound is located in the south of the Proposed Wind Farm site and forms part of the Proposed Grid Connection. 3 no. potential locations were identified were considered at the early stage of the design of the Proposed Project, as shown in Figure 3-6:

- Option A – located approx. 670m southeast of T08 in the northeast of the Proposed Wind Farm site
- Option B – located approx. 230m west of T08 in northeast of the Proposed Wind Farm site
- Option C- located approx. 560m northeast of T01 in the south of the Proposed Wind Farm site

The onsite 110kV substation and BESS compound locations were also subject to detailed habitat surveys and mapping, ecological surveys, hydrological and geotechnical investigations. Option B was identified to be within a sensitive ecological habitat and as a result was no longer progressed. This area was instead included within the Biodiversity Management and Enhancement Plan included as Appendix 6-4.

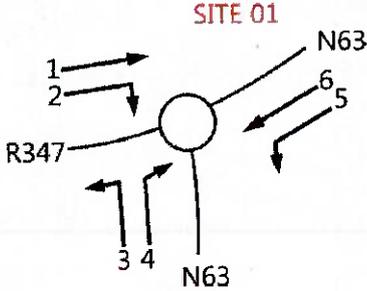
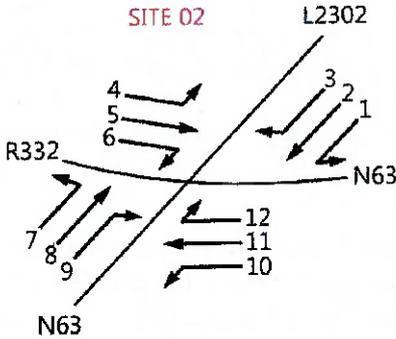
Option C is located strategically within the Proposed Wind Farm site, providing proximity to the public road network in which the Proposed Grid Connection underground cabling route is primarily located within an agricultural grassland field. This grassland is of low ecological value and proposed enhancement measures will facilitate screening from sensitive receptors. This location was deemed to be suitable due to the habitats it is located on, proximity to the local road network in which to facilitate the connection of the Proposed Wind Farm site to the national grid, and the existing ground conditions.

- Road Layout: Access tracks are essential within the Proposed Wind Farm to facilitate the safe transport of materials and equipment were designed with appropriate gradients and widths. From the outset, the design aimed to maximise use of existing tracks to minimise environmental impacts. To avoid significant disruption to local traffic, particularly along the L6301 local road, only crossing points were included there, with new internal roads used instead of upgrading public roads. The final internal road layout was developed based on site constraints, ensuring efficient access while avoiding sensitive ecological areas. While initial plans considered using the R332 regional road for all access, it was later limited to abnormal load deliveries only, with the L6301 local road designated as the main operational access route;
- Alternative Internal Site Cabling Route: The internal 33kV underground cabling will follow the internal road network to connect all nine turbines to the onsite 110kV substation. Although this results in a longer cabling route, it was chosen as the most suitable due to the low ecological value of the habitat, avoiding greater disturbance and increased peat and spoil generation that would occur with a direct, ‘as the crow flies’ route;
- Onsite 110kV Substation and Battery Storage Compound: The proposed onsite 110kV substation and BESS compound is located in the south of the Proposed Wind Farm site and forms part of the Proposed Grid Connection. 3 no. potential locations were identified were considered at the early stage of the design of the Proposed Project. This location was deemed to be suitable due to the habitats it is located on, proximity to the

local road network in which to facilitate the connection of the Proposed Wind Farm site to the national grid, and the existing ground conditions;

Response: This Battery Storage System is not included in the application.

Alternative Grid Connection Underground Electrical Cabling Route Options

Site Locations		Movement Numbering	
			
			
	Job number: TRA/25/125	Job Date: 8 th July 2025	Drawing No: TRA/25/125-01
	Client: Alan Lipscombe	Job Day: Tuesday	Author: JW
			

TRAFFINOMICS LIMITED																					
COOLOO WIND FARM TRAFFIC COUNTS														JULY 2025							
MANUAL CLASSIFIED JUNCTION TURNING COUNTS														TRA/25/125							
SITE: 02				DATE: 8th July 2025																	
LOCATION: L2302/R332/N63				DAY: Tuesday																	
MOVEMENT 1					MOVEMENT 2					MOVEMENT 3											
TIME	CAR	LGV	OGV1	OGV2	BUS	TOT	PCU	CAR	LGV	OGV1	OGV2	BUS	TOT	PCU	CAR	LGV	OGV1	OGV2	BUS	TOT	PCU

Response: Adjoining Briarhill N.S. closed in July for summer holidays. This traffic count is nonsense.

TRAFFIC MANAGEMENT MEASURES DURING CONSTRUCTION OF PROPOSED GRID CONNECTION ROUTE

Traffic impacts and diversion routes identified for the Proposed Grid Connection Route works are included in Section 15.1.7 of the EIAR. Sections along the Proposed Grid Connection Route where there will be road and pedestrian footpath closures and traffic diversions are identified.

It is proposed that the 110kV onsite substation is connected by 110kV underground cabling to the existing 110kV Cloon Substation located in the townland of Cloonascragh. The underground cabling route measures approximately 21km of which approximately 18.2km is located within the public road corridor.

The extent of the underground cabling route that will impact on the public road networks is considered in the 10 sections (8 on-road 2-off road) shown in Figure 15-6a and summarised in Table 15-26 of the EIAR inserted below. Based on a construction rate of 100m per day, it is estimated that the grid route will take approximately 210 working

days to complete based on one construction crew operating at one location. In practice the construction duration may be significantly reduced using 2 construction crews operating at different locations on the route.

Table 15-26 Proposed Grid Connection underground cabling route link, traffic management measure, link length (km), construction duration (days)

Response: Landowner consents have not been provided to use the public road as per Cremins v Dromada Windfarm.

Underground Cabling Route Section	Traffic management	Length (kms)	Construction duration (days)
Off road at Proposed Wind Farm site	Off-road	2.6	26
Section 1 – R332	Closure	2.3	23
Section 2 – N63	Closure	4.2	42
Section 3 – L6234	Closure	3.3	33
Section 4 – L2115	Closure	1.1	11
Section 5 – L2127	Closure	0.1	1
Section 6 – L2125	Closure	3.0	30
Section 7 – R347	Closure	3.9	39
Section 8 – L6141	Closure	0.3	3
Off road section at Cloon Substation site	Off road	0.2	2
Total		21.0	210

The on-road sections of the Proposed Grid Connection underground cabling route travels along 4.2km of the N63 National Secondary Road, a 2.3 km section of the R332 Regional Road, a 3.9km section of the R347 Regional Road, with the remaining 12km of the on-road route travelling along the local road network. An inspection of the route would indicate that the significant majority of the route will require a road closure at the point of construction during the construction of the underground cable route. A precautionary scenario where a road closure will be required for the entire route is assumed for the purpose of the assessment.

Response: Landowner consents have not been provided to use the public road as per Cremins v Dromada Windfarm.

The potential diversion routes that may be used during the construction of the various sections of the grid route that are on the public road network are set out in Table 15-27 and shown in Figure 16-6b. For sections 3, 4, 5, 6 and 8, which comprises of 7.8 km of the total route, the diversions will result in low volumes of existing traffic on local roads being diverted onto other local roads, or onto roads of a higher standard, including the N63, R332 and the R347. Table 15-27 Proposed Grid Connection underground cabling route link, link length (km), potential diversion route, length of diversion route (km), additional trip length (km)

Response: It is totally unacceptable to close roads for 210 days & indicate diversions up to 16.7kms. and 33.4km round trip. This is a rural area & no cognisance is taken of schools, shops, employment, etc.

Underground Cabling Route Section	Length (kms)	Potential diversion route	Length of diversion route (kms)	Additional trip length (kms)
Off road at Proposed Wind Farm site	2.6	N/A	N/A	N/A
Section 1 – R332	2.3	N63, L6234, L2115, R332	13.2	10.9
Section 2 – N63	4.2	L6234, L2115, R332	11.3	7.1
Section 3 – L6234	3.3	L2115, R332, N63	12.2	8.9
Section 4 – L2115	1.1	L2127, L2118	2	0.9
Section 5 – L2127	0.1	L2127, L2118, L2115	3	2.9
Section 6 – L2125	3.0	L2127, L2115, L6234, N63, R347	16.7	13.7
Section 7 – R347	3.9	R347, R332, L2114, L2127, L2125	14.5	10.6
Section 8 – L6141	0.3	L6141, L2113, L2135, R332, R347	7	6.7
Off road section at Cloon Substation site	0.2	NA	NA	NA
Total	21.0			

For Sections 1 on the R332, 2 on the N63, and 7 on the R347, this will either result in traffic volumes on these roads being diverted onto some sections of lower standard local roads (shown in orange in Figure 15-6b), or via longer diversions onto roads of a similar standard (shown in red in Figure 15- 6b). Prior to the construction of the Proposed Grid Connection, the final diversion routes that will be used during the construction of the various sections of the cabling route will be discussed and agreed with Galway County Council.

For the diversion routes shown in Figure 15-6b, the temporary additional trip length incurred by drivers during the construction of the Proposed Grid Connection will range from a minimum of 0.9km to a maximum of 13.7km. It should also be noted that the length of the diversion routes shown for the various sections of the Proposed Grid Connection are the longest that may be incurred, measured from either end of the section being constructed, and that in practice, many drivers undertaking longer trips will divert onto other parallel routes further afield to avoid the closure, incurring shorter actual diversions. It is estimated that the Proposed Grid Connection Route will take approximately 210 days, or approximately 10 months to construct. With respect to the traffic volumes that will be generated during the construction of the Proposed Grid Connection Route, it is estimated that there will be approximately 14 daily return trips made by a truck transporting materials, and a further trip made by minibus to transport construction staff to and from the point of construction.

Response: Landowner consents have not been provided to use the public road as per Cremins v Dromada Windfarm.

Two underground grid connection options were considered to link the Proposed Grid Connection onsite substation with existing substations. Option A connects to the Cloon 110kV substation approximately 11.1km west, with a total route length of 20.9km, mainly within public road corridors and including 2.6km of new or upgraded access tracks. Option B connects to the Cashla 220kV substation about 22.2km southwest, with a longer total route of 35.5km and similar access track requirements. While Option B is approximately 14.6km longer and poses greater potential for short-term disturbance to residents and long-term habitat loss, Option A crosses more watercourses (5 compared to 4). However, Option B presents greater risks to material assets due to crossings of a railway, motorway, and high-pressure gas line, which Option A avoids. Based on these environmental considerations, Option A was identified as the preferred grid connection route. Environmental considerations for the two grid connection options highlight Option A as having generally lower potential impacts compared to Option B. Option A passes fewer residential dwellings, reducing the likelihood of dust, noise, and vibration nuisances, and has a smaller development footprint, resulting in less habitat loss, peat excavation, and disturbance to potential subsurface archaeology. While Option A crosses more

EPA-mapped watercourses, Option B's longer route increases potential for habitat loss, higher excavation volumes, greater emissions, and more significant interactions with sensitive infrastructure such as railways, motorways, and gas lines. Overall, Option A presents fewer environmental risks and impacts, making it the more favourable route. The Proposed Grid Connection (Option A) includes connection to the national grid via underground electrical cabling, located primarily within the public road corridor to the Cloon 110kV substation. Underground electrical cables will transmit the power from each wind turbine to the proposed onsite substation. The power from the proposed onsite 110kV substation will be transmitted to the existing Cloon 110kV substation, via an underground electrical cabling route, measuring approximately 20.9km in length.

The chosen underground electrical cabling route will follow existing public roads and new/existing track across private land, and thereby have a reduced permanent visual impact due to the placement of the cabling route underground, with no above ground infrastructure visible in the operational phase.

The Proposed Grid Connection will be subject to a separate planning application but has been assessed within this EIAR.

Response: Landowner consents have not been provided to use the public road as per Cremins v Dromada Windfarm.

2.3.4.5 Joint Bays

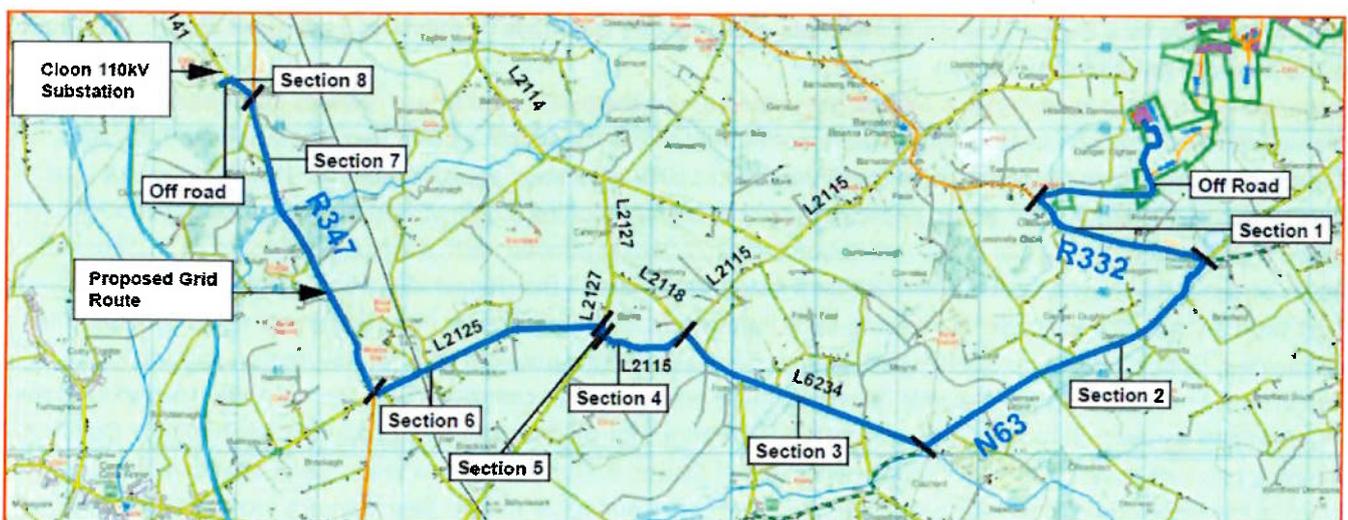
Joint bays are typically pre-cast concrete chambers where lengths of cable will be joined to form one continuous cable. They will be located at various points along the ducting route generally between 600 to 800 metres intervals or as otherwise required by ESB/EirGrid and electrical requirements. The **Installed Joint Bays will be 2m x 6m x 1.5m pre-cast concrete structures** installed below the finished ground level.

Where possible, joint bays will be located in areas where there is a **natural widening/wide grass margin** on the road in order to accommodate easier construction, cable installation and create less traffic congestion. Joint Bays will be located in the non-wheel bearing strip of roadways, however given the narrow profile of local roads this may not always be possible. During construction the joint bay locations will be completely fenced off once they have been constructed they will be backfilled until cables are being installed. Once the cabling is installed the joint bays will be permanently backfilled with the existing surface re-instated and there will be no discernible evidence of the joint bay on the ground.

In association with joint bays, Communication Chambers are required at every joint bay location to facilitate jointing of the communication cabling. Earth Sheath Link Chambers are also required approximately every second joint bay along the cable route. Earth Sheath Links are used for earthing and bonding cable sheaths of underground electrical cabling, installed in a flat formation, so that the circulating currents and induced voltages are eliminated or reduced. Earth Sheath Link Chambers and Communication Chambers are located in proximity to Joint Bays. Earth Sheath Link Chambers and Communication Chambers will be pre-cast concrete structures with a steel access cover at finished surface level. The locations of the joint bays and chambers are shown in Appendix 4-1 of the EIAR. Please see Figure 4-23 of the EIAR for a standard joint bay.

The precise siting of all Joint Bays, Earth Sheath Link Chambers and Communication Chambers within the underground cabling route corridor assessed is subject to approval by ESB and EirGrid

Response: Landowner consents have not been provided to use the public road as per Cremins v Dromada Windfarm.



Alternative Transport Route and Site Access

Turbine components will be transported from Galway Port via the M6, M17, and N63, using the consented N63 Liss to Abbey Realignment Scheme before connecting to the R332 and entering the site.

Chapter 4: Description of the Proposed Project

4.3.1.1.6 *Generating Capacity*

The exact generating capacity of the installed turbine will be designed to match the wind regime on the Site and will be determined by the selected manufacturer.

For the purposes of this EIA, a rated generating capacity of 7 MW has been chosen to calculate the potential capacity of the proposed 9-turbine renewable energy development, which would result in an estimated installed capacity of 63 MW.

With regards to the modern turbine range, i.e., those available on the market at the time of writing, of 6 – 7.2MW, the resulting electricity produced would range from 165,564MWh to 198,677MWh per annum. The lower end of this range (165,564MWh) would be sufficient to supply approx. 39,420 Irish households with electricity per year, based on the average Irish household using 4.2MWh of electricity. The higher end of this range (198,677MWh) would be sufficient to supply approx. 47,304 Irish households with electricity per year, based on the average Irish household using 4.2MWh of electricity.

Response: A "rated generating capacity" is not output. All of the statistics have to relate to output. The above figures based on capacity are nonsense. This is similar to suggesting that a Ferrari with 400 Brake Horse Power should allow you to drive to Dublin from Clifden in an hour, while you would never get the Ferrari out of 1st gear on Irish roads.

4.3.1.2 *Site Roads*

4.3.1.2.1 *Road Construction Types*

Construction of New Roads

The excavation of peat and spoil and founding of access roads on competent stratum (below the peat) for new access roads will be carried out at various locations on the Proposed Wind Farm site. Excavate and replace type access roads are the conventional method for construction of access roads on peatland sites and the preferred construction technique in shallow peat (<1.0m) provided sufficient placement/reinstatement capacity is available onsite for the excavated peat. **Floating tracks are also proposed** to minimise the impact on the peat, particularly peat hydrology. As there is no excavation required, no peat arisings are generated. However, a founded access track is more suitable if the underlying peat is shallow (<1m) or due to topographic restrictions or stability concerns. The methodology for the construction of new roads (excavated and floating) is detailed in Section 4.1 of the Peat and Spoil Management Plan in Appendix 4-2. This methodology includes construction procedures that will minimise any adverse impact on peat stability.

Response: No scientific peer reviewed paper to show that such roads can carry the nacelle weight.

4.3.1.8.2 *Enhancement Measures*

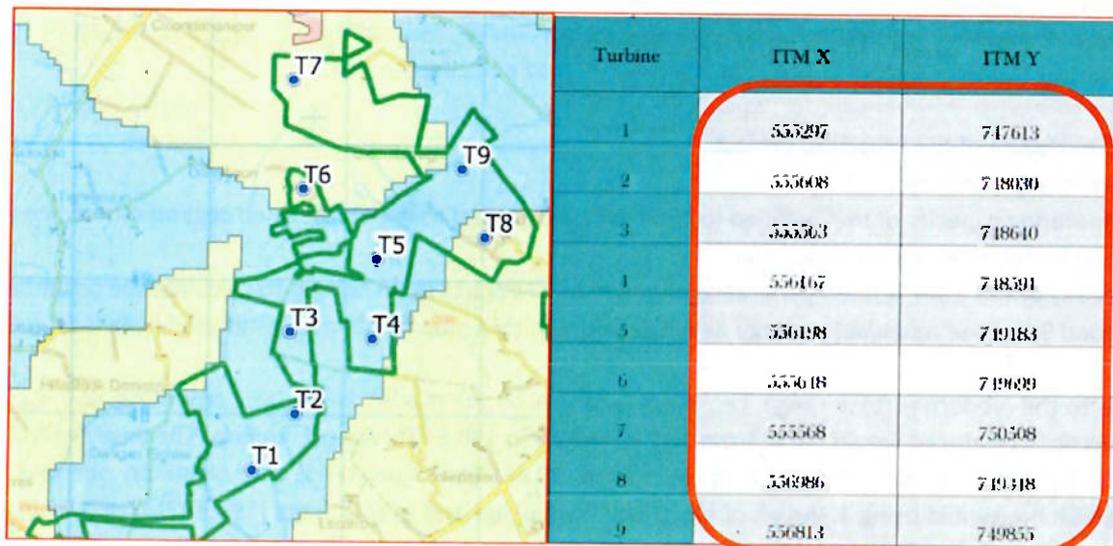
Marsh Fritillary Breeding Habitat

Marsh fritillary habitat has been identified throughout the Site. As part of proposed enhancement measures, existing Marsh Fritillary breeding habitat be safeguarded and maintained within the Proposed Wind Farm site. It has been agreed that these areas will be protected from development, land clearance or use conversion, or significant agricultural works for at least the duration of the BMEP

The proposed turbine layout has been verified using **industry standard wind farm design software** ensuring that it maximises the energy yield from the Proposed Project, **while maintaining sufficient distances** between the proposed turbines so as to ensure turbulence and wake effects do not compromise turbine performance.

Response: This "industry standard wind farm design software" has not been provided & is in breach of the lacunae requirement. Previous tables above & below show non compliance with 2006/2019 Wind Energy Guidelines. Who then decides "sufficient distances"?

Providing locations in 6 figure coordinate tables is totally unacceptable to the citizen as he/she without difficulty cannot assess such distances & they are used to take advantage of the Citizen. Using such tactics gives rise to questioning of all data.



Turbine No.	Easting Coordinate	Difference	Square	Northing Coordinate	Difference	Square	Sum of Squares	Sq root of sum of squares = Separation distance
1	555297			747613				
2	555608	311	96721	748030	417	173889	270610	T1 to T2 = 520.2m
3	555563	-45	2025	748640	610	372100	374125	T2 TO T3 = 611.7m
4	556167	604	364816	748591	-49	2401	367217	T3 to T4 = 606.0m
5	556198	31	961	749183	592	350464	351425	T4 to T5 = 592.8m
6	555648	-550	302500	749699	516	266256	568756	T5 to T6 = 754.2m
7	555568	-80	6400	750508	809	654481	660881	T6 to T7 = 812.9m
8	556986	1418	2010724	749348	-1160	1345600	3356324	T7 to T8 = 1832m
9	556813	-173	29929	749855	507	257049	286978	T8 to T9 = 535.7m
3	555563			748640				
5	556198	635	403225	749183	543	294849	698074	T3 to T5 = 835.5m
3	555563			748640				
6	555648	85	7225	749699	1059	1121481	1128706	T3 to T6 = 1062.4m
5	556198			749183				
8	556986	788	620944	749348	165	27225	648169	T5 to T8 = 805.1m

The proposed wind turbines to be installed on the Proposed Wind Farm site will have the following dimension range:

- Turbine Tip Height – 180 metres
- Hub Height – Maximum height 105 metres, Minimum height 99 metres
- Rotor Diameter:- Maximum diameter 162 metre, Minimum diameter 150 metres

The Proposed Wind Farm would have a **combined generating capacity** of between 54 to 64.8 MW. For the purposes of this EIAR, a rated generating capacity of 7 MW has been chosen to calculate the potential capacity of the proposed 9-turbine renewable energy development, which would result in an estimated installed capacity of 63 MW.

Response: Potential capacity is not output.

The Proposed Wind Farm site makes use of the existing road network insofar as possible. It is proposed to upgrade approx. 1.25km of existing site roads and tracks, and to construct approx. 9.3km of new access roads. The excavation of peat and spoil and founding of access roads on competent stratum (below the peat) for new access roads will be carried out at various locations on the Proposed Wind Farm site. **Floating tracks** are also proposed to minimise the impact on the peat, particularly peat hydrology.

The electricity and fibre-optic cabling connecting to the onsite substation compound will be run in cable ducts approx. 1.2 metres beneath ground level, along the sides of roadways or under the roadways.

Tree felling will be required within and around Proposed Wind Farm infrastructure footprint to allow for the construction of the turbine bases, access roads underground cabling, and the other ancillary infrastructure. In addition to the commercial forestry felling, segments of hedgerows will require removal to facilitate the construction of wind farms roads and ancillary infrastructure, and to achieve the required bat foraging buffers from the proposed turbines. It is intended to construct a 110kV electricity substation within the Site. Access to the proposed onsite 110kV substation will be via the operational site access points along an existing local track. Upon decommissioning of the Proposed Wind Farm, the 110kV substation will remain in situ and form part of the national grid infrastructure. **Two substation control buildings will be located within the substation compound. A battery-based energy storage system (BESS) will be located adjacent to the 110kV substation compound.**

Response: This application does not include a battery based energy storage system.

It is intended to connect the onsite 110kV substation to the existing 110kV Cloon substation in the townland of Cloonascragh, Co. Galway via 110kV underground electrical cabling. The underground electrical cabling route is approx. 20.9km in length and located primarily within the public road corridor, with approx. 2.6km located within the Proposed Wind Farm site.

The construction of the Proposed Wind Farm will require the excavation of peat and spoil. It is proposed to manage any excess overburden generated through construction activities locally within the Site, in identified 4 no. peat deposition areas and 5 no. spoil management areas. Peat excavation has been considered available for placement, reinstatement and re-use across the Proposed Wind Farm site and spoil volumes have also been considered as available for re-use in the construction of safety berms across the Proposed Wind Farm site. This provides enough capacity for the total volume of peat and spoil requiring management for the Proposed Wind Farm.

As part of the Proposed Project, a new site entrance will be constructed from the R332 regional road in the southwest of the Proposed Wind Farm site. This entrance will be used during the construction phase of the Proposed Project. On completion of the construction phase, this entrance will be reduced in size and gated for security and will only be used for the delivery of abnormal loads (i.e., turbine component replacement) if required. **Construction traffic will access the Proposed Wind Farm site via 2 no. proposed access junctions on either side of L6506 local road for crossing. No construction traffic will access the Proposed Wind Farm site or exit onto the L6506 via these access and egress points.**

The Proposed Wind Farm site will be accessible during the operational phase at 3 no. locations, which includes the upgrade of 1 no. existing access track running north from the L62312 local road and the construction of 2 no. new operational entrances at 2 no. locations along the L6301 local road within the centre of the Proposed Wind Farm site.

It is proposed that the large wind turbine components will be delivered from the Galway Port. After exiting the M17 at Junction 19 the turbine delivery vehicles will travel northeast for 12.7km along the N63 national road before turning north and traveling in a northwestern direction for along the R332 regional road. The turbines will continue straight on the R332 for approx. 2.1km before turning right into the Proposed Wind Farm site entrance. The proposed route will utilise the approx. 2.1km of new national secondary road along the N63 as proposed in the consented N63 Liss to Abbey Realignment Scheme (PI Ref: ABP 312877-22).

The **preliminary swept path analysis** indicates that a temporary track is required in a field west of the N63/R332 junction, in the townland of Slievegorm, in order to facilitate the movement of wind turbine vehicles through this junction. Upon the completion of the construction phase, the temporary road will be covered with a layer of topsoil and reseeded and will only be used again in the unlikely event that an oversized delivery was required for wind turbine maintenance purposes.

Response: Is there a secondary swept path analysis subsequent to the "preliminary swept path analysis" that has been excluded from this application?

It is estimated that the construction phase of the Proposed Project will take approx. **18-24 months** from commencement of civil works to the commissioning of the wind turbines. The construction phase can be broken down into three main overlapping phases 1) **civil engineering works- 10 months**, 2) **electrical works including grid connection works- 9-12 months**, and 3) **turbine erection and commissioning – 8 months**.

4.3.2.3 Battery Storage

A battery-based energy storage system (BESS) will be located adjacent to the 110kV substation compound. The BESS primarily consists of 15 no. steel containers and 6 no. power supply units assembled in rows at the development site. Prior to installing the steel containers, clearance of the site area, levelling of the ground surface and creation of a hard stand will be undertaken. These containers and the adjacent infrastructure house the batteries, inverters, transformers, fire suppression equipment and associated electrical components. The containers will be mounted onto concrete plinth foundations. The containers shall be spaced to allow airflow around the containers, feeding their climate control systems.

In addition to the modular steel containers, other components of the development include:

- A grid transformer within the electrical compound;
- Above ground cable junction boxes/ cabling cabinets and cable racks/steel trunking facilitating the necessary electrical connections between containers;
- Underground ducting and cabling;

Response: This Battery Energy Storage System is not included in the application.

Chapter 5: Population and Human Health

The Proposed Wind Farm is located within a rural, agricultural setting in east Galway, approximately 12km southeast of Tuam. The village of Brierfield is located approximately 1.3km south of the nearest proposed turbine, and the village of Moylough is located approximately 5.3km east of the nearest proposed turbine. The N63 National Road runs south of the Proposed Wind Farm site in a general northeast-southwest orientation entering the settlement of Abbeyknockmoy and then heading northeast towards Moylough, passing within 1.27km of the nearest proposed turbine.

Land use within the Site is predominately agricultural with some adjacent areas in the north of the Proposed Wind Farm occupied by active raised blanket bog. Land-use in the wider landscape comprises a mix of pastoral agriculture, peat bogs and low density residential. The Proposed Wind Farm site is accessed via local roads from the R332 Regional Road which travels in a southeastnorthwest direction between Tuam and the N63 National Road, Co. Galway and L6301 Local Road which transverses the Proposed Wind Farm site. The Proposed Wind Farm site itself is served by a number of existing agricultural roads and tracks.

There is currently no published credible scientific evidence to positively link wind turbines with adverse health effects.

The main publications supporting the view that there is no evidence of any direct link between wind turbines and health are summarised in Chapter 5. Similarly, there is insufficient evidence from the scientific literature discussed in Chapter 5 to credibly determine that there is the potential for a significant effect on property values in Ireland, or abroad, as a result of the Proposed Wind Farm and Proposed Grid Connection.

Response: This is absolute nonsense. The High Court in Ireland has determined that windfarm noise causes health issues. Similar Court cases in Australia confirm the same. The response from the HSE below is totally at odds with this situation. The HSE is the competent Public Health Body in Ireland.

Name NEHS (HSE) National Email Address : Andrew Sully, Senior Environmental Health Officer

Address National Business Services Unit, National Environmental Health 2nd Floor, Oak House, Millenium Park Naas, Co. Kildare W91 KDC2

Note National Environmental Health Submission

In relation to application File Number 2561003

Name Energy Ltd. Ballynisky Green

Address within the townlands of Ballynisky, Graigoor, Ballyegny More, Kilbradran, Ballysteen, Dunmoylan Carrons and Lisbane Co. Limerick

"The HSE is a statutory consultee under Article 28 of the Planning and Development Act 2000 (as amended) and has a remit to make observations on a planning application accompanied by an EIAR with regard to any likely significant effects on Public Health. The NEHS can make observations on any planning application as a statutory consultee.

The objective of any observations by the NEHS are to inform the Planning Authority on any likely significant effects on Public Health and give an opinion on any proposed mitigation to protect Public and Environmental Health. Any observations made are to inform and assist the decision making of the Planning Authority in the planning process. This submission is the observations and comments of the NEHS based on the submitted planning application and the accompanying Environmental Impact Assessment Report (EIAR). The NEHS does not carry out any independent environmental monitoring or validation of any measurements or data reproduced in an EIAR.

Criteria for Consideration of Likely Significant Effects on Public Health

The NEHS considers likely significant effects on Public Health as per the EPA issued National Guidance (known as the EIAR Guidance): **Guidelines on the information to be contained in Environmental Impact Assessment Reports, 2022** https://www.epa.ie/publications/monitoring--assessment/assessment/EIAR_Guidelines_2022_Web.pdf

The NEHS therefore considers likely significant effects within a population and Human Health context that uses a source – pathway- receptor model, based on emissions through environmental media and population exposure. The exposure of populations, if any, is then considered against recognised health protection criteria.

Whilst EIAR Guidance recognises the requirement to identify sensitive receptors within the assessment process, the Planning Authority should be clear that it is within a Population health approach.

A Population Health approach to the sensitivity of receptors would not consider individual specific sensitivity of a human receptor, but the sensitivity of the established land use or service provision.

For example, a school would be considered a sensitive receptor within a Population Health approach, but an individual student who was particularly sensitive to noise attending the school would not be specifically considered in the assessment criteria. But, a health care facility that provided services for people with recognised noise sensitivity would be considered in its entirety as a particular noise sensitive location.

The Population Health approach therefore has important differences in how likely significant effects on Population and Human Health are considered in EIA. The assessment should consider established land development and use and service provision and activities within communities and not individual members of communities.

It is recommended that the Planning Authority also follows this method when consider Public Health in their decision making.

Project Specific Guidance for Wind Energy Development

The current Guidelines for Wind Energy Development are: *Wind Energy Development Guidelines (2006)* <https://www.gov.ie/en/publication/ff449e-wind-energy-development-guidelines-2006/>

It is recognised that the nature of wind energy development has significantly changed since the publication of these Guidelines. Particularly the size of the turbines and the proximity to centres of populations and the cumulative effects with other wind energy development. There has also been substantial increases in the body of knowledge around the likely significant effects of the operation of wind farm development on Population Health, in particular around the characteristic of the noise emissions and health effects of shadow flicker.

A revision of the 2006 GWED commenced in 2013 and Draft Revised Wind Energy Development Guidelines were issued in December 2019. <https://www.gov.ie/en/publication/9d0f66-draft-revisedwind-energy-development-guidelines-december-2019/> These are yet to be adopted.

The Revised WEDG 2013 states ‘the revised guidelines will provide greater consistency of approach in planning for onshore wind energy development, as well as providing greater certainty and clarity to the planning system, to the wind industry and to local communities

The NEHS is aware of the High Court decision in **Webster/Rollo V Meenaclogher (Wind) Limited (2024 IEHC 136) 8th March 2024**, and details of the judgement. The judgement that the noise from the wind farm was a Private Nuisance is a predominately health based assessment, in that the elements that were deemed to create the nuisance were directly related to health effects on the complainants. It is the understanding of the NEHS that assessment of compliance with health protection conditions set in the consent process was not a material consideration in the judgement.

The judge did state that she could consider nuisance irrespective of any compliance with consent conditions, particularly in the absence of up to date national Policy and Guidance in the area. The Judgement also states the revised Draft Guidance has been withdrawn. There is no public indication this is the case. It is still on the Department’s website as of the date of this submission.

Nuisance from noise is fundamentally a subjective assessment based on 'reasonable' perception and reaction of the effects of the noise exposure. This perception and reaction depends on situational specific conditions and land use. This was recognised in the Judgement after 51 days of evidence and consideration of the specific facts. It also the understanding of the NEHS that the Judgement did not make an order as to the level or characteristic of the noise that would abate the nuisance.

*If the Planning Authority are now considering that they are under a duty to incorporate the likelihood of a Private Nuisance into their decision making, then they should consider the judgement in **Webster/Rollo V Meenaclogher (Wind) Limited (2024 IEHC 136) 8th March 2024**. This judgement identified, in the absence of Irish Guidance, the usefulness of UK Guidance in the investigation of wind farm noise as a statutory nuisance. This is, of course, a reactionary methodology where specific noise exposure is known and not a predictive methodology for the likelihood of a Private Nuisance. <https://assets.publishing.service.gov.uk/media/5a795184e5274a3864fd5f82/pb-13584-windfarmnoise-statutory-nuisance.pdf>*

Scoping of the EIA

The NEHS were requested to scope the EIA and a scoping submission was made ref ID5228. This is reported in the EIAR and the NEHS is satisfied that the areas included in our scoping submission have been included in the EIAR.

Chapter 5 Population and Human Health

The NEHS has considered chapter 5 of the EIAR. Consideration of Population and Human Health should be done in a proportionate manner that is specific to the proposed development and any likely significant effects the proposal might have on Population Health.

Observations of the NEHS

The main consideration for protection Population and Human Health is a source – pathway- receptor with regard to emissions into the environment during construction and operation of the proposed development.

Particularly:

- a) Any likely significant effect from exposure to noise during construction and operation*
- b) Any likely exposure to shadow flicker during operation,*
- c) Any likely significant reduction in air quality during construction, particularly dust emissions,*
- d) Protection of ground and surface water during construction activities from contamination with hydrocarbon spillages or sedimentary run off.*

Shadow Flicker

The NEHS welcomes the commitment to eliminate any shadow flicker that may occur as a result of the proposed development.

In the interest of the protection of public Health the proposed mitigation detailed in the EIAR to prevent any shadow flicker exposure at sensitive locations should be made a condition of any permission that may be granted for the proposed development.

Likely Significant Effects from Noise and Vibration (Chapter 11 of EIAR)

Chapter 11 identifies research papers around health and wind turbine development.

The following should be considered by the Planning Authority:

- a) The quoted research evidence is primarily into research on potential health impacts that are specifically attributable to the operation of a wind farm. Any conclusions on specific potential health impacts does not exclude potential impacts on health that are attributable to any large-scale development.*
- b) The conclusion that there are no reported or evidence base to support adverse health impacts from wind farm development is not accurate. Wind Farms have the potential to have adverse impacts on health during construction and operation as does any large-scale development in the environment.*
- c) There is a strong evidence base that post construction wind farms doe have the potential to cause health impacts, especially through noise disturbance, and this has been confirmed by recent Irish Court decisions. (referenced previously)*
- d) The NEHS recommends the Planning Authority consider the evidence quoted in the EIAR in the context of our previous recommendations in this submission, i.e. emissions into the environment and exposure of populations to the emissions and an evaluation against recognised health protection standards.*

The NEHS has considered Chapter 11 of the EIAR and makes the following observations:

a) The 2006 Guidelines include guidance on how to derive noise limits for daytime and nighttime periods, which can be summarised as: daytime limits take account of existing background noise levels and include a fixed limit of 45 dB, or background + 5 dB, whichever is the greater, except in low background noise environments where a fixed minimum limit in the range 35-40 dB should be considered.

b) This criteria is therefore that turbine noise at noise sensitive locations should not exceed for daytime periods: 40 dB(A) where background noise levels are below 30 dB; and,

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

c) This criteria can potentially see a predicted increase of up to 15 dB(A) change in the noise environment as compliant with the criteria. Any change in the noise environment of this magnitude is highly likely to cause complaints and/or nuisance. **BS 4142:2014+A1:2019**

Methods for rating and assessing industrial and commercial sound identifies an increase of 10 dB above existing rated noise levels will have a significant adverse impact and is highly likely to cause complaints.

d) The evaluation of significance of the effect is based on the most up to date scientific knowledge and data. The EIA process specifically requires the assessment to be 'the likely significant effects' and if the knowledge on an evaluation criteria for significance has developed since the publication of a guidance, then it is reasonable and correct to use the developed knowledge base in assessing the significance of any effect. This is particularly relevant to the protection of Public Health. Statutory Guidance issued under the Planning Development Act 2000 (as amended) has to be considered by the Planning Authority when making a decision, but it is not a consideration that precludes all other evidence and knowledge. In **Webster/Rollo V Meenaclogher (Wind) Limited (2024 IEHC 136) 8th March 2024** the Judgement supports this position, in that the judgement makes it clear that compliance with the current Planning Guidance does not preclude a private noise nuisance.

e) In the opinion of the NEHS, tabulation of the predicted change in the noise environment from the proposed development and the cumulative change in the original baseline noise environment before any wind farm development in the area is the most informative way of reporting the likely effect of operational noise in an EIAR.

f) The NEHS would consider the most appropriate criteria for assessing significance of the predicted noise would be consideration of the **ENVIRONMENTAL NOISE GUIDELINES for the European Region, 2018** The 2018 WHO Guidance set health protection levels from environmental noise.

<https://iris.who.int/bitstream/handle/10665/279952/9789289053563-eng.pdf?sequence=1>

g) Whilst section the EIAR does not accept the above position of the NEHS, the use of the 2006 Guidance with regards to noise exposure, and in particular the 'balance between development and protection of public health' stated in ETSU R-97 are resulting in a significant volume of complaints from communities exposed to noise from wind turbines post development. This position that the absolute noise exposure limits set in the 2006 Guidance do not necessarily protect Public Health in specific development situations is now supported by Judgements of the Irish Courts, as reference previously in this submission.

The above include low background levels and the adopted criteria for noise limits can be 'except in low background noise environments where a fixed minimum limit in the range 35- 40 dB should be considered', there is no rationale give as to why the higher level of 40 dB has been adopted.

a) The tabulated predicted noise exposure are in appendix 11E. These indicted predicted levels below the adopted criteria in the EIAR.

b) The predicted change in the noise environment has not been tabulated. This would be the most informative assessment when considering likely significant impacts on the noise sensitive locations.

Consideration of the predicted noise exposure from construction of the proposed development

The NEHS makes the following comments:

a) The NEHS is of the opinion that there is no requirement for additional noise mitigation measures during the construction phase providing those measures identified in the in Chapter 11 of the EIAR are implemented in full.

b) It is the opinion of the NEHS that conditioning hours of construction activity is an important element of the protection of Public Health. Particularly to prevent sleep disturbance. The recommended hours of construction are:

Monday to Friday 08.00 to 19.00

Saturday 09.00 to 14.00

No work on Sunday or Bank Holidays

Exceptionally work outside these hours at the express permission of the Planning Authority.

This recommendation is made in the interest of the protection of Public Health Construction and Environmental Management Plan (CEMP)

The NEHS has considered the draft CEMP in appendix 3D. Additional considerations in the interest of the protection of Public Health:

- a) All drinking water and water used for the preparation of food in the temporary construction compounds should meet the requirements of S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014,
- b) There should be no direct emission to ground or surface water of any foul waste water. All waste water should be contained and taken off site to a licensed treatment facility,
- c) Site drainage should ensure the protection of surface and ground water during the construction phase.
- d) The dust monitoring is a monthly average standard. Compliance with standard can incorporate short periods of very high levels of dust deposition followed by low levels and still be compliant. It is therefore important that dust minimisation is continually implemented and any complaints are investigated and responded to.

Chapter 16 – Schedule of Mitigation

The NEHS has considered the schedule of mitigation in chapter 16 in the context of the Protection of Public and Environmental Health, and in particular the protection of any drinking water sources and emissions into the environment that could have a significant effect on Population Health.

The NEHS has no additional observations on the proposed mitigation measures and considers there will be adequate protection of Public and Environmental Health during the construction phased if all mitigation measures identified are implemented in full.”

Chapter 5

5.1.4 Health and Safety

5.1.4.1 Health Impact Studies

1. 'Wind Turbine Syndrome – An independent review of the state of knowledge about the alleged health condition', Expert Panel on behalf of Renewable UK, July 2010
2. 'Wind Turbine Sound and Health Effects – An Expert Panel Review', American Wind Energy Association and Canadian Wind Energy Association, December 2009
3. A Rapid Review of the Evidence', Australian Government National Health and Medical Research Council (NHMRC) Wind Turbines & Health, July 2010
4. Position Statement on Health and Wind Turbines', Climate and Health Alliance, February 2012
5. Wind Turbine Health Impact Study -Report of Independent Expert Panel' – Massachusetts Departments of Environmental Protection and Public Health (2012)
6. Wind Turbines and Health, A Critical Review of the Scientific Literature, Massachusetts Institute of Technology (Journal of Occupational and Environmental Medicine Vol. 56, Number 11, November 2014)
7. Position Paper on Wind Turbines and Public Health: HSE Public Health Medicine Environment and Health Group, February 2017
8. Environmental Noise Guidelines for the European Region: World Health Organisation Regional Office for Europe, 2018.
9. 'The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive Health Adults' Woolcock Institute for Medical Research, New South Wales, Australia 2023

APPENDIX 5-1 WIND FARMS & HEALTH LITERATURE REVIEW, CHAPMAN 2015

2015 Summary of main conclusions reached in 25 reviews of the research literature on wind farms and health.

Compiled by Prof Simon Chapman, School of Public Health and Teresa Simonetti, Sydney University Medical School

simon.chapman@sydney.edu.au Updated 10 April 2015.

1. 2015 Council of Canadian Academies (2015). Understanding the evidence. Wind Turbine Noise.
2. 2014 Schmidt JH, Klokner M (2014) Health effects related to wind turbine noise exposure: a systematic review. PLoS ONE 9(12): e114183. doi:10.1371/journal.pone.0114183

3. 2014: McCunney RJ, Mundt KA, Colby WD, Dobie R, Kaliski K, Blais M. Wind turbines and health: a critical review of the scientific literature. *Journal of Occupational & Environmental Medicine* 2014; 56(11):pe108-130.
4. 2014: Knopper LD, Olson CA, McCallum LC, Whitfield Aslund ML, Berger RG, Souweine K, McDaniel M. Wind turbines and human health. *Frontiers in Public Health* 2014; 19 June
5. 2014: Arra I, Lynn H, Barker K, Ogbunike C, Regalado S. Systematic review 2013: association between wind turbines and human distress. *Cureus* 6(5): e183. doi:10.7759/cureus.183 [Note: this review is a very poor quality paper published in a non-indexed, pay-to-publish journal. A detailed critique of it can be found at the end of this file.]
6. 2014: National Health and Medical Research Council (Australia). University of Adelaide full report (296pp) and draft consultation report (26pp). Final Report (Feb 15 2015)
7. 2013: VTT Technical Research Centre of Finland. (in Finnish) – summary at end of document
8. 2013: Department of Health, Victoria (Australia) Wind farms, sound and health.
9. 2012: Massachusetts Department of Environmental Protection. Independent Expert Science Panel Releases Report on Potential Health Effects of Wind Turbines
10. 2012: Oregon Wind Energy Health Impact Assessment.
11. 2011: Fiumicelli D. Windfarm noise dose-response: a literature review. *Acoustics Bulletin* 2011; Nov/Dec:26-34 [copies available from simon.chapman@sydney.edu.au]
12. 2011: Bolin K et al. Infrasound and low frequency noise from wind turbines: exposure and health effects. *Environmental Res Let* 2011;
13. 2010: Knopper LD, Ollsén CA. Health effects and wind turbines: a review of the literature. *Environmental Health* 2010; 10:78
14. 2010: UK Health Protection Agency Report on the health effects of infrasound
15. 2010: NHMRC (Australia) Rapid Review of the evidence
16. 2010: Chief Medical Officer of Health in Ontario
17. 2010: UK Health Protection Agency. Environmental noise and health in the UK. A report by the Ad Hoc Expert Group on Noise and Health. (this report is about all environmental noise)
18. 2009: Minnesota Department of Health. Environmental Health Division. Public Health Impacts of Wind Turbines.
19. 2009: Colby et al. Wind Turbine Sound and Health Effects: An Expert Panel Review.
20. 2008: Chatham-Kent Public Health Unit.
21. 2007: National Research Council (USA): Impact of wind energy development on humans (Chapter 4: pp97-120) of: *Environmental Impacts of Wind-Energy Projects*.
22. 2006: Context and Opinion Related to the Health Effects of Noise Generated by Wind Turbines, Agence Française de Sécurité Sanitaire de l'Environnement et du Travail(Affset), 2006. (in French only)
23. 2005: Jakobsen J. Infrasound emission from wind turbines. *J Low Frequency Noise, Vibration and Active Control* 2005; 24(3):145-155
24. 2004: Leventhall G. Low frequency noise and annoyance. *Noise & Health* 2004;6(23):59-72
25. 2003: Eja Pedersen's Review for the Swedish EPA

Response: These references are historic & for the most part are 10-years old. The size of wind turbines in that period were a lot smaller & the medical advances were not at the present levels. The Irish High Court has determined that health issues & property losses are caused by windfarms.

The following Response is from the Australian Parliament in a reference to Health issues from windfarms.Select Committee on Wind Turbines: Final report. August 2015. ISBN 978-1-76010-260-9

Wind turbines and ill-health

2.7 The committee has taken evidence from a number of people who reside in proximity to wind turbines who have complained of a range of adverse health impacts. These include tinnitus, raised blood pressure, heart palpitations, tachycardia, stress, anxiety, vertigo, dizziness, nausea, blurred vision, fatigue, cognitive dysfunction, headaches, nausea, ear pressure, exacerbated migraine disorders, motion sensitivity, inner ear damage and worst of all, sleep deprivation.

2.8 Dr Sarah Laurie told the committee:

The human cost of the failure to protect people from excessive noise pollution, especially at night, is terrible. I have personally helped to prevent a number of suicides of people who were utterly desperate because of the consequences of excessive noise pollution and who reached out for help.

From my experience there is a subset of people who are terribly impacted very early on. Those people are the ones who tend to present with acute vestibular disorder type of symptoms—dizziness and motion sickness, which can be accompanied by extreme anxiety. Those people often just cannot last very long, and they move if they can.

2.9 Ms Janet Hetherington, an adjacent landholder to the Macarthur wind farm in south-west Victoria, relayed her own experience:

At my farm, I experience severe adverse health effects such as vibration, heart palpitations, tinnitus, head pressure, headaches, sleep deprivation, anxiety, night sweats, nausea, itchy skin, cramps, and ear, nose and throat pain. Twice now I have experienced horrendous pain in my chest stabbing through to my backbone in between my shoulder blades. I contemplated calling an ambulance both times but could not move to do so because of the severity of the pain. Ten minutes later it had dissipated, leaving me with great stress and anxiety and feeling washed out. All these sensations leave me drained in the morning. I find it very hard to start work that day.

2.10 Ms Anne Gardner also attributed her and her husband's ill health to the nearby Macarthur wind farm. She described the following symptoms:

My husband experienced bolts of pressure which tallied up with pressure peaks measured by Les Houston (sic) 86 per cent of the time while my husband was blind to the acoustic measurements of the time. Refer to his recap statement. I suffer day and night from headaches, nose and ear pressure, nausea, heart palpitations and chest burning from vibrations through the floor, couch, chair and in bed all night.⁶

2.11 Mr Clive Gare and his wife host 19 towers from the North Brown Hill wind farm located 17 kilometres from Jamestown in South Australia. Mr Gare told the committee:

After a short period of living with an operating wind farm, we had these products installed. I find that, because I work and reside in close proximity to the wind farm, I suffer sleep interruption, mild headaches, agitation and a general feeling of unease; however, this occurs only when the towers are turning, depending on the wind direction and wind strength. My occupation requires that I work amongst the wind towers during the day which means I suffer the full impacts of noise for days at a time without relief. The impacts are that we are not able to open our windows because of the noise at night and we are not able to entertain outside because of the noise.

In conclusion, if we did not have soundproof batts in VLam Hush windows (special window laminate designed to dampen noise), our house would not be habitable. In my opinion, towers should not be within five kilometres of residences, and I would personally not buy a house within 20 kilometres of a wind farm.

2.12 The committee notes that the Gares have received payment of \$2 million over five years to host turbines and have reported serious adverse impacts. The committee notes, therefore, that their evidence is an 'admission against interest' and as such represents highly reliable evidence.

2.13 Mr John Pollard, a resident of Glenthompson near the Oaklands Hill wind farm in Victoria, told the committee:

The wind farm guidelines on health issues of this very serious problem have to be assessed. They will not acknowledge infrasound. I will relate one incident that happened in our home one night. My wife was sleeping in the chair beside me and I was watching television. This is after they had turned the turbines off. She was dead to the world and I was just watching the television. All of a sudden she woke up, completely startled and disorientated, and I was really worried about her because I thought she had had a stroke or something. Eventually she came to her senses and she said the turbines must be on. I said, 'No, they're not. It's 10.30. They turn off at nine o'clock.' I went outside and they were still running. So I thought that next day I would ring AGL. When I was about to ring, they rang me and said, 'I'm sorry, John. We forgot to turn the turbines off last night.'

2.14 Waubra resident Mr Donald Thomas identified hearing difficulties from the nearby Waubra wind farm turbines.⁹ He claimed that these difficulties disappeared when he left the area:

I went to the doctor with what I kept saying was a lot of ear pressure and earaches. I went to see a specialist, and my ears came back as being in good health and functioning pretty well, even though I have lost a lot of hearing. Basically, my left ear does not work too good... My ears—especially when I go to my Stud Farm Road property, I have ear pressure that can develop into a headache and rapid heartbeat. If I leave that area and go back to one of my other properties, that can settle back down.

2.15 Mr Peter Jelbart, a 25 year old who had lived with his family nearby the Macarthur wind farm in south-west Victoria, noted the difficulty of sleeping in the family home. He told the committee he had worked and slept unaffected in noisy environments outside of the family home in Victoria:

While I was working in Western Australia I used to do three weeks on, one week off and come home for a week. Over in Western Australia I was sleeping at times on the sides of busy highways and in the back of trucks with ice packs running... At home, I noticed pretty much from day one that there is a serious problem there. Something is completely different when sleeping. I would wake up after a couple of hours of sleep—at times, not even after a couple of hours—and have disrupted sleep that I have had nowhere else. There is a proper problem... Whether it is low-frequency noise and the infrasound combining with it, it seems worse when it is quiet. Around our house the yard is pretty well protected by trees. When it is relatively quiet around the house yard there is still a really soft drone that comes through and just gets into you. It is pretty hard to explain. There are probably a lot of people going through the same thing who will have the same trouble trying to explain it, especially to people who have not experienced it. The problem with it is, it also seems to affect different people over different periods of time.¹¹

2.16 The committee has had the opportunity to take evidence from researchers in the United States and Canada who expressed their concern with the health effects of turbines. Ms Lilli-Ann Green is the Chief Executive Officer of a healthcare consulting firm in the United States. In 2012, Ms Green and her husband conducted interviews with people living near wind turbines in 15 different countries. As she told the committee: We have interviewed people on three continents who live more than five miles from the nearest wind turbine and are sick since wind turbine wind turbines need to be sited from people in order to do no harm. People report to us that over time their symptoms become more severe. Many report not experiencing ill effects for some time following wind turbine construction, meanwhile their spouse became ill the day the wind turbines nearby became operational. They speak of thinking they were one of the lucky ones at first, but after a number of months or years they become as ill as their spouse. Not one person who stayed near wind turbines reported to us that they got used to it or got better; they all became more ill over time... I really believe that we just do not have enough information yet. But throughout the interviews, country by country, people described the same symptoms. Many times they used the same phrases to describe them and the same gestures—and they were not speaking English. There is a common thread here.

2.17 Dr Jay Tibbetts, a medical practitioner and vice chair of the Brown County Board of Health in Wisconsin, drew the committee's attention to the board's October 2013 finding that the Shirley wind farm was a 'human health hazard'. Dr Tibbetts described how the declaration came about:

The [Board of Health] has been studying adverse health effects for the past 4 ½ years in the Shirley Wind Project. We have reviewed many peer reviewed studies, at least 50 medical complaints including ear pain, pressure, headache, tinnitus, vertigo, nausea, chest pain, chest pressure, loss of concentration, sleep deprivation and more, as well as more than 80 other complaints from citizens of Shirley Wind. There have been 2 formal studies of infrasound/low frequency noise by acousticians in 2012 and 2014. The latter study revealed symptom generating [Infrasound/Low Frequency Noise] at a distance of 4 ½ [miles].

2.18 The committee also heard of detailed research by Professor Emeritus Robert McMurtry from Western University in Ontario, Canada. Professor McMurtry made a number of points to the committee:

- adverse health effects have been reported globally in the environs of wind turbines for more than 30 years with the old design of turbines and the new;
- the wind energy industry has denied adverse health effects, preferring to call it 'annoyance'. Annoyance is recognised and was treated by the World Health Organization as an adverse health effect, which is a risk factor for serious chronic disease including cardiovascular and cancer;
- the regulations surrounding noise exposure are based upon out-of-date standards ETSU-97, which fail to evaluate infrasound and low-frequency

Professor Chapman and his critics

2.19 Professor Simon Chapman AO, Professor of Public Health at the University of Sydney, has been an outspoken critic of those who suffer ill-effects from wind turbines. In both his written and oral submissions, **Professor Chapman cited many of his own publications in support for his view that:**

...the phenomenon of people claiming to be adversely affected by exposure to wind turbines is best understood as a communicated disease that exhibits many signs of the classic psychosocial and nocebo phenomenon where negative expectations can translate into symptoms of tension and anxiety.

2.20 Several highly qualified and very experienced professionals have challenged this argument. Dr Malcolm Swinbanks, an acoustical engineer based in the United Kingdom, reasoned:

The argument that adverse health reactions are the result of nocebo effects, ie a directly anticipated adverse reaction, completely fails to consider the many cases where communities have initially welcomed the introduction of wind turbines, believing them to represent a clean, benign form of low-cost energy generation. It is only after the wind-turbines are commissioned, that residents start to experience directly the adverse nature of the health problems that they can induce.

2.21 The committee highlights the fact that Professor Chapman is not a qualified, registered nor experienced medical practitioner, psychiatrist, psychologist, acoustician, audiologist, physicist or engineer. Accordingly:

- he has not medically assessed a single person suffering adverse health impacts from wind turbines;**
- his research work has been mainly—and perhaps solely—from an academic perspective without field studies;**
- his views have been heavily criticised by several independent medical and acoustic experts in the international community; and**
- many of his assertions do not withstand fact check analyses.**

2.22 Professor Chapman has made several claims which are contrary to the evidence gathered by this committee. First, he argues that the majority of Australia's wind turbines have never received a single complaint. There are various problems with this statement:

(i) wind turbines located significant distances from residents will not generate complaints;

(ii) many residents suffering adverse health effects were not aware of any nexus between their health and the impact of wind turbines in order to make a complaint;

(iii) just because residents do not lodge a formal complaint does not mean they are not suffering adverse health effects;

(iv) data obtained by Professor Chapman from wind farm operators of the numbers of complaints lodged cannot be relied upon; and

(v) the use of non-disclosure clauses and 'good neighbour agreements' legally restricts people from making adverse public statements or complaints.

2.23 Second, Professor Chapman has argued that complaints of adverse health effects from wind turbines tend to be limited to Anglophone nations. However, the committee has received written and oral evidence from several sources directly contradicting this view. The German Medical Assembly recently submitted a motion to the executive board of the German Medical Association calling for the German government to provide the necessary funding to research adverse health effects. This would not have happened in the absence of community concern. Moreover, Dr Bruce Rapley has argued that in terms of the limited number—and concentrated nature—of wind farm complaints:

It is the reporting which is largely at fault. The fact is that people are affected by this, and the numbers are in the thousands. I only have to look at the emails that cross my desk from all over the world. I get bombarded from the UK, Ireland, France, Canada, the United States, Australia, Germany. There are tonnes of these things out there but, because the system does not understand the problem, nor does it have a strategy, many of those complaints go unlisted.

2.24 Third, Professor Chapman has queried that if turbines are said to have acute, immediate effects on some people, why were there no such reports until recent years given that wind turbines have operated in different parts of the world for over 25 years. Several submissions to the committee have stated that adverse health effects from wind turbines do not necessarily have an acute immediate effect and can take time to manifest.

2.25 Fourth, Professor Chapman contests that people report symptoms from even micro-turbines. The committee heard evidence that once people are sensitised to low frequency infrasound, they can be affected by a range of noise sources, including large fans used in underground coal mines, coal fired power stations, gas fired power stations and even small wind turbines. As acoustician Dr Bob Thorne told the committee:

Low-frequency noise from large fans is a well-known and well-published issue, and wind turbines are simply large fans on top of a big pole; no more, no less. They have the same sort of physical characteristics; it is just that they have some fairly unique characteristics as well. But annoyance from low-frequency sound especially is very well known.

2.26 Fifth, Professor Chapman contends that there are apparently only two known examples anywhere in the world of wind turbine hosts complaining about the turbines on their land. However, there have been several Australian wind turbine hosts who have made submissions to this inquiry complaining of adverse health effects.

Paragraphs 2.11–2.12 (above) noted the example of Mr Clive Gare and his wife from Jamestown. Submitters have also directed attention to the international experience.

In Texas in 2014, twenty-three hosts sued two wind farm companies despite the fact that they stood to gain more than \$50 million between them in revenue. The committee also makes the point that contractual non-disclosure clauses and 'good neighbour' agreements have significantly limited hosts from speaking out. This was a prominent theme of many submissions.

2.27 Sixth, Professor Chapman claims that there has been no case series or even single case studies of so-called wind turbine syndrome published in any reputable medical journal. But Professor Chapman does not define 'reputable medical journal' nor does he explain why the category of journals is limited to medical (as distinct, for assertion. However, the committee does note that a decision to publish – or not to publish – an article in a journal is ultimately a business decision of the publisher: it does not necessarily reflect the quality of the article being submitted, nor an acknowledgment of the existence or otherwise of prevailing circumstances. The committee also notes that there exist considerable published and publicly available reports into adverse health effects from wind turbines.

2.28 The committee also notes that a peer reviewed case series crossover study involving 38 people was published in the form of a book by American paediatrician Dr Nina Pierpont, PhD, MD. Dr Pierpont's *Report for Clinicians* and the raw case data was submitted by her to a previous Australian Senate inquiry (2011) to which Dr Pierpont also provided oral testimony. Further, at a workshop conducted by the NHMRC in June 2011, acoustical consultant Dr Geoffrey Leventhall stated that the symptoms of 'wind turbine syndrome' (as identified by Dr Pierpont), and what he and other acousticians refer to as 'noise annoyance', were the same. Dr Leventhall has also acknowledged Dr Pierpont's peer reviewed work in identifying susceptibility or risk factors for developing wind turbine syndrome / 'noise annoyance'. Whilst Dr Leventhall is critical of some aspects of Dr Pierpont's research, he does state:

Pierpont has made one genuine contribution to the science of environmental noise, by showing that a proportion of those affected have underlying medical conditions, which act to increase their susceptibility.³⁰

2.29 Seventh, Professor Chapman claims that no medical practitioner has come forward with a submission to any committee in Australia about having diagnosed disease caused by a wind farm. Again, Professor Chapman fails to define 'disease'.

Nonetheless, both this committee, and inquiries undertaken by two Senate Standing Committees, have received oral and written evidence from medical practitioners contrary to Professor Chapman's claim.

2.30 Eighth, Professor Chapman claims that there is not a single example of an accredited acoustics, medical or environmental association which has given any credence to direct harmful effects of wind turbines. The committee notes that the semantic distinction between 'direct' and 'indirect' effects is not helpful. Dr Leventhall and the NHMRC describe stress, anxiety and sleep deprivation as 'indirect' effects, but these ailments nonetheless affect residents' health.

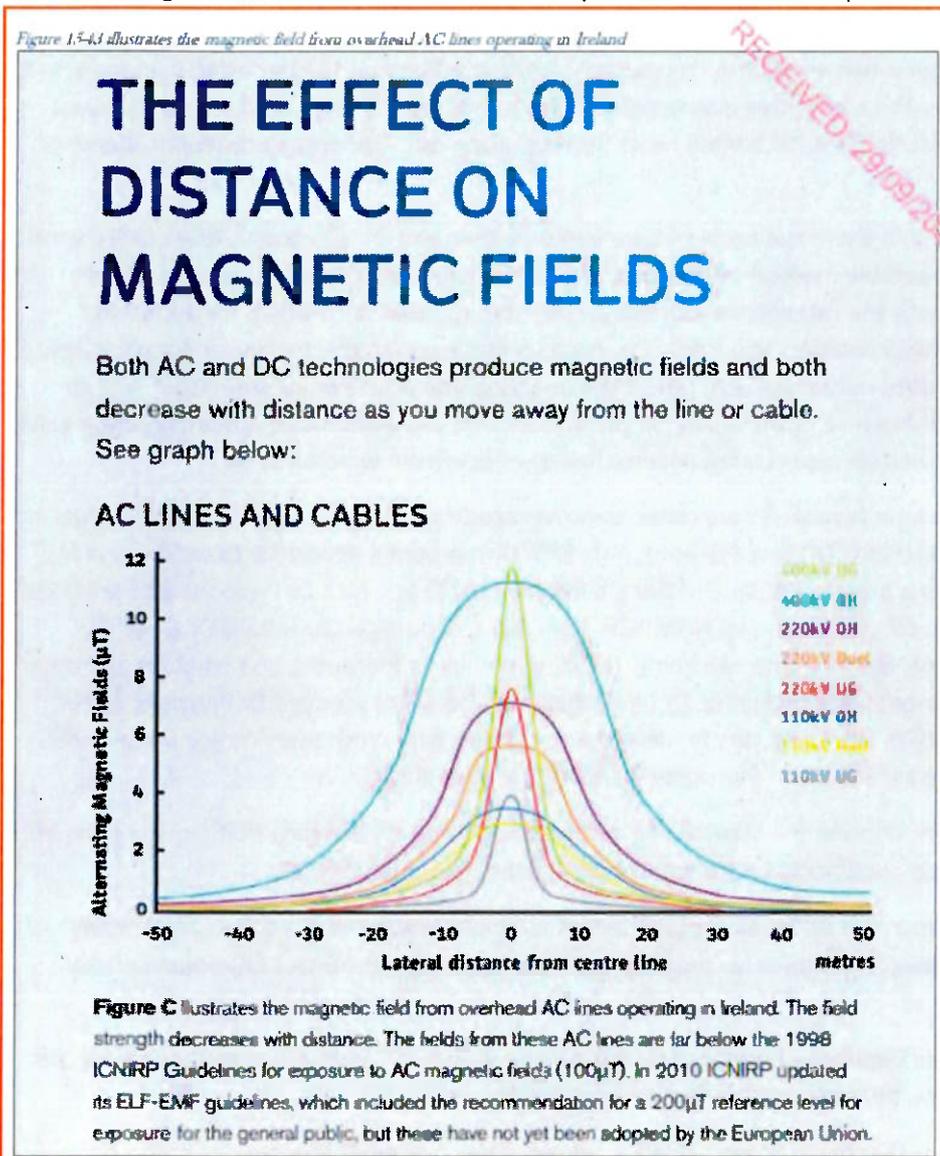
2.31 Finally, Professor Chapman queries why there has never been a complainant that has succeeded in a common-law suit for negligence against a wind farm operator.

This statement is simply incorrect. The committee is aware of court judgements against wind farm operators, operators making out of court settlements or withdrawing from proceedings, injunctions or shutdown orders being granted against operators, and properties adjacent to wind turbines being purchased by operators to avoid future conflict. The committee also reiterates its earlier point that contractual non-disclosure clauses have discouraged legal action by victims.

5.1.4.3 Electromagnetic Interference

The provision of underground electric cables of the capacity proposed is common practice throughout the country and installation to the required specification does not give rise to any specific health concerns.

The extremely low frequency (ELF) electric and magnetic fields (EMF) associated with the operation of the proposed cables fully comply with the international guidelines for ELF-EMF set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a formal advisory agency to the World Health Organisation, as well as the EU guidelines for human exposure to EMF. Accordingly, there will be no operational impact on properties (residential or other uses) as the ICNIRP guidelines will not be exceeded at any distances even directly above the cables.



Response The laying of 110kv cable on a narrow Local road will affect existing houses close to the roadway within the 20m risk area.

Table 5.6 Farm Size and Classification within the Study Area in 2020 (Source: CSO)

Electoral Division	No of holdings	Average size (hectares)	Median age of holder	Livestock units	Total Cereals (hectares)	Average farmed (hectares)
Cooloo	84	33.2	58	4938	44.3	2790
Hillsbrook	75	22.8	63	2583	0	1713
Moyne	69	18.6	63	1770	0	1284
Total	228	24.9	61	9291	44.3	1929

Response: Note the 228 Farm holdings in the study area. All of them would be affected by Wake losses due to Climatic temperature drop of 3^oCentigrade. Consent is required from each of them under Constitutional Property Rights.

5.6 Property Values

5.6.1 Property Values and Wind Farms

- In 2023 CERIS published a working paper entitled 'Wind Turbines and House Prices Along the West of Ireland: A Hedonic Pricing Approach'.²⁶ This paper looked at wind turbine developments in Donegal, Leitrim, Sligo, Mayo, Galway, Kerry and Cork and associated property values. This working paper utilised satellite imagery to identify individual turbines and sourced its housing data from www.daft.ie; while the published price on Daft is not equivalent to the final agreed sale price, it was assumed that the listing and transaction prices are correlated. The findings of this research revealed a potential decrease in property values of -14.7% within a 0-1km radius of a wind turbine.
 - One of the largest studies of the impact of wind farms on property values has been carried out in the United States. 'The Impact of Wind Power Projects on Residential Property Values in the United States: A multi-Site Hedonic Analysis', December 2009, was carried out by the Lawrence Berkley National Laboratory (LBNL) for the U.S Department of Energy...
 - A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States", in August 2013
 - In September 2023, the Energy Policy Journal published 'Commercial wind turbines and residential home values: new evidence from the universe of land-based wind projects in the United States
 - The Effect of Wind Farms on House Prices. Centre for Economics and Business Research (Cebr) in March 2014
 - Impact of wind Turbines on House Prices in Scotland' (2016) was published by Climate Exchange.
- APPENDIX 5-2 IMPACT OF WIND TURBINES ON HOUSE PRICES IN SCOTLAND – CLIMATE EXCHANGE (2016)**
 Impact of wind turbines on house prices in Scotland Dr Stephan Heblich, Dr Dan Olnet, Prof Gwilym Pryce and Prof Chris Timmins With research assistance from Dr Ellie Bates and Dr Tim Birabi. October 2016

The literature described above demonstrates that there is insufficient evidence from the scientific literature and studies conducted to determine that there is the potential for a significant effect on property values as a result of the Proposed Wind Farm.

Response: This statement is untrue. There are many scientific reports in addition to the Ceres Report for the West of Ireland. All of the ones that are referenced are historic & relate to far smaller wind turbines with different population densities/landscape areas in different climates.

However, the following are available and we question the Applicant's statement that there is insufficient evidence from the scientific literature. We found other similar reports that reflected the same scale of property losses.

- 1) Property Value Impacts Of Onshore Wind Energy In New England: The Importance Of Spatial Heterogeneity And Temporal Dynamics. Luran Dong, Vasundhara Gaur, and Corey Lang May 1, 2023.
<https://www.sciencedirect.com/science/article/pii/S0301421523002288>.
 4415c1dc347151814453eff145efd76e

“ We only estimate consistent negative price impacts for the region consisting of Cape Cod and Nantucket, MA, and the price impacts are much larger, ranging from -7.0% to -10.8%.”

“However, for Cape Cod and Nantucket, while price impacts do rebound some, they remain around -9% up to nine years post construction.”

- 2) The Effect of Wind Power Projects on Property Values: A Decade (2011–2021) of Hedonic Price Analysis, George Parsons and Martin D. Heintzelman (2022), International Review of Environmental and Resource Economics: Vol. 16: No. 1, pp 93-170. <http://dx.doi.org/10.1561/101.00000132>

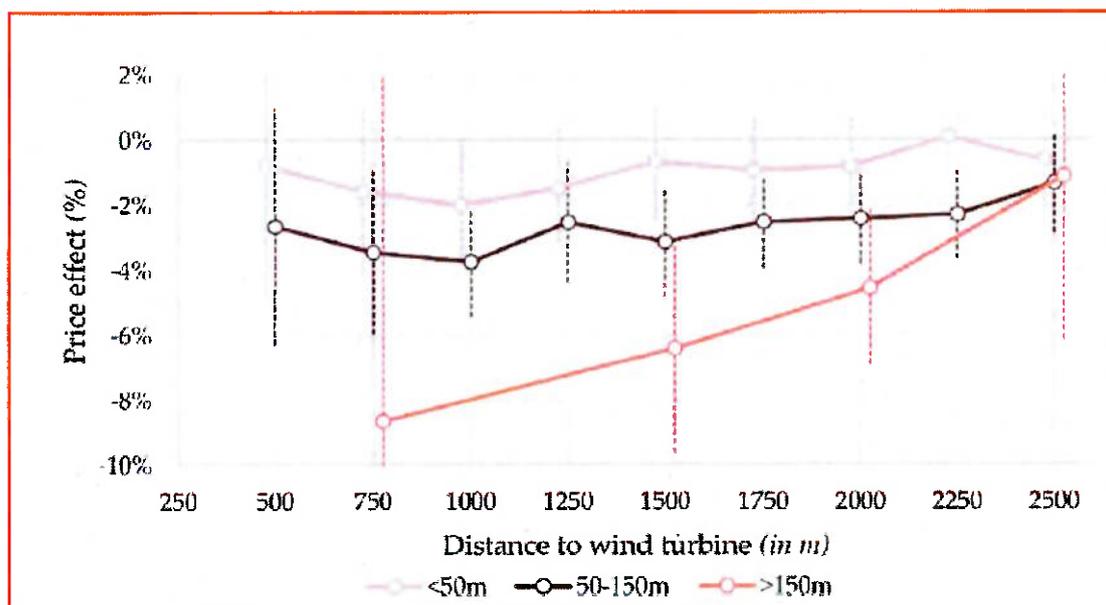
“This essay is a review of the hedonic price literature examining the effect of wind power projects on property values. It covers 18 core studies done from 2011 to 2021. The studies include applications in Europe (10) and North America (8).”

“The impacts are larger the closer a property is located to a wind power project. In 1 km increments, beginning with less than 1 km, the average impact on property values across all core studies is -5.0%, -4.0%, -2.6%, and -1.2%. In the <1km range 67% of the studies find net-negative effects. In the 3–4 km range, only 28% find net-negative effects and beyond 4km effects are uncommon or diminishingly small. “

- 3) Wind turbines, solar farms, and house prices. Martijn I. Droes , Hans R.A. Koster. Energy Policy 155 (2021) 112327 Science Direct. www.elsevier.com/locate/enpol

“This paper relies on detailed housing transactions data from the Netherlands between 1985 and 2019, which we combine with data on all wind turbines and solar farms that have been placed during this period. The Netherlands is typically seen as a fairly urbanized country and thus provides an ideal study area to examine the external effects of wind turbines and solar farms on house prices.

The results in this paper show that the construction of a wind turbine leads to a decrease in local house prices of 1.8%. In particular, we find that a turbine taller than 150m decreases prices within 2 km by 5.4%, while the effect of small turbines (<50m) is statistically indistinguishable from zero. Also, the effect of tall wind turbines does not extend much beyond 2 km, but we do find evidence that the impact radius is smaller (<1 km) for low wind turbines. Various additional robustness checks support the main findings. Regarding solar farms, we find that house prices decrease by about 2.6% after opening. The effect is confined to 1 km, so it is more localized than that of wind turbines”.



- 4) **Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States** Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman. *Energy Policy* 185 (2024) 113837. ScienceDirect. www.elsevier.com/locate/enpol

“We examine the impact of proximity to land-based commercial wind turbines on residential home values in the United States using data on the universe of commercial wind turbines and residential property transactions from 2005 to 2020. Using event study and difference-in-differences identification strategies we find that, on average, homes located within 1 mile of a commercial wind turbine experience approximately an 11% decline in value following the announcement of a new commercial wind energy project, relative to counterfactual homes located 3 to 5 miles away.”

5.7 Residential Amenity

There are 43 Sensitive Receptors located within 1 kilometre of the proposed turbine locations.

When considering the amenity of residents in the context of a Proposed Project, there are three main potential impacts of relevance: 1) Shadow Flicker, 2) Noise, and 3) Visual Amenity. Shadow flicker and noise are quantifiable aspects of residential amenity while visual amenity is more subjective.

- The predicted shadow flicker levels have been modelled for all 218 Sensitive Receptors located within 1.62km (10 x 162m rotor diameter) of the proposed turbine locations. The predicted shadow flicker model results indicate:
 - 47 Sensitive Receptors are theoretically predicted to experience zero shadow flicker;
 - 171 Sensitive Receptors are theoretically predicted to experience some shadow flicker;
 - Of the 218 Sensitive Receptors, 76 Sensitive Receptors are theoretically predicted to experience shadow flicker that exceeds the Guidelines (DoEHLG, 2006)

Response: Have each of these consented to the wake effect on their properties?

5.10.2.2.3 Land Use Patterns & Activities

Proposed Grid Connection

Proposed Mitigation Measures

The following measures will be adhered for the Proposed Project. Please refer to Chapter 18 Schedule of Mitigation and Monitoring Measures for a full list of measures.

The construction of the Proposed Grid Connection through the public road network will be undertaken in a rolling construction method with 100m of road constructed and back filled each day providing access in the evenings and night hours along the Proposed Grid Connection.

A Traffic Management Plan, agreed with the Local Authority, will be in place for the construction phase of the grid route.

Local access for residents living along the grid route will not be closed for the construction phase as there are alternative access roads into the area.

Response: The Application indicates road closures. 33km round trips are not alternative access roads.

Farm access into the Proposed Wind Farm site will be permitted as and when required.

APPENDIX 5-3 ADVICE ON WIND TURBINES AND HORSES – GUIDANCE FOR PLANNERS AND DEVELOPERS (BRITISH HORSE SOCIETY). 08/2015

ADVICE ON Wind Turbines and Horses – Guidance for Planners and Developers

Response: This document is not competent.

Response: Reference Number 9.1: Wind turbines and horse husbandry in France. Translated from french by : Karen DUFFY - Agata RZEKEĆ - Gwenaëlle GRANDCHAMP-RENARD

A wind turbine produces neither infectious nor chemical agents, but does produce physical phenomena. There are four types of physical effects :

- Acoustic vibration phenomena, i.e. audible sound and infrasounds produced by the movements of the blades and the electric generator.
- Ground vibrations.
- Electromagnetic fields resulting from converting the mechanical power of the wind to an electric current, and the transfer of this current.
- Parasitic electrical current, induced by the electromagnetic fields, but also linked to current leakage, to couplings between electrical and mechanical elements, and faulty earthing.

Horses are not as sensitive to infrasounds as humans, or even as cattle (Heffner and Heffner, 1983)

Scale of sound frequencies in several animal species and in humans (according to Heffner (1998))				
Animal species	Low frequency limit (Hz)	High frequency limit (Hz)	Ideal sensitivity (dB)	Ideal frequency (Hz)
Cattle	23	37 000	-11	8 000
Human	20	20 000	-10	4 000
Pigs	42	40 500	9	8 000
Horses	55	33 500	7	2 000
Cats	55	79 000	-10	8 000
Dogs	67	44 000	-1	8 000
Laboratory rats	530	70 500	0	8 000
Laboratory mice	900	79 000	5	15 000

The persistence of audible sounds does not appear to affect animal behaviour, unlike some people suffering from hyperacusis.

However, infrasound remains controversial in the equine sector. In an expert study conducted in Portugal, there was a suspicion of consequences on joint tissue in Lusitano horses (Branco *et al*, 2005). The results of this expert study have however not been confirmed by the Lisbon University veterinary thesis (Costa, Pereira e Curto 2012) which analysed the afore mentioned cases

Ground vibrations

Ground vibrations are produced by the wind turbine itself, like any building with foundations and wind. The transmission of vibrations through the ground depends on the nature and structure of the ground they go through. The mechanical waves through the ground, produced by wind turbines, are essentially surface vibrations (Saccorotti G. *et al*, 2011). There is very little data regarding the level of the vibrations for local residents, produced by wind turbines. The few studies conducted show that when further than 300 metres (Lubw, 2016) to 700 metres away from a wind turbine (internal study by Cerema), the vibrations merge into the background noise of the site (vibration speeds below 0,07mm/s).

Electromagnetic fields

The study of electromagnetic fields revolves around three themes:

- Behaviour and neurophysiology
- Zootechnical and sanitary impact
- Cellular and physiological impact

Behaviour and neurobiology

There is little information regarding perception of electromagnetic fields, and our knowledge is mainly related to wildlife. Likewise, there is no data as to whether electromagnetic fields produced by various structures (wind turbines, high voltage power lines...) have an influence on perception. There are no effects noted on the behaviour of farm animals, only on laboratory animals (rats and mice).

Zootechnical and sanitary impact

With regard to cattle, the results of experiments conducted in the field differ from those of experiments in a controlled environment. In an experimental environment, a decrease in the quantity of milk produced and in the percentage of fat was noticeable, as was an increase in the quantity of feed ingested. The field studies showed no changes.

With regard to poultry, electromagnetic fields presented a teratogenic effect (affecting the embryo, and causing malformation) with a window effect (non-linear effect, i.e. the negative effect of electromagnetic fields is lesser for the weaker and the stronger fields).

Cellular and physiological impact

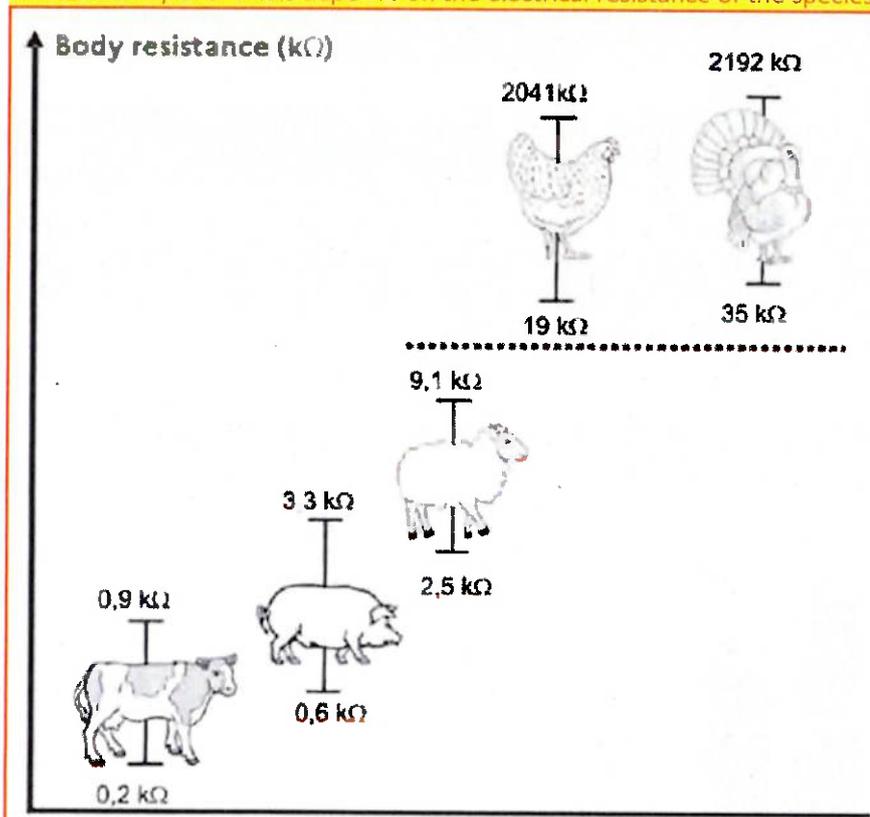
Studies conducted *in vitro* show a genotoxic effect (capacity to compromise the structure or the functioning of the genome) of electromagnetic fields. Moreover, these fields amplify the action of chemical products which have an effect on DNA. Cells submitted to electromagnetic fields are more sensitive to oxidative stress, i.e. there is a higher count of DNA lesions, therefore more frequent cell death. Electromagnetic fields also have an effect on the circadian cycle («the internal clock» of an organism) by modifying the release patterns of melatonin, or through other mechanisms yet to be discovered. However, electromagnetic fields have no effect on immunity and physiological stress (ways in which the organism copes with real or presumed aggression).

Parasitic current

Parasitic current is derived either from electromagnetic fields, or from electrical current (cables...). Parasitic currents can cause different types of voltage :

- **Contact voltage** (contact with a metallic element such as a drinking trough) \Rightarrow the current goes through the animal and back to earth through the legs.
- **Pace voltage** \Rightarrow Current goes from the front legs to the rear legs.

The sensitivity of animals depends on the electrical resistance of the species, of the individual and on living conditions.



Animals are more sensitive than humans. Parasitic currents cause pain, leading to physiological stress which can modify behaviour (avoidance, refusing to drink, memory and training issues...) and the state of health (weight loss, decrease in immunity, higher risk of gastric ulcers and colic, genetic alterations in the long term...). An animal's sensitivity to parasitic current can be increased due to its living conditions.

A horse stabled in a building with a lot of metallic structures and/or in a box with damp bedding, is more at risk of being a conductor of parasitic current.

To summarize

Wind turbines produce sounds and infrasound, vibrations, electromagnetic fields and parasitic current

To date, only parasitic currents are a real issue for horses, but vigilance is required nevertheless, due to our lack of knowledge.

Reference 9.2: Racehorses & Stud farms

Renewable Energy Developments have to be balanced with equine facilities & this requires informed policy frameworks. Recent statements from Planning Authorities indicate the growing tension between renewable energy expansion and the protection of rural sensitive agricultural sectors, which includes racehorses & stud farms. Thoroughbred horses, horse racing & the industry itself are an integral part of our national identity. Ireland is recognised as the world horse industry leader. Ireland is the third largest producer of thoroughbred foals in the world. Only the USA & Australia have more foal births. Ireland exceeds the combined totals of the UK & France.

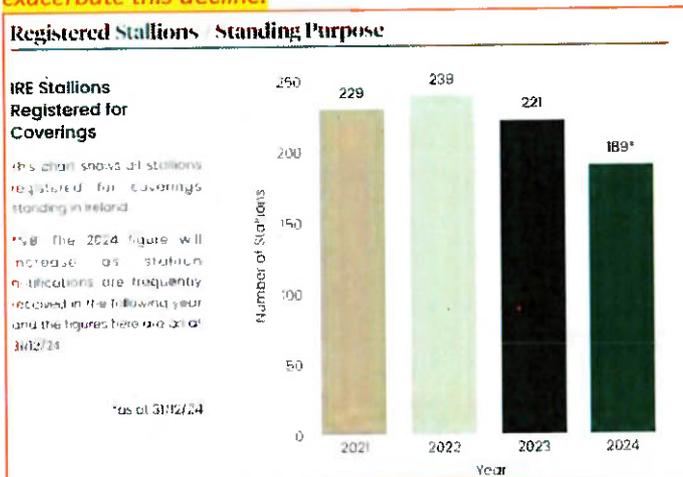
The UK's Secretary of State for Communities & Local Government acknowledged, in one of the reasons given for refusing permission for a proposed development of 9 wind turbines, that the proposed development would have a potential significant adverse impact on three nearby equine businesses (stud farms) and that "considerable weight should be attached to this."

The Planning Inspector who reported to the Secretary of State on this case noted that "There are three particular aspects of wind turbines that have a very significant detrimental effect on horses & riders that compromises their safety. Firstly, the movement of the blades when they suddenly come into view from the road, the gallops or a paddock. Secondly, the shadow flicker which has been known to spook a horse. Lastly, the noise from a group of very large turbines, particularly at start up and on a crowded site such as the southern group of 6, could have a very serious effect."

The Planning Inspector's report acknowledged that thoroughbred horses are "high value, highly strung & volatile" and that "where turbines would suddenly appear in the view" or where shadows thrown by turbines are visible "there is the potential for spooking the highly strung & volatile horses."

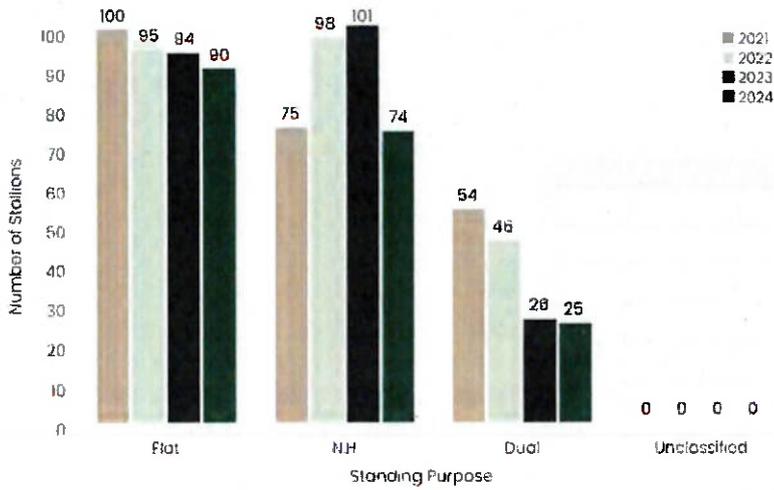
The Planning Inspector's report continued by stating that "Whilst not every horse would be startled & as a result injures itself or its rider, some would. In my view this happening would exist over and above the normal risks these stables experience in dealing with this type of horse. These horses represent a significant investment. Thus, every horse owner who uses these stables & every potential client will believe that their valuable investment will be at risk and as such will go elsewhere. The horse racing industry is highly competitive and one where perception and reputation are significant drivers in choosing a trainer and yard. Thus, it strikes me as inevitable that the businesses would decline and given the particular impact of the windfarm would unlikely be replaced with anything similar."

2024 Weatherby's Fact Book: The tables indicate a serious decline in the Stud farm industry & Windfarms will exacerbate this decline.



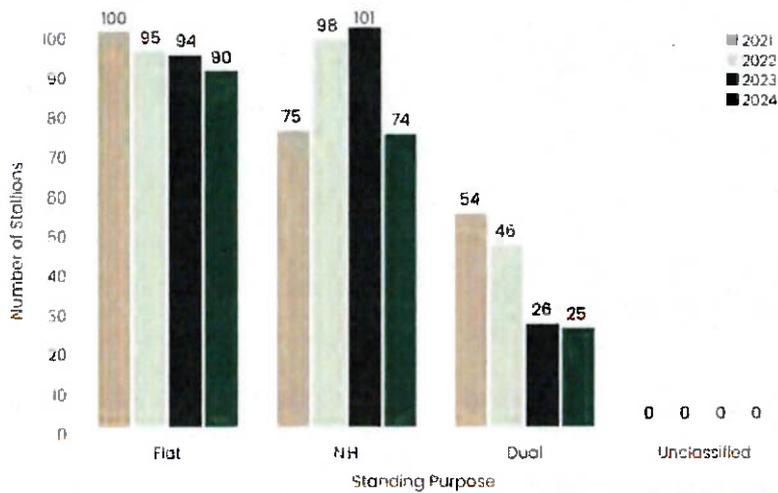
IRE Stallions Standing Purpose

The proportion of stallions standing for National Hunt purposes was higher than those standing for Flat purposes in 2022 and 2023, compared to 2021 when there were 1% less stallions standing for National Hunt purposes than for the Flat. We expect further stallion registrations for 2024 as noted above.



IRE Stallions Standing Purpose

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Breeders by County

This table shows the distribution of the 6,354 breeders of Thoroughbreds between 32 Irish Counties. It also highlights the number of mares owned and number of foals produced by those mares. The largest number of individual breeders are found in County Cork but the largest concentration of mares are in County Kildare.

Included in this data is a figure for breeders not resident in an Irish county, but which have breeding stock permanently domiciled in Ireland. This has been categorised as "Other".

County	Breeders	Mares	Foals	County	Breeders	Mares	Foals
Co. Cork	810	1,811	1,021	Co. Armagh	46	68	39
Co. Tipperary	799	1,783	1,068	Co. Antrim	44	97	43
Co. Kildare	707	1,935	1,113	Co. Mayo	39	80	27
Co. Wickford	555	1,340	831	Co. Kerry	37	64	43
Co. Meath	440	1,053	575	Co. Louth	35	68	34
Co. Kilkenny	425	1,060	672	Co. Tyrone	31	53	25
Co. Waterford	254	669	349	Co. Longford	23	38	19
Co. Limerick	242	574	343	Co. Monaghan	22	28	16
Co. Galway	203	388	217	Co. Cavan	19	27	14
Co. Down	181	237	123	Co. Sligo	11	17	9
Co. Westmeath	160	373	179	Co. Fermanagh	9	14	6
Co. Wicklow	145	321	172	Co. Donegal	8	11	7
Co. Laois	145	253	136	Co. Leitrim	8	12	5
Co. Carlow	137	413	232	Co. Londonderry	8	20	8
Co. Offaly	117	289	165				
Co. Dublin	105	157	91	Sub Total	5,932	13,446	7,978
Co. Clare	92	162	82	Other	492	972	565
Co. Roscommon	82	111	59	Total	6,354	14,418	8,543

Number of IRE Broodmares Owned per Breeder

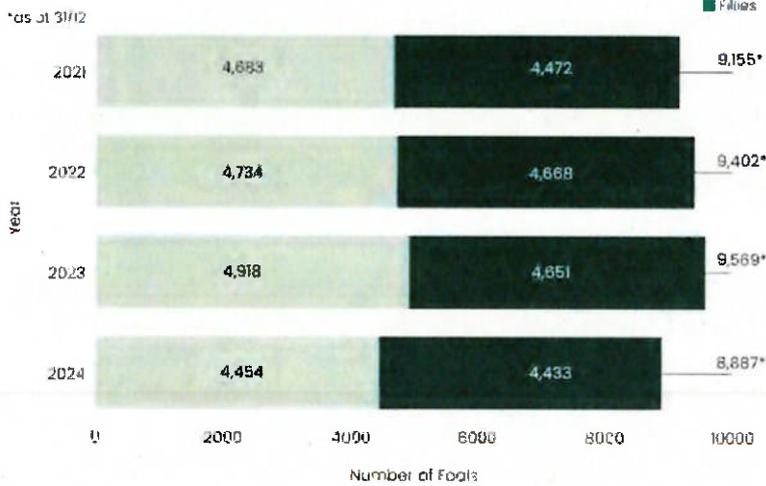
This table shows the distribution of Irish broodmares between breeders by county with 92% of breeders owning fewer than 5 broodmares.

Included in this data is a figure for breeders not resident in an Irish county, but which have breeding stock permanently domiciled in Ireland. This has been categorised as "Other".

County	1-2	3-4	5-10	11-20	21-30	31+	Total	County	1-2	3-4	5-10	11-20	21-30	31+	Total
Co. Cork	669	84	46	7	3	1	810	Co. Armagh	41	3	2	0	0	0	46
Co. Tipperary	854	82	42	15	3	3	998	Co. Antrim	35	3	4	2	0	0	44
Co. Kildare	555	78	43	18	2	7	707	Co. Mayo	36	2	1	0	0	0	39
Co. Wickford	453	68	29	5	0	0	555	Co. Kerry	31	4	2	0	0	0	37
Co. Meath	352	48	32	4	2	2	440	Co. Louth	28	3	4	0	0	0	35
Co. Kilkenny	339	47	26	10	1	2	425	Co. Tyrone	29	2	2	0	0	0	33
Co. Waterford	201	31	15	2	1	3	254	Co. Longford	21	1	1	0	0	0	23
Co. Limerick	182	28	14	5	0	2	242	Co. Monaghan	21	1	0	0	0	0	22
Co. Galway	173	22	5	3	0	0	203	Co. Cavan	16	3	0	0	0	0	19
Co. Down	162	27	10	2	0	0	181	Co. Sligo	9	1	1	0	0	0	11
Co. Westmeath	131	24	18	3	0	4	180	Co. Fermanagh	8	0	1	0	0	0	9
Co. Wicklow	120	13	12	2	0	1	148	Co. Donegal	8	0	0	0	0	0	8
Co. Laois	125	9	10	1	0	0	145	Co. Leitrim	7	1	0	0	0	0	8
Co. Carlow	113	15	3	2	0	4	137	Co. Londonderry	8	0	2	0	0	0	10
Co. Offaly	85	21	8	2	1	0	117								
Co. Dublin	92	3	3	0	1	0	105	Sub Total	4,805	651	352	81	14	29	5,932
Co. Clare	65	11	6	0	0	0	82	Other	233	43	36	8	1	1	422
Co. Roscommon	46	10	4	0	0	0	60	Total	5,138	694	388	89	15	30	6,354

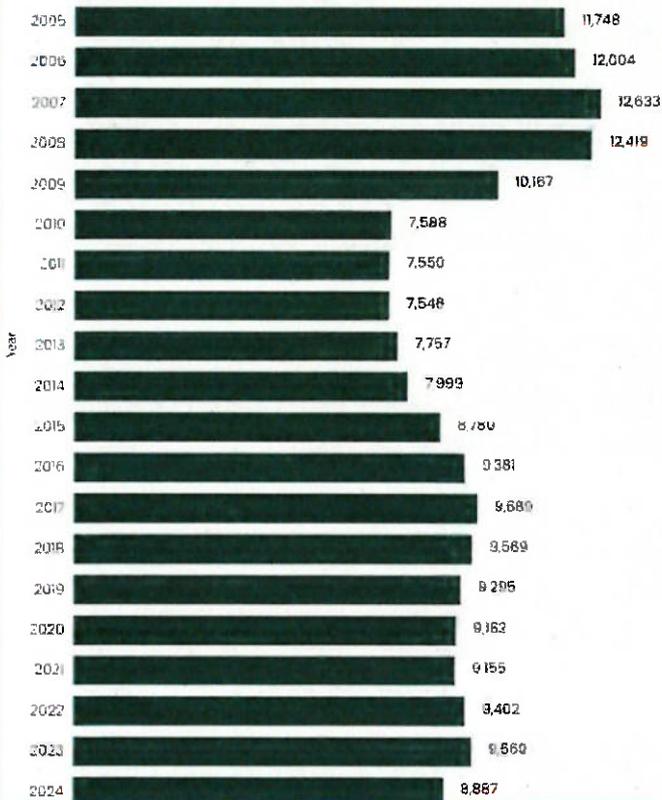
IRE Foals Born 2021-2024

The foal crop has decreased by 7% over the last year



Historical Foal Crops

IRE Foal Crop 2005 - 2024



Horses have been shown to have significant right forebrain dominance – they are exceptionally adept at processing sensory stimuli (Johnson et al. 2019). Because they are a prey species, the sensory systems of horses have evolved to enable a prompt detection of potential danger through a combination of visual, auditory and olfactory cues (Christensen et al. 2006, Saslow 2002, Tierartzliche Praxis 1997) and unexpected & hitherto unknown noises cause rapid flight reactions more frequently (Christensen et al. 2005, Algers 1984). Horses are most easily scared by noise that arises outside their field of binocular vision. Hearing ability is thus very important to the survival for horses over the centuries and a horse's ears can pick up sound at a lower level & at a greater distance than that detected by

humans (Saslow, 2002). A horse's range of hearing is greater than a humans to higher frequencies >33kHz while the range for humans is under 20kHz.

Horses can show unpredictable anxiety behaviours during any noise producing events, which include sweating, trembling, escape attempts, which may cause severe accidents for the horse and the rider/handler. More than 84% of horses show immediate avoidance and/or attempts to flee after perceived threats (Scopa et al. 2018). Injury to riders/handlers, etc., is a significant occupational hazard and can extend to thousands of accidents with associated fatalities (Holler 1984, Gimsing 2001). Dealing with an anxious or fearful horse exacerbates this risk. There is a high rate of incidence of injury (26%) among horses rated as either anxious or very anxious in the face of noise and/or light related flashes, and simply moving horses to adjacent paddocks was found to be ineffective in 37% of cases (Gronqvist 2016) Noise has also been shown to elicit restlessness, vocalisation & colic/gastro-intestinal disturbances (Dai et al. 2020)

"Noise aversion" or "noise anxiety" are terms used when an animal overreacts to noise. Unpredictable noise causes the greatest fear reactions. These noises can have long lasting effects and have been reported to adversely affect food intake, growth and production rates (Broucek 2014. Tracy et al. 2007. Head et al. 1993). Severe noise anxiety is reported to cause serious welfare consequences, impacting both the physiology and behaviour of the horse (Riva et al. 2022). Very anxious horses showed signs of noise reactivity and their reactions did not improve with time (they do not habituate with time). Very severe injuries can occur as a result of the unpredictable & very severe anxiety. Riva et al. have also shown that the effects of noise-related anxiety can persist for hours/days after the noise event. It is noteworthy that compared to visual and olfactory stimuli, unexpected unknown noises can cause rapid flight reactions.

Highly sensitive mares & newborn foals are particularly vulnerable to environmental stressors. O'Connor & Walsh (2021) emphasised that pregnant mares exhibit heightened sensitivity to noise and light fluctuations, which may interfere with gestation & increase the risk of premature birth or behavioural distress. Smith et al. (2020) reported that foals exposed to elevated noise levels during early development showed signs of sleep disruption, increased startle responses, and reduced social bonding behaviours. Green et al. (2021) noted that neonatal horses are especially susceptible to visual flicker and tonal noise, which can impair rest cycles and contribute to development instability. Chronic exposure to such stimuli may result in heightened stress responses, altered behaviour, and compromised physiological stability as evidenced by Jones et al (2019). They also noted increased agitation, visual stress, reduced rest patterns and avoidance behaviours in horses exposed to nearby wind farms. Many management strategies are used to try to reduce the effects of noise and have been shown to be ineffective (Gronqvist, 2016). Placing horses in stables is unsatisfactory as those in single stables exhibit even stronger reactions to unknown stimuli with an increased risk of accidents and adverse effects on welfare, which can include long-term behavioural abnormalities (Lesimple et al. 2020). Sedation can often give disappointing results and cause undesirable side effects (Dai et al. 2020) & long-term sedation and or stabling is impractical & inhumane.

2025 Planning Authority Statements underscore the growing tension between renewable energy expansion and the protection of sensitive agricultural sectors, including equine studfarms. An Bord Pleanala (2025) reported that of the 69 energy cases reviewed in the period 2023 – 2024, several windfarms were refused as a result of objections citing proximity to studfarms. In several decisions, the Board cited concerns over elevated noise levels and their potential impact on equine welfare. The Board emphasised the need to balance strategic infrastructure development with environmental and agricultural sensitivities.

It is noted that ABP 23-225138 on appeal from Tipperary County Council 07/111 refused planning permission for a biogas & biodiesel production facility at Castleblake, Rosegreen, County Tipperary for the following reason:
"The site of the proposed development is located in open countryside in an area of national importance for the bloodstock industry alongside a major horse training establishment. It is the policy of the planning authority, as set out in the current South Tipperary Development Plan, to support the equine industry. It is also the policy of Government to support the equine sector. It is considered that the proposed development of this large scale industrial type facility at this location, employing the particular technology on the scale proposed, having regard to its nature, scale and visual impact, would be incompatible with equine related activities in the vicinity and would be prejudicial to the viability of the equine industry in this area(including undermining confidence therein). Notwithstanding the desirability of providing such facilities, it is considered that the proposed development would seriously injure the amenities of the area and property in the vicinity, would be incompatible with the surrounding land uses, and would, therefore, be

contrary to the said Development Plan objectives and to national policy and to proper planning and sustainable development of the area.”

“The equine industry and in particular the bloodstock industry is a highly competitive commercial industry, which needs a high quality in relation to environmental standards and what could best be described as a clean image. The area of County Tipperary has developed a niche industry comparable with other bloodstock areas as for example Newmarket & Kentucky with major financial benefits to the area and any consideration of permitting development must have consider policy ENV11, for proposals for non-agriculture related development.”

The Planning Inspector Derek Daly noted that it could be necessary and appropriate to invoke the Precautionary Principle “as we are not talking about just any agricultural operation, but one of the international leaders, a business that carries Ireland’s reputation in the bloodstock industry and one which the local economy benefits well beyond the level were it to be on only local, or minimal standing.”

The Planning Inspector’s report also noted that it should be a consideration in the planning process if one successful enterprise of benefit to an area’s economy is placed at risk by a development, which is not by its nature locationally tied to the area. The Planning Inspector stated that “the onus is on any new development in the rural area and in particular non-agricultural development, which for reasons already outlined is not specifically locationally dependent to a rural area to demonstrate that it will not have a negative impact on the viability of existing stud farms or stables and that it is reasonable to consider the development in this context.”

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Reference Number 9.3:

Perceptions of Fear and Anxiety in Horses as Reported in Interviews with Equine Behaviourists. Suzanne Rogers and Catherine Bell. *Animals* 2022, 12, 2904. <https://doi.org/10.3390/ani12212904> <https://www.mdpi.com/journal/animals>

One of the key welfare concerns for horses in the United Kingdom is lack of recognition of fear in horses. This study aimed to gain an understanding of how well horse care givers recognise fear and/or anxiety in horses by interviewing equine behaviourists (who interact with large numbers of horse care givers and talk to them about this topic routinely). The experiences of Animal Behaviour and Training Council (ABTC)-registered equine behaviourists working with horse caregivers were examined, including the ability of clients to recognise fear and/or anxiety in horses, how clients respond when discussing fear as the reason for their horse's behaviour, and what explanations the participants use to explain fear and anxiety. Semi-structured interviews were conducted with nine participants and analysed using thematic analysis before being written up to reflect the discussion points. When asked how well horse caregivers recognise fear and/or anxiety in horses, three key response themes emerged: caregivers are extremely poor at recognizing fear and anxiety in horses; some clients do recognise behavioural signs indicating fear and/or anxiety but only the overt signs (e.g., rearing, running away) rather than the more subtle signs (e.g., tension in face, subtle avoidance behaviours such as a hesitant gait); and fear and/or anxiety behaviour is often misinterpreted or mislabelled. These key themes recurred throughout several other interview questions. This study has provided initial insights into the lack of recognition of fear and anxiety of horses by their caregivers in the United Kingdom as well as tried and tested approaches to conversations to change this. Such synthesis of experience and techniques across the equine behaviour sector, together with the information gained regarding perception of equine caregivers, could be a valuable approach to improve the effectiveness of behaviour consultations and welfare initiatives.

Reference Number 9.4:

Equine Welfare Under Environmental Challenges. Olena Lesnovska¹, Lyudmila Lytvyschenko, Larysa Ulko, Liudmyla Zlamaniuk, Olena Bezalychna, Volodymyr Liskovych, Lyudmila Mykolaichuk, Roman Mylostyyvi. *Journal of Animal Health and Production* 2025 | Volume 13 | Special Issue 1 | Page 442. DOI <https://dx.doi.org/10.17582/journal.jahp/2025/13.s1.442.452>. ISSN (Online) | 2308-2801.

Current understanding of equine welfare under environmental challenges is based on the integration of physiological, behavioural, environmental and management-related factors, which interact within a complex adaptive system. Heat stress, as the leading environmental threat, exerts systemic effects on the equine body, disrupting thermoregulation, cardiovascular homeostasis, reproductive function and immune reactivity. Behavioural and physiological indicators (such as body temperature, respiratory rate, heart rate variability and cortisol levels), when combined with modern monitoring technologies (including infrared thermography, surface electromyography and microsensors), provide accurate assessments of animal condition and enable timely detection of stress loads. Adaptive mechanisms, including heat acclimatisation, selection based on resilience traits and nutritional optimisation, play a key role in reducing horses' vulnerability to adverse conditions. However, the effectiveness of these strategies depends on individual variability, age, breed and housing conditions. Sustaining equine welfare requires a systemic approach that integrates precise monitoring, personalised interventions and interdisciplinary perspectives within the context of global environmental change.

The WindPRO computer software was used to model the predicted daily and annual shadow flicker levels in significant detail, identifying the predicted daily start and end times, maximum daily duration and the individual turbines predicted to give rise to shadow flicker.

Response: This WindPro modelling computer software has not been provided as part of lacunae as required by EEC Directive.

The maximum shadow flicker model assumes that daylight hours consist of 100% sunshine. This is a conservative assumption which represents a worst-case scenario. Following the detail provided above on sunshine hours, a sunshine factor of 26.46% was applied. The predicted shadow flicker levels have been modelled for all 218 Sensitive Receptors located within 1.62km (10 x 162m rotor diameter) of the proposed turbine locations. The predicted shadow flicker model results indicate:

- 47 Sensitive Receptors are theoretically predicted to experience zero shadow flicker;
- 171 Sensitive Receptors are theoretically predicted to experience some shadow flicker;
- Of the 218 Sensitive Receptors, 76 Sensitive Receptors are theoretically predicted to experience shadow flicker that exceeds the Guidelines (DoEHLG, 2006) . Please see Table 5-11 below for details.

Appendix 5-4 of this EIAR contains the shadow flicker results for the 218 houses, i.e. including the Sensitive Receptors experiencing zero or less than the Guidelines (DoEHLG, 2006) threshold for daily and annual shadow flicker.

Where daily shadow flicker exceedances have been predicted at buildings by the modelling software, a Site visit will be undertaken firstly to determine the level of occurrence, existing screening and window orientation. The shadow flicker prediction data will be used to select dates on which a shadow flicker event could be observed at one or multiple affected properties and the following process will be followed.

Overall, the construction, operation and decommissioning of the Proposed Project will not have any significant adverse effects on population and human health, following the implementation of the appropriate mitigation measures.

Chapter 6: Biodiversity

Habitats found alongside the Proposed Grid Connection Underground Cabling Route (which is restricted to the existing road) include Improved agricultural grassland (GA1), Buildings and artificial surfaces (BL3), Cutover bog (PB4), Treelines (WL2), Hedgerows (WL1), Wet grassland (GS4), Parkland and scattered trees (WD5), Conifer plantation (WD4), (Mixed) Broadleaved woodland and Dry meadows and grassy verges (GS2). There are eight watercourse crossings over watercourses (FW2) and drains (FW4), which pass beneath the existing road along which the underground cable connection route will be located.

The Proposed Wind Farm site consists of 18 different habitat types, including the following: Wet grassland (GS4) Improved agricultural grassland (GA1), Dry meadows and grassy verges (GS2), Arable crops (BC1), Buildings and artificial surfaces (BL3), Stone walls and other stonework (BL1), Recolonizing bare ground (ED3), Conifer plantation (WD4), Broadleaved woodland (WD1), Scrub (WS1), Wet grassland/scrub (GS4/WS1), Cutover bog (PB4), Raised bog (PB1), Rich fen (PF1), Treelines (WL2), Hedgerows (WL1), Lowland/depositing rivers (FW2) and Drainage ditches (FW4). The proposed Substation and BESS Compound are also proposed to be located within an Improved Agricultural Grassland (GA1) habitat.

Response: The BESS Compound is not included in this planning application.

The construction of the Proposed Grid Connection underground cabling will not result in the permanent loss of any habitat. The works will be restricted to the existing road categorised as Buildings and Artificial Surfaces (BL3). This is not significant at any geographic scale. The construction of the Proposed Wind Farm will result in the direct loss of 8.77ha of Improved Agricultural Grassland (GA1), 1.85ha of Dry Meadows and Grassy Verges (GS2), 3.05ha of Wet Grassland (GS4) and 0.81ha of Arable Crops (BC1). These habitats are assessed as being of local importance (lower value), the loss of which is not considered significant at any scale.

Response: There is no landowner consent to lay cables on the public road as per Cremin v Dromada Windfarm.

There will be a loss of 2.12ha of Cutover Bog (PB4) habitat associated with new roads and proposed infrastructure within the Proposed Wind Farm site. This loss constitutes approximately 5% of the total cutover bog habitat area located within the site. Additionally, 0.18ha of raised bog (PB1) will be lost as a result of the proposed new floating access road between T7 and T9. By taking a precautionary approach, this habitat has been assessed as corresponding to the Annex 1 habitat 7120 Degraded raised bogs still capable of natural regeneration. The loss of 0.18ha of raised bog habitat corresponds to a loss

of 0.54% of the total raised bog habitat area within the Proposed Project. This is considered a significant effect at a county scale.

A total of 3.74ha of linear features including hedgerows (WL1), treelines (WL2) and stone walls (BL1) will be lost as a result of the Proposed Project. Approximately 0.17ha of broadleaved woodland (WD1) will be lost to accommodate access road widenings and a turning bay, and approximately 0.7ha of conifer woodland (WD4) will be lost to accommodate new access roads and turbine bat buffers. An additional 10.55ha of conifer woodland is to be felled as part of the biodiversity enhancement measures and will be replaced with native broadleaves (as described below).

A number of uncut raised bog (PB1) and regenerating cutover bog (PB4) habitat areas have started to recolonize with scrub. It is proposed to allow these areas to regenerate into what is expected will become bog woodland habitat. Approximately 18ha is available within the site to provide this habitat enhancement.

Response: Is this 18ha included for Carbon savings calculation.



There are two main rivers which flow through the Proposed Wind Farm site; the Grange River in the north and the Abbert River in the south. The southern portion of the Proposed Wind Farm site is drained by the Lecarrow Stream and the Forty Acres Stream, both of which are headwater streams of the Abbert River. The Dangan Eighter Stream and a number of unnamed streams drain into the Grange River to the north of the Proposed Wind Farm site. No residual significant effects on surface and groundwater quality or the hydrological/ hydrogeological regime were identified during construction, operation or decommissioning phases. A full hydrological assessment in relation to the Proposed Project has been carried out in Chapter 7 of the EIAR.

Response: There are 3 underground public drinking sources proximate to this site. The Precautionary Principle on foot of the Geological Risk assessment determines that this site is unsuitable for a windfarm.

Bat species composition and abundance was found during detailed bat surveys undertaken at the Proposed Wind Farm site to be typical of the geographic location and the largely open nature of the Proposed Wind Farm site. Bats as an Ecological Receptor have been assigned Local Importance (Higher value) on the basis that the habitats within the study area are utilized by a regularly occurring bat population of Local Importance. Following the implementation of mitigation, no potential for residual significant effects with regard to loss of commuting and foraging habitat, loss or damage to roosts, displacement or other construction phase impacts have been identified; the proposed net gain in

linear landscape features within the site will result in a long-term positive impact on bats at the local level. In relation to potential collision risk and injury with operational turbines, a bespoke adaptive monitoring and mitigation strategy has been devised for the Proposed Project in line with NatureScot (2021) Guidance, which will ensure that there is no potential for significant residual effects on local bat populations during the operational phase of the Proposed Project.

Table 3-2 Structures inspected within and around the Cooloo wind farm site

Structure No.	Description	IG Reference	Nearest Turbine	Distance to nearest turbine (m)
1	Shed	M 55031 47386	T1	370
2	Large Hay Shed	M 55135 47805	T1	300
3	Small Farm Shed	M 55089 47969	T1	470
4	Cattle Shed	M 55758 49008	T3	470
5	Turf Shed	M 56299 48333	T4	245
6	Derelict Building	M 55768 49063	T5	198
7	Turf Barn	M 55966 50469	T7	350
8	Unused Building	M 56152 50500	T7	550
9	Unused House	M 57203 49326	T8	160
10	Farm Buildings	M 57430 49132	T8	130
11	Farm Buildings	M 57493 49530	T8	512
12	Unused House	M 57481 49608	T8	532

2.2.1 Bats

The data collected regarding bats is limited to a single survey season, collected from May 2024 to September 2024. The maximum age profile for acceptable data in this regard is 2 years in accordance with best practice. Updated bat survey is required to make an informed, accurate and up to date assessment of this application.

Appendix 6.2: Bat Survey Report

Table 3-1 Multidisciplinary Walkover Surveys and Bat Survey Effort

Multidisciplinary Survey	Dedicated Bat Survey
13 th August 2024	7 th May 2024
14 th August 2024	22 nd May 2024
21 st August 2024	27 th May 2024
18 th September 2024	26 th June 2024
18 th June 2025	23 rd July 2024
2 nd September 2025	27 th August 2024
	10 th September 2024

Table 3-3 Emergence Surveys during the 2021, 2022 and 2024 survey periods

Date	Surveyors	Structure No.	Time	Weather	Conditions
27 th May 2024	Ryan Connors and Kate Greaney	No. 9	21:48	Dusk Emergence	10-12°C, dry, calm, 40%-70% cloud cover, moon not visible
26 th June 2024	Ryan Connors and Cormac Roberts	No. 8	22:08	Dusk Emergence	14°C, dry, light breeze, 100% cloud cover, moon not visible
27 th August 2024	Ryan Connors and Fredrick Mosley	No. 6	20:36	Dusk Emergence	16°C, dry to light rain, calm to a slight breeze, 75% - 90% cloud cover, moon not visible

Table 34 Survey Effort - 2024 Walked Transects

Date	Surveyors	Sunrise/ Sunset	Time	Weather	Transect (km)
27 th May 2024	Ryan Connors and Kate Creaney	21:48	23:10 – 00:20	10°C, light to moderate rain, calm, moon not visible, 70% cloud cover	3.9 km
26 th June 2024	Ryan Connors and Cormac Roberts	22:08	23:35 – 01:06	12-14°C, drizzle, light to moderate breeze, moon not visible, 95% cloud cover	5.0 km
27 th August 2024	Ryan Connors and Fredrick Mosley	20:36	22:08 – 23:30	14-16°C, dry, light breeze, moon not visible, 20% cloud cover	3.7 km

Table 36 Survey Effort - Ground-level Static Surveys 2024

Season	Survey Period	Total Survey Nights per Detector Location	Nights with Appropriate Weather
Spring	7 th May – 22 nd May 2024	15	13
Summer	26 th June – 23 rd July 2024	27	27
Autumn	27 th August – 10 th September 2024	14	14
Total Survey Effort		56	54

Twelve structures and their associated outbuildings were identified within and around the Proposed Wind Farm as containing features with potential to support roosting bats. Of the twelve structures surveyed, six were assessed as having negligible bat roost potential, three as low, two as moderate, and one as high. One structure (Structure 6, a derelict building near Turbine 5) was assessed as having moderate roost potential and is proposed for demolition. Acoustic monitoring identified the following species activity patterns:

- T1: High soprano pipistrelle activity within the GA1 habitat with adjacent hedgerow.
- T2: High common pipistrelle and Leisler's bat activity within a scrub and GA1 habitat.
- T7: High common pipistrelle activity within a GA1 habitat with adjacent hedgerow.
- T8: High common pipistrelle activity and proximity to a known roost.

The habitats at T1, T2 and T7 are considered sub-optimal for bats (open grassland, scrub) yet recorded high bat activity. These areas will be targeted for mitigation to discourage bat use within the rotor-swept zone.

Additionally, two roosts were confirmed at the Proposed Wind Farm site:

- Structure 8 (Close to T6): Single soprano pipistrelle, emerged from a vacant single-storey house during surveys carried out in June 2024. Located approx. 550m east of T7.
- Structure 9 (Close to T8): At least 10 soprano pipistrelles emerged from a vacant farmhouse during emergence surveys carried out in May 2024, 20 soprano pipistrelles emerged during surveys carried out in September 2022 and 7 soprano pipistrelles emerged during surveys carried out in October 2021. Located approx. 160m east of T8.

A structure (No. 6) located near Turbine 5 is scheduled for demolition as part of the Proposed Project and is the only structure that will be removed. As no bats were identified roosting within the structure during emergence surveys carried out in 2021 or 2024, a derogation licence is not considered necessary. However, in line with best practice guidance, a pre-demolition inspection by a suitably qualified ecologist will be undertaken prior to any works. If any bats or signs of bat use are detected, appropriate mitigation — including potential exclusion under NPWS licence and provision of compensatory roosting habitat — will be implemented to ensure compliance with legal protections and avoid significant effects on bat populations. The recommendation of a pre-demolition survey does not present a lacuna in the survey assessment but is fully in line with best practice guidance. The function of this survey is to assess any potential changes in baseline environment since the surveys were undertaken.

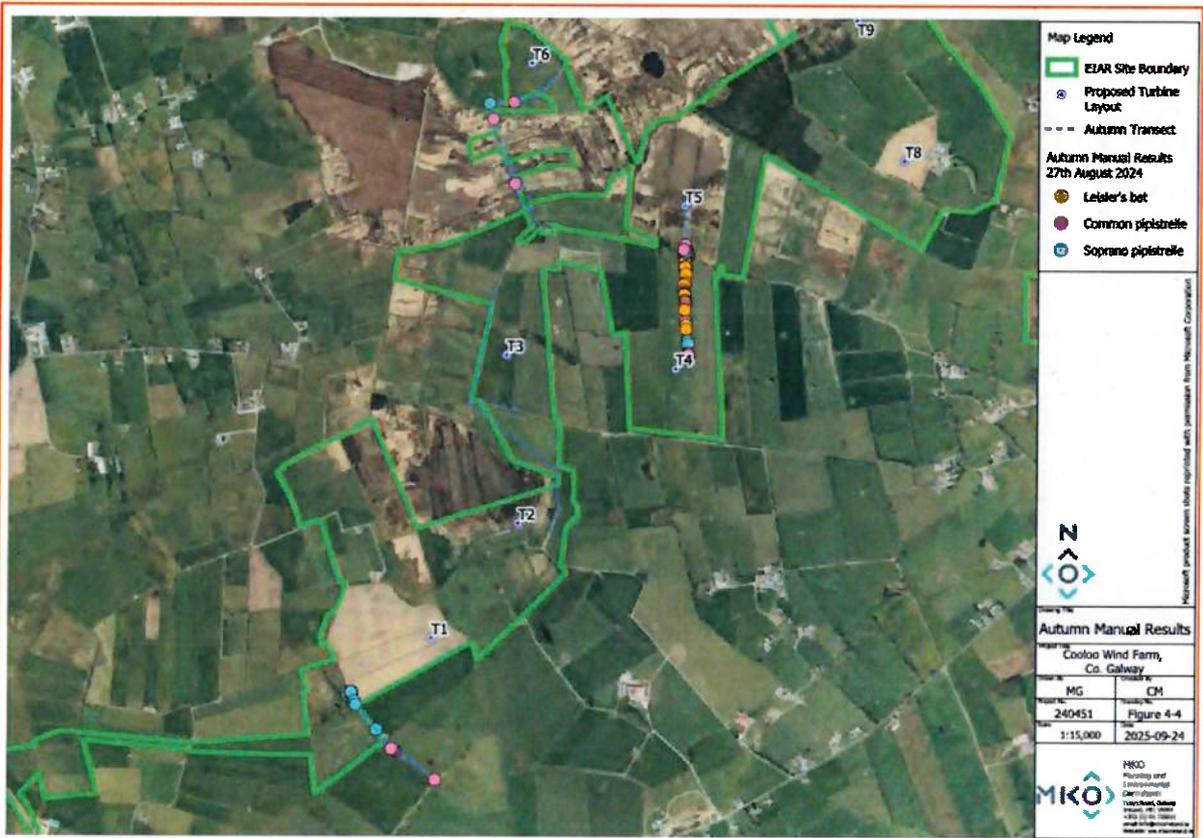


Table 4.9 Static Detector Surveys: Species Composition Across All Deployments (Total Bat Passes Per Hour, All Nights)

	Spring	Summer	Autumn
Total Survey Hours	122.4	198.9	135.7
<i>Myotis</i> spp.	0.614	0.245	0.273
Leisler's bat	1.384	2.09	2.095
Nathusius' pipistrelle	0.157	0.015	0.01
Common pipistrelle	20.433	7.865	7.605
Soprano pipistrelle	7.922	4.643	6.25
Brown long-eared bat	0.108	0.023	0.177

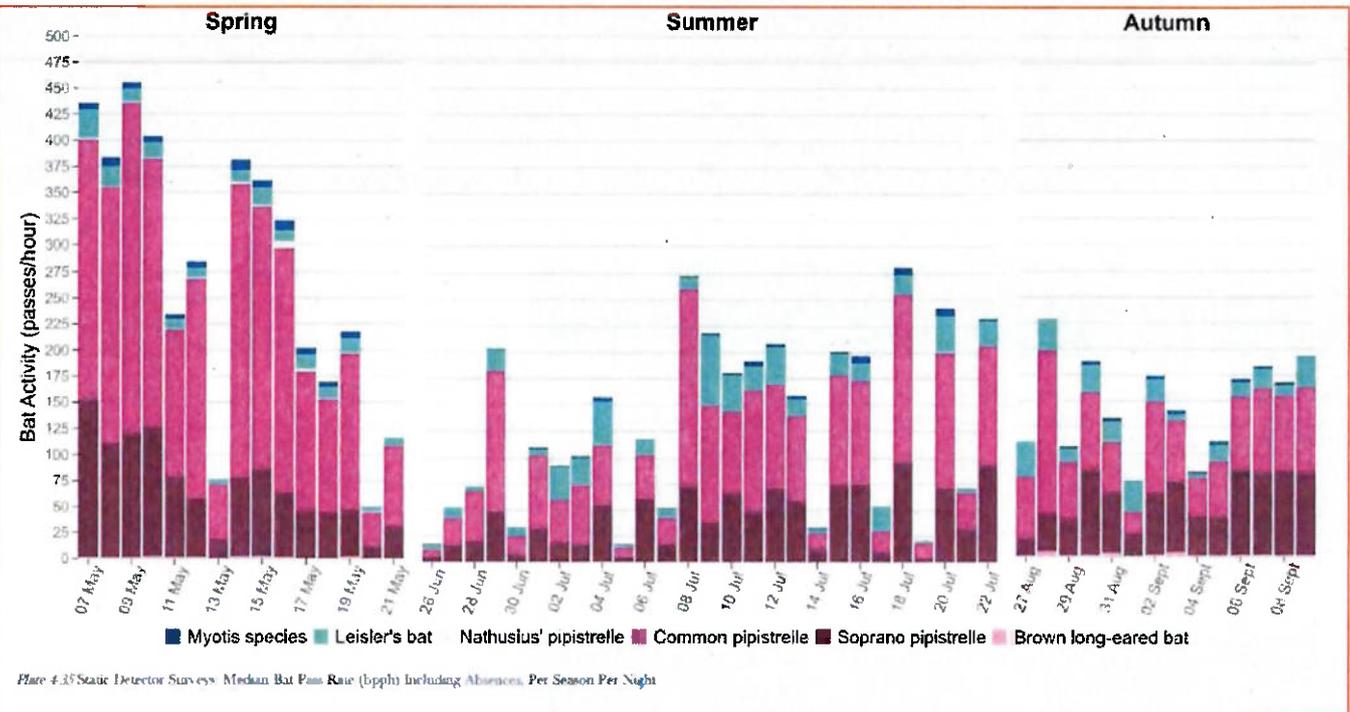


Figure 4.35 Static Detector Surveys: Median Bat Pass Rate (bpph) Including Absences, Per Season Per Night

Table 4-10 Median Nightly Bat Activity (bpps) per Species, per Season, per Detector Location 2024 (Low, Medium, High)

2024 Season	Detector	Myotis spp.		Leisler's bat		Nathusius' pipistrelle		Common pipistrelle		Soprano pipistrelle		Brown long-eared bat	
		Median Bat Activity	Max Bat Activity	Median Bat Activity	Max Bat Activity	Median Bat Activity	Max Bat Activity	Median Bat Activity	Max Bat Activity	Median Bat Activity	Max Bat Activity	Median Bat Activity	Max Bat Activity
Spring	D01	0.00	0.10	0.00	1.10	0.00	0.10	0.00	5.20	0.00	2.70	-	-
	D02	0.00	0.20	1.90	9.60	0.20	1.10	43.80	87.20	15.20	35.80	0.00	0.60
	D03	0.80	3.20	0.70	2.10	0.00	0.90	23.70	43.50	5.90	21.90	0.00	0.70
	D04	0.00	0.10	0.50	1.50	0.00	0.40	5.70	11.40	2.00	7.20	0.00	0.60
	D05	0.10	0.70	1.30	2.30	0.00	1.30	11.20	24.60	2.40	20.00	0.10	0.20
	D06	0.40	1.00	0.80	2.20	0.00	0.40	3.20	13.00	1.60	3.30	0.00	0.20
	D07	0.50	1.70	0.60	1.80	0.10	1.20	77.00	188.60	17.10	67.10	0.10	0.60
	D08	0.20	0.70	3.10	7.80	0.10	1.00	21.70	46.00	9.40	26.60	0.20	0.50
	D09	2.50	7.80	1.50	5.20	0.00	0.70	5.00	15.20	3.60	9.80	0.10	1.10
Summer	D01	0.30	3.10	0.60	1.60	0.00	0.10	4.70	30.10	2.50	53.10	0.00	0.40
	D02	0.00	0.10	6.90	40.30	0.00	0.30	1.70	12.60	1.10	11.70	0.00	0.30
	D03	0.00	0.30	1.10	11.60	0.00	0.10	1.70	5.60	3.20	11.70	0.00	0.10
	D04	0.00	0.50	0.80	6.30	0.00	0.10	6.00	23.20	2.80	15.90	0.00	0.10
	D05	0.10	0.50	0.70	2.70	0.00	0.10	3.50	21.90	1.60	49.50	0.00	0.10
	D06	-	-	0.00	1.40	-	-	0.00	21.50	0.00	12.10	-	-
	D07	0.30	4.70	0.30	4.80	0.00	0.10	8.80	36.00	4.80	18.80	0.00	0.10
	D08	0.30	0.90	0.50	2.00	0.00	0.10	6.20	22.00	4.70	23.00	0.00	0.10
	D09	0.10	1.00	1.70	24.00	0.00	0.40	12.10	62.00	3.40	11.70	0.00	0.30
Autumn	D01	0.25	1.30	1.50	3.70	0.00	0.10	13.90	27.40	28.60	32.70	0.05	0.70
	D02	0.20	0.90	1.35	9.40	0.00	0.10	1.85	6.80	1.80	6.40	0.00	0.40
	D03	0.20	0.60	1.00	2.60	-	-	1.10	3.70	1.40	3.00	0.10	0.40
	D04	0.30	0.70	6.15	24.60	0.00	0.10	8.15	36.30	3.70	19.90	0.00	0.30
	D05	0.10	0.60	1.15	4.30	-	-	2.80	11.00	1.45	11.30	0.10	0.40
	D06	9.50	1.20	0.40	1.70	0.00	0.10	2.05	12.30	1.25	6.00	0.10	0.30
	D07	0.00	0.40	0.00	0.30	0.00	0.10	1.25	15.10	0.75	6.50	0.00	0.10
	D08	0.40	0.90	1.15	8.20	0.00	0.20	9.95	58.10	4.55	7.80	0.30	0.70
	D09	0.35	0.70	1.35	5.70	0.00	0.10	13.00	27.90	5.50	11.50	0.55	3.50

Table 5-2 Leisler's bat - Overall Risk Assessment

Survey Period	Site Risk	Typical Activity (Median)	Typical Risk Assessment (as per Table 3b NatureScot 2021)	Activity Peaks (Maximum)	Peak Risk Assessment (as per Table 3b NatureScot 2021)
Spring 2024	Medium (3)	Low-moderate (2)	Typical Risk is Low (6)	Moderate (3)	Peak Risk is Medium (9)
Summer 2024*		Low-moderate (2)	Typical Risk is Low (6)	Moderate-high (4)	Peak Risk is Medium (12)
Autumn 2024		Low-moderate (2)	Typical Risk is Low (6)	Moderate-high (4)	Peak Risk is Medium (12)

*The summer median value for D02 was identified as an outlier and was excluded from the assessment of Typical Activity as it considerably skews the data, providing an inaccurate representation of the typical activity observed across the Proposed Wind Farm.

Table 5-3 Soprano pipistrelle - Overall Risk Assessment

Survey Period	Site Risk	Typical Activity (Median)	Typical Risk Assessment (as per Table 3b NatureScot 2021)	Activity Peaks (Maximum)	Peak Risk Assessment (as per Table 3b NatureScot 2021)
Spring 2024	Medium (3)	Low-moderate (2)	Typical Risk is Low (6)	Moderate-high (4)	Peak Risk is Medium (12)
Summer 2024		Low (1)	Typical Risk is Low (3)	Moderate-high (4)	Peak Risk is Medium (12)
Autumn 2024		Low (1)	Typical Risk is Low (3)	Moderate (3)	Peak Risk is Medium (9)

Table 5-4 Common pipistrelle - Overall Risk Assessment

Survey Period	Site Risk	Typical Activity (Median)	Typical Risk Assessment (as per Table 3b NatureScot 21)	Activity Peaks (Maximum)	Peak Risk Assessment (as per Table 3b NatureScot 2021)
Spring 2024	Medium (3)	Moderate (3)	Typical Risk is Medium (9)	Moderate-high (4)	Peak Risk is Medium (12)
Summer 2024		Low-moderate (2)	Typical Risk is Low (6)	Moderate-high (4)	Peak Risk is Medium (12)
Autumn 2024		Low-moderate (2)	Typical Risk is Low (6)	Moderate-high (4)	Peak Risk is Medium (12)

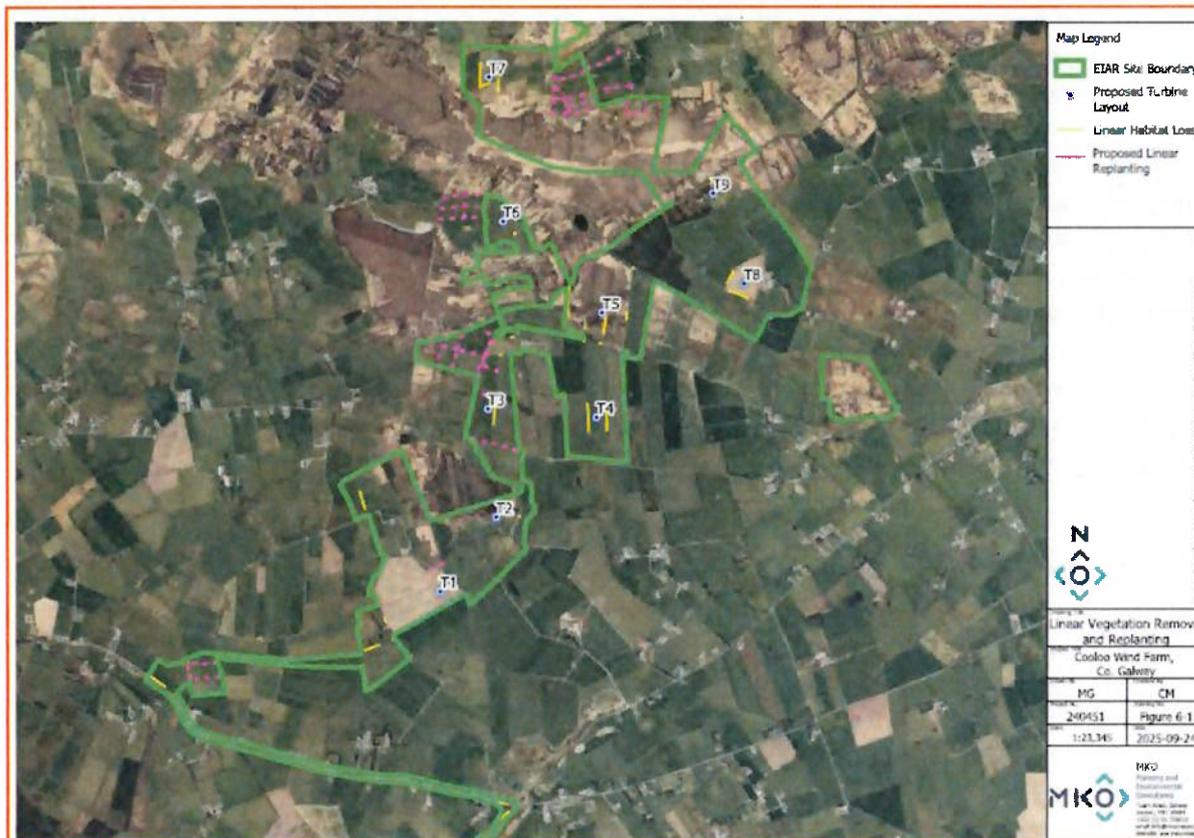
*The spring median values for D02 and D07 were identified as outliers and were excluded from the assessment of Typical Activity as it considerably skews the data, providing an inaccurate representation of the typical activity observed across the Proposed Wind Farm.

Table 55 *Nathusius' pipistrelle* - Overall Risk Assessment

Survey Period	Site Risk	Typical Activity (Median)	Typical Risk Assessment (as per Table 3b NatureScot 2021)	Activity Peaks (Maximum)	Peak Risk Assessment (as per Table 3b NatureScot 2021)
Spring 2024	Medium (3)	Low (1)	Typical Risk is Low (3)	Moderate (3)	Peak Risk is Medium (9)
Summer 2024		Low (1)	Typical Risk is Low (3)	Low (1)	Peak Risk is Low (3)
Autumn 2024		Low (1)	Typical Risk is Low (3)	Low (1)	Peak Risk is Low (3)

Table 56 Detector Location Recording High Median Activity in 2024 for High-risk Bat Species

Detector ID	Turbine	Species	High Median Activity Survey Period
D01	T01	Soprano pipistrelle	Autumn 2024
D02	T02	Common pipistrelle	Spring 2024
D02	T02	Leisler's bat	Summer 2024
D03	T03	Common pipistrelle	Spring 2024
D04	T04	Leisler's bat	Autumn 2024
D07	T07	Common pipistrelle	Spring 2024
D08	T08	Common pipistrelle	Spring 2024



4. SUMMARY OF RESULTS

Surveys in 2021 and 2022 were undertaken in line with SNH (2019) standards for medium-risk sites. The site supported a soprano pipistrelle roost near T08 and provided suitable commuting and foraging habitat, particularly along treelines and hedgerows.

Static detectors confirmed pipistrelle species as dominant across the site, with localised seasonal peaks for Leisler's bat (autumn, D04) and *Nathusius' pipistrelle* (spring, D03). Brown long-eared bat and *Myotis* spp. were recorded occasionally, with lesser horseshoe bat detected only twice.

Overall, the 2021/2022 surveys indicate that bat activity at Cooloo is characterised by widespread pipistrelle use, with limited but notable records of higher-risk or rarer species. These results complement the 2024 survey data presented in the EIAR and have been considered in combination to inform the impact assessment and mitigation design.

5.2 Loss or Damage to Commuting and Foraging Habitat

In the absence of appropriate design, the loss or degradation of commuting and foraging habitat has the potential to reduce feeding opportunities and/or displace local bat populations. The Cooloo Wind Farm site is predominantly comprised of agricultural and wet grassland, with smaller areas of peatland, limited woodland, and sparse linear features such as hedgerows and treelines.

Approximately 0.7 hectares (ha) of conifer forestry will be felled to accommodate the bat buffer (Section 6.1.3) associated with T9 and development footprint. An additional 10.55 ha of monoculture Sitka spruce conifer woodland will be removed resulting in a total loss of 11.25 ha of conifer woodland.

Further details on vegetation removal required within and around development footprint is detailed in Chapter 4 and Chapter 6 of this EIAR. Any tree removal will be undertaken to maintain an appropriate buffer between turbine blade tips and adjacent canopy, in line with current best practice (Natural England, 2014; NatureScot, 2021). As the plantation was established as a commercial crop, this felling is expected regardless of the wind farm proceeding. The removal of dense closed canopy plantation may result in a positive effect to bat populations by increasing linear edge habitat, which is known to support commuting and foraging activity.

Most turbines are sited within improved grassland areas, thereby avoiding significant linear habitat features. However, approximately 0.17 ha of broadleaved woodland, 0.53 km of treeline and 3.21 km of hedgerow and associated stone walls will be removed to allow for turbine foundations, access tracks, TDR accommodation works and overrun area, and ancillary infrastructure. This includes vegetation removed to maintain turbine-to-habitat buffers as detailed in Section 6.1.3 and Appendix 6-4, Section 3.4.1.

To offset this loss of woodland and linear features, approximately 11.5 ha of broadleaved woodland and 4.7 km of linear habitat planting is proposed elsewhere on site. This will result in a net gain of approximately 960m of linear habitat within the site. Planting will incorporate native species appropriate to the local area and will aim to strengthen existing habitat connectivity and ecological function.

While these measures will maintain and enhance ecological corridors in the long term, a short-medium term reduction in connectivity may occur until newly planted or enhanced hedgerow becomes fully established. Final details of this enhancement planting are provided in the Biodiversity Management and Enhancement Plan (BMEP) (Appendix 6-4). The extent of vegetation removal and proposed replanting is shown in Figure 6-1 below. Following the implementation of the replanting plan, as outlined in the BMEP, no significant effects in relation to habitat fragmentation or loss of commuting or foraging habitat for bats is anticipated.

4.2.1 Previous Baseline Surveys (2021–2022)

Baseline bat surveys undertaken in 2021 and 2022, in accordance with SNH (2019) and NatureScot (2021) guidance, comprised a desk study, habitat suitability appraisal, roost inspections, dusk emergence surveys, manual transects, and ground-level static detector surveys.

One building within the survey area was confirmed as a soprano pipistrelle roost. **Static detector surveys in 2022 recorded approximately 59,516 bat passes, dominated by common pipistrelle and soprano pipistrelle, with smaller proportions of Leisler's bat, Myotis spp., brown long-eared bat, Nathusius' pipistrelle, and one lesser horseshoe bat pass.**

Static detector surveys in 2021 revealed a total of 55,229 bat passes, also dominated by common and soprano pipistrelle. Fewer records of Leisler's bat, Myotis spp., brown long-eared bat and Nathusius' pipistrelle were also recorded.

It was noted that although the site is outside the current known range for lesser horseshoe bat, a single bat pass was recorded at D09 in autumn 2022. No other records of lesser horseshoe bat were recorded during the survey effort in either 2021 or 2024. This single lesser horseshoe bat record is considered to be an outlier and based on the results from the 2021, 2022 and 2024 surveys, it is not anticipated that a larger population of lesser horseshoe bat resides in the area. Regardless, the record has been considered. It is noted that lesser horseshoe bats are considered a low collision risk species, and no net loss of habitat connectivity is anticipated as a result of the Proposed Project. The Site will remain suitable for potential future lesser horseshoe bat activity.

Response: The EIAR information indicates that this site is unsuitable as a windfarm.

Marsh Fritillary suitable habitat was recorded within the Proposed Wind Farm Site. Dedicated Marsh Fritillary surveys undertaken recorded larval webs northwest of the Proposed Wind Farm site, as well as within a stand-alone field within the Proposed Wind Farm site to the southeast. A singular Marsh Fritillary larval web was also recorded approximately 17m north of the proposed new access road located north of T5. There will be no loss of suitable marsh fritillary habitat associated with the Proposed Project, and enhancement measures detailed above will ensure that existing suitable habitat and additional suitable habitat will remain within the Proposed Wind Farm site for the lifetime of the Project.

2.2.2 Marsh Fritillary

Multiple marsh fritillary larval webs were identified within the stand-alone field to the east of the Proposed Wind Farm site, as well as one larval web identified approximately 20m north of T5. Additional fields with suitable marsh fritillary habitat (but no identified larval webs during surveys carried out in 2024) have been identified as suitable marsh fritillary enhancement areas. Landowner agreements will be in place to ensure that no ploughing, re-seeding, intensive grazing or intensive management will take place within these areas of the site.

The proposed new floating road between T7-T9 is partially located within an area mapped as the Article 17 raised bog habitat. Detailed botanical relevé data was collected within these habitat areas to assess the condition of the habitat determine any affinity to Annex 1 habitats. The proposed new 580m floating road between T7 and T9 crosses through approximately 285m of uncut raised bog habitat. The data was assessed using Ecotope criteria within the IWM 81. It is likely that this habitat is a degraded raised bog habitat with small, fragmented areas of active raised bog. By taking a precautionary approach, it was determined that the location of the proposed floating road between T7 and T9 is located within a habitat that corresponds to the Annex 1 habitat 7120 Degraded raised bogs still capable of natural regeneration.

In relation to nationally designated sites, the following Nationally Designated Sites have been identified as being within the Likely Zone of Impact and have been assessed in the EIAR:

- Turlough Monaghan pNHA [001322]
- Turloughcor pNHA [001788]
- Lough Corrib pNHA [000297]

Lough Corrib pNHA is also designated as European designated sites including the following:

- Lough Corrib SAC
- Lough Corrib SPA

These European Sites (SACs and SPAs) have been fully assessed under those designations within the Appropriate Assessment Screening and Natura Impact Statement (NIS) that accompanies this EIAR.

This report has been prepared to provide the competent authorities with the information necessary to complete an Appropriate Assessment screening and an Appropriate Assessment for the Proposed Project in compliance with Article 6(3) of the Habitats Directive. The NIS concludes that the Proposed Project, individually or in-combination with other plans or projects, will not adversely affect the integrity of any European Site.

Following consideration of the residual effects it is concluded that the Proposed Project will result in a residual significant effect on the KER Raised Bog (PB1) Degraded Raised Bogs Still Capable of Natural Regeneration (7120) in the form of the direct loss of approximately 0.18ha of this habitat as a result of the proposed new floating access road between T7 and T9, which amounts to approximately 0.54% of the total raised bog habitat area within the Proposed Project. This floating road structure, although designed to minimize impacts on the hydrology of the underlying habitats and avoiding the need for any excavations, will result in likely significant effects on the underlying hydrology of this habitat in an area of approximately 50-100m of the proposed new floating road. This identified significant residual effects will be on a receptor of County Importance.

2.3 Loss of Habitat

2.3.1 Hedgerow (WL1), Treelines (WL2) and Stone Wall Loss (BL1)

The loss of linear features will largely be as a result of the construction of new roads, turbine hard-standing areas and turbine buffers required to avoid impacts on bats as per NatureScot recommendations. The total loss of linear habitats

within the site will be approximately 3.74km. Approximately 773m of this figure is as a result of the bat buffers associated with the 9 turbines.

It is proposed to offset the potential loss of approximately 3.74km of linear features within the Proposed Wind Farm site by replanting approximately 4.70km of hedgerows along field boundaries outside of the required bat buffers. This additional habitat creation (approx. 960m) is proposed given that it would not be a like for like replacement and would take time to establish as an enhancement.

The proposed additional 960m of hedgerows within the Proposed Wind Farm site will result in approximately a 26% addition of linear features. The replanting will focus on integrating with existing hedgerow networks, reinforcing connectivity across the landscape, and providing long-term biodiversity benefits.

2.3.2 Scrub (WS1) and Broadleaved Woodland (WD1) Loss

The proposed road between T7 and T9 will traverse through a small section of this habitat and therefore considered a KER for further assessment. Additionally, proposed roads between T5 and T6, infrastructure associated with T5, and hardstands/a small section of a proposed road at T2 will result in the loss of areas of recolonizing scrub associated with cutover bog (PB4) habitats within the Proposed Wind Farm site.

The existing broadleaf woodland (WD1) within the Proposed Wind Farm site is located south of the proposed road between T5/T9 and T8. These habitats are plantation forestry associated with the adjoining conifer woodland (WD4) to the northwest. One block of this forestry is a monoculture of Alder (*Alnus glutinosa*) and a smaller plot is Ash (*Fraxinus excelsior*) woodland. The ash woodland is affected by ash dieback. There is approximately 3.80ha total of existing broadleaved woodland (WD1), made up of approximately 0.90 of the Ash (*Fraxinus excelsior*) plantations affected by Ash Dieback, and 2.9ha of the Alder woodland. There is also approximately 15.94ha of monoculture Sitka spruce (*Picea sitchensis*) conifer plantation (WD4) within the Proposed Wind Farm site.

There will be a loss of approximately 0.17ha of broadleaved woodland largely concentrated within the Ash plantation as a result of a turning bay within the proposed new access road. It is proposed to replace all conifer plantation woodland (WD4) with healthy native trees of various ages in order to enhance the age structure and longevity of this woodland.

2.3.3 Cutover Bog (PB4) Loss

The Proposed Wind Farm will result in the loss of this habitat area for sections of the proposed new road between T7 to T9, between T5 to T9 and between T5 to T6. Additional areas will be lost to accommodate T5 and associated hard-standing areas, as well as a section of the hard-standing areas of T2. Peat repository and spoil repository areas (PRA2 and SRA4) are included in these loss calculations.

There is approximately 42.0ha of existing cutover bog habitat within the Proposed Wind Farm site boundaries. There will be a loss of approximately 2.12ha of PB4 habitat, which constitutes a loss of approximately 5% of the total habitat area. The peat required to be extracted to accommodate these infrastructure areas will be stored within peat storage areas within the Site.

2.3.4 Raised Bog (PB1) Loss

The northwest side of the Proposed Wind Farm site is mapped under Article 17 habitat as Annex I Active Raised Bog [7110]. A section of approximately 580m of the proposed new floating road between T7-T9 will be located within the mapped Article 17 habitat. The proposed 'floating road' is detailed in Section 4.9.2.1 of Chapter 4 Description of this EIA.

The habitat areas within the Proposed Wind Farm site corresponding to the habitat uncut raised bog (PB1) are largely found in a number of small, non-continuous areas. All of these habitat areas have been drained and the entire high bog area is surrounded by either historical or active peat extraction, with small pockets of uncut areas that have not been drained. Approximately 285m of the proposed floating road will travel through the raised bog (PB1) habitat, while the remaining 295m will travel through the cutover bog (PB4) habitat.

Approximately 32.29ha of PB1 habitats exist within the Proposed Wind Farm site. The loss of approximately 0.18ha for the proposed new road between T7 and T9 will result in the loss of approximately 0.54% of the total habitat area within the Proposed Wind Farm site. However, this loss is still considered to be a significant loss of habitat.

3.1.1 Enhancement and protection of Existing Rich Fen (PF1) Habitat

An existing rich fen (PF1) habitat has been identified within a stand-alone field to the east of the main area of the Proposed Project. Species recorded within this habitat are indicators species of the Annex 1 habitat 7230 Alkaline Fen, and therefore there this habitat likely confirms to 7230 Alkaline Fen.

Early on in this project, this habitat area was originally proposed as the location for the proposed substation. However, following the surveys carried out within this area, it was flagged as unsuitable for infrastructure. This field has been retained as part of the Proposed Project in order to provide enhancement opportunities with landowner agreements in place to implement.

Given that the existing habitat already corresponds to rich fen (PF1), the following measures will be implemented to ensure that the habitat is enhanced and does not deteriorate in condition due to heavy management or grazing.

Low intensity cattle grazing (0.03 Livestock Unit/ha³) will be implemented within this area with existing cattle, which will help to reduce the dominance of taller plants as cattle are less selective feeders. Grazing will also help to prevent the spread of encroaching scrub. Grazing should be carried out between May and late September each year.

As the grounds get wetter, reduce grazing to prevent poaching of specific areas of this habitat area.

Do not implement any additional drainage works within the field or the adjoining fields.

Existing drains and ditches may need occasional clearing to prevent silt build up.

Do not allow scrub to recolonize the fen habitat. Some low-laying scrub can be beneficial, but do not let dominate.

Cutting back may be necessary to prevent overgrowth.

There will be no fertilization applied within the grassland field surrounding the existing fen habitat. Fens are sensitive of pollution and may suffer from pollution.

Invasive species are known to readily colonize fen, marsh and swamp habitats. Invasive species management will be required if they begin to recolonize these habitat areas.

3.1.2 Protection and Maintenance of Existing Marsh Fritillary Breeding Habitat

It is proposed to enhance approximately 3.2ha of existing grassland areas that have existing marsh fritillary suitable habitat and an abundance of devil's bit scabious (*Succisa pratensis*), the larval foodplant of the species, within the Proposed Wind Farm site.

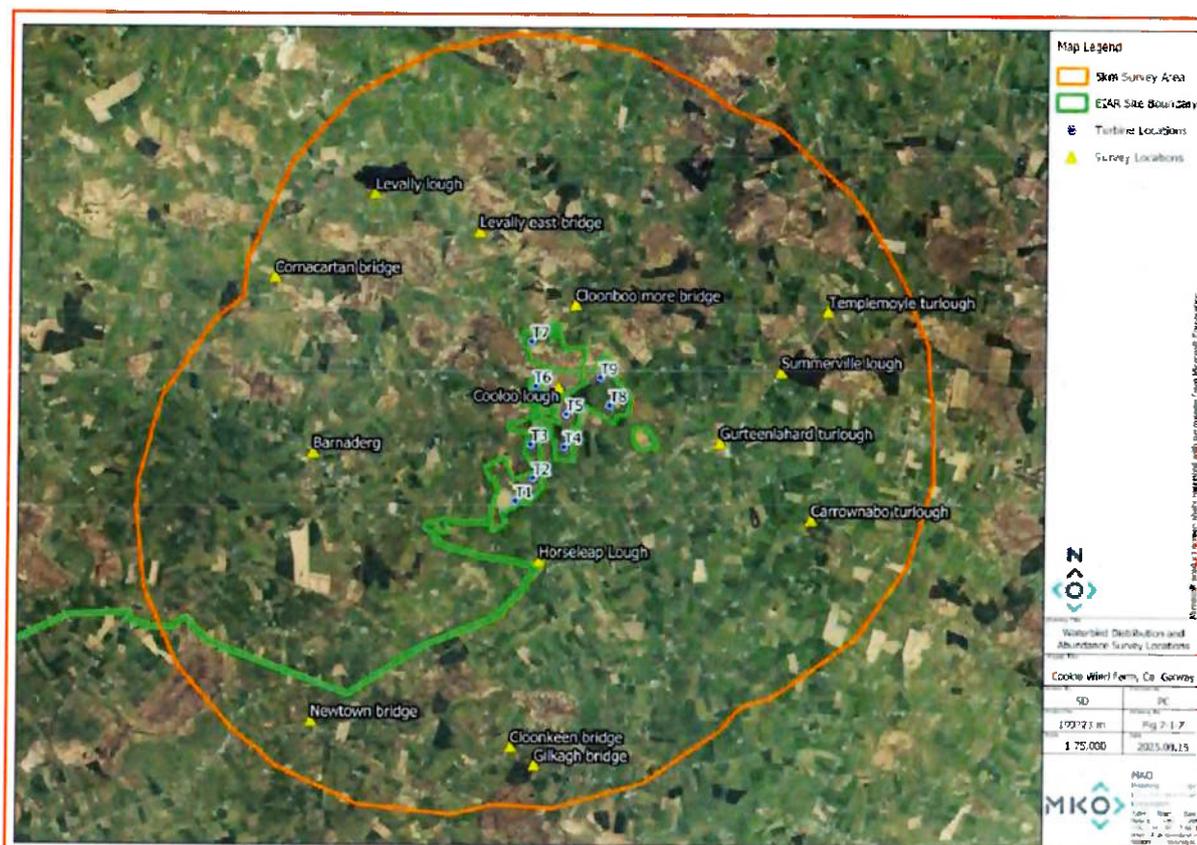
Existing marsh fritillary breeding habitats that occur adjacent to the proposed road from T5 and adjacent to the proposed turbine base at T5 will be fenced off in advance of construction of the Proposed Wind Farm. These areas were identified during ecological surveys of the Proposed Wind Farm, and the Proposed Project was designed to avoid these areas. The fencing will contain signage strictly prohibiting entry to these areas. This will denote the area where strictly no machinery, storage of materials or entry of construction site personnel will be permitted. The protective fencing will be inspected and signed off by the supervising ECoW prior to commencement of the Proposed Project. As described in Chapter 6 of the EIA, the following protective measures will be in place:

- Existing known marsh fritillary breeding areas will be fenced off with a minimum buffer of 5m. This is particularly important at the known location of a larval web, directly north of T5.
- The construction works area for proposed turbine T5 and associated site access routes will be fully fenced off (with solid hoarding where possible) to ensure there is no access or egress to adjacent areas of sensitive habitat.

There is no infrastructure proposed within the small stand-alone field to the east of the Proposed Project. There will be no access requirements to this area for construction or operation of the Proposed Wind Farm site or for the Proposed Grid Connection Route. The field was retained entirely as a habitat enhancement opportunity. Therefore, the known Marsh Fritillary habitat with larval webs does not need to be fenced off from any work. However, management of this habitat area in order to enhance the suitability of this habitat has been provided below in Section 3.4.2 below.

No further significant residual effects on features of International, National, County Importance or Local importance (higher value) were identified.

The proposal will result in a net gain of 960m of hedgerows, 1.23km of permanent fencing and riparian hedgerow planting, as well as planting 11.5ha of broadleaved woodland to offset the loss of 0.17ha of broadleaf woodland and 11.25ha of conifer woodland. Enhancement proposals will enhance the existing Annex 1 habitat 7230 Alkaline Fen habitat, marsh fritillary habitat, bog woodland/scrub enhancement, encouraging long-flowering meadows in existing agricultural grassland and creating new marsh fritillary habitat within existing wet grassland areas.



APPENDIX 7-2 SPECIES LIST

1. TARGET SPECIES RECORDED	Species Name	Scientific Name
	Barn Owl	Tyto alba
	Buzzard	Buteo buteo
	Common Gull	Larus canus
	Curlew	Numenius arquata
	Golden Plover	Pluvialis apricaria
	Great White Egret	Egretta alba (Ardea alba)
	Grey Wagtail	Motacilla cinerea
	Hen Harrier	Circus cyaneus
	Kestrel	Falco tinnunculus
	Kingfisher	Alcedo atthis
	Lapwing	Vanellus vanellus
	Little Egret	Egretta garzetta
	Long-eared Owl	Asio otus
	Meadow Pipit	Anthus pratensis
	Merlin	Falco columbarius
	Peregrine Falcon	Falco peregrinus
	Pochard	Aythya ferina
	Redwing	Turdus iliacus
	Shoveler	Spatula clypeata
	Snipe	Gallinago gallinago
	Sparrowhawk	Accipiter nisus
	Swift	Apus apus
	Whooper Swan	Cygnus cygnus
	Woodcock	Scolopax rusticola
2. NON-TARGET SPECIES RECORDED	Species Name	Scientific Name
	Barn Swallow	Hirundo rustica
	Blackbird	Turdus merula

Blackcap	<i>Sylvia atricapilla</i>
Blue Tit	<i>Cyanistes caeruleus</i>
Bullfinch	<i>Pyrrhula pyrrhula</i>
Canada Goose	<i>Branta canadensis</i>
Chaffinch	<i>Fringilla coelebs</i>
Chiffchaff	<i>Phylloscopus collybita</i>
Coal Tit	<i>Pariparus ater</i>
Collared Dove	<i>Streptopelia decaocto</i>
Redpoll	<i>Acanthis flammea</i>
Cuckoo	<i>Cuculus canorus</i>
Dunnock	<i>Prunella modularis</i>
Fieldfare	<i>Turdus pilaris</i>
Garden Warbler	<i>Sylvia borin</i>
Goldcrest	<i>Regulus regulus</i>
Goldfinch	<i>Carduelis carduelis</i>
Grasshopper Warbler	<i>Locustella naevia</i>
Great Spotted Woodpecker	<i>Dendrocopos major</i>
Great Tit	<i>Parus major</i>
Greenfinch	<i>Chloris chloris</i>
Hooded Crow	<i>Corvus cornix</i>
House Martin	<i>Delichon urbicum</i>
House Sparrow	<i>Passer domesticus</i>
Jackdaw	<i>Coloeus monedula</i>
Jay	<i>Garrulus glandarius</i>
Linnet	<i>Linaria cannabina</i>
Long-tailed Tit	<i>Aegithalos caudatus</i>
Magpie	<i>Pica pica</i>
Mistle Thrush	<i>Turdus viscivorus</i>
Pheasant	<i>Phasianus colchicus</i>
Pied Wagtail	<i>Motacilla alba</i>
Raven	<i>Corvus corax</i>
Reed Bunting	<i>Emberiza schoeniclus</i>
Robin	<i>Erithacus rubecula</i>
Rook	<i>Corvus frugilegus</i>
Sand Martin	<i>Riparia riparia</i>
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>
Siskin	<i>Spinus spinus</i>
Skylark	<i>Alauda arvensis</i>
Song Thrush	<i>Turdus philomelos</i>
Spotted Flycatcher	<i>Muscicapa striata</i>
Starling	<i>Sturnus vulgaris</i>
Stonechat	<i>Saxicola rubicola</i>
Treecreeper	<i>Certhia familiaris</i>
Whitethroat	<i>Sylvia communis</i>
Willow Warbler	<i>Phylloscopus trochilus</i>
Woodpigeon	<i>Columba palumbus</i>
Wren	<i>Troglodytes troglodytes</i>

**APPENDIX 7-3
SUMMARY DATA**

Table 7.3.1 Summary of vantage point records

Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Buzzaard	2019	number of observations										7	5	3	15	
		flight duration (seconds)											2833	760	97	3690
		bird seconds at PCH											1900	480		2470
	2020	number of observations	5	2	10	5	7	4	1	1			2		2	39
		flight duration (seconds)	642	1300	4063	3030	3935	240	25	40			2430		420	16125
		bird seconds at PCH	220	370	3095	1290	1838	85					400		80	7378
	2021	number of observations		2	4	2				4	3		3	2	1	21
		flight duration (seconds)		5	595	430				1920	1070		200	10		4260
		bird seconds at PCH			810	100				300	820					2030
	2022	number of observations		2	6											8
		flight duration (seconds)		260	2477											2737
		bird seconds at PCH			1195											1195
	2023	number of observations												17	1	18
		flight duration (seconds)												906	22	928
		bird seconds at PCH												121		121
	2024	number of observations	7	1	5	9	1	12			1	6		10		52
		flight duration (seconds)	235	142	1340	5164	804	6320			43	2202		3354		19604
		bird seconds at PCH	22	71	670	2766	402	5899				646		2048		12524
2025	number of observations		12	11											23	
	flight duration (seconds)		1543	5234											6777	
		bird seconds at PCH		313	3142										3455	



Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Golden Plover	2019	number of observations										9	9	9	27	
		flight duration (seconds)											10140	1715	8020	19675
		bird seconds at PCH											226400	64740	1829830	2120970
	2020	number of observations	9	10	7	1								1	3	31
		flight duration (seconds)	8660	15016	5600	90								45	500	29911
		bird seconds at PCH	805000	4744838	206700	765									22000	5779303
	2021	number of observations	2	3	2								9	1	3	20
		flight duration (seconds)	956	295	180								4020	240	4640	10331
		bird seconds at PCH	123025	7150	17600								11970	700	280500	441845
	2022	number of observations	3	3	3											9
		flight duration (seconds)	390	1440	347											2177
		bird seconds at PCH	2700	128000	448											131148
	2023	number of observations											2	10		12
		flight duration (seconds)											432	9640		10072
		bird seconds at PCH											43440	724846		768286
	2024	number of observations		5		2										7
		flight duration (seconds)		1378		886										2264
		bird seconds at PCH		3836		12618										16454
	2025	number of observations		2												2
		flight duration (seconds)		4980												4980
		bird seconds at PCH		17,8500												1738500

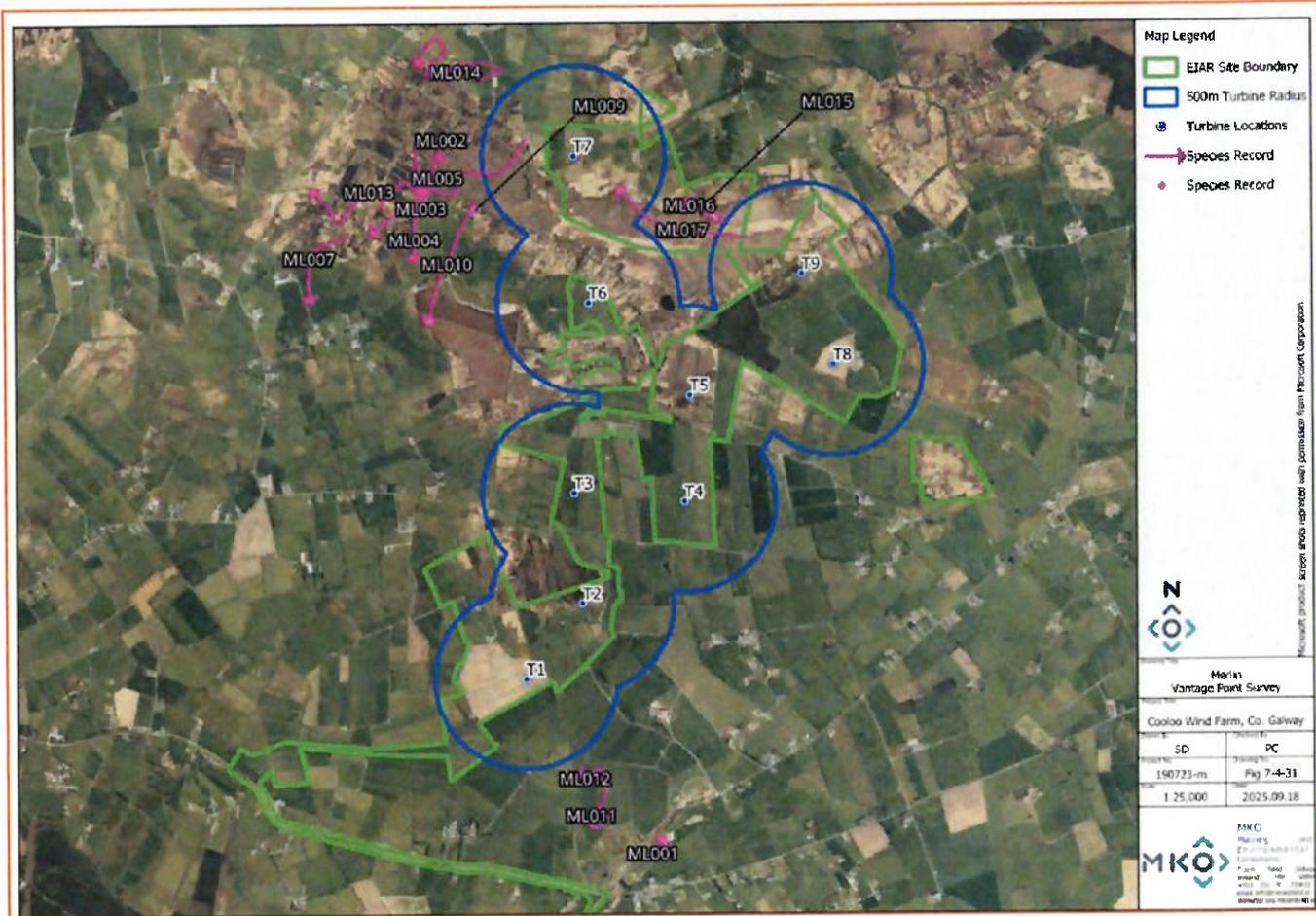
A proportion of golden plover winter flight activity was associated with Horseleap Lough, which provides suitable habitat for the birds. This flight activity was predictable, consistent, and generally involved short or circling flights around and over the lough. These flights were outside the turbine area (defined as a 500m radius of the proposed turbine layout). Because of the regular flight pattern (i.e., predictable and consistent), a regular model was applied to these flights.



Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Keastrel	2019	bird seconds at PCH										2	7	5	14	
		number of observations											171	1548	430	2149
		flight duration (seconds)											58	570	200	828
	2020	bird seconds at PCH	9	13	8	6	2		1	1	3	2	2	6	53	
		number of observations	394	1478	978	2060	281		30	180	470	920	150	1260	8201	
		flight duration (seconds)	50	250	250	320	99					150	20	320	1459	
	2021	bird seconds at PCH	3		8	1	1	2	5	3		5	1	2	31	
		number of observations	227		2505	80	180	360	910	310		420	950	50	5992	
		flight duration (seconds)	60		150			80	80	100		50	200		720	
	2022	bird seconds at PCH		1	1										2	
		number of observations		30	68										98	
		flight duration (seconds)														
2023	bird seconds at PCH											4	8	5	17	
	number of observations											910	555	1798	3203	
		bird seconds at PCH										261	92	516	869	
2024	number of observations	1		1		1	5	7	1	2	4	15	2	39		
	flight duration (seconds)	92		733		212	1590	1964	64	871	659	744	149	7078		
	bird seconds at PCH	21		210		36	593	400		200	296	75		1831		
2025	number of observations		4	3										7		
	flight duration (seconds)		976	322										1298		
	bird seconds at PCH		300	20										320		



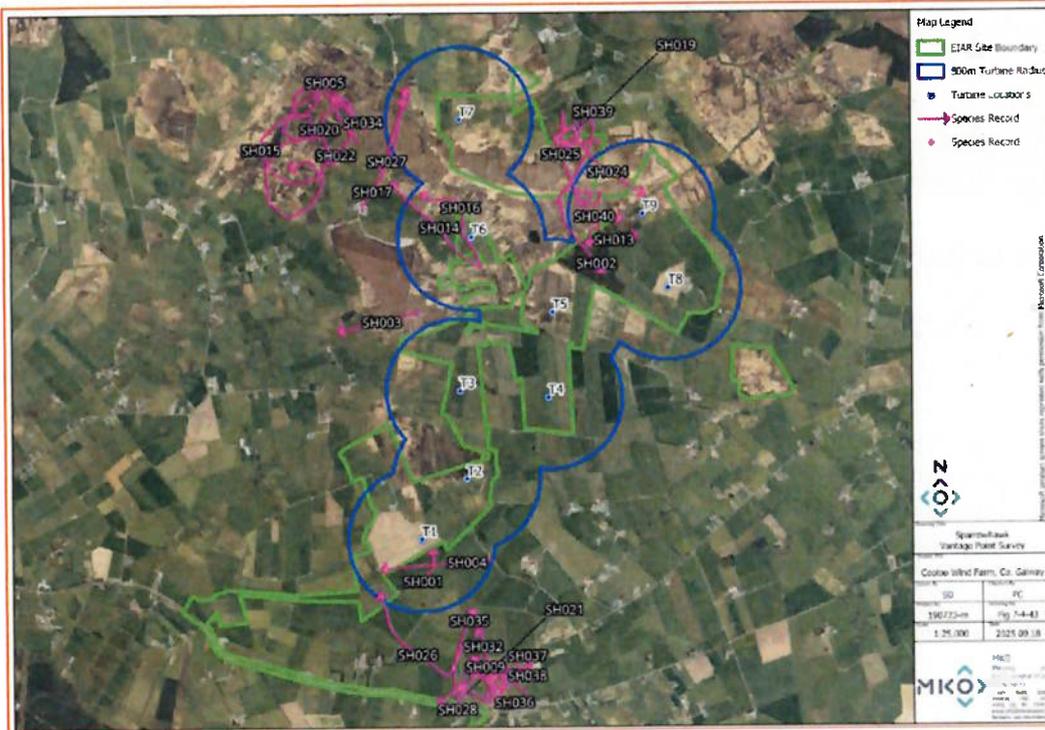
Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Merlin	2019	number of observations										1			1	
		flight duration (seconds)											8			8
		bird seconds at PCH														
	2020	number of observations													11	11
		flight duration (seconds)													445	445
		bird seconds at PCH													20	20
	2021	number of observations														
		flight duration (seconds)														
		bird seconds at PCH														
	2022	number of observations	2													2
		flight duration (seconds)	220													220
		bird seconds at PCH														
	2023	number of observations														
		flight duration (seconds)														
		bird seconds at PCH														
2024	number of observations		2				1								3	
	flight duration (seconds)		17				52								69	
	bird seconds at PCH						26								26	
2025	number of observations															
	flight duration (seconds)															
	bird seconds at PCH															



Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Peregrine Falcon	2019	number of observations												1	1	
		flight duration (seconds)												5	5	
		bird seconds at PCH														
	2020	number of observations	2						2							4
		flight duration (seconds)	1195						87							1282
		bird seconds at PCH	290						30							320
	2021	number of observations										1			1	
		flight duration (seconds)										120			120	
		bird seconds at PCH										30			30	
	2022	number of observations	1													1
		flight duration (seconds)	50													50
		bird seconds at PCH														
	2023	number of observations											2			2
		flight duration (seconds)											380			380
	2024	bird seconds at PCH											170			170
		number of observations														
		flight duration (seconds)														
	2025	bird seconds at PCH														
		number of observations				1										1
flight duration (seconds)					12										12	
		bird seconds at PCH														



Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Sparrowhawk	2019	number of observations										1	1		2	
		flight duration (seconds)											74	90		164
		bird seconds at PCH														
	2020	number of observations	2			1	1				1				6	11
		flight duration (seconds)	170			20	10				20				122	342
		bird seconds at PCH	65													65
	2021	number of observations			1				1				1		3	
			flight duration (seconds)			60			510				40			610
			bird seconds at PCH						50							50
2022		number of observations														
		flight duration (seconds)														
2023		number of observations											3	2	5	
		flight duration (seconds)											47	62	109	
2024		number of observations	3	1	1		3	2	2			2	3		17	
		flight duration (seconds)	149	35	74		47	293	38			48	192		876	
		bird seconds at PCH						139					81		220	
2025		number of observations	1		1										2	
		flight duration (seconds)	116		166										282	
		bird seconds at PCH														



Species	Year	Observations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
Whooper Swan	2019	number of observations										4	14	2	20	
		flight duration (seconds)											380	1365	85	1830
		bird seconds at PCH											558	2517		3075
	2020	number of observations	11	13	10	1			1				1	1	7	45
		flight duration (seconds)	308	236	468								250		465	1787
		bird seconds at PCH	78		25										420	523
	2021	number of observations	6	5	1								1	3	10	26
		flight duration (seconds)	140	25	105								600	160	320	1350
		bird seconds at PCH											2100		90	2190
	2022	number of observations	2	15	10											27
		flight duration (seconds)		980	146											1126
		bird seconds at PCH		60												60
	2023	number of observations											1	8	3	15
		flight duration (seconds)											450	1534	21	2005
		bird seconds at PCH												356		356
	2024	number of observations	34	22	3								1	5		65
		flight duration (seconds)	2833	809	243								216	425		4526
		bird seconds at PCH	2540	249	120								108	396		3413
	2025	number of observations	13	9	6											28
		flight duration (seconds)	918	654	426											1798
		bird seconds at PCH		2120	143											2263

A proportion of whooper swan flight activity was associated with Horseleap Lough and surrounds, which provides suitable foraging and roosting habitat that is favoured by the birds. This flight activity was predictable, consistent, and generally involved short or circling flights around and over the lough and fields. These flights were often outside the turbine area. Because of the regular flight pattern, a regular model was applied to these flights.

Response: This site is centered in the East Galway lakes & turloughs that host a myriad of bird species. Using loose English to try and justify the installation of a bird killing facility, a habitat & foraging reducer determines that the Precautionary Principle be used to refuse the development.

APPENDIX 7-6 Collision Risk Assessment

2. METHODOLOGY

2.1 The Band Model. *Band et al. (2007):*

- Birds are assumed to be of a simple cruciform shape;
- Turbine blades are assumed to have length, depth and pitch angle, but no thickness;
- Birds fly through turbines in straight lines;
- Bird flight is not affected by the slipstream of the turbine blade;
- Because the model assumes that no action is taken by a bird to avoid collision, it is recognised that the collision risk figures derived are purely theoretical.

Response: No objective peer reviewed Scientific papers are included for these assumptions.

Two forms of collision risk modelling a 'Regular Flight Model' and the 'Random Flight Model'.

The Regular Flight Model predicts the number of transits through a cross-sectional area of a wind farm which represents the width of the commuting corridor.

There are a number of key assumptions and limitations:

- **The turbine rotor swept area is 2-dimensional, i.e. there is a single row of turbines in the wind farm.** This represents all turbines within the commuting corridor accounted for by a single straight-line;
- Bird activity is spatially explicit;
- **Birds in an observed flight only cross the turbine area once and do not pass through the cross-section a second time (or multiple times);**
- Habitat and bird activity will remain the same over time and be unchanged during the operational stage of the wind farm;
- All flight activity used in the model occurred within the viewshed area calculated at the lowest swept rotor height.

The **Random Flight Model** predicts the number of transits through a wind farm while assuming that all flights within the vantage point viewshed are randomly occurring (i.e., any observed flight could just as easily occur within a wind farm site as outside it).

- Bird activity is not spatially explicit, i.e. activity is equal throughout the viewshed area and this is equal to activity in the wind farm area;
- Habitat and bird activity will remain the same over time and be unchanged during the operational stage of the wind farm;
- All flight activity used in the model occurred within the viewshed area calculated at the lowest swept rotor height.

Table 7-5-3 Bird biometrics

Species	Body Length (m)	Wingspan (m)	Flight Speed (m/s)
Golden Plover	0.275	0.715	17.9
Hen Harrier	0.48	1.1	9.1
Merlin	0.275	0.56	10.9
Peregrine Falcon	0.445	1.05	12.1
Whooper Swan	1.5	2.2	17.3
Kestrel	0.335	0.755	10.1
Lapwing	0.295	0.815	12.8
Snipe	0.255	0.42	17.1
Buzzard	0.54	1.205	11.6
Long-eared Owl	0.36	0.895	6.7
Sparrowhawk	0.33	0.625	10

Table 7-5-4 presents the model input values. During field surveys, bird flight height was assigned to predefined height bands (0-15m, 15-25m, 25-200m and 200m+). For the assessment of the V162 turbine scenario, birds in flight within the viewshed at height bands between 15-200m above ground level have been included in the collision risk model. For the assessment of the SG155 and V150 turbine scenarios, birds in flight within the viewshed at the height band between 25-200m above ground level have been included.

For the random model, input values were bird seconds in flight at PCH observed from the vantage points during the relevant survey period. Bird seconds in flight at PCH is calculated by multiplying the number of birds observed per flight by the duration of the flight spent within PCH. For the regular model, input values were the number of birds crossing into the risk area at PCH observed from the vantage points during the relevant survey period. To apportion the 12 regular golden plover flights, 143 regular lapwing flights and 152 regular whooper swan flights into those at risk and those not at risk of a collision, the following mapping exercise was undertaken to delineate where a collision could theoretically occur. The following paragraph should be read in conjunction with Figure 7-6-1.

On a map of the turbine area, a line was drawn connecting the centroid of the turbine area to the centroid of Horseleap Lough (as delineated on the Ordnance Survey map). Two additional parallel lines were drawn- one marking the maximum extent of the turbine area in one direction, and the other in the other direction. A fourth line was drawn perpendicular to the first line marking the closest extent of the turbine area to Horseleap Lough. The length of this fourth line was the distance between the two parallel lines (i.e., the maximum extent of the turbine area; 2,562m). This fourth line represents the area in space at which flying birds associated with Horseleap Lough and the surrounding agricultural grassland fields could enter the turbine area, in which there is potential for a collision to occur.

Golden plover flights at PCH that intersect the fourth line were included in the model. These represent **golden plover** crossing between Horseleap Lough and the turbine area, **where there is potential for a collision to occur**. A total of eight flights intersected this line.

Similarly, lapwing flights at PCH that intersect the fourth line were included in the model. These represent **lapwing** crossing between L-2 and the turbine area, **where there is potential for a collision to occur**. A total of 54 flights intersected this line. Finally, whooper swan flights at PCH that intersect the fourth line were included in the model. These represent **whooper swan** crossing between WS-2 and the turbine area, **where there is potential for a collision to occur**. A total of 93 flights intersected this line.

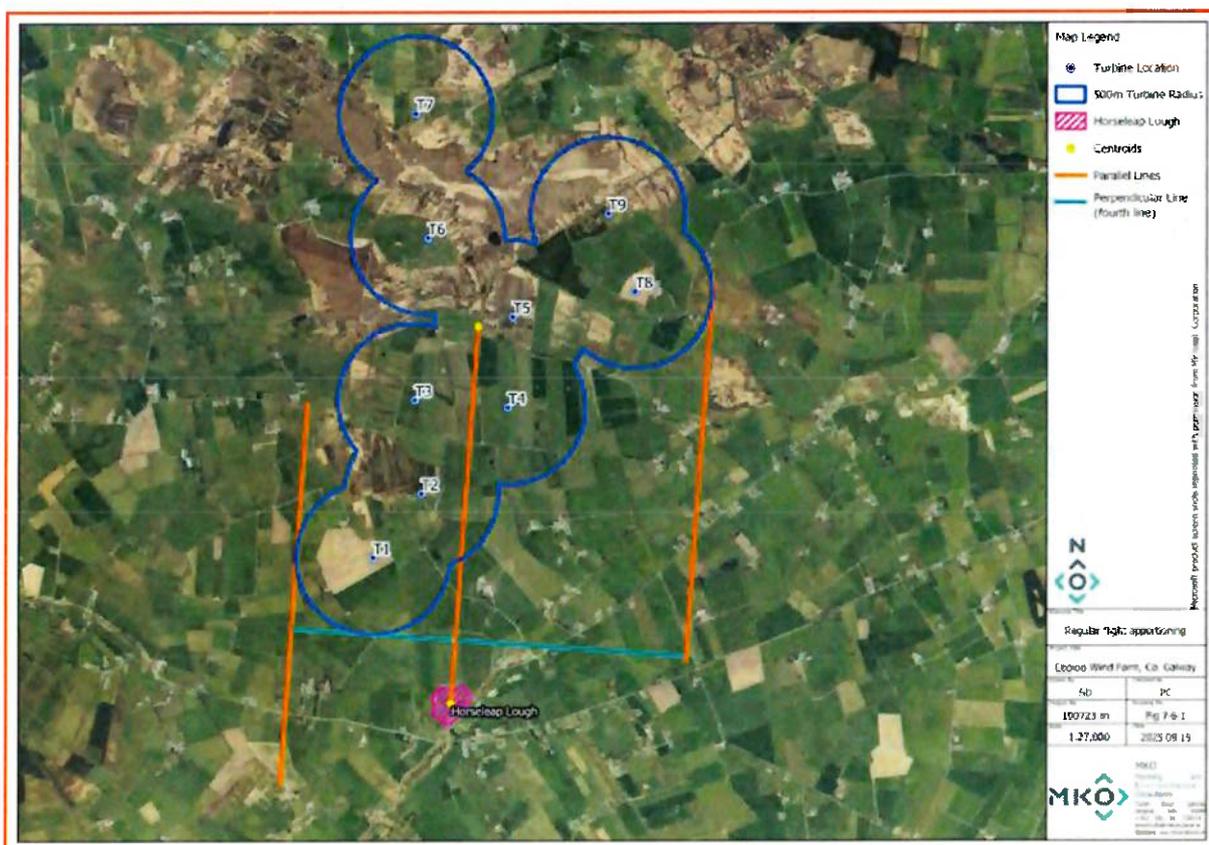


Table 7-3-3. Collision risk predictions. For each species, the survey period and model type are specified, along with the predicted number of transects through the risk area and the collision risk (the flying, flight, gliding flight and the average of both). Two values for collision risk are presented: the total collision risk without avoidance and a final estimated collision risk (with an avoidance factor). Finally, the estimated number of collisions over the lifetime of the turbine is presented, along with the corresponding estimated number of years of operation for one collision to occur.

Species	Survey Period	Model	Transects	Collision Risk			Collision Rate			Estimated Collisions Over Lifetime of Wind Farm	One Bird Collision
				flying	gliding	overall	without avoidance	with avoidance factor	with avoidance		
Scenario V102											
Golden Plover	October to April	random	1101.985	4.15%	no gliding flight	4.45%	4900	99.6%	196,200	6967 birds	<1 year
Hen Harrier	September to March	random	8.7	6.24%	6.13%	6.19%	0.34	99%	0.005	0.19 birds	186 years
Merlin	All	random	3	3.81%	3.77%	3.78%	0.14	98%	0.003	0.1 birds	348 years
Peregrine Falcon	All	random	49.8	5.49%	5.34%	5.12%	2.21	98%	0.041	1.75 birds	23 years
Whooper Swan	October to April	random	1202	8.11%	no gliding flight	8.11%	97.52	99.5%	0.488	17.07 birds	2 years
Kestrel	All	random	475.7	5.23%	5.16%	5.19%	24.7	95%	1.235	33.25 birds	1 year
Lapwing	Winter	random	8769.5	3.82%	no gliding flight	3.82%	122.4	98%	8.448	295.68 birds	<1 year
Snipe	All	random	3574	4.29%	no gliding flight	4.29%	153.31	98%	3.066	107.32 birds	<1 year
Buzzard	All	random	1790.9	5.98%	5.81%	5.91%	105.98	98%	2.116	74.12 birds	<1 year
Long-eared Owl	Breeding	random	1.1	6.31%	6.27%	6.28%	0.169	98%	0.002	0.06 birds	581 years
Sparrowhawk	All	random	33.1	5.19%	5.14%	5.16%	1.71	98%	0.034	1.2 birds	29 years
Lapwing	Winter	regular	24305.8	4.82%	no gliding flight	4.82%	1170.74	98%	23.415	819.52 birds	<1 year
Golden Plover	October to April	regular	9037.7	4.45%	no gliding flight	4.45%	492.12	99.6%	1.610	56.34 birds	1 year
Whooper Swan	Winter	regular	3473.1	8.11%	no gliding flight	8.11%	281.79	99.5%	1.109	49.91 birds	1 year
Scenario SG155											
Golden Plover	October to April	random	860285.6	4.17%	no gliding flight	4.37%	35880.3	99.6%	143.521	9723.23 birds	<1 year
Hen Harrier	September to March	random	2.1	5.63%	5.51%	5.58%	0.12	98%	0.001	0.61 birds	867 years
Merlin	All	random	1.6	4.4%	4.31%	4.37%	0.08	98%	0.002	0.03 birds	649 years

Peregrine Falcon	All	random	22	5.04%	4.80%	4.95%	1.09	98%	0.022	0.76 birds	46 years
Whooper Swan	October to April	random	500.7	7.32%	no gliding flight	7.32%	37.26	99.5%	0.116	6.32 birds	5 years
Kestrel	All	random	222.6	4.78%	4.67%	4.72%	10.31	95%	0.526	18.89 birds	2 years
Lapwing	Winter	random	7997.9	4.47%	no gliding flight	4.47%	337.57	98%	7.151	250.3 birds	41 years
Snipe	All	random	1900.7	3.97%	no gliding flight	3.97%	73.78	98%	1.516	510.5 birds	1 year
Buzzard	All	random	1220.2	5.43%	5.26%	5.33%	65.8	98%	1.316	46.06 birds	1 year
Sparrowhawk	All	random	13.9	4.73%	4.63%	4.68%	0.65	98%	0.013	0.45 birds	77 years
Lapwing	Winter	regular	19790.2	4.47%	no gliding flight	4.47%	881.78	98%	17.686	619.35 birds	41 years
Golden Plover	October to April	regular	6127.4	4.17%	no gliding flight	4.17%	253.36	99.0%	1.022	35.78 birds	1 year
Whooper Swan	Winter	regular	766.4	7.32%	no gliding flight	7.32%	36.13	99.5%	0.281	9.82 birds	4 years
Scenario V130											
Golden Plover	October to April	random	739307.9	4.3%	no gliding flight	4.3%	32651.37	99.0%	1.30645	4571.19 birds	41 years
Hen Harrier	September to March	random	1.9	5.27%	5.63%	5.7%	0.11	95%	0.001	0.04 birds	500 years
Merlin	All	random	1.7	4.52%	3.14%	4.48%	0.07	98%	0.001	0.05 birds	469 years
Peregrine Falcon	All	random	20.8	5.16%	4.93%	5.06%	1.07	98%	0.021	0.74 birds	46 years
Whooper Swan	October to April	random	437.9	7.96%	no gliding flight	7.96%	34.16	99.7%	0.171	5.98 birds	6 years
Kestrel	All	random	207.3	4.9%	4.78%	4.84%	10.03	95%	0.501	17.55 birds	2 years
Lapwing	Winter	random	7648.7	4.6%	no gliding flight	4.6%	351.62	98%	7.032	246.14 birds	41 years
Snipe	All	random	1680.8	4.08%	no gliding flight	4.08%	88.09	98%	1.88	18.29 birds	1 year
Buzzard	All	random	1134.1	5.58%	5.37%	5.48%	62.65	98%	1.253	13.86 birds	1 year
Sparrowhawk	All	random	12.2	4.84%	4.76%	4.8%	0.28	98%	0.012	0.41 birds	86 years
Lapwing	Winter	regular	19111.8	4.6%	no gliding flight	4.6%	880.15	98%	17.669	616.31 birds	41 years
Golden Plover	October to April	regular	5826.8	4.3%	no gliding flight	4.3%	254.9	99.0%	1.02	35.69 birds	1 year
Whooper Swan	Winter	regular	741.7	7.96%	no gliding flight	7.96%	33.33	99.5%	0.277	9.68 birds	4 years

APPENDIX 7-6-1: GOLDEN PLOVER AVOIDANCE RATES. REPORT NUMBER: 2211-F1 STATUS OF REPORT: Revision 2
DATE OF REPORT: 18 July 2022. Tom Gittings BSc, PhD, MCIEEM, Ecological Consultant, 3 Coastguard Cottages, Roches Point, Whitegate, CO. CORK www.gittings.ie

3. REVIEW OF GOLDEN PLOVER AVOIDANCE RATES

3.1. SOURCES

I found post-construction monitoring reports for three UK wind farms that provide robust data on Golden Plover collision fatality rates, and, for which, there was appropriate data available that could be used to estimate avoidance rates. These reports were for the Blood Hill Wind Farm (Percival *at al.*, 2008), the Goole Fields I Wind Farm (Percival *at al.*, 2018a) and the Goole Fields II Wind Farm (Percival *at al.*, 2018b, 2019). In addition, information on Golden Plover collision fatality rates and avoidance rates is included in the Habitats Regulations Assessment reports for another UK wind farm site (Haverigg II and III; Percival, 2020a, 2020b), although the reports do not contain sufficient detail to allow full review of the collision monitoring methods and results. Unless otherwise stated, all information and data used in this report for each wind farm was taken from the relevant references cited above.

The characteristics of these wind farms are summarised in Table 3.1.

Table 3.1. Characteristics of the wind farms.

Wind farm	Location	Commissioned	Number of turbines	Hub height (m)	Turbine diameter (m)
Blood Hill Wind Farm	Norfolk	1992	10	30	27
Goole Fields I	Yorkshire	2014	16	80	92
Goole Fields II	Yorkshire	2016	17	80	92
Haverigg II	Cumbria	1998	4	62.5	42
Haverigg III	Cumbria	2005	4	76	52

Sources: Percival (2020a, 2020 b); Percival *et al.* (2008, 2018a, 2018b, 2019).

3.2. COLLISION MONITORING

3.2.1. Methods

The post-construction monitoring for the Blood Hill and Goole Fields I and II wind farms were carried out by the same consultancy and used the similar methodology for collision monitoring. These included weekly searches for carcasses, and searcher efficiency trials and carcass removal trials (Table 3.2). The weekly carcass searches included detailed searches of radii of 100 m (Blood Hill and Goole Fields I), or 130 m (Goole Fields II) around each turbine, with an additional 250 m scanned for large carcasses (Goole Fields I and Goole Fields II). The carcasses found were left in situ to provide data on searcher efficiency and removal rates. In addition, dedicated searcher efficiency, and carcass removal, trials were carried out at all three wind farms. These involved putting out a number of carcasses. A separate observer then tried to locate these carcasses the same day, while the carcasses were also monitored by trail cameras to investigate removal rates.

Table 3.2. Collision monitoring methods. Wind farm	Seasons	Search frequency	Search radius	Searcher efficiency / carcass removal trials
Blood Hill	2006/07-2007/08	weekly	100 m	67 carcasses
Goole Fields I	2015/16-2018/19	weekly	100 m detailed search 250 m large carcass search	18 carcasses
Goole Fields II	2017/18-2018/19	weekly	130 m detailed search 250 m large carcass search	48 carcasses

APPENDIX 7-7 BIRD MITIGATION PLAN

The objective of the Bird Mitigation Plan is to reduce the significance of the effect of collision risk for golden plover. This will be achieved by introducing measures to reduce flight activity of golden plover in the vicinity of the operating turbines.

1.1 Golden Plover Ecology

During winter, foraging golden plover in Ireland utilise lowland agricultural pastures (particularly permanent pasture and damp fields), where their invertebrate prey resides just below the soil surface and are accessible to the birds, even during periods of cold weather. Golden plover may also utilise winter cereals, although their invertebrate prey tend to be less abundant here. Birds tend to avoid bare till, as the lack of vegetative insulation causes their invertebrate prey to move down the soil profile, where it cannot be reached by the birds (Fuller and Lloyd, 1981; Gillings and Fuller, 1999). There is some evidence that they may also avoid sheep pasture for similar reasons; sheep graze the grass tightly, reducing vegetative insulation and thus reducing access to invertebrate prey (Tucker, 1992). Golden plover also tend to avoid pasture with high swards (Brough and Bridgman, 1980; Gregory, 1987). This may be because invertebrate prey are more difficult to detect and access among obscuring vegetation, in combination with other factors such as reduced mobility and the chilling effects of wet vegetation (Butler and Gillings, 2004). Roosting golden plover utilise pasture and arable land during winter (Fuller and Lloyd, 1981). Open fields with short swards may be preferred because of improved predator detection by roosting flocks (Brough and Bridgman, 1980).

1.2 Description of Impacts

During pre-planning surveys from September 2019 to March 2025, golden plover was regularly recorded at the Proposed Wind Farm site in winter. Birds were observed in flight and sometimes foraging and roosting. Birds were observed foraging (it is possible some birds in these flocks were roosting) on grassland at Leecarrow (labelled as GP-3 in the map in Appendix 7-5). Flocks here were concentrated in the fields south of the Proposed Wind

Farm site boundary, however four were within the Proposed Wind Farm site boundary itself, in proximity to a proposed turbine location.

Other foraging activity was recorded outside the Proposed Wind Farm site. A flock was recorded foraging once at Cooloo, outside the Proposed Wind Farm site boundary and ~270m from the nearest proposed turbine location (GP-4). Birds were also foraging in a section of bog at Derrybaun (GP-1), largely outside the Proposed Wind Farm site and where no infrastructure is proposed.

Similarly, golden plover was recorded roosting in proximity outside the Proposed Wind Farm site. There was a roosting area in a section of bog at Derrybaun that was used on multiple occasions (GP-1). The roost was outside the Proposed Wind Farm site boundary and no infrastructure is proposed here. This section of bog is ~390m from the nearest proposed turbine location at the closest point. However, the separation distance exceeds 390m as birds were generally using the open centre of the bog (roughly 600m from the nearest proposed turbine location), rather than the nearest edge. There was a second roosting area at Horseleap Lough (GP-2). This roost was also outside the Proposed Wind Farm site boundary and ~900m from the nearest proposed turbine location.

During preparation of the EIA, a collision risk assessment was conducted for golden plover using the Band Model (Band, 2007). Data collected during vantage point surveys was used to predict the number of collisions that may be caused by a turbine, based on winter season flight activity (refer to Appendix 7-6 Collision Risk Assessment of the EIA). **The number of golden plover collisions per year was estimated to be 197.81 birds.**

The county population of golden plover was estimated to be 5,895 birds.

The literature indicates that annual natural mortality of golden plover is 27% (Sandercock, 2003). Thus, an estimated 1,591.65 golden plover in the county are assumed to die of natural causes each year. If 197.81 golden plover fatalities were to occur at the Proposed Wind Farm each year, it would increase mortality rates in the county population by 12%. This impact is of 'medium significance' (as defined by Percival, 2003). Thus, mitigation measures are proposed.

2.1 Approach

Collision risk mitigation will focus on reducing golden plover flight activity within 500m of the turbines. Because golden plover were observed flying in to forage in certain fields within the Proposed Wind Farm site, the mitigation approach is to deter birds from flying into these fields. Tethered bird control kites will be erected in the fields to provide visual deterrents. Similar approaches have been used to deter birds from airfields in Ireland to reduce the risk of collision with aircraft (O'Shea et al., 2020). Foraging golden plover often circle above foraging areas before choosing a patch to land and when relocating between patches, as well as when flushed by potential dangers. The absence of grounded foraging flocks should further reduce the flight activity of flocks in the turbine area. This mitigation approach will be implemented in the areas of the site that were observed to be the most regularly used by golden plover. The process of field selection for mitigation is discussed in further detail in the next section.



Bird Control Kites

The bird control kites will be imitations of raptor birds (eg. hawks, falcons) and attached to a tether approximately 8m in length, in turn attached to a pole approximately 10m in length, that is secured to the ground near the centre of the field to maximise the effect. This will create weaving and hovering movements akin to hunting raptor birds c. 2-18m above the ground and will be suitable for a range of wind speeds (O'Shea et al., 2020). This representation of a hunting predator will provide a deterrent to golden plover landing in the field. Bird control kites are widely used to deter birds from crops, businesses and gardens and have been shown to reduce the number of birds present in agricultural fields (O'Shea et al., 2020).

Response: The author of this report was previously employed by Fingal County Council as Senior Executive Engineer Environment in the mid 1990's. His responsibility extended to Dunsink & Balleally landfills. At that time we had major issues with birds as we were close to the Dublin Airport & flight paths. We tried kites and they worked for a week or two & the birds became accustomed to them. We then employed a Falconer with a hawk. The Birds within a very short period were able to recognise his vehicle as he entered the landfill. They disappeared until he left.

3. MONITORING AND EVALUATION

3.1 Previous Studies

Similar approaches to the Bird Mitigation Plan proposed here have been used to deter birds at other places. For example, O'Shea et al. (2020) investigated imitation hawk-kites as a method for deterring woodpigeons from airfields in Ireland. Trials with and without kites were conducted at an airfield and agricultural farmland. There was a significant reduction in the mean number of woodpigeons crossing sites with kites compared to control sites.

This approach has benefits in comparison to other bird deterrent approaches. It is a passive approach that does not require the use of disruptive noise or light (e.g., in comparison to other deterrence methods such as playing distress calls or using pyrotechnics and gas cannons), is not disturbing to landowners with livestock or crops (e.g., in comparison to deterring birds with trained falcons and dogs or using water spray) and is not disturbing to other wildlife (e.g., in comparison to ultrasound, infrasound or microwave broadcasts). A passive approach will also avoid risky evasive flying manoeuvres in birds that have entered the turbine area in comparison to many active bird control measures.

Based on the detailed assessment, it is considered that the potential effects of the Proposed Project upon birds will not be significant. Effects associated with habitat loss, disturbance displacement, collision risk and cumulative effects have been assessed to be no greater than long-term slight negative effect (EPA, 2017) and low effect significance (Percival, 2003).

Birds and windfarms

Table 1. Bird-windfarm collision studies: summary of findings.

Species group	Sites studied	Windfarm size	Turbine type	Exposure to collision risk	Incidence of collision	Population effect
Divers	Burgar Hill ^{1,4}	S	S/M	M	Nil	No
Cormorants	Buffalo Ridge ³	VL	M	L	Nil	No
Swans	Blyth ^{4,5}	S	S	L	VS	No
	Yukon ⁹	S	S	S	Nil	No
Greese	Urk ⁷	M	S	M/L	VS	No
	Buffalo Ridge ³	VL	M	L	Nil	No
	Klondike ⁸	M	M	M	S	No
	Kreekrak ¹¹	S	S	M	S	No
Ducks	Gotland ¹⁰	L	M	L	Nil	No
	Urk ⁷	M	S	M	Nil	No
	Blyth ^{4,5}	S	S	L	S	No
Eagles, vultures, hawks	Buffalo Ridge ³	VL	M	L	VS	No
	San Geronimo ¹²	VL	S	-	VS	No
	Kreekrak ¹¹	S	S	L	M	No
	Altamont ^{13,14}	VL	S	L	S	Likely
	Tehachapi ¹⁵	VL	S	-	VS	Possible
Hammers	San Geronimo ¹²	VL	S	-	VS	No
	Tarifa ^{16,17}	VL	S	L	VS	Possible
	Navarre ¹⁸	VL	M	L	S	Possible
	Buffalo Ridge ³	VL	M	M	Nil	No
Falcons	Altamont ^{13,14}	VL	S	L	VS	No
	Foot Creek Ram ⁹	L	M	-	VS	No
	Altamont ^{13,14}	VL	S	L	S	Possible
	Burgar Hill ¹	S	S	S	VS	No
	Novar ¹⁹	M	M	M	VS	No
Upland gamebirds	Tehachapi ¹⁵	VL	S	-	VS	No
	Tarifa ^{16,17}	VL	S	L	VS	Possible
	Buffalo Ridge ³	VL	M	S	VS	No
Owls	Novar ¹⁹	M	M	S	VS	No
	Tehachapi ¹⁵	VL	S	-	VS	No
	Altamont ^{13,14}	VL	S	L	VS	Possible
	San Geronimo ¹²	VL	S	-	VS	No
Waders	Tehachapi ¹⁵	VL	S	-	VS	Possible
	Kreekrak ¹¹	S	S	L	S	No
	Gotland ¹⁰	L	M	L	VS	No
	Blyth ^{4,5}	S	S	M/L	VS	No
	Oosterbaerum ¹⁸	M	S	M/L	VS	No
	Ovenden Moor ¹⁷	M	S	L	VS	No
Gulls	Buffalo Ridge ³	VL	M	L	VS	No
	Blyth ^{4,5}	S	S	L	M	No
	Kreekrak ¹¹	S	S	L	M	No
	Zeebrugge ²⁰	M	S/M	L	L	Possible
Terns	Buffalo Ridge ³	VL	M	L	Nil	No
	Zeebrugge ²⁰	M	S/M	L	M	Possible
Passerines	Blyth ^{4,5}	S	S	M	Nil	No
	Blyth ^{4,5}	S	S	M/L	Nil	No
	Buffalo Ridge ³	VL	M	L	M	No
	Oosterbaerum ¹⁸	M	S	L	L	No

KEY

Sources: 1. Meek *et al.* 1993; 2. Haworth 2002; 3. Johnson *et al.* 2000; 4. Still *et al.* 1995; 5. Hunter *et al.* 1999; 6. Missop 1998; 7. Winkelman 1998; 8. Young *et al.* 2003; 9. Johnson *et al.* 2000; 10. Percival 1990b; 11. Erickson *et al.* 2001; 12. Masters *et al.* 1995; 13. Thelander *et al.* 2003; 14. SEO/BirdLife 1995; 15. Leikona 2001; 16. Jans 2000; 17. Boosan 2001; 18. Winkelman 1992a; 19. EAS 1997; 20. Everaert *et al.* 2002; 21. Percival 2000.

Windfarm size: VL = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 KW-1.5 MW); S = small (<500 KW).

Exposure to collision risk (based on number of nights at outer edge or proximity to turbines per year): L = large (>10,000); M = medium (1,000-10,000); S = small (<1,000).

Incidence of collision: L = large (>10/turbine/yr); M = medium (1-10/turbine/yr); S = small (0.1-1/turbine/yr); VS = very small (<0.1/turbine/yr).

Population effect: determined on the basis of the total numbers killed in relation to the population dynamics.

Response: Percival 2003 turbine types. Large is classified as 0.5Mw to 1.5Mw. It is not possible to use these figures for 7Mw turbines, which are far larger & far faster. The tip speed is c300kph.

Table 2. Bird-windfarm disturbance studies, summary of findings.

Species group	Sites studied	Habitat	Windfarm size	Turbine type	Disturbance distance
Cormorant	Blyth ⁴	Coastal	S	S	None ⁴
Swans	Urk ⁴	Farmland and coastal	M	S	None (Bewick's), 300 m (Whooper)
Geese	Germany ^{4,5}	Farmland	M	S/M	Up to 600 m
	Urk ⁴	Farmland and coastal	M	S	None
	Denmark ⁶	Farmland	L	M	1-200 m
	Gotland ⁷	Coastal marsh	L	M	0-25 m
	Toronto ⁸	Parkland	S	M	None
Ducks	Tuno Knob ⁹	Offshore	M	M	None
	Utgrunden ¹⁰	Offshore	S	L	None
	Urk ⁴	Coastal	M	S	Up to 300 m
Raptors	Bryn Tylti ¹⁶	Upland moor	M	S	None
	Altamont ¹⁷	Grassland	VI	S	None
Waders: breeding	Ovenden Moor ¹¹	Upland moor	M	S	None
	Various UK sites ¹²	Upland	S/M	S/M	None
	Gotland ²²	Coastal and farmland	L	M	None
	Oosterbierum ¹³	Lowland farmland	S	S	Up to 300 m
Waders: non-breeding	Germany ¹⁴	Lowland farmland	S/M	S/M	Up to 200 m
	Blyth ⁴	Coastal	S	S	None
	Tjaereborg ²	Farmland	S	M	800 m
	Zeebrugge ¹⁵	Coastal	M	S/M	Up to 250 m
Gulls	Oosterbierum ¹⁶	Farmland	M	S	500 m
	Tjaereborg ²	Farmland	S	M	800 m
terns	Blyth ⁴	Coastal	S	S	None
	Zeebrugge ¹⁵	Coastal	M	S/M	None
Passerines	Blyth ⁴	Coastal	S	S	None
	Various UK sites ¹²	Upland	S/M	S/M	None
	Buffalo Ridge ¹⁸	Grassland	VI	M	1-200 m
	Bryn Tylti ¹⁶	Upland moor	M	S	None
	Burgar Hill ²⁰	Upland moor	S	S	None
	Novar ^{14,23}	Upland moor	M	M	None

KEY

Sources: 1. Still *et al.* 1995; 2. Pedersen and Poulsen 1994; 3. Winkelman 1989; 4. Kowalik & Borbach-Jaene 2001; 5. Kruckenberg & Jaene 1999; 6. Larsen & Madsen 2000; 7. Percival 1998a; 8. James 2003; 9. Guillemette *et al.* 1998, 1999; 10. Pettersson & Ståhl 2003; 11. Bullen Consultants 2002; 12. Thomas 1999; 13. Ketzenberg *et al.* 2002; 14. Everaert *et al.* 2002; 15. Winkelman 1992b; 16. Green 1995; 17. Thelander *et al.* 2003; 18. Leddy *et al.* 1999; 19. Phillips 1994; 20. Meek *et al.* 1993; 21. Brogan 2001; 22. Percival & Percival 1999; 23. Percival 2002.

Windfarm size: VI = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 KW-1.5 MW); S = small (<500 KW).

Disturbance distance: None indicates no significant disturbance effect; disturbance noted during construction but not operation.

The turbine layout is engineered to maintain a minimum buffer zone exceeding 800 meters from Horseleap Lough, a critical avian habitat, thereby **mitigating** habitat loss, minimizing construction and operational disturbances, and **reducing** avian collision risk during flight paths. Similarly, turbines are sited over 700 meters away from the hen harrier roost at Cloonboo More bog, preserving key roosting habitat, reducing disturbance and displacement, and lowering collision risk for hen harriers and sympatric merlin populations. Hardstanding areas are optimized to the minimal spatial footprint required by the turbine specifications, limiting ground disturbance.

Response: The use of the phrases “mitigating habitat loss” & “minimising disturbances” and “reducing avian collisions” recognises the effect of this windfarm location.

The proposed grid connection predominantly follows existing built infrastructure corridors, with underground cable installation beneath public roads to prevent impacts on roadside hedgerows and minimize disruption to nesting bird populations.

Following consideration of the residual effects (post-mitigation), it is concluded that the Proposed Wind Farm will not result in any significant effects on any of the identified KORs. No significant effects on receptors of International,

National or County Importance were identified. Provided that the Proposed Wind Farm is constructed, operated and decommissioned in accordance with the design, best practice mitigation measures and Bird Mitigation Plan that are described within this application, significant individual or cumulative effects on the identified KORs are not anticipated.

Chapter 8: Land, Soils and Geology

2.1 BEDROCK GEOLOGY

According to the Geological Survey Ireland (GSI) bedrock geological map of Ireland at 1:100,000 scale (GSI, 2025) (Figure B- 2 in Appendix B), the bedrock underlying the Proposed Wind Farm site consists of limestone of the Burren Formation, undifferentiated Viséan limestones and the Croghan Limestone formation. The northern part of the Proposed Wind Farm site, approximately 100m northeast of T7, is mapped as consisting of the Croghan Formation, while the remainder of the Proposed Wind Farm site is mapped as Undifferentiated Viséan Limestones, aside from a small band of Burren Formation rocks, mapped at T7, and running south east from this location, to approximately 150m north of T9. All turbine locations except for T7 are mapped as being underlain by Undifferentiated Viséan Limestones.

The Burren and Croghan formations are typified by pale grey argillaceous and bioclastic packstones and wackestones. These formations also contain intervals of dark cherty limestones and shales, often associated with oolitic grainstones. Little information is available regarding the Undifferentiated Viséan Limestones; however they are anticipated to consist of pure, bedded limestone. A summary of the expected lithologies is shown in Table 2-1.

One rotary core borehole (GSI-17-003) from the GSI borehole database was drilled within the Proposed Wind Farm site, approximately 390m east of T7 (Figure B-2 in Appendix B). According to the available borehole log, the borehole encountered bedrock at 5 m BGL and was drilled to a final depth of 122 m BGL. A dark grey-argillaceous limestone and calcareous mudstone from the Croghan formation was encountered from 5.0 to 105 m BGL. A very fine-grained argillaceous limestone of the Ballymore formation was encountered from 105 to 122m BGL.

Table 2-1: Summary of bedrock lithologies (descriptions as per Pracht et al., 2015 and GSI).

Bedrock Formation	System	Series	Stage	Brief Description
Burren Formation	Carboniferous	Dinantian	Viséan	Medium- and coarse-grained light and dark grey well-bedded and massive limestone, rare clay bands; frequent coral colonies and brachiopod bands; rare massive fine-grained limestone intervals with cavities; some partial dolomitization.
Croghan Formation	Carboniferous	Dinantian	Viséan	Mostly fine-to-medium-grained, dark grey, well-bedded argillaceous limestone.
Undifferentiated Viséan Limestone	Carboniferous	Dinantian	Viséan	Undifferentiated Limestones of Viséan age.

As limestones dominate the underlying geology of the Proposed Wind Farm site, karstic features may be present and pose additional risks. Karst risk is discussed in detail in Technical Appendix 8-2 of the EIAR (Geotechnical Karst Risk Assessment).

2.2 QUATERNARY SEDIMENTS

The map of GSI Quaternary sediments (mapped at a 1:50,000) scale shown in Figure B-2 in Appendix B (GSI, 2025) shows that the Proposed Wind Farm site is underlain by either cut-over raised peat or glacial till. Cut-over raised peat consists of discrete, raised, dome-shaped masses of peat with part of their peat volume removed by anthropogenic peat harvesting methods. Parts of the Proposed Wind Farm site area consist of uncut raised peat bog, surrounded by cut-over peat. These raised bog areas are located north of T5, between T7 and T9, and north of T2.

Alluvium deposits are not mapped within the Proposed Wind Farm site; however, some form of alluvium is expected to be present adjacent to the minor watercourses that cross the Proposed Wind Farm site.

Pockets of till derived from limestones are mapped throughout the Proposed Wind Farm site, largely corresponding with small ridge features mapped by the GSI as drumlins. Glacial till consists typically of over-consolidated sediments directly deposited by glacial activity and can vary between clays, sands, and gravels. T1, T3, T4, T6, T8, the construction

compound, and parts of the substation are located in areas mapped by the GSI as till derived from limestone. A small area of gravels derived from limestone, associated with an esker, is mapped approximately 300m north of T7, outside of the EIAR boundary.

2.5.1 BEDROCK AQUIFERS

According to the GSI Bedrock Aquifer map (2025), shown in Figure E-1 in Appendix E, the entirety of the Proposed Wind Farm site is underlain by a Regionally Important Aquifer – Karstified (conduit). This corresponds to the GSI aquifer category “Rkc”. This aquifer is classed as capable of supporting large public water supplies sufficient to support a large town.

2.5.2 SUBSOIL PERMEABILITY

The GSI Subsoil Permeability map, shown in Figure E-2 in Appendix E, indicates that the Proposed Wind Farm site varies between areas of low and moderate permeability. T2, T5, T7 and T9 are mapped in areas of moderate permeability (corresponding with areas mapped as peat), while the remaining turbines are mapped in areas of low permeability (corresponding with areas mapped as till). A small area marked by the GSI as “not mapped” is close to T1, and along the southern access, as far as the construction compound. This indicates that insufficient data is available for the GSI to assign a subsoil permeability rating, or that bedrock is close to or at the surface.

2.8 SLOPE INSTABILITY MAPPING

The GSI landslide inventory (GSI, 2022a), the multi-temporal aerial / satellite imagery, the DEM, the landslide susceptibility map (GSI, 2016), and the rainfall information of Met Éireann data 1981-2010 have been used for this part of the desk study.

Figure G-1 in Appendix G illustrates the landslide susceptibility (GSI, 2016) across the Site. This map was obtained by using an empirical probabilistic method at a regional scale and should provide input into site-specific scale engineering studies. The entirety of the Proposed Wind Farm site is mapped as having low susceptibility due to the low slope angles encountered. Field visits by the geotechnical team noted no visual signs of slope instability at the time of the visits (2022-2025).

Figure G-2 in Appendix G depicts the spatial relationship between records of previous landslide events (GSI, 2022a, 2022b) and rainfall across Ireland from the Met Éireann (2018) average annual rainfall dataset. The study area is in a region of moderately high rainfall and relatively flat topography. According to the GSI landslide inventory (GSI, 2022), the closest landslide is located around 12 km north of the closest turbine (T01) and around 11.8km from the Proposed Wind Farm site boundary, in Dunmore, Co. Galway. The exact area of the peat slide was not recorded, but it is recorded to have occurred in 1873 and “moved quickly first and continued slowly for 11 days” (Praeger, 1893). This landslide resulted in the peat “burying three farmhouses and covering about 300 acres of pasture and arable land, 6 feet deep”. No other significant information is available, but this location appears to be a relatively flat, deep raised peat bog, and therefore, the failure mechanism was likely a margin rupture (Warburton et al. 2004) triggered bog burst event caused by the extraction of peat from the raised bog due to steep cuttings (7-9m high), removing toe support for the high raised bog.

An additional historic landslide is recorded 11.8km SW of the Proposed Wind Farm site boundary, at Kilmore, Co. Galway. This landslide is noted as having occurred in cut-over raised peat in 1909, but no other details are available from the GSI database.

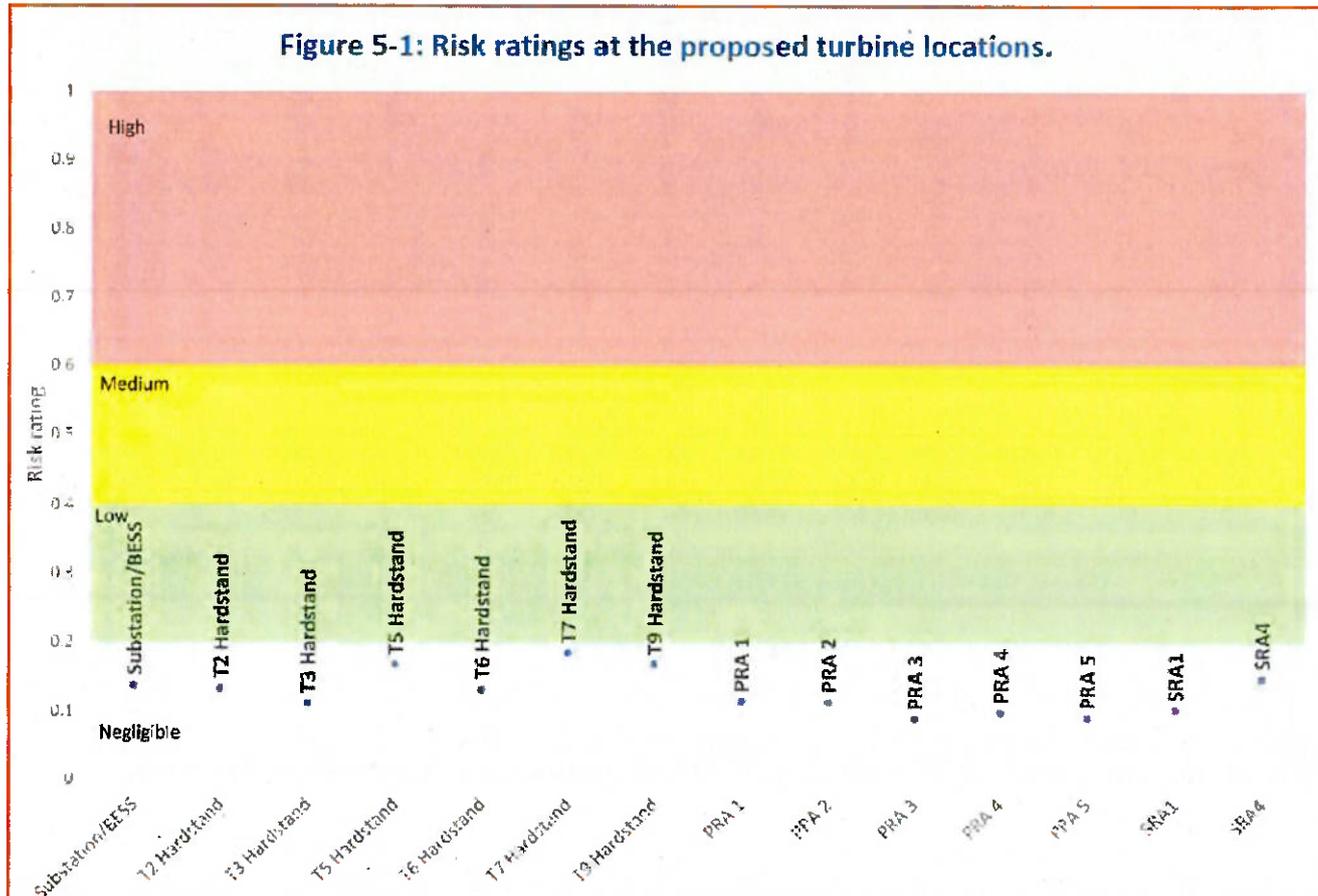
2.14 LITERATURE REVIEW

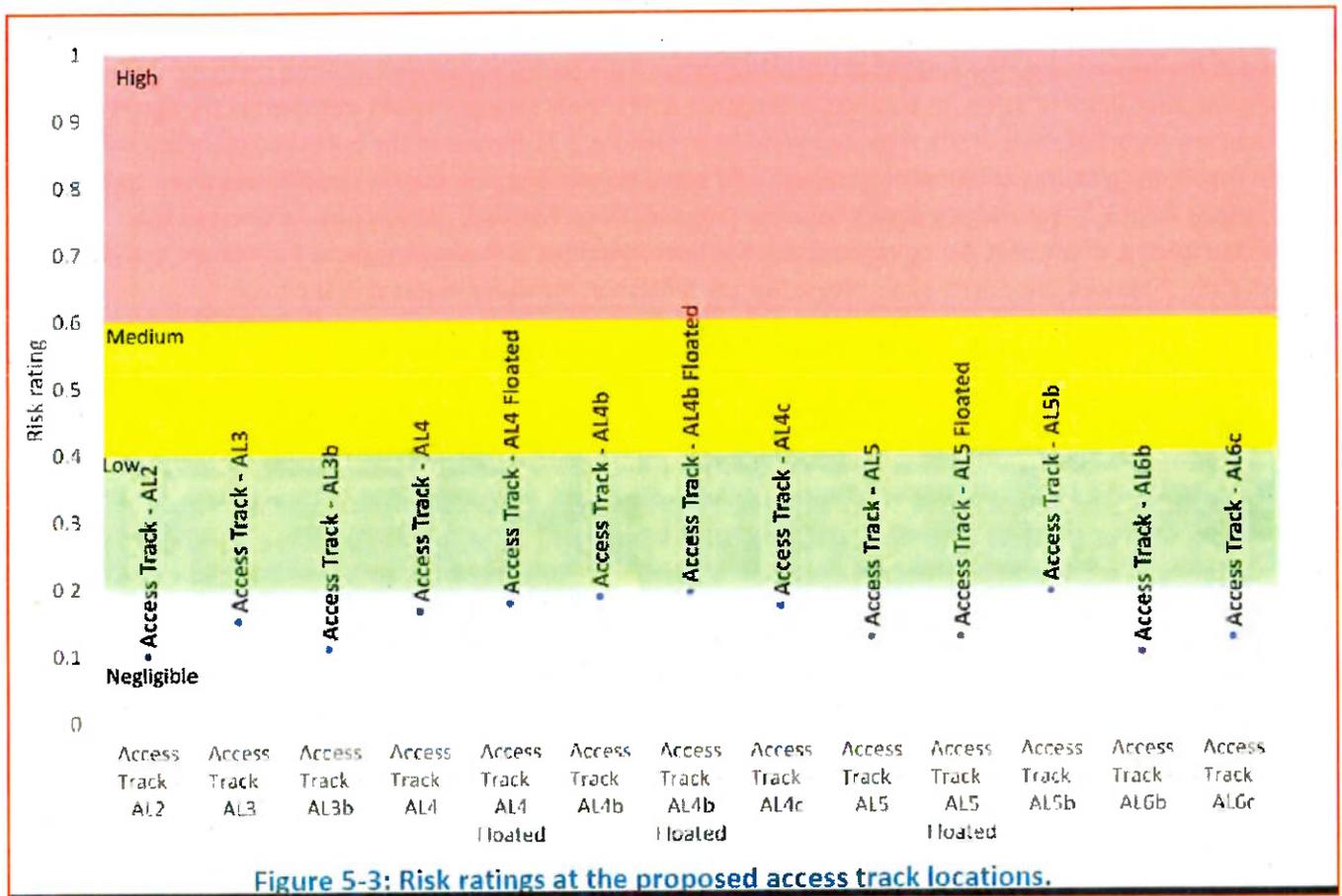
While no directly relevant studies of peat landslides in the immediate vicinity of the Proposed Wind Farm site are available, this PSRA has considered the findings of the recently published report into the causes of the 2020 Meenbog, Shass Mountain and Mt. Eagle peat landslides (GSI and Fehilly Timoney, 2024). Of particular relevance is the 2020 Meenbog landslide, which occurred during the construction phase of the Meenbog Wind Farm in Co. Donegal. Review of the published literature indicates that the conditioning factors at Meenbog (upland, afforested blanket bog with convex slope breaks and a consistent slope, increasing from 2-6° immediately downslope of the failure zone) are largely absent from the Proposed Wind Farm site. Post failure investigations by GSI and Fehilly Timoney indicate undrained shear strength values in the saturated blanket peat at the Meenbog failure location range between 2-9kPa, with an average of just under 5kPa recorded, indicating a large body of extremely weak peat. This value is lower than any recorded value at the Proposed Wind Farm (Section 3.1), and in line with the value adopted for the FoS analysis (5kPa, Section 4.3).

The PSRA has also considered the findings of forensic investigations into the 2003 Derrybrien landslide, at the Derrybrien Wind Farm in Co. Galway (approximately 40km South of the Proposed Wind Farm site). Based on the findings of the investigations into Derrybrien failure (Lindsay and Bragg, 2004), undrained loading during construction

was found to be the critical failure mechanism, with undrained shear strength values as low as 2.8kPa recorded (3.8kPa recorded at the failure sites). The findings of this investigation have been incorporated into the methodology for assessing the peat factor of safety, as outlined in Section 4.3. The shear strength values observed at Derrybrien are lower than any recorded value at the Proposed Wind Farm (Section 3.1). Review of the published literature indicates that the conditioning factors at Derrybrien (upland, afforested blanket bog with convex slope breaks and a consistent slope, ranging from 3-5°) are largely absent from the Proposed Wind Farm site. It must also be stressed that unrestricted loading of the peat during construction has been identified at the key trigger at Derrybrien, and is to be avoided at the Proposed Wind Farm site – please see the mitigation measures outlined in Section 6.

Figure 5-1: Risk ratings at the proposed turbine locations.





The geology of the Site comprises cutover raised bog (peat) and limestone tills over limestone bedrock. The peat thickness encountered by intrusive investigations across the Site varies from 0m (in areas where peat is absent) to a maximum of 7.1m, with an average of 1.3m, and a median of 0.4m recorded. The ground conditions are generally variable across the Site, and comprise Peat, Lacustrine Marl (CLAY/SILT), Cohesive Glacial Till (CLAY/SILT) and Granular Glacial Till (SAND/GRAVEL) layers overlying limestone bedrock. Overburden depths at the Site typical range from approximately 1 to 5m. Investigation drilling at the Site typically encountered strong dark grey LIMESTONE with MUDSTONE. No karst conduits, significant fractures or clay infilled fractures were encountered during the site investigation drilling due to the competent nature of the bedrock. Construction of the Proposed Project infrastructure will require the removal of peat, soil and rock to competent foundation.

The Peat Stability Risk Assessment undertaken showed that all Proposed Project infrastructure elements are located in areas of negligible risk. Notwithstanding the above, the management of peat stability and appropriate construction practices will be inherent in the construction phase of the Proposed Project to ensure peat failures do not occur on site.

The findings of the Geotechnical Karst Risk assessment, indicate that the majority of the Proposed Wind Farm site can be classed as having a low to medium karst hazard. In these locations, it is considered that significant karst development is unlikely and unstable ground and significant cavities are not anticipated. In areas of higher hazard mitigation measures can be employed to reduce the overall karst risk to low – moderate.

A Peat and Spoil Management Plan has been prepared for the Proposed Project which details management of peat and spoil during construction works and long-term storage thereafter. The majority of peat and spoil removed during the excavation works will be deposited in proposed on-site spoil and peat repositories. A smaller quantity will be taken off-site to a licenced waste facility.

The potential residual impacts associated with soil or ground contamination and subsequent health effects are imperceptible.

The land, soils and geology impact assessment undertaken in this chapter outlines that significant effects will not occur due to the localised nature of the construction works and therefore there is no potential for cumulative effects.

Chapter 9: Hydrology and Hydrogeology

Due to the nature of Proposed Wind Farm and Proposed Grid Connection developments, being near surface construction activities, effects on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater would be from oil spillage and leakages at turbine foundations or during construction plant refuelling. These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the proposed site during the construction and operational phases of the Proposed Wind Farm and measures are proposed within the EIAR to deal with these potential minor local impacts.

The Site is underlain by a Regionally Important Aquifer, however due to the basin peat geological setting there is relatively low recharge to groundwater. This is because the majority of the Site is covered by low permeability peat as well as CLAY/SILT glacial deposits, which acts as a protective cover to the underlying limestone aquifer. Surface water runoff rates are relatively high.

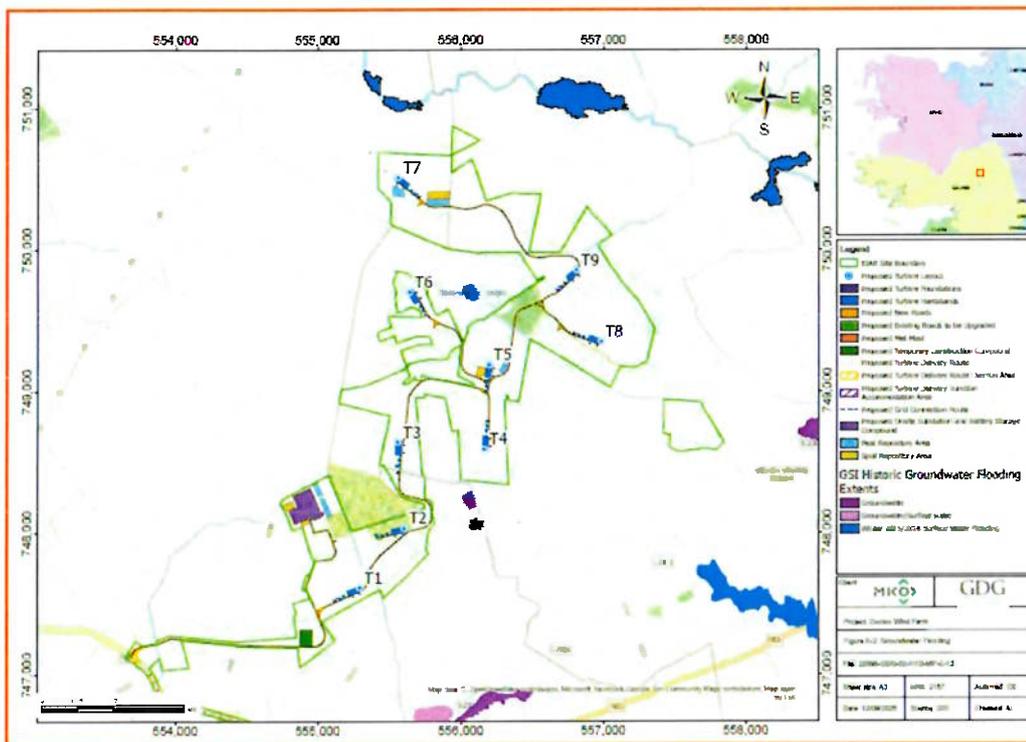
Any contaminants which may be accidentally released on-site are more likely to travel to nearby streams within surface runoff. The deep and relatively low permeability of the glacial deposits means contaminants are unlikely to reach the bedrock and will instead disperse with the glacial deposits and would remain localised to the source or would be removed as runoff during wet periods.

During each phase of the Proposed Development (construction, operation, and decommissioning) a number of activities will take place at the proposed Site, some of which will have the potential to significantly affect the hydrological regime or water quality at the proposed Site or downstream of the proposed Site. These significant potential effects generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement-based compounds.

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant impacts on water quality and downstream designated sites. A self-imposed 50m stream buffer was used during the design of the Proposed Project, thereby avoiding sensitive hydrological features. The surface water drainage plan will be the principal means of significantly reducing sediment runoff arising from construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of Site runoff into local watercourses or into the existing bog drainage network. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water drainage plan). Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan.

No significant impacts to surface water (quality and flows) and groundwater (quality and quantity, and any local groundwater wells) will occur as a result of the Proposed Project provided the proposed mitigation measures are implemented. This EIAR presents proven and effective mitigation measures to mitigate the release of sediment which will reduce the concentration of suspended solids to acceptable levels. The storage and handling of hydrocarbons/chemicals will be carried out using best practice methods which will ensure the protection of surface and groundwater quality. The Proposed Project drainage system will be designed to slow surface water runoff from the proposed site by providing greater attenuation. This will ensure that the Proposed Project does not alter downstream surface water flows and will not contribute to downstream flooding.

A Flood Risk Assessment was carried out for the Proposed Project. There is no proposed development in fluvial, pluvial or groundwater flood zones. The Proposed Project will not increase flood risk in the area of the Site.



APPENDIX 8-2 KARST RISK ASSESSMENT

The GSI karst database notes the presence of turloughs in the area surrounding the Proposed Wind Farm site. As a result, a review of GSI Groundwater flooding has been conducted, and is shown in Figure E-2 in Appendix E. Historic groundwater flooding is not recorded within the EIAR boundary; however, historic groundwater flooding is noted approximately 100m southwest of the EIAR boundary, approximately 350m southwest of T4, at locations identified in Section 3 as karst features (K16 and K21). Additionally, an area of medium probability for groundwater flooding is recognised by the GSI approximately 170m from the EIAR boundary, approximately 350m east of T6, at the feature recorded at Derrynacrick Lough by the OSI mapping. Flood risk, including groundwater flooding, is discussed in detail in Chapter 9 of the EIAR (Water).

The assessment findings showed that the majority of the proposed infrastructure locations are located in areas of low to medium karst hazard, with additional localised areas of high and very high hazard identified. One turbine (T4) was identified as being located in an area of high karst hazard, with a section of the access track immediately north of T4 also being classified as having a high karst hazard. Areas identified as being of very high karst hazard within the Proposed Wind Farm site do not interact with any of the proposed infrastructure footprint.

The karst risk assessment shows that the risk at each infrastructure location ranges from medium to very high (at T4) before the application of mitigation measures. Following the implementation of mitigation measures, the residual risk at each infrastructure location ranges from low to medium, indicating that development can proceed as long as mitigation measures are implemented and that the risk assessment is further refined following a more detailed confirmatory ground investigation.

The karst risk assessment shows that the risk at each infrastructure location ranges from medium to very high (at T4) before the application of mitigation measures. Following the implementation of mitigation measures, the residual risk at each infrastructure location ranges from low to medium, indicating that development can proceed as long as mitigation measures are implemented and that the risk assessment is further refined following a more detailed confirmatory ground investigation.

2.3.5 GROUNDWATER VULNERABILITY

The GSI Groundwater Vulnerability map indicates land where groundwater is susceptible to pollution. The vulnerability category assigned to a site or area is based on how easily water, which may contain pollutants, can reach the groundwater. GSI mapping (2025) indicates that the groundwater vulnerability across the Proposed Wind Farm site is highly variable, ranging from low in central portions of the Proposed Wind Farm site, to extreme/Rock at or near surface or karst in localised areas along watercourses in the centre of the Proposed Wind Farm site, and along the southern access track as far as the temporary construction compound. The GSI groundwater vulnerability map for the

Proposed Wind Farm site is shown in Figure C-4 in Appendix C. Areas of low vulnerability generally correspond to areas mapped by the GSI as peat (such as at T2, T5, T7 and T9), with areas of moderate vulnerability mapped by the GSI in areas of glacial till (such as T3, T4, T6 and T8). T1 is mapped in an area of high vulnerability adjacent to an area classified as having extreme vulnerability, suggesting that the bedrock is relatively close to the surface in this location.

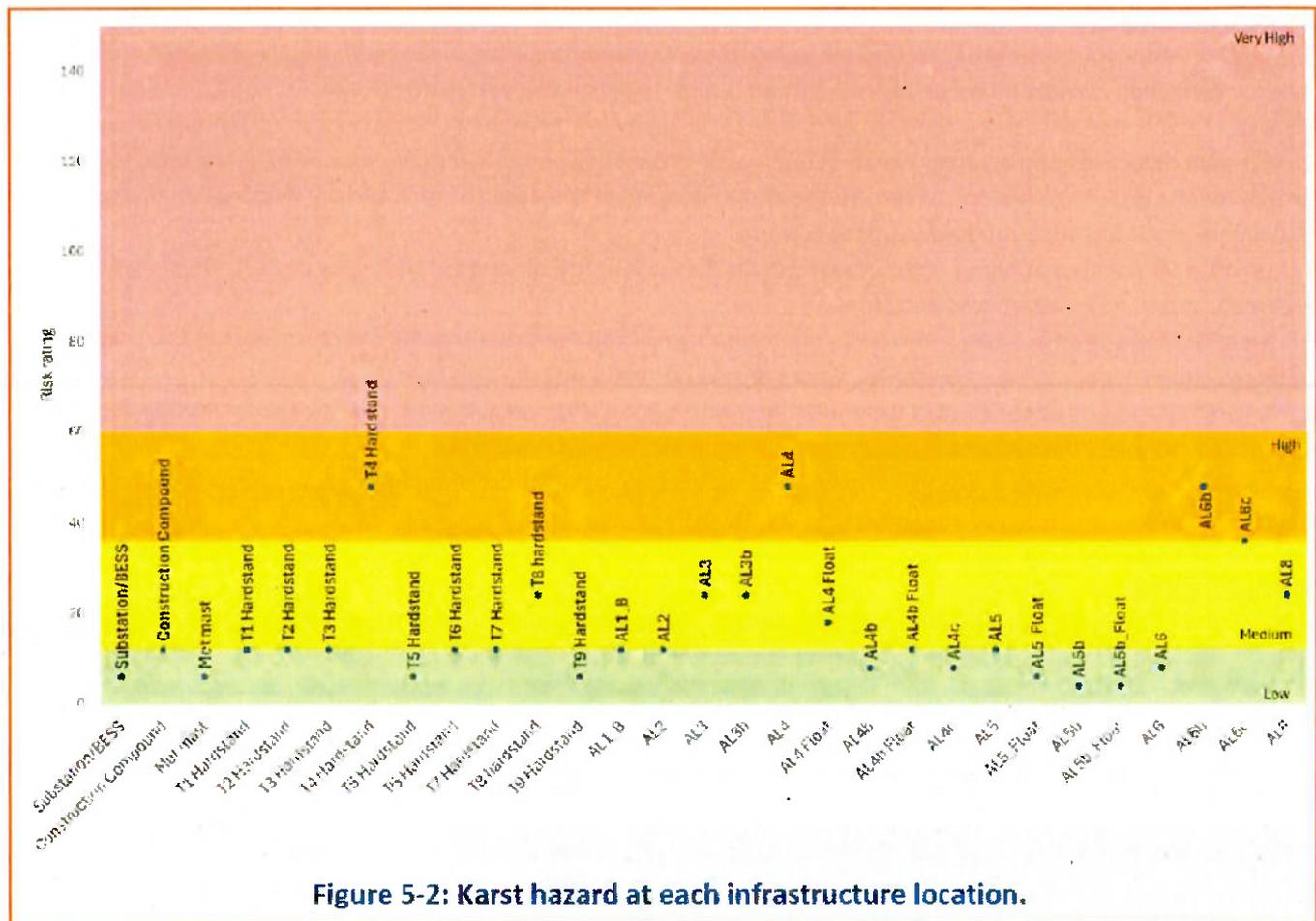


Figure 5-2: Karst hazard at each infrastructure location.

The normalised hazard rating across the Proposed Wind Farm site is shown in Figure H-8 in Appendix H. The identified karst risk at the Proposed Wind Farm site is generally classed as low; however, portions of the Proposed Wind Farm site, particularly in the vicinity of T1 and T8, are classified as medium hazard. A portion of the centre of the Proposed Wind Farm site, in the vicinity of T4, is calculated to have a high hazard rating, with small, localised areas of very high hazard rating identified at specific karst features, primarily in the area surrounding T4. A detailed view of the karst hazard at T4 is shown in Figure H-9 in Appendix H. Areas identified as being of very high karst hazard within the Proposed Wind Farm site do not interact with any of the proposed infrastructure footprint.

5.7 ADVERSE CONSEQUENCES ASSESSMENT

The adverse consequences assessment has been compiled based on the criteria outlined in Table 5-10. This scoring system has been applied at all infrastructure locations and is presented in the Geotechnical Karst Risk Register in Appendix I. For each infrastructure location, a series of potential risks are identified (e.g. collapse of dolines, subsidence over buried or suffusion dolines, leading to differential settlement at turbine foundations). For each risk, an adverse consequence score is applied.

It is recommended that the consequence assessment be revised and updated at the detailed design stage by a suitably qualified Geotechnical Engineer as new consequences are identified and development timelines and costs are finalised.

6 MITIGATION MEASURES

The findings of the karst risk assessment, as outlined in Section 5.6, indicate that the majority of the Proposed Wind Farm site can be classed as having a low to medium karst risk. In these locations, it is considered that significant karst development is unlikely and unstable ground and significant cavities are not anticipated. All proposed infrastructure

has been sited to avoid areas of very high karst hazard. Mitigation measures are not envisaged based on the available information, but the risk of encountering a karst feature is not negligible.

Cooloo Wind Farm: Geophysical Survey Report Status: Final MGX Project Number: 6903 MGX File Reference: 6903f-005.doc 5th September 2025

EXECUTIVE SUMMARY

1. Minerex Geophysics Ltd. (MGX) carried out a geophysical survey consisting of the methods 2D- Resistivity (ERT) and Seismic Refraction (p-wave). The survey was carried out for the ground investigation for the Cooloo Wind Farm, Co Galway.
2. The main objectives of the survey are to detect possible karstified zones within the rock or karst features, to determine the ground conditions under the site and to determine the depth to rock and the overburden thickness.
3. Ground conditions were modelled with two layers.
4. Layer A is interpreted as highly consolidated overburden consisting of sandy gravelly clay and silt, which may represent glacial till or weathered limestone.
5. Layer B is interpreted as fresh limestone, with a depth generally shallower than 10 m across most of the site, except in the western sections of lines R3 and R4, where it deepens and exceeds 10 m bgl.
6. No karst features or karstified rock were identified within the survey area, but considering the increasing depth to bedrock to the west, their potential occurrence further west cannot be excluded.
7. Trial Pit logs were provided after the survey. TP11 was carried out within the survey area and terminates on possible bedrock at 2.4m.

4. CONCLUSIONS

- The depth to good bedrock is relatively consistent along the entire length of the survey lines, except in the western sections of lines R3 and R4, where it deepens and exceeds 10 m bgl.
- Considering the increasing depth to good bedrock to the west, the potential occurrence of karst features further west cannot be excluded.
- No karst features or karstified rock were identified within the survey area.



Geotechnical Risk ID	Infrastructure Location	Hazard Title	Risk Description	Risk Cause	Risk Impact
1	T1 Foundation	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
2		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement or the use of piled foundations.
3		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g ground improvement or the use of piled foundations
4		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g ground improvement or the use of piled foundations.
5		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement or the use of piled foundations
4	T1 Hardstand	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
5		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement
6		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g ground improvement or the use of piled foundations
7		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g ground improvement
8		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement or the use of piled foundations.
9	T2 Foundation	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
10		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement or the use of piled foundations.
11		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g ground improvement or the use of piled foundations
12		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g ground improvement or the use of piled foundations.
13		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g ground improvement or the use of piled foundations

14	T2 Hardstand	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
15		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement
16		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
17		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. ground improvement
18		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
19	T3 Foundation	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
20		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
21		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
22		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
23		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
24	T3 Hardstand	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
25		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement
26		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
27		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
28		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity.	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
29	T4 Foundation	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
30		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
31		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
32		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
33		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

					foundations
54	T6 Hardstand	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. ground improvement
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity.	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
59	T7 Foundation	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
64	T7 Hardstand	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
69	T8 Foundation	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity.	Deeply weathered limestone with voids and softened zones.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

74	T8 Hardstand	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
79	T9 Foundation	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence over buried or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead,	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
84	T9 Hardstand	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
89	Substation/BESS Compound	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

94	Construction Compound	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
95		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement
96		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
97		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
98		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
99	Met Mast	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
100		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at hardstand	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement
101		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
102		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. ground improvement
103		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
104	Access Track - AL1	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
105		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure. 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
106		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
107		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

108		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement. 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations.
109	Access Track - AL1b	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Risk of severe injuries or death 2 Bearing capacity failure 3 Severe damage to foundations and plant
110		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement. 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
111		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
112		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement 2 Bearing capacity failure. 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
113		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement. 2 Bearing capacity failure. 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations.
114	Access Track - AL2	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Risk of severe injuries or death 2 Bearing capacity failure 3 Severe damage to foundations and plant
115		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
116		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
117		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement 2 Bearing capacity failure. 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
118		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement. 2 Bearing capacity failure. 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
119	Access Track - AL3	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Risk of severe injuries or death 2 Bearing capacity failure. 3 Severe damage to foundations and plant
120		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
121		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
122		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement. 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations.
123		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	<ol style="list-style-type: none"> 1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations

124	Access Track - AL3b	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
129	Access Track - AL4	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity.	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
134	Access Track - AL4 Float	Rapid collapse of sikhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure. 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity.	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure. 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations

139	Access Track - AL4b	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1 Risk of severe injuries or death 2 Bearing capacity failure. 3 Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations.
144	Access Track - AL4b Float	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Risk of severe injuries or death 2 Bearing capacity failure. 3 Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations.
149	Access Track - AL4c	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Risk of severe injuries or death 2 Bearing capacity failure. 3 Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1 Unacceptable amounts of settlement 2 Bearing capacity failure 3 Requirement for remediation through e.g. ground improvement or the use of piled foundations

154	Access Track - ALS	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
159	Access Track - ALS float	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
164	Access Track - ALSb	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

169	Access Track - AL5b Float	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
170		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
171		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
172		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
173		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
174	Access Track - AL6	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction.	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover. Slight reduction in hazard score applied due to lack of evidence for large cavities in geophysical surveying.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
175		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
176		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
177		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
178		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
179	Access Track - AL6b	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
180		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
181		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover.	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
182		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations
183		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones.	1. Unacceptable amounts of settlement. 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations

184	Access Track - AL6c	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
185		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
186		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
187		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
188		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
189	Access Track - AL8	Rapid collapse of sinkhole/doline cavity	Rapid collapse of cavity roof during construction	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Risk of severe injuries or death 2. Bearing capacity failure 3. Severe damage to foundations and plant
190		Subsidence of soils overlying suffosion or buried dolines	Subsidence overburied or suffosion dolines, leading to differential settlement at turbine foundations	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
191		Variable rockhead, or unexpected cavities	Variable rockhead, or unexpected cavities leading to unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Requirement for remediation through e.g. geogrid blanket, or thicker structural fill make up
192		Cavities / Voids	Foundation failure or differential settlement. Unforeseen requirement for piled foundations or geotechnical re-design	Development of subsurface cavities due to karstification of underlying bedrock, with cohesive soil cover	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.
193		Solutionally Weathered Rock	Excavation instability and reduced bearing capacity	Deeply weathered limestone with voids and softened zones	1. Unacceptable amounts of settlement 2. Bearing capacity failure 3. Requirement for remediation through e.g. ground improvement or the use of piled foundations.

Response: This risk assessment reflects 193 impacts under the Precautionary Principle that determines this site is unsuitable for a windfarm. The Consultant has omitted one further risk - to the existing major underground drinking water sources.

The EIAR acknowledges that the Mid Galway PWS and Barnaderg GWSs sources are very important local water supply that serves a wide population in the area, and that it is classified as an extremely sensitive water supply source.

WATER FRAMEWORK DIRECTIVE COMPLIANCE ASSESSMENT: PROPOSED WIND FARM AND GRID CONNECTION, COOLOO, CO. GALWAY. HYDRO-ENVIRONMENTAL SERVICES

Table D: Screening of WFD water bodies located within the study area

Type	WFD Classification	Waterbody Name/ID	Inclusion in Assessment	Justification
Drinking Water Protected Areas		Corrib Lower	No	The Corrib Lower DWPA has been screened out due to its distal location downstream (-28km), intervening lands and increasing volumes of water within Lough Corrib.
		Corrib 020	No	The Corrib_020 DWPA has been screened out due to its distal location downstream (-31.6km), intervening lands, and increasing volumes of water within the River Corrib.
		Mid-Galway PWS	Yes	The southern portion of the Wind Farm Site, including 2 no. turbines and ~3.8km of the Proposed Grid connection route is mapped inside the Mid-Galway PWS SPA. An assessment is required to consider the potential impacts of the Proposed Project on this source.
		Feigh East and West GWS	No	The Proposed Project is not located inside the Feigh East and West GWS SPA and is therefore scoped out for further assessment.
		Barnaderg GWS	Yes	The southern portion of the Wind Farm Site, including 2 no. turbines, and ~3.8km of the Proposed Grid connection route is mapped inside the Barnaderg GWS SPA. An assessment is required to consider the potential impacts of the Proposed Project on this source.

4.2.1.4 Potential Protected Area Impacts

Mid-Galway PWS and Barnaderg GWS: Elements of the Proposed Project are located inside the mapped groundwater SPAs to these sources. Please refer to Section 9.5.2.1 of Chapter 9 of the EIAR (Hydrology/Hydrogeology) for a detailed impact assessment relating to these sources. Due to the hydrological and hydrogeological setting of the Proposed

Project site (as explained in Chapter 9), no significant effects are expected to occur on these sources in the pre-mitigation scenario during the construction phase.

4.3.2.5 Mitigation Measure to Protect Mid Galway PWS & Barnaderg GWS Source

- During the operational phase of the Proposed Project, the only regular plant which will be required on site will be maintenance/inspection vehicles (jeeps/vans/quads) and these will not be refuelled on-site;
- Any hydrocarbons (oil) present within the turbine generator and gear box will be enclosed within a bund with 110% capacity;
- There will be no storage of fuels, oils and chemicals inside any of the turbines;
- Automated oil leak detectors will be placed in each of the turbines which will allow early detection of even the smallest leaks of oil or hydraulic fluid that may arise from components such as the transformer or gearbox; and,
- The automated detection system will then rapidly notify the wind farm operator by cloud-based systems. This early detection system will prevent large leaks of oil or hydraulic fluid.

Considering the source importance and potential sensitivity to impacts from the Proposed Project detailed hydrogeological investigations/monitoring to assess the impact of the Proposed Project.

A hydrological assessment of potential impacts on local designated sites was undertaken. Lough Corrib SAC is located downstream of the Site and is considered very sensitive to affect. Following implementation of the appropriate mitigation measures as outlined in the EIAR no significant impacts on this designated site will occur as a result of the Proposed Project.

A Water Framework Directive (WFD) Compliance Assessment has been completed for all waterbodies (surface water and groundwater bodies) with the potential to be impacted by the Proposed Project. With the implementation of the mitigation measures detailed in this EIAR there will be no change in the WFD status of the underlying groundwater body or downstream surface waterbodies as a result of the Proposed Project. The Proposed Project has been found to be fully compliant with the WFD and will not prevent any waterbody from achieving its WFD objectives.

An assessment of potential cumulative effects associated with the Proposed Project and other developments on the hydrological and hydrogeological environment has been completed. With the implementation of the mitigation measures detailed in this EIAR, the cumulative assessment found that there will be no significant effects on the hydrological and hydrogeological environments.

APPENDIX 9-1 : Flood Risk Assessment

3.4.1 Existing Site Drainage

The northern portion of the Proposed Wind Farm Site, within the Clare[Galway]_SC_040 sub-catchment (i.e. the Grange River), is drained by the Dangan Eighter Stream (EPA Code 30D35) which flows into the Grange River approximately 1km downstream of the Proposed Wind Farm site.

3 no. unnamed 1st order streams merge within the Proposed Wind Farm site to form the Dangan Eighter Stream. The 3 no. streams merge close to the location of Derrynacrick Loughs.

Derrynacrick Loughs comprise two small, connected loughs that are located within a raised bog area on the northern portion of the Proposed Wind Farm site.

None of the 3 no. unnamed streams flow into the larger, furthest upstream lough. 2 no. of the streams flows into the smaller downstream lough, while 1 no. unnamed stream flows into the Dangan Eighter Stream downstream of both loughs. The catchment area of the 3 no. streams comprises both peatland and agricultural land. Proposed turbine locations T3 to T9 drain into the Dangan Eighter Stream via a network of bog and land drains.

The southern portion of the Proposed Wind Farm site, within the Clare[Galway]_SC_050 sub-catchment, is drained by the EPA named Lecarrow 30 Stream (EPA Code 30L49) and the Forty Acres Stream (EPA 30F16), both of which are headwater streams of the Abbert River which flows approximately 5km downstream of the Proposed Wind Farm site. The majority of the southern portion of the Proposed Wind Farm site (including proposed turbine locations T1 and T2 as well as the temporary construction compound) drain to the Lecarrow 30 Stream. The Lecarrow 30 Stream then flows to the south before discharging into Horseleap Lough which is located 1km to the south of the Proposed Wind Farm site. Horseleap Lough is a wetland with significant reed vegetation. Lecarrow 30 Stream exits from the southern side of Horseleap Lough and flows for approximately 4km prior to merging with the Abbert River.

The southwestern portion of the Proposed Wind Farm site, which includes the construction site entrance and access road, drains to the Forty Acres Stream. The Forty Acres Stream flows for approximately 3km prior to merging with the

Lecarrow 30 Stream at a location 3km downstream of Horseleap Lough. The Substation element of the Proposed Grid Connection also drains to the Forty Acres Stream.

Aside from natural streams draining the Proposed Wind Farm site as described above, there is also a high density of man-made drains located within the cutover bog, grassland, and forestry areas. The grassland and forestry areas typically comprise peaty or poorly draining soil (underlain by SILT and CLAY-dominated/low to moderate permeability glacial tills).

Table B. S-P-R Assessment of Flood Sources for the Proposed Project

Source	Pathway	Receptor	Comment
Fluvial	Overbank flooding of the rivers and streams that are close to some of the wind farm infrastructures.	Land infrastructure &	The Proposed Wind Farm site is located in Fluvial Flood Zone C where there is a low risk of fluvial flooding. Some areas of the Proposed Grid Connection route are located within Flood Zone A or B, but due to the underground nature of the infrastructure, are not risk.
Pluvial	Ponding of rainwater on site	Land infrastructure &	There is a low risk of significant pluvial flooding due to the extensive manmade drainage networks
Surface water	Surface ponding/ Overflow	Land infrastructure &	Same as above (pluvial).
Groundwater	Rising groundwater levels	Land infrastructure &	Based on local hydrogeological regime and GSI mapping, there is no apparent risk of groundwater flooding at the Site.
Coastal/tidal	Overbank flooding	Land, People, property	No coastal flooding will be possible at the Site

Chapter 10: Air Quality

The production of energy from wind turbines generates no direct emissions, unlike fossil fuel-based power stations. Harnessing more energy through renewable sources will reduce dependency on fossil fuels, thereby reducing harmful emissions that are damaging to human health and the environment.

Some minor short term or temporary indirect emissions associated with the construction and decommissioning of the Proposed Project include vehicular and dust emissions.

The potential for health effects are considered negligible as the potential for exhaust emissions will be limited and controlled through site layout design and mitigation measures.

Response: This Chapter omits the impact of cleaning the detritus of dead insects off the blades with chemicals/detergents/pressure jetting & ignores the breakdown of the blades over the lifetime of the windfarm. The suggested "compound" will not control these impacts, which will be in suspension & then in water bodies.

Chapter 11: Climate

The objective of this assessment is to assess the potential effects that the Proposed Project may have on Climate and sets out proposed mitigation measures to avoid, reduce or offset any potential significant effects that are identified.

The objective of this assessment is to assess the potential effects that the Proposed Project may have on Climate and sets out proposed mitigation measures to avoid, reduce or offset any potential significant effects that are identified.

Table 11.3 Data from Met Eireann Weather Station at Birr 1978-2008

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
WIND (knots)													
mean monthly speed	10.2	10.3	10.2	8.7	8.1	7.7	7.2	6.8	7.7	8.7	8.9	9.7	8.7
max. gust	96	85	74	74	62	51	66	78	58	70	67	81	96
Max. gust m/s [0.51444m/s]	49.39	43.73	38.07	38.07	31.89	26.24	33.95	40.13	29.84	36.01	34.47	41.67	49.39

11.4 Calculating Carbon Losses and Savings from the Proposed Project

11.4.1 Background

Bogs and peatlands are known to store large amounts of carbon. Due to the waterlogged nature of these habitats, stored carbon is not broken down and released into the atmosphere. The construction of wind farms on bog and peat habitats may affect the natural hydrological regime, thus exposing and drying out the peat and allowing the decomposition of carbon. It is therefore necessary to demonstrate that any wind farm constructed on such sites saves more carbon than is released. The Proposed Wind Farm site is predominately agricultural with some adjacent areas in the north of the Site occupied by active raised blanket bog, and small sections being covered by coniferous forestry;

A methodology was published in June 2008 by scientists at the University of Aberdeen and the Macauley Institute with support from the Rural and Environment Research and Analysis Directorate of the Scottish Government, Science Policy and Co-ordination Division. The document, "Calculating Carbon Savings from Wind Farms on Scottish Peat Lands", was developed to calculate the impact of wind farm developments on the soil carbon stocks held in peat. This methodology was refined and updated in 2011 based on feedback from users of the initial methodology and further research in the area. The web-based version of the carbon calculator, which supersedes the excel based versions of the tool, was released in 2016. Please note, the web-based version of the carbon calculator is currently not available, the Macauley Institute has supplied a worksheet of the calculator (Version 2.14.0) which has been used to complete the following carbon loss assessment. The tool provides a transparent and easy to follow method for estimating the impacts of wind farms on the carbon dynamics of peatlands.

Previously guidance produced by Scottish Natural Heritage in 2003 had been widely employed to determine carbon payback in the absence of any more detailed methods.

Given the absence of peat, the Proposed Project will not give rise to any impact on peat habitat.

Response: Is the Applicant dealing with a different site?

The Macauley Institute methodology states that the total volume of peat impacted by the construction of a wind farm is strongly correlated to the extent of the peatland affected by drainage at a site. Therefore, in calculating the carbon loss/saving of the Proposed Project, all potential carbon losses associated with constructing a wind farm on peatland environments were discounted. The carbon losses as a result of the manufacture, transportation and erection of the proposed turbines were included in the calculation.

The full life cycle and embodied carbon of the proposed turbines have been taken account of in the Macauley Institute model. The emissions associated with the embodied carbon, along with the construction phase transport movements of the remaining site infrastructure associated with the Proposed Development are considered using the Transport Infrastructure Ireland (TII) Carbon Tool (TII 2022)³. The TII Carbon Tool is customised for road and light rail projects in Ireland, using emission factors from recognised sources during the construction, maintenance, and operation of TII projects in Ireland.

Table 11-1 CO₂ Losses from the Proposed Project

Origin of Losses	CO ₂ Losses (tonnes CO ₂ equivalent)	
	Expected	Maximum
Losses due to turbine life (e.g., manufacture, construction, decommissioning)	51,056	55,197
Losses due to backup	40,949	41,531
Losses from reduced carbon fixing potential	1,056	2,208
Losses from soil organic matter and due to leaching of dissolved and particulate organic carbon (CO ₂ loss from removed)	17,537	91,267
Losses associated to tree felling	4,981	5,126
Losses associated with embodied carbon in construction materials	25,001	25,001
Losses associated with traffic and transport movements	304	304
Total	145,705	224,530

The worksheet models and online tools calculate that the Proposed Project will give rise to 145,705 tonnes of CO₂ equivalent losses over its 35-year life.

Response: This does not include the Wake losses downwind for 30-40km from a 3⁰Centigrade temperature reduction.

Key contributors include turbines (38%), backup generation (28%), soil disturbance (12%), embodied carbon in construction materials (17.6%), with smaller contributions from tree felling, reduced carbon fixation, and construction transport. Soil-related emissions are conservatively estimated assuming all disturbed land is acid bog, though actual emissions are expected to be lower due to a mixed habitat composition. Forestry impacts will be partially offset by replanting and habitat enhancements such as native woodland and hedgerow planting. Embodied carbon and transport emissions are calculated using standardized material and logistics assumptions. Decommissioning plans involve dismantling turbines and removing cables, with foundations left in situ to minimize disturbance, further reducing potential CO₂ losses. Overall, habitat restoration and management measures are anticipated to lower the net carbon emissions relative to initial estimates.

11.4.3.2 Carbon Savings

A simple formula can be used to calculate carbon dioxide emissions reductions resulting from the generation of electricity from wind power rather than from carbon-based fuels such as peat, coal, gas and oil. The formula is:

$$\text{CO}_2 \text{ (in tonnes)} = (A \times B \times C \times D) / 1000$$

where: A = The rated capacity of the wind energy development in MW [This should be output & not rated capacity.

Rated capacity is a brochure item & not related to site characteristics of wind speed.]

B = The capacity or load factor, which takes into account the intermittent nature of the wind, the availability of wind turbines and array losses etc.

C = The number of hours in a year

D = Carbon load in grams per kWh (kilowatt hour) of electricity generated and distributed via the national grid.

For the purposes of this calculation, the rated capacity of the Proposed Wind Farm site is assumed to be 63 MW (as outlined Section 4.3.1.1.7 in Chapter 4 Description).

A capacity factor of 0.35 (or 35%) has been used for the Proposed Project.

The number of hours in a year is 8,760.

A conservative figure for the carbon load of electricity generated by natural gas in Ireland was sourced from Sustainable Energy Authority Ireland's (SEAI) Conversion and Emissions Factors for Publication worksheet. The emission factor for electricity generated in Ireland provisionally for 2024 was 204.3 gCO₂/kWh.

The calculation for carbon savings is therefore as follows:

$$\text{CO}_2 \text{ (in tonnes)} = (63 \times 0.35 \times 8,760 \times 204.3) / 1000 = 39,462 \text{ tonnes per annum}$$

Based on this calculation, 39,462 tonnes of carbon dioxide will be displaced per annum from the largely carbon-based traditional energy mix by the Proposed Wind Farm site. Over the proposed 35-year lifetime of the development, therefore 1,381,176 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation.

Based on the Scottish Government carbon calculator as presented above in Section 11.4.3.1, approximately 145,705 tonnes of CO₂ will be lost to the atmosphere due to changes in the soil and ground conditions and due to the construction and operation of the Proposed Project. This represents 11% of the total amount of carbon dioxide emissions that will be offset by the Proposed Project. The 72,211 tonnes of CO₂ that will be lost to the atmosphere due to changes in soil and ground conditions and due to the construction and operation of the Proposed Project will be offset by the Proposed Wind Farm site in approximately 44 months (3.6 years) of operation.

Response: This is an incorrect interpretation of results. The calculated carbon losses are far higher due to ignoring of wake climatic effects & the savings are far too high through usage of Brochure "Rated capacity" versus SEAI Wind Atlas wind speed "output". The corresponding losses will not be offset in the 35year life of the project. Additional issues regarding the non-compliance with separation distances, the area unsuited to wind turbines, the geological & drinking water issues, the bat & bird fatalities indicate far fewer turbines can be installed, which indicate the unsuitability of this site.

The Proposed Project is expected to displace 39,462 tonnes of CO₂ annually by generating clean electricity, replacing carbon-intensive sources like natural gas. Over its 35-year lifespan, this amounts to approximately 1,381,176 tonnes of CO₂ emissions avoided. However, the project will generate 145,705 tonnes of CO₂ emissions due to soil disturbance, construction, and operation—about 11% of the total CO₂ savings. The emissions from soil and ground changes (72,211 tonnes) will be offset by the wind farm's clean energy production within roughly 3.6 years of operation. Habitat enhancement and afforestation activities, including replanting coniferous forestry and native woodland, hedgerow planting, and wet grassland restoration, are planned to improve carbon storage potential, though these benefits have not been quantified in the current assessment. The carbon sequestration potential of these restoration efforts will be better understood in the future through tools like the Teagasc Forest Carbon Tool.

Following construction of the Proposed Development, there will be a Permanent Imperceptible Negative Effect on Climate as a result of greenhouse gas emissions from construction plant and vehicles, embodied carbon associated with the turbines and construction materials. Operation of the Proposed Project will have a Direct Long-Term Moderate Positive Effect on climate as a result of reduced greenhouse gas emissions.

Response: Using incorrect calculations produces incorrect results. This project will not produce reduced greenhouse gas emissions.

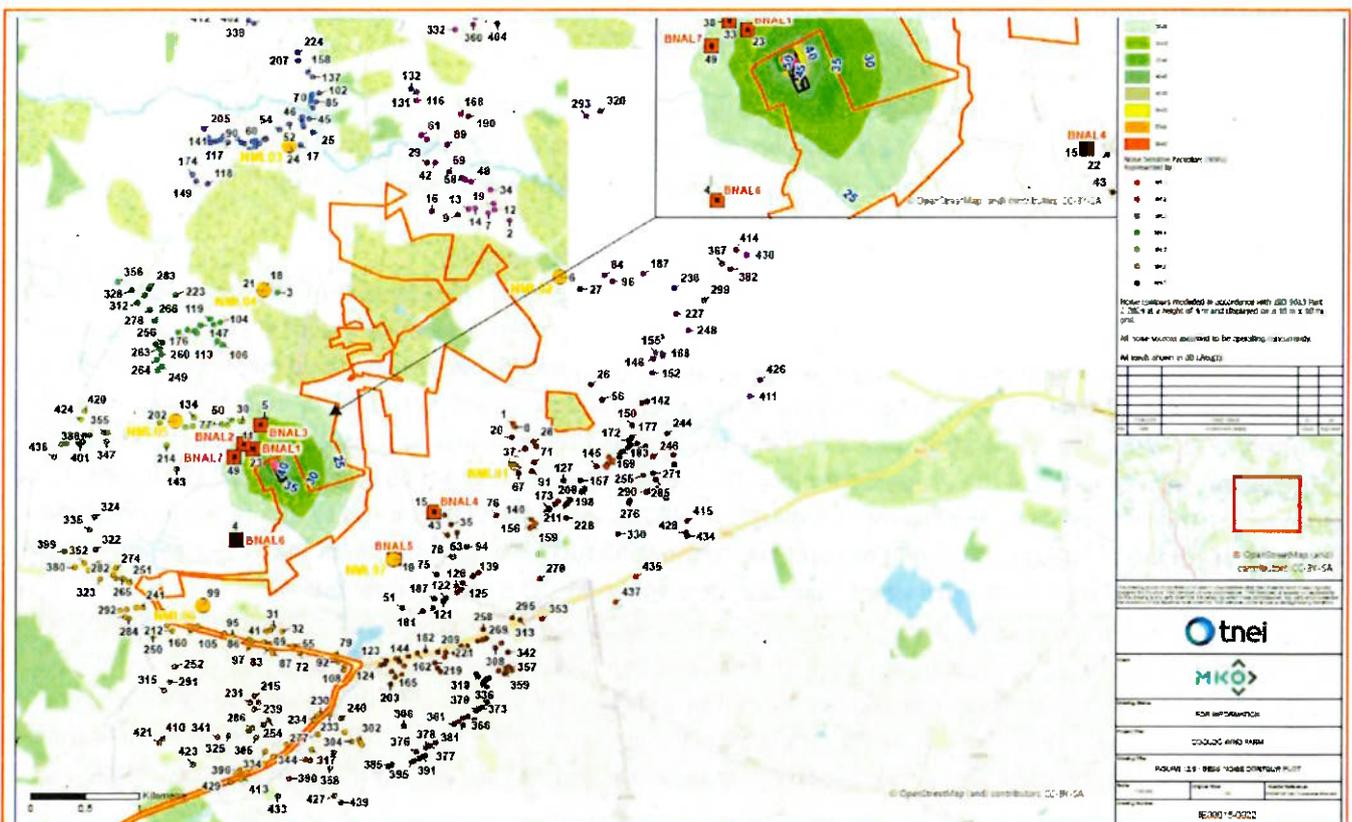
Chapter 12: Noise and Vibration

An additional Scoping Response was issued by HSE on 28th August 2025. Again, this response referred to the WHO documentation and the 2019 Draft WEDG. In addition, the HSE response stated;

"It should be noted that in the judgement of Ms. Justice Emily Egan delivered on the 8th day of March 2024 in Webster/Rollo V Meenaclogher (Wind) Limited (2024 IEHC 136) 8th March 2024 it was stated very clearly that considerations should be given to the most up to date knowledge and Guidance when considering impacts from noise. This would include the assessment methodology and the known significance of health effects from exposure to noise."

It is noted that the Webster/Rollo V Meenaclogher (Wind) Limited case is in fact, a noise nuisance case, rather than related to a planning application and/or Environmental Impact Assessment, and as such, we do not consider it directly relevant to this assessment. Nonetheless, TNEI can confirm that the assessment of wind turbine noise included in this EIAR, has been undertaken in accordance with 'the most up to date knowledge and guidance'.

Response: The HSE have already rejected this position. (above)



12.4.5.3 Criteria for Assessing Significance – BESS Operational Noise **[Note- What does BESS Operational Noise refer to? There is no BESS in this application]**

The British Standard (BS) 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound BS 4142 (hereafter referred to as BS 4142) form of assessment is based on the predicted or measured levels of an assessed sound source compared to the measured background sound levels without the specific sound source present and uses, "outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident". The BS 4142 Assessment Method is outlined in further detail in Section 3.1.1 of Appendix 12-3.

BS 4142 does not define significance criteria; rather it describes a framework for the measurement of noise and provides a method to determine the likelihood of adverse impact.

The assessment is undertaken in two parts; firstly, a comparison is made between the Rating Level and the Background Sound Level. Secondly, the assessment considers the context in which the sound occurs to determine a qualitative assessment outcome. As such there is no definitive pass/ fail. This is described in the standard as follows:

"Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following..."

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

12.5 Baseline Conditions

12.5.1 Current Baseline

The Proposed Wind Farm is located within a rural location where existing background noise levels at the NSRs are generally considered to be low (<30 dB at low wind speeds as defined in the 2006 Guidelines). The predominant sound sources in the area are wind induced noise (wind passing through vegetation and around buildings) and birdsong, with cars on local roads also audible on occasions.

Table 12.10 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

Noise Monitoring Location	Wind Speed (ms ⁻¹) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	30.1*	30.1*	30.1*	30.1	30.5	31.4	32.9	34.9	37.5	40.6	44.3	48.5
NML2	24.9*	24.9*	24.9	25.4	26.5	28.3	30.6	33.4	36.6	40.2	44.2	48.4
NML3	22.3*	22.3*	22.3	22.6	23.7	25.6	28.1	31.3	35	39.3	44.1	49.3
NML4	34.4*	34.4*	34.4	34.5	34.9	35.5	36.5	37.9	39.8	42.3	45.5	49.4
NML5	26.3*	26.3*	26.3	26.7	27.5	28.7	30.3	32.6	35.5	39.3	43.9	49.6
NML6	28.6*	28.6	29.0	29.5	30.2	31.1	32.4	34.1	36.3	39.2	42.7	47.1
NML7	30.8*	30.8	30.9	31.6	32.8	34.6	37	39.9	43.4	47.4	52	57.2

* Flattened where derived minimum occurs at lower wind speeds, see Section 5.8 of Appendix 12.2: Operational Noise Report.

Response: As the SEAI Windspeed is 7-8m/s, we can determine that daytime operating noise should be background noise plus 5dBa & should be lower than 33.1dBa (28.1+5) (below).

Table 12-11 Summary of Prevailing Background Noise Levels during Night-time Periods (dB(A))

Noise Monitoring Location	Wind Speed (ms ⁻¹) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	28.0*	28.0*	28.0*	28.0	28.3	29.3	30.8	32.9	35.6	38.9	42.8	47.3
NML2	18.5*	18.5*	18.5	18.7	20.2	22.7	26.1	30.1	34.7	39.5	44.4	49.3
NML3	16.7*	16.7*	16.7	16.9	18.3	20.6	23.8	27.9	32.6	38.0	43.8	50.2
NML4	33.3*	33.3	33.1	33.1	33.3	33.9	34.9	36.4	38.4	41.0	44.4	48.4
NML5	19.1*	19.1*	19.1	19.2	20.3	22.1	24.8	28.1	32.1	36.7	41.7	47.2
NML6	20.3*	20.3*	20.3*	20.3	21.2	22.9	25.3	28.3	31.8	35.7	39.9	44.2
NML7	22.1*	22.1	22.6	23.9	25.8	28.4	31.7	35.7	40.3	45.7	51.8	58.5

Response: As the SEAI Windspeed is 7-8m/s, we can determine that nighttime operating noise should be background noise plus 5dBa & should be lower than 28.8dBa (23.8+5).

A noise and vibration assessment was undertaken to determine the likely significant effects from the construction, operational and decommissioning phases of the Proposed Wind Farm, at nearby noise sensitive receptors (residential properties).

The operational noise assessment was undertaken in three stages, which involved setting the Total 2006 Guidelines Noise Limits (which are limits for noise from all wind farms in the area) at the nearest noise sensitive receptors (NSRs), predicting the likely effects (undertaking cumulative noise predictions) and finally setting Site-Specific Noise Limits for the operation of the Proposed Wind Farm on its own. The Total 2006 Guidelines Noise Limits have been derived in relation to background noise levels and other applicable criteria in accordance with the 2006 Guidelines.

Predicted cumulative operational noise levels indicate that for noise sensitive receptors neighbouring the Proposed Wind Farm, cumulative wind turbine noise (which considers noise predictions from all nearby operational and permitted wind farms and the Proposed Wind Farm) would meet the Total 2006 Guidelines Noise Limits at all Noise Assessment Locations.

The Total 2006 Guidelines Noise Limit is applicable to all operational and permitted wind farms in the area. Therefore, Site-Specific Noise Limits have also been derived to control the specific noise from the Proposed Wind Farm. In accordance with the guidance in IOA GPG, the Site-Specific Noise Limits have been derived with due regard to cumulative noise by accounting for the proportion of the Total 2006 Guidelines Noise Limit which is potentially being used by other nearby developments. The Site-Specific Noise Limits have been derived in accordance with the IOA GPG.

Predictions of Proposed Wind Farm turbine noise have been made in accordance with good practice using four candidate wind turbines, a max tip height of 180 m, a 150-162 m rotor diameter range and a hub height range of 99-105 m. Predicted operational noise levels from the Proposed Wind Farm indicate that for noise sensitive receptors neighbouring the Proposed Wind Farm, wind turbine noise from the Proposed Wind Farm would meet the Site-Specific Noise Limits at all Noise Assessment Locations (NAL) and are therefore deemed to be not significant.

The use of Site-Specific Noise Limits would ensure that the Proposed Wind Farm could operate concurrently with other operational wind farm developments in the area and would also ensure that the Proposed Wind Farm's individual contribution could be measured and enforced if required.

The four candidate wind turbine models were chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Wind Farm receive planning permission, the final choice of wind turbine would be subject to a competitive tendering process. The final choice of wind turbine will be required to meet the noise limits determined and contained within any condition imposed. Predicted noise levels from the BESS indicate there would be no significant effects at all BNALs.

Chapter 13: Landscape and Visual

13.1.3 Essential Aspects of the Proposed Wind Farm from an LVIA Perspective

In terms of landscape and visual effects, this LVIA takes the 9 no. proposed turbines as the essential aspect of the Proposed Project from an LVIA perspective and also gives due to consideration to the associated ancillary elements and underground Proposed Grid Connection.

The tall, vertical nature of the proposed turbines make them the most prominent element from a landscape and visual perspective, having the most potential to give rise to significant landscape and visual effects.

In this regard, the proposed turbines are deemed to be the “essential aspect” of the Proposed Project which will give rise to effects on the landscape and visual amenity and therefore are the primary focus of the LVIA.

13.1.4.2 Assessing the Turbine Dimension Range using Photomontages and Comparative Wirelines

Irrespective of which combination of hub height and rotor diameter outlined above is installed on-site, the significance of residual landscape and visual effects will not be altered.

13.1.5 Mitigation by Design

- ***Sparsely Settled & Highly Modified Landscape:*** The infrastructure of the Proposed Wind Farm has been strategically sited within a sparsely settled landscape characterised by common agricultural land, commercial forestry and cutover peatland. It is therefore a modified working landscape deemed to be of low landscape sensitivity, and a site capable of effectively absorbing the Proposed Wind Farm.
- ***Large Setback from Population Centres and Receptors:*** Site selection and siting of proposed turbines ensures limited visibility and large setback distances from large population centres and designated landscape and visual receptors of high sensitivity.
- ***Flat Nature of the Proposed Wind Farm site & Surrounds:*** The proposed turbines have been located within a flat site surrounded by lands of similar elevations which limit open views of the project. This topographic feature of the Proposed Wind Farm site and surrounds mitigates the potential for overbearing or domineering effects provided sufficient setback from receptors is designed into the project. It also means that separation distances between receptors and turbines becomes important as the proposed turbines appear smaller in perceived scale quickly (over shorter distances) when viewed in this planar view.
- ***Limited Visual Exposure:*** At a macro scale, the landscape of the entire Site is predominantly characterised by agricultural fields with mature boundary vegetation and localised landform undulations, i.e. low hilly terrain. Consequently, as reported throughout this LVIA, the visual exposure of the proposed turbines is generally very limited from receptors beyond 5km from the proposed turbines, thereby limiting potential for landscape and visual effects in vast areas of the LVIA Study Area and from a large number of sensitive receptors.

13.2.5 LVIA Wind Energy Context

The focus for visual impact assessment of wind energy developments is therefore distance, arrangement, location and potential disruption to key scenic sensitivities rather than a commonly misconceived focus on whether turbines are visible or not from a particular vantage point.

Over time, wind turbines have, and will become, a more familiar and accepted component of the Irish landscape, particularly in working rural contexts. Accordingly, their presence may not carry the same level of perceived visual intrusion as less common or incongruous forms of development. In this context, the calibration of visual impact significance reflects both the policy-driven imperative for renewable energy development and the evolving visual baseline in parts of the Irish landscape. While the visibility of turbines remains an important consideration, it does not in itself equate to significant visual impact.

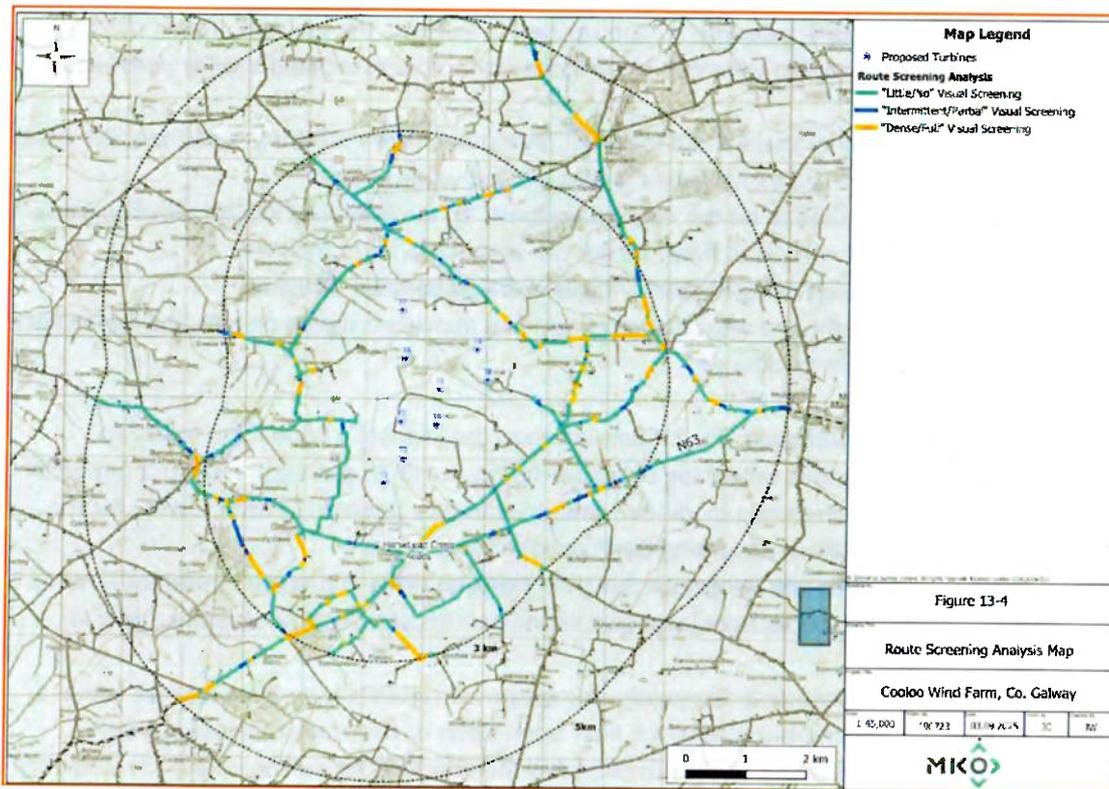
Theoretical Visibility within 5km of the Proposed Turbines

The proposed turbines are located within a relatively flat area of land with gentle undulations in the topography, resulting in **predominantly full theoretical visibility within 5km of the proposed turbines**. Localised undulations near the Proposed Wind Farm result in small areas of partial theoretical visibility due to the topographical screening from localised hills. The potential for actual visibility within 5km of the proposed turbines is further reduced by intermittent roadside vegetation screening, which is discussed in the next Section 13.3.3 On-Site Visibility Appraisal.

Response: Intermittent roadside vegetation only exists in Summer period. Visibility exists for the rest of the year.

13.3.3.2 Visibility in Close Proximity: Route Screening Analysis (RSA)

For this LVIA, Route Screening Analysis (RSA) was carried out within a 5km radius of the proposed turbines, in January 2024. Local roads within 3km were assessed, while major roads, such as regional and national roads, were assessed to 5km from the proposed turbines.



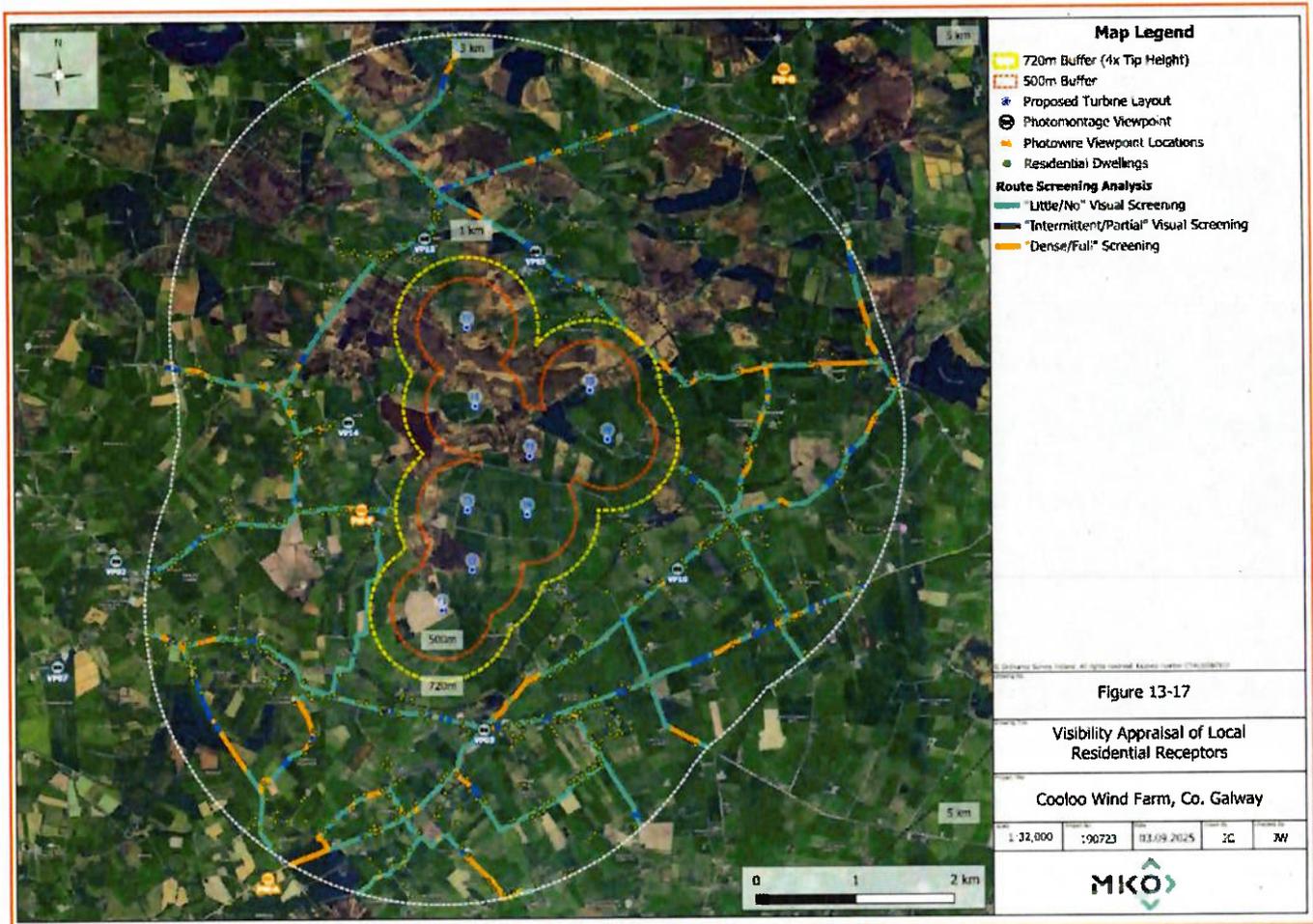
13.7.3.1 Landscape Effects during Operational Phase

13.7.3.1.1 *Landscape of the Proposed Wind Farm site*

The landscape of the Proposed Wind Farm site will undergo substantial changes by the introduction of the turbines as vertical, man-made structures within the material area of the site. **As a result, there will be a “Substantial” magnitude of change to the landscape in localised areas within the Site where the landscape is materially altered (infrastructure footprint).**

13.7.3.2.6 *Visual Effects on Local Residential Receptors*

The Proposed Wind Farm site is located in a sparsely settled flat landscape, well set-back from sensitive landscape and visual receptors, large population centres and receptors protected in local planning policy. During the site selection process, **early stage LVIA appraisals identified local residential receptors as the most sensitive receptors with the greatest potential to be adversely impacted by the proposed turbines with regard to visual impacts.** Consequently, residential visual impact assessment was of key consideration during site selection and throughout the iterative design process for the Proposed Project. During multiple surveys conducted in 2021, 2022, 2023 and 2024, visibility appraisals determined that most visibility of the proposed turbines will occur within 1-3km of the proposed turbines. This area is a modified working and settled landscape with residential housing organised along the local road network, as well as small settlement clusters around local crossroads and junctions. **Some residential receptors located in close proximity to the Proposed Wind Farm site will likely have views of the proposed turbines and are likely to have the greatest visual effects arising as a result of the Proposed Wind Farm.** As detailed in Chapter 5 Population and Human Health, the landscape surrounding the Proposed Wind Farm site has a significantly low population density compared to both the national figure and that of Co. Galway (refer to Table 5.2 in Ch.5).



Residential Receptors to the North

VP05 and VP15 illustrate the potential visual effects from receptors to the north at 1km from the proposed turbines. Both viewpoints were deemed **"High" sensitivity** on account of the residential proximity to the proposed turbines. In VP05, the proposed turbines appear in a linear layout and are evenly spaced over a moderate horizontal extent within the view. In VP15, the proposed turbines which are visible appear to be reducing in size proportionally to their set-back distance when panning from left to the right in the view. The two different fields of view are indicated in the aerial image below.



Figure 13-18 Two fields of view for receptors to the north; map uses Figure 13-17 legend

Residential Receptors to the East

VP10 illustrates the potential visual effect from receptors to the east at 1.5km from the proposed turbines. The landscape in this area is slightly more hilly terrain, with larger undulations in the topography that reduce potential visibility of the proposed turbines. The primary landcover is agricultural fields bounded by mature vegetation. VP10 is deemed “High” sensitivity on account of the residential proximity to the proposed turbines. From this field of view, the proposed turbines are viewed in a linear layout along the horizon of the ridgeline over a moderate horizontal extent, thereby constituting a “Moderate” magnitude of change. The field of view is indicated in the figure below.



Figure 13-19 Moderate horizontal extent field of view from the east in hilly terrain; map uses Figure 13-17 legend

Residential Receptors to the South

VP03 illustrates the potential visual effect from receptors to the south at 1.3km from the proposed turbines, given a “High” sensitivity on account of residential receptors in close proximity. From this field of view the turbines are seen to diminish in perceived scale over a moderate horizontal extent, setback beyond the ridgeline of gently undulating terrain. The magnitude of change at this viewpoint was therefore deemed “Moderate”. The field of view is indicated in the figure below.



Figure 13-20 Narrow field of view from the south, causing perceived scale of proposed turbines to diminish with distance; map uses Figure 13-17 legend

Residential Receptors to the West

VP14 illustrates the potential visual effect from receptors to the west of the study area at 1.3km, given a “High” sensitivity on account of the proximity of residential receptors to the proposed turbines.

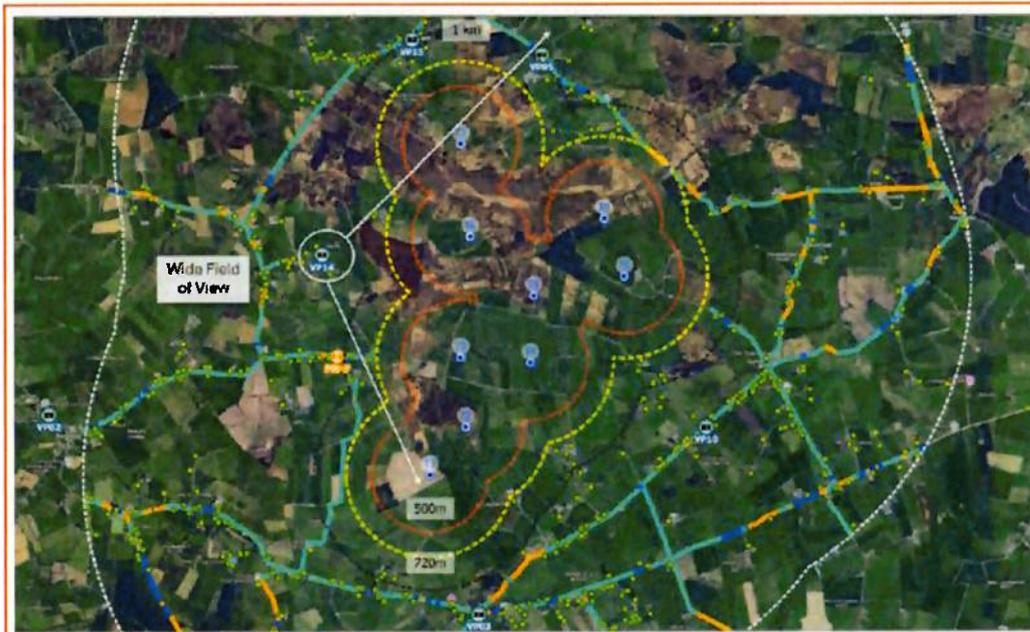


Figure 13-21 Wide field of view from the west; map uses Figure 13-17 legend

In the figure above, it can be seen that from the vantage point of VP14, the proposed turbines occupy a wide horizontal extent of the field of view. In the Photomontage Booklet, the proposed turbines are seen in a linear layout staggered in front and behind low hilly terrain features, and the large perceived scale (height and breadth) of some of the visible proposed turbines, particularly T6, gives rise to a “Substantial” magnitude of change. The proposed turbines situated farther away appear more modest in scale. Some of the proposed turbines are visually screened from view by dense, mature vegetation and would be so intermittently in a journey scenario from this vantage point along the local road network owing to patches of roadside screening and the undulating topography. Residual visual effects for receptors in this area are likely to be “Significant”. The number of receptors to be experiencing this level of visual effects is low.

Considering the 20km LVIA Study Area, no residual Significant effects will occur on designated landscape and visual receptors or scenic sensitivities of county, regional or national. No designated landscape receptors, landscape

sensitivities or scenic views as set out in local planning policy exist within the 20km LVIA Study Area. 9 No. proposed turbines and all Proposed Wind Farm infrastructure are sited within landscape of Co. Galway designated as “Low” sensitivity in the Galway County Development Plan (GCDP) 2022-2028 defined as “Unlikely to be adversely affected by change”. The proposed Grid Connection underground electrical cabling route is sited within the same.

The presence of wind turbines in the rural landscape of Ireland is consistent with evolving national climate policy and the changing character of Ireland’s working landscapes. The focus for the LVIA of the Proposed Project was on a combination of distance, arrangement, location and potential disruption to key scenic sensitivities, rather than simply on whether turbines are visible or not from a particular vantage point. **The outcome of the LVIA, with regards to the EPA, 2022 definition of significance, is calibrated in the overall context of LVIA of wind energy developments in Ireland and what is acceptable in the context of emerging baseline trends and the acceptability of wind turbines within views as a result of national policy.** The Proposed Project is therefore considered acceptable in this context and is in alignment with emerging baseline trends.

Response: This entire LVIA Report refuses to deal with existing residences inside the 1.3km envelope. The proposal is not acceptable to the existing households & the Report excludes Photomontages from their properties conveniently.

Considering the 20km LVIA Study Area, no residual Significant effects will occur on designated landscape and visual receptors or scenic sensitivities of county, regional or national. No designated landscape receptors, landscape sensitivities or scenic views as set out in local planning policy exist within the 20km LVIA Study Area. 9 No. proposed turbines and all Proposed Wind Farm infrastructure are sited within landscape of Co. Galway designated as “Low” sensitivity in the Galway County Development Plan (GCDP) 2022-2028 defined as “Unlikely to be adversely affected by change”. The proposed Grid Connection underground electrical cabling route is sited within the same.

Proposed turbines T1-T5 and T9 are located within areas zoned as Open to Consideration to wind energy development in the GCDP Local Authority Renewable Energy Strategy (LARES). Proposed turbines T6, T7 and T8 are sited within areas zoned as Generally to be Discouraged, thus the potential impact of the proposed turbines on these areas was a key consideration of the LVIA. It was determined that landscape sensitivity is not considered to be the key factor influencing the zoning of lands where proposed turbines T6, T7 and T8 are located. The landscape type and character of the Generally to be Discouraged lands where T6, T7 and T8 are located were determined to be generally the same type and character as that of the surrounding lands zoned as Open to Consideration, that is, modified working landscape types of low sensitivity which can effectively accommodate wind energy development, comprising agricultural fields, cutover peatlands, and commercial forestry.

The proposed turbines at 180m tip height, deemed the essential aspect of the Proposed Project from an LVIA perspective, are sited in primarily flat terrain of agricultural fields, forestry and cutover and raised boglands with localised undulations and mature boundary vegetation that provide visual screening from most receptors beyond 3km of the proposed turbines. A range of turbine model scenarios was assessed in the LVIA, with hub height ranging from 99-105m and rotor diameter ranging from 150-162m. For the avoidance of doubt, the turbine model scenario with the greatest potential to result in landscape and visual effects (Scenario 3 Maximum) was assessed in all visualisations, and additional representative visualisations of the Scenario 1 Minimum and Scenario 2 Median turbine scenarios were also produced for assessment. Irrespective of which turbine scenario is used, the determination of residual visual effects in the visual impact assessment tables will not be altered.

15 No. photomontage viewpoints were selected to represent a good geographic spread of views from within the 20km LVIA Study Area, focussed in the direction of the proposed turbines. **The LVIA determined the potential for “Significant” residual visual effects at one viewpoint, VP14 Tigreenaun. The rating of predicted effects at VP14 is mainly owing to the proximity of residential receptors to the proposed turbines (within 1.3km) and the substantial magnitude of change observed from that vantage point.** The number of receptors experiencing these effects is very low as the landscape surrounding the Proposed Wind Farm site has a significantly low population density. The visual effects ratings for the remaining viewpoints range from “Imperceptible” and “Not Significant” at viewpoints greater than 4.5km from the proposed turbines, to “Moderate” at viewpoints as close in as 1km. In terms of visual effects on local (within 3km) residential receptors, the LVIA determined that, in general, when viewing the proposed turbines from the north or south, the narrow field of view causes the perceived scale (height and breadth) of turbines to diminish quickly with distance, thereby mitigating visual impacts.

Other factors contributing to the mitigation of visual impacts include intermittent screening by mature forestry and boundary vegetation, and visual screening by localised undulations in topography which allow a sense of set-back from most receptors. In addition, from a distance, the layout of the proposed turbines ensures a relatively even height profile and even spacing between turbines, with the blades typically viewed above the horizon, slightly staggered among localised low hills, thereby meeting good aesthetic design as recommended in best practice guidance for LVIA and wind energy development.

4 No. designated Landscape Character Units (LCUs) were assessed for effects on landscape character within 15km of the proposed turbines, including cumulative effects. All LCUs were deemed to be Low sensitivity and no Significant landscape effects are predicted to occur. Factors contributing to the mitigation of effects on landscape character included the vast areas of the LCUs where no existing, permitted or proposed wind farms are sited, and the long distance between the proposed turbines and other developments which ensures that material alteration of the landscape is confined to individual areas and that visual connection between developments is minimised. No key sensitivities of the LCUs were found to be affected as a result of the Proposed Project.

1 no. designated protected view G-V42 Glenmaddy Turlough was scoped in for assessment, with a residual visual effect of "Imperceptible." 7 no. settlements, 3 no. recreational destinations and 3 no. transport routes were scoped in for assessment; no "Significant" effects are predicted for any receptors.

The LVIA focused on assessing the visual impact on local residential receptors within 3km of the proposed turbines considered high-sensitivity owing to their close proximity and determined that most receptors within 3km—those to the north, east and south of the Proposed Wind Farm site—are likely to experience "Moderate" residual visual effects, which are not significant.

The presence of wind turbines in the rural landscape of Ireland is consistent with evolving national climate policy and the changing character of Ireland's working landscapes. The focus for the LVIA of the Proposed Project was on a combination of distance, arrangement, location and potential disruption to key scenic sensitivities, rather than simply on whether turbines are visible or not from a particular vantage point. The outcome of the LVIA, with regards to the EPA, 2022 definition of significance, is calibrated in the overall context of LVIA of wind energy developments in Ireland and what is acceptable in the context of emerging baseline trends and the acceptability of wind turbines within views as a result of national policy. The Proposed Project is therefore considered acceptable in this context and is in alignment with emerging baseline trends.

Chapter 14: Cultural Heritage

1.14.1.1 Baseline Environment

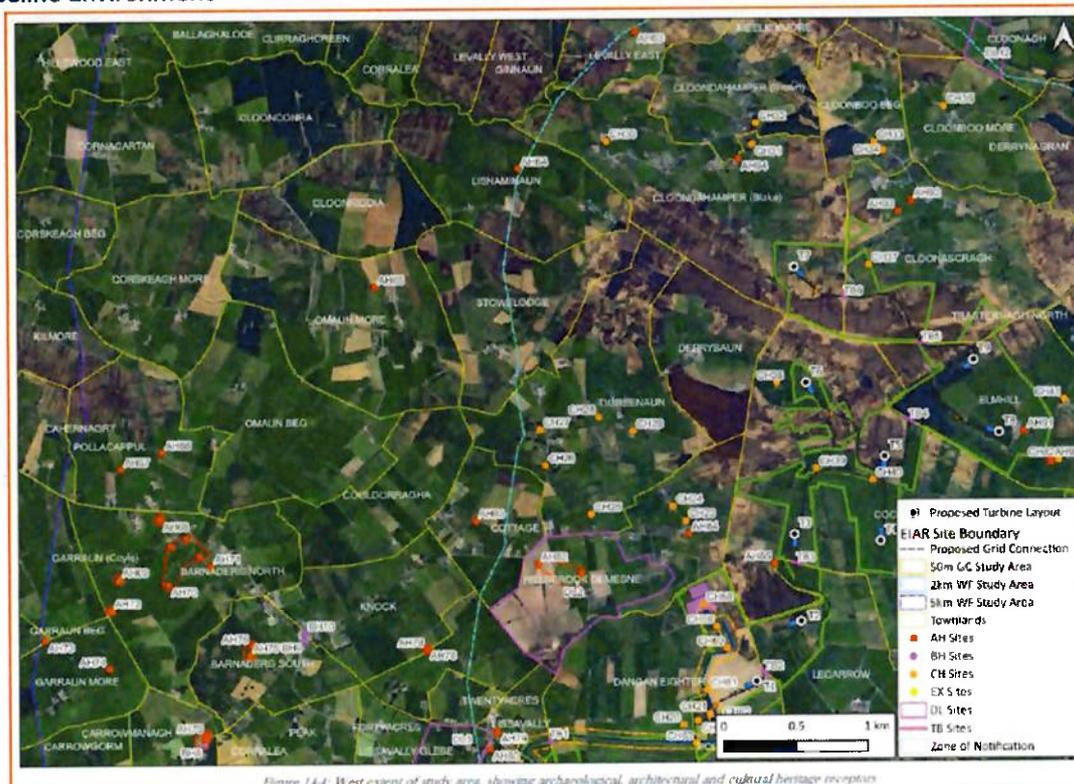


Figure 14-4: West extent of study area, showing archaeological, architectural and cultural heritage receptors

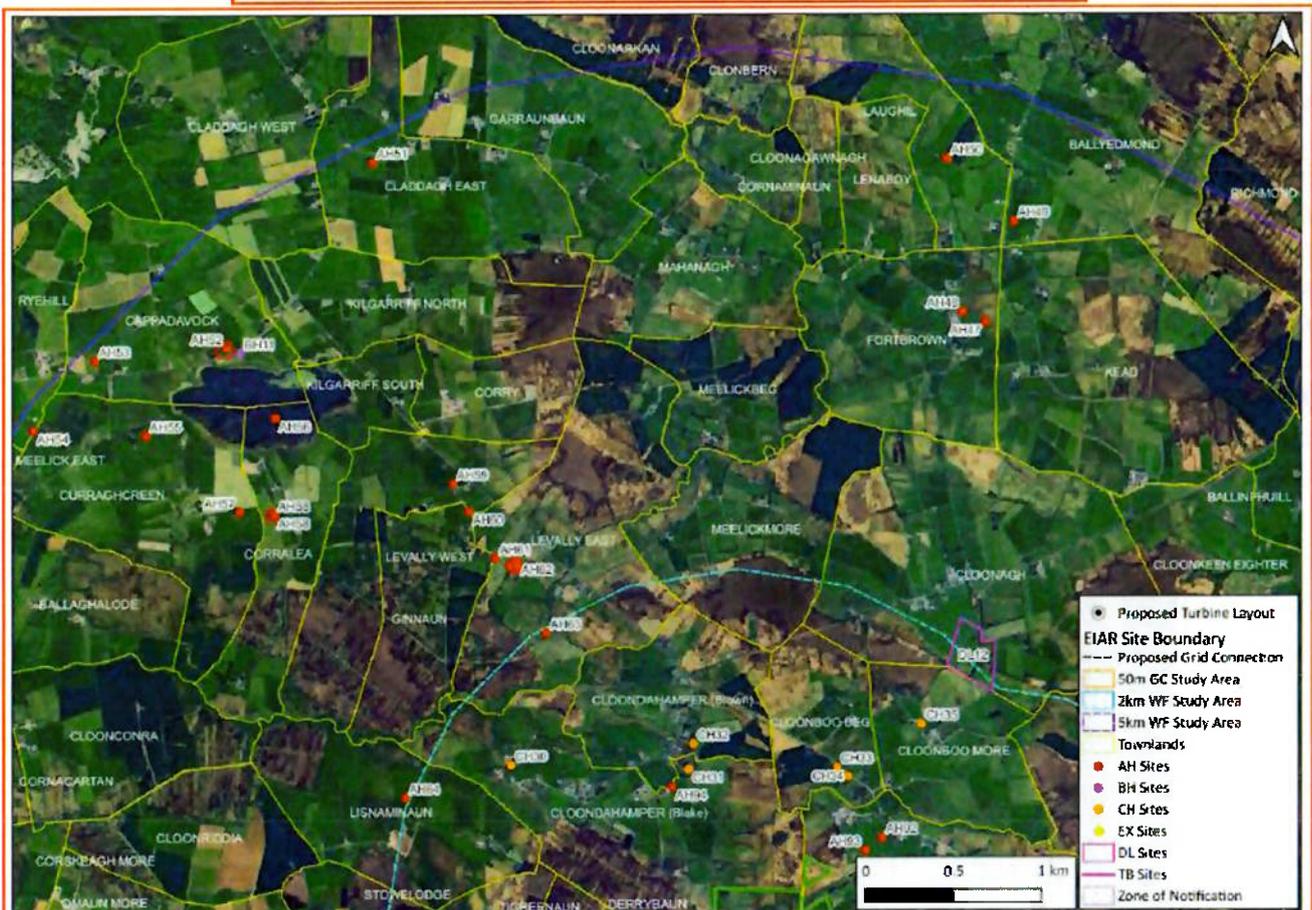
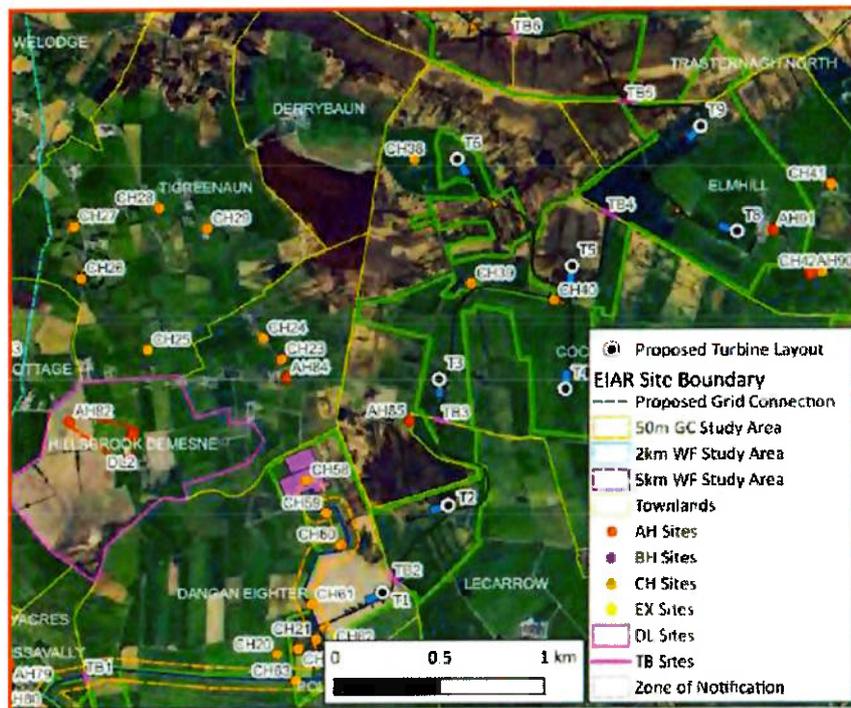
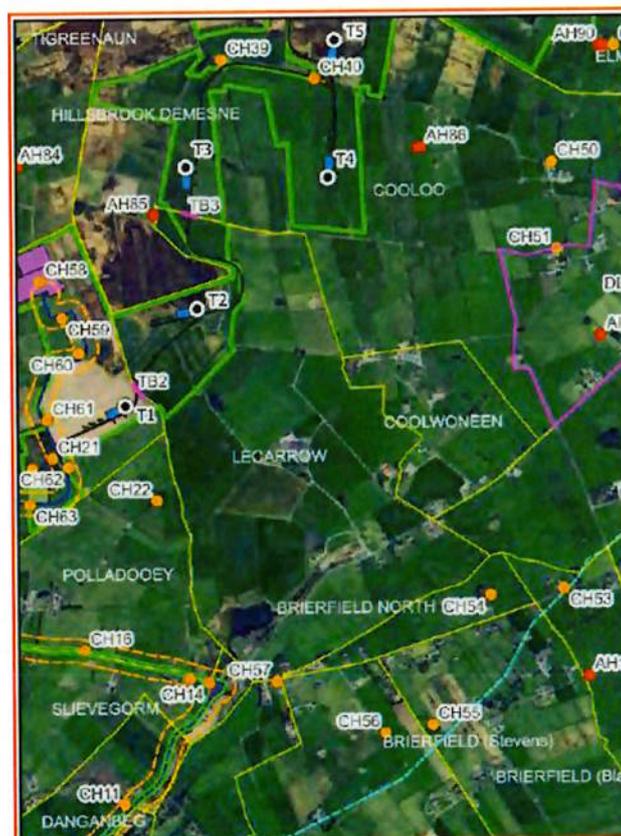


Figure 14-5: North extent of study area, showing archaeological, architectural and cultural heritage receptors



There is one recorded archaeological site within the Proposed Wind Farm site, comprising an 18th/19th century house (AH91), located 160m to the east of Turbine 8. There are a further 90 archaeological sites, or groups of sites, within the 5km study area (of the Proposed Wind Farm site), 11 of which include redundant records.

14.3.1.2 Historic Period Early Medieval Period (AD 500–1100)

A total of 34 ringforts are located within the 5km study area of the proposed turbines, as well as an additional 17 enclosures (listed in Table 14-6). Many monuments recorded as enclosures represent ringforts or similar sites, which

are too denuded or do not meet the standard shape and size expected of sites classified as ringforts. In addition, there are five souterrains in the 5km study area of the proposed turbines (AH52, AH58, AH69, AH90, AH92). Souterrains are often associated with ringforts and consist of underground passages and chambers. These sites are usually interpreted as being used for storage and defence by early medieval groups. These sites indicate that the study area surrounding the Site was characterised by a dispersed rural population during the early medieval period.

Three crannogs are also recorded in the 5km study area of the proposed turbines (AH24, AH46 and AH56). Crannogs comprise settlements constructed on artificial or modified islands, located in lacustrine and riverine environments and usually date to the early medieval period.

The early medieval period marked the arrival of Christianity in Ireland, which was to have a profound impact on the country. This is evidenced by the proliferation of ecclesiastical sites throughout the country during this period. One ecclesiastical enclosure is recorded 0.8km to the northeast of the Turbine 7 (AH93). Additionally, a total of seven churches are recorded within the 5km study area (AH29, AH36, AH42, AH62, AH76, AH79), several of which may have early medieval origins. Bullaun stones are often associated with early medieval ecclesiastical sites. Two are located within the 5km study area of the proposed turbines, AH36 and AH93, both of which are associated with ecclesiastical sites. Additionally, one holy well is recorded 2.4km to the south of Turbine 1 (AH12). The veneration of well sites is one of the oldest traditions in Irish Christianity and most likely has its origins in pagan ritual activities. These wells can manifest themselves in a variety of forms ranging from natural springs to rain collecting rock depressions. Many holy wells can be found associated with early ecclesiastical sites and well veneration and its antecedent well worship is not confined to Ireland or even to Europe. Plummer (1910) demonstrates that at least some holy wells in Ireland were important venues of pre-Christian ritual activity.

During the 14th to 16th centuries, tower houses were the typical residence of the Irish gentry and are a common feature in the Irish landscape. A medieval tower house built by Melughlin O'Kelly (AH71) is located 3.8km west-northwest of the Turbine 1. The site of two castles is recorded within the 5km study area of the proposed turbines. AH62 is located 2.4km to the northwest of Turbine 7 and AH21 is located 3.6km to the southeast of Turbine 1. Although no upstanding remains are present, these may have been the fortified residences of the Irish gentry. Additionally, a hall house is located 4.5km to the east of Turbine 8.

Seven churches are recorded within the 5km study area of the proposed turbines (AH29, AH36, AH42, AH62, AH76, AH79). While some these churches may date to the early medieval period or the post-medieval period, they are also noted here under the medieval heading as many may have been used in the medieval period, even if the upstanding remains post-date the medieval period.

There are a total of 11 demesne landscapes in the 5km study area of the proposed turbines, and a further one within 50m of the Proposed Grid Connection. These are examples of the estates of wealthy landowners.

Ballinderry House demesne (DL1) is shown on the 1837 OS map immediately to the west of the Proposed Grid Connection. A narrow strip along the eastern side of DL1 is located within the 50m study area of the Proposed Grid Connection. The principal building, Ballinderry House, is no longer present, although the ruins of Ballinderry Castle, a tower house, remain upstanding in the north of the demesne. Several demesne features are retained, including a tree-lined avenue, tree-lined boundaries, a walled garden, parkland and tree-lined boundaries. Residential buildings have been constructed along the R347 in the east of the demesne boundary.

Hillsbrook House demesne (DL2) is shown on the 1837 OS map 880m to the west of T3 and is recorded on the NIAH Garden Survey (GA5319). The demesne has been largely subsumed into agricultural lands, and the principal structure, Hillsbrook House (AH82), has been demolished. The outline of the walled garden is visible and a designed landscape feature (a tree ring; AH82) survives.

Glebe House demesne (DL3; Lissavally Glebe townland) is shown on the 1837 OS map 1.8km to the west of T1. It is shown as a modest demesne focused around the principal structure, Glebe House, which is no longer present. Areas of planting around the site of the house are retained, as is the walled garden and original entrance avenue.

Moyne House demesne (DL4) is depicted on the 1837 OS map 2.6km to the southwest of T1 and is recorded on the NIAH Garden Survey (GA5356). This is an extensive demesne which survives largely intact. The principal structure, Moyne House (AH6; BH7) survives on a slight rise. The house, built in 1825, is an impressive building associated with several surviving outbuildings. The house is situated within extensive grounds, which has retained its parkland

character. Several areas of woodland remain. The original entrance avenue is retained, which is entered via a formal entrance (BH4). A large walled garden is retained to the east of the principal structure. Additionally, several recorded archaeological and built heritage features are located within the demesne, including an earthwork (AH4), a quarry (AH5), a chapel and burial ground (AH6), a house (AH7), a ringfort (AH8), a folly (AH9) and a memorial (AH10; BH6)

Newtown demesne (DL5) is located 4.1km to the southwest of T1. It is depicted on the 1837 OS map and is recorded on the NIAH Garden Survey (GA5365). The demesne is largely intact, and is associated with Newtown House (AH11; BH17), which is upstanding. Newtown House overlooks the River Abbert, which passes through the centre of the demesne. The river is crossed by a bridge (BH16). The demesne lands retain their parkland character, and the planting is largely intact. A walled garden and farmyard are retained to the northeast of the house.

Abbert demesne (DL6) is located 4.6km to the south of T1. The demesne is depicted on the 1837 OS map and is recorded on the NIAH Garden Survey (GA5221). The principal structure, Abbert, is no longer present although part of the attached farmyard is retained, as is the walled garden. The house was formerly approached by an entrance avenue, which has been incorporated into the local road network. The surrounding parkland has subsumed into agricultural land, with several domestic developments alongside the road. The extensive planting that was formerly present in the demesne has largely been lost, although some tree-lined boundaries have been retained. A lane extends from the site of the principal structure to a ruinous church and graveyard.

Windfield House demesne (DL7) is depicted on the 1837 OS map 4.0km to the southwest of T1 and is recorded on the NIAH Garden Survey (GA5406). The principal structure, Windfield house, is no longer present, although several outbuildings, the walled gardens and walled enclosures have been retained. The entrance avenue extended to the east of the house, although this is no longer present. The entrance has been retained, although the gatehouse has been replaced by a modern structure. The surrounding parkland has generally been subdivided and cleared of much of the planting that was formerly present, including a large number of designed landscape features (AH14), predominantly tree-rings.

Cooloo Cottage demesne (DL8) is depicted 800m to the east of T4 on the 1837 OS map. The principal structure, Cooloo Cottage, is no longer present although an outbuilding (CH51) has been retained in a modern farmyard. The walled garden survives to the west of the farmyard. The entrance avenue, which originally led to the southwest of the house, has been lost. The surrounding parkland has been subdivided and the extensive planting shown on the 1837 OS map have been removed. Burial mounds (AH87) are located within DL8, although these are unrelated to the demesne and are not marked on historic mapping.

Glebe House demesne (DL9; Moylough More townland) is shown 4.7km to the east of T8 on the 1837 OS map. DL9 is a small demesne surrounding the principal structure, Glebe House (AH28; BH12; later known as Moylough Rectory). The house shown on the 1837 OS map appears to have been rebuilt/extended by the time of the 1892 OS map. An outbuilding and part of the walled garden survives to the north of the house. The entrance is still present, comprising limestone piers and cast-iron gates, and a detached gate lodge also survives. The tree-lined boundaries of the demesne remain present.

Summer Ville demesne (DL10) is located 3.2km to the east of T8, and is depicted on the 1837 OS map. The principal structure, Summer Ville, is present although the outbuildings depicted to the east of the house appear to have been replaced by a modern farmyard. The walled garden is defined to the south of the house, and the original entrance avenue is retained. Stone gate piers mark the entrance where the avenue reaches the R328. Much of the parkland that surrounds Summer Ville survives, although some has been lost along the shores of Summerville Lough, which has expanded since the time of the 1837 OS map.

Moathill Lodge demesne (DL11) is depicted on the 1837 OS map 2.3km to the east of T9 and is recorded on the NIAH Garden Survey (GA5348). DL11 comprises a modest demesne surrounding the principal structure, Moathill Lodge (AH39), which is still present. The demesne was substantially extended by the time of the 1892 OS map, with woodland plantations serving a saw mill. A large lake was added to the east of Moathill Lodge, which fed the mill and provided a landscape feature. Several features were associated with the lake, including a boat house and a bridge,

although these are no longer present. A complex of outbuildings and the mill partially survive to the west of Moathill Lodge. The entrance avenue was altered by the time of the 1892 OS map, and this entrance is still present, comprising stone gate piers. The majority of the demesne lands, as depicted on the 1837 OS map, are covered by plantation.

Cloonagh House demesne (DL12) is depicted on the 1837 OS map 1.9km to the northeast of T7. The map shows a modest demesne, comprising a principal structure (Cloonagh House), a walled garden and outbuildings. None of these features survive. The demesne was accessed by a road that led to the north and to the northwest. The section that led to the north has survived as a lane, although the northwest section is no longer present. Much of the planting within the demesne has been retained.

No buildings of architectural heritage value were identified within the Proposed Wind Farm site. **In total, there are 20 buildings of architectural heritage merit, or the sites of buildings, within the 5km study area of the proposed turbines site and the 50m study area of the Proposed Grid Connection.** This includes bridges, churches, houses, gated entrances, a mill, monuments, a bellstand, a post-box and water pumps. The variety of structures represent the ecclesiastical, infrastructural and industrial heritage of the surrounding area. In addition to the civic or public structures, several houses and outbuildings are recorded as Cultural Heritage (CH) sites. A total of 63 cultural heritage sites have been identified within the study areas of the Proposed Project. These structures are characteristic of the post-medieval landscape and represent the homes of farmers and workers. 'Vernacular architecture' is a term used to describe traditional buildings constructed using locally available materials and according to local/regional styles i.e. the homes and workplaces of the ordinary people. This is in contrast to formal architecture, such as the grand estate houses of the gentry, churches and public buildings, which were often designed by architects or engineers. The majority of vernacular buildings are domestic dwellings. Examples of other structures that may fall into this category include shops, outbuildings, mills, limekilns, farmsteads, forges, gates and gate piers.

There are 14 recorded structures of architectural merit within the 5km study area of the Proposed Wind Farm site, including 10 protected structures. Additionally, 54 previously unrecorded sites of cultural heritage significance have been identified within the 2km study area of the Proposed Wind Farm site as part of this assessment. Four sites are within the footprint of proposed works associated with the Proposed Project (CH40, post-1892 vernacular building; CH14, a stone retaining wall with a round-arch culvert; CH58, the site of a vernacular building and well and extant upstanding drystone walls; CH63, a curvilinear anomaly of unclear origin identified from aerial photography).

1.14.1.2 Likely Effects and Associated Mitigation Measures

Direct Effects on the Proposed Project

The construction of the Proposed Project will not result in any direct, negative effects on the recorded archaeological or architectural heritage resource as none of these sites are located within the footprint of the development that require excavations and ground works.

Four previously unidentified cultural heritage receptors (CH14, CH40, CH58, CH63) will be directly impacted by the construction of the Proposed Wind Farm:

- CH14: within the route of the proposed TDR accommodation works. Prior to mitigation, these works will have a direct negative (permanent) effect on CH14. The effect will be slight.
- CH40: partially within the route of the proposed new road. Prior to mitigation, construction activities will have a direct negative (permanent) effect on CH40. The effect will be moderate.
- CH58: within the location of the proposed substation. Construction of the substation will have a (permanent) effect on CH58. Prior to mitigation, the effect will be moderate.
- CH63: partially within the location of the proposed temporary construction compound and the route of the proposed new road. At this stage it is unknown whether the anomaly is of anthropogenic or natural origin, and its sensitivity is unknown. Construction activities have the potential for a direct, negative (permanent) effect to this potential cultural heritage receptor. Prior to the application of mitigation measures, effects may vary from moderate to significant.

14.4.3 Operation Phase (Indirect): Mitigation and Monitoring Measures During Operational Phase

It is not possible to mitigate indirect effects on the archaeological, architectural and cultural heritage resource, due to the nature and scale of the proposed turbines within the landscape. It is noted that effects are not permanent and would be removed following the decommissioning and removal of the turbines.

Residual Effects

There will be residual effects on the archaeological, architectural and cultural heritage resource, due to indirect effects on the setting of a number of recorded sites and structures, ranging from imperceptible to moderate significance. Whilst these are long-term effects, they are not permanent.

Significance of Effect

There are no further significant negative effects on the archaeological, architectural and cultural heritage resource.

The Proposed Grid Connection passes through the Zone of Notification of two archaeological heritage receptors: bridge AH2 and vernacular building AH3. The laying of the cable route has the potential to have direct, negative (permanent) effects on features that may be associated with AH3. Direct effects to bridge AH2 will be avoided through the use of directional drilling although this method involves the excavation of launch and reception pits, which have the potential for direct, negative (permanent) effects to previously unrecorded archaeological features. Prior to the application of mitigation effects to AH2 and AH3 have the potential to range from slight to moderate, depending on the sensitivity of any such archaeological features.

Although much of the Proposed Wind Farm site has been disturbed by turbary peat extraction activities it remains possible that previously unknown archaeological sites and features may survive below the current ground level across the area, particularly in areas of pasture that have not been previously disturbed. Ground disturbances associated with the Proposed Wind Farm have the potential to result in direct, negative (permanent) effects on any such remains that may be present. Additionally, groundworks along the c. 55m of greenfield required for TDR accommodation works have the potential to result in direct, negative (permanent) effects on possible sub-surface archaeological remains. Prior to the application of mitigation these effects have the potential to range from moderate to significant, depending on the sensitivity of any such archaeological features.

Significance of Effects

Following the completion of the mitigation measures, there will be no significant negative residual effects on the archaeological, architectural and cultural heritage resource.

Chapter 15: Material Assets (including Traffic and Transport, Telecommunications and Aviation)

15.1 Traffic and Transport

It is noted that neither a Road Safety Audit or a Design Phase Procedure for Road Safety Improvement Scheme, Urban Renewal Schemes and Local Improvements Schemes (DN-GEO- 03030) Report are not required and therefore have not been undertaken. However, these will be undertaken and provided if required by TII.

Table 15.1 All day traffic flows by location, year 2025 (2-way vehicles)

Link	2025
1 - N63 (south of Annagh Cross)	7,798
2 - N63 (east of Annagh Cross)	6,862
3 - N63 (south of Brierfield)	4,245
4 - R322 (leading to Proposed Wind Farm site)	1,635

Table 15.7 All day flows, percentage HGVs and flows by vehicle type, year 2028

Link	All day flow (vehs)	% HGV's	Vehicles		PCUs		Total
			HGVs	Cars / lgvs	HGVs	Cars / lgvs	
1 - N63 (south of Annagh Cross)	8,422	5.1%	430	7,992	1,031	7,992	9,023
2 - N63 (east of Annagh Cross)	7,411	5.1%	378	7,033	907	7,033	7,940
3 - N63 (south of Brierfield)	4,585	5.5%	252	4,332	605	4,332	4,938
4 - R322 (leading to Proposed Wind Farm site)	1,766	6.4%	113	1,653	271	1,653	1,924

15.1.4.1.1 Stage 1 – Site Preparation and Groundworks including Cable Laying

During this construction phase there will be two distinct types of days with respect to trip generation. A total of 9 days will be used to pour the 9 concrete wind turbine foundations. Foundations will likely be poured one per day, with circa 107 concrete loads required for each turbine delivered to the Proposed Wind Farm site over a 10-hour period, resulting in 11 HGV trips to and from the site per hour. On the remaining 341 working days for this stage other general materials will be delivered to the Proposed Wind Farm site.

The estimated additional daily traffic generated on the road network during these days are shown in Tables 15-9 and 15-10.

Table 15.9 Trip generation - Stage 1 - Concrete foundation pouring - total movements and volumes per delivery day

Material	Total Truck Loads	Truck type	PCU Value	Total PCUs	PCU Movements /day*	2-way PCUs/day
Concrete	963	Concrete mixers	2.1	2,311	256.8	513.6

* Estimation based on 9 concrete pouring days

Table 15.10 Trip generation - Stage 1 - Site preparation and groundworks - total movements and volumes per delivery day

Material	Total Truck Loads	Truck type	PCU Value	Total PCUs	PCU Movements /day*	2-way PCUs/day
Delivery of plant	35	Large artic	2.4	84.0	0.25	0.49
Fencing & gates	3	Large artic	2.4	7.2	0.02	0.04

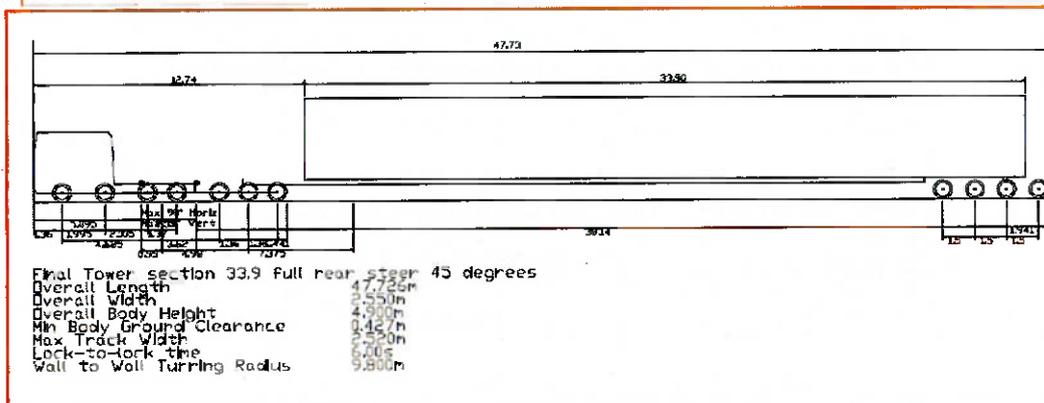
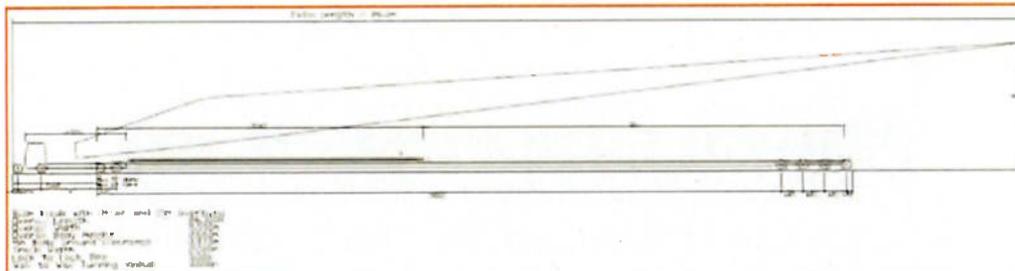
Compound setup	36	Large artic	2.4	86.4	0.25	0.51
Steel	24	Large artic	2.4	57.6	0.17	0.34
Rock and stone	14,450	Truck	2.4	34,680.0	101.7	203.40
Ducting and cabling (internal)	264	Large artic	2.4	633.6	1.86	3.72
Grid connection cable laying	2,940	Large artic	2.4	7,056.0	20.69	41.38
Tree felling	17	Large artic	2.4	40.8	0.12	0.24
Crane (to lift steel)	1	Large artic	2.4	2.4	0.01	0.02
Substation	100	Large artic	2.4	240.0	0.70	1.41
BESS	100	Large artic	2.4	240.0	0.70	1.41

Cranes for turbines	12	Large artic	2.4	28.8	0.08	0.17
Refuelling for plant	186	Large artic	2.4	446.4	1.31	2.62
Site maintenance	135	Large artic	2.4	324.0	0.95	1.90
Miscellaneous	90	Large artic	2.4	216.0	0.63	1.27
Total	15,453			37,087	108.76	217.5

* Estimation based on groundwork period of 341 working days

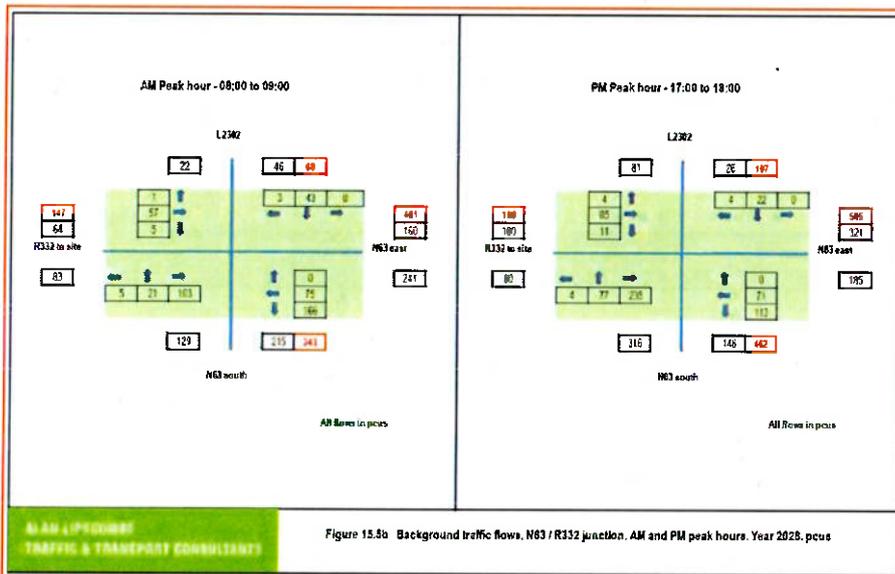
Table 15-11 Trip generation - Stage 2 - Wind turbine plant - total loads

Material	Units	Quantity per Unit	Total Quantity	Quantity per Truck	Total Truck Loads	Truck type
Nacelle	9	1	9	1	9	Extended Artic
Blades	9	3	27	1	27	Extended Artic
Towers	9	4	36	1	36	Extended Artic
Sub total					72	
Transformer	9	1	9	1	9	Large Artic
Drive train and blade hub	9	1	9	1	9	Large Artic
Base and other deliveries	9	2	18	1	18	Large Artic
Sub total					36	
Total					108	



1.15.1.1 Traffic and Transport

From the Port of Galway the turbine delivery route travels from Galway Harbour through Galway city onto the N6 via the L5048 Lough Atalia Road, the L5034 and the R336 Tuam Road. The route then travels east on the N6 passing through junctions with the R865 at Ballybrit and the R339 Monivea Road at Briarhill, before heading southeast to the Coonagh Roundabout. From the Coonagh Roundabout the route heads east on the N6 and M6, to Junction 18 of the M6 with the M17. The route then travels north on the M17 before turning off at Junction 19 onto the N63. The turbine delivery route then travels east on the N63 passing through Abbeyknockmoy and Dereen to the junction with the R332. The turbine then turns left off the N63 to travel northwest on the R332 before turning right into the Proposed Wind Farm site entrance.



Response: No traffic count with 85% ile speeds is included with the application. A one-day traffic count in summer with the nearby school closed is not adequate or reliable.

Access to the Proposed Wind Farm site will be provided during the construction stage via a new access junction of the R332 Regional Road at a location approximately 2.2km west of the existing R332 / N63 junction. This access will provide for all vehicle types during the construction and decommissioning phases of the Proposed Wind Farm.

Table 15.14 Daily traffic volumes on during concrete pouring - background, Proposed Wind Farm generated and total (PCUs), year 2028

Link	Background PCUs			Proposed Wind Farm PCUs			Total PCUs (Background + Proposed Wind Farm)		
	Car	HGV	Total	Car	HGV	Total	Car	HGV	Total
1 - N63 (south of Annagh Cross)	7,992	1,031	9,023	70	514	584	8,062	1,545	9,607
2 - N63 (east of Annagh Cross)	7,033	907	7,940	70	514	584	7,103	1,421	8,524
3 - N63 (south of Brierfield)	4,332	605	4,938	70	514	584	4,402	1,119	5,522
4 - R322 (leading to Proposed Wind Farm site)	1,653	271	1,924	70	514	584	1,723	785	2,508

Table 15.15 Daily Traffic volumes during site preparation and groundworks - background, Proposed Wind Farm generated and total (PCUs), year 2028

Link	Background PCUs			Proposed Wind Farm PCUs			Total PCUs (Background + Proposed Wind Farm)		
	Car	HGV	Total	Car	HGV	Total	Car	HGV	Total
1 - N63 (south of Annagh Cross)	7,992	1,031	9,023	70	259	329	8,062	1,290	9,352
2 - N63 (east of Annagh Cross)	7,033	907	7,940	70	259	329	7,103	1,166	8,269
3 - N63 (south of Brierfield)	4,332	605	4,938	70	259	329	4,402	864	5,267
4 - R322 (leading to Proposed Wind Farm site)	1,653	271	1,924	70	259	329	1,723	530	2,253

Table 15-16 Daily traffic volumes during turbine construction, extended arterials - background, Proposed Wind Farm generated and total (PCUs), year 2028

Link	Background PCUs			Proposed PCUs			Project			Total PCUs (Background + Proposed Project)		
	Car	HGV	Total	Car	HGV	Total	Car	HGV	Total	Car	HGV	Total
1 - N63 (south of Annagh Cross)	7,992	1,031	9,023	45	60	105	8,037	1,091	9,128			
2 - N63 (east of Annagh Cross)	7,033	907	7,940	45	60	105	7,078	967	8,045			
3 - N63 (south of Brierfield)	4,332	605	4,938	45	60	105	4,377	665	5,043			
4 - R322 (leading to Proposed Wind Farm site)	1,653	271	1,924	45	60	105	1,698	331	2,029			

Table 15-17 Daily traffic volumes during turbine construction - standard arterials, background, Proposed Wind Farm generated and total (PCUs), year 2028

Link	Background PCUs			Proposed Wind Farm PCUs			Total PCUs (Background + Proposed Wind Farm)		
	Car	HGV	Total	Car	HGV	Total	Car	HGV	Total
1 - N63 (south of Annagh Cross)	7,992	1,031	9,023	45	19	64	8,037	1,050	9,087
2 - N63 (east of Annagh Cross)	7,033	907	7,940	45	19	64	7,078	926	8,004
3 - N63 (south of Brierfield)	4,332	605	4,938	45	19	64	4,377	624	5,002
4 - R322 (leading to Proposed Wind Farm site)	1,653	271	1,924	45	19	64	1,698	290	1,988

Table 15-19 Summary daily effect of Proposed Wind Farm traffic - site preparation and ground works - % increase and number of days, year 2028

Link	Background	Proposed Wind Farm	Total	% increase	Estimated No. of days
1 - N63 (south of Annagh Cross)	9,023	329	9,352	3.6%	341
2 - N63 (east of Annagh Cross)	7,940	329	8,269	4.1%	341
3 - N63 (south of Brierfield)	4,938	329	5,267	6.7%	341
4 - R322 (leading to Proposed Wind Farm site)	1,924	329	2,253	17.1%	341

Table 15.21 Summary link effects of Proposed Wind Farm traffic - turbine construction, avoided trips - % increase and number of days, year 2028

Link	Background	Proposed Wind Farm	Total	% increase	Estimated No. of days
1 - N63 (south of Annagh Cross)	9,023	105	9,128	1.2%	21
2 - N63 (east of Annagh Cross)	7,910	105	8,015	1.3%	21
3 - N63 (south of Brierfield)	4,948	105	5,043	2.1%	21
4 - R322 (leading to Proposed Wind Farm site)	1,924	103	2,027	5.5%	21

Table 15.22 Delivery route link type and link capacity (at Level of Service D)

Link	Link type	Link capacity (Level of Service D)
1 - N63 (south of Annagh Cross)	Type 2 Single	8,600
2 - N63 (east of Annagh Cross)	Type 2 Single	8,600
3 - N63 (south of Brierfield)	Type 2 Single	8,600
4 - R322 (leading to Proposed Wind Farm site)	Type 3 Single	5,000

The Proposed Grid Connection includes for underground 110V cabling from the onsite 110kV substation, in the townland of Dangan Eighter, Co. Galway, to the existing Cloon 110kV substation in the townland of Cloonascragh, Co. Galway. The total length of the Proposed Grid Connection underground cable route, measures approximately 20.9km in length with approximately 2.6km located within the Proposed Wind Farm site.

Response: This grid connection is coloured red on the submitted site location drawings even though the applicant does not have ownership or control of the area & any proposal involves trespass.

Table 15.26 Proposed Grid Connection underground cabling route link traffic management measure, link length (km), construction duration (days)

Underground Cabling Route Section	Traffic management	Length (kms)	Construction duration (days)
Off road at Proposed Wind Farm site	Off-road	2.6	26
Section 1 - R332	Closure	2.3	23
Section 2 - N63	Closure	4.2	42
Section 3 - L6234	Closure	3.3	33
Section 4 - L2115	Closure	1.1	11
Section 5 - L2127	Closure	0.1	1
Section 6 - L2125	Closure	3.0	30
Section 7 - R347	Closure	3.9	39
Section 8 - L6141	Closure	0.3	3
Off road section at Cloon Substation site	Off road	0.2	2

Total	21.0	210
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Table 15.27 Proposed Grid Connection underground cabling cross-link, link length (km), potential diversion route, length of diversion route (km), additional trip length (km)

Underground Cabling Route Section	Length (km)	Potential diversion route	Length of diversion route (km)	Additional trip length (km)
Off road at Proposed Wind Farm site	2.6	N/A	N/A	N/A
Section 1 – R332	2.8	N63, L6234, L2115, R332	13.2	10.9
Section 2 – N63	4.2	L6234, L2115, R332	11.3	7.1
Section 3 – L6234	3.3	L2115, R332, N63	12.2	8.9
Section 4 – L2115	1.1	L2127, L2118	2	0.9
Section 5 – L2127	0.1	L2127, L2118, L2115	3	2.9
Section 6 – L2125	3.0	L2127, L2115, L6234, N63, R347	16.2	13.2
Section 7 – R347	3.9	R347, R332, L2114, L2127, L2125	14.5	10.6
Section 8 – L6141	0.3	L6141, L2113, L2135, R332, R347	7	6.7
Off road section at Clonon Substation site	0.2	NA	NA	NA
Total	21.0			

15.1.10 Proposed Project Access Junctions

Access junctions 4 and 5 – Crossings of the L6301

Access junctions 4 and 5 are will both be used during the construction and operational phase from the L6301 local road network. The access points of the Proposed Wind Farm access road over the L6301 together with the 90m visibility splays taken from a setback of 2.4m are shown for Access junction 4 in Figure 15-24 and for Access junction 5 in Figure 15-25.

Response: A 2.4m setback is not adequate.

Vehicle types and network geometry

The types of vehicles that will be required to negotiate the local network will be up to 86.3 metres long and will carry a blade 81.0 metres in length.

An assessment of the geometric requirements of the delivery vehicles was undertaken on the delivery route. Locations where it was established that the existing road geometry will not accommodate all of the vehicles associated with the Proposed Project are highlighted, with the extent of remedial works identified. In addition to the assessment presented, it is recommended that a dry run is undertaken by the transport company to check vertical and horizontal clearance on the transport route prior to construction.

Traffic impact on local network

During the 9 days when the concrete foundations are poured, the effect on the surrounding road network will be that an additional 584 PCUs will travel to/from the Proposed Wind Farm site. On the delivery route it is forecast that the increase in traffic volumes on these days will range from between +6.5% and +11.8% on the N63. On the R322 leading to the Proposed Wind Farm site where background traffic flows are lower, it is forecast that traffic flows will increase by 30.4%. On these busiest 9 days it is estimated that this will have a temporary, negative and slight effect on the N63 and R332.

During the remaining 314 days when the construction of the Proposed Wind Farm continues, including the site preparation and groundworks and construction of the , an additional 329 PCUS will travel to and from the Site. It is forecast that the increase in traffic volumes on these days will be between +3.6% and 6.7% on the N63. On the R332 leading to the Proposed Wind Farm site it is forecast that traffic flows will increase by 17%. On these 341 days it is

estimated that this will have a temporary, negative and slight effect on the N63 and R332 leading to the Proposed Wind Farm site.

With respect to the traffic volumes that will be generated during the construction of the underground electrical cabling route, it is estimated that there will be approximately 30 daily return trips made by trucks removing spoil and transporting materials to the site, and 4 return trips made by a car to transport construction staff, to and from the Site. By its nature the effect impacts of these additional trips on the network will be transient and will therefore be temporary and slight.

During the 24 days / nights that the abnormal loads carrying the large turbine components travel to the Proposed Wind Farm site, an additional 105 PCUs will travel to/from the Proposed Project. It is forecast that the increase in traffic volumes on these days will be between +1.2% and 2.1% on the N63, while on the R322 leading to the Proposed Wind Farm site it is forecast that traffic flows will increase by 5.5% on these 24 days / nights. It is forecast that there will be a temporary, slight negative effect on the TDR as the delivery of the abnormally sized loads is undertaken at night. For 9 days an additional 64 PCUs will travel to/from the Proposed Wind Farm site delivering smaller component parts using standard HGVs, it is forecast that the increase in traffic volumes on these days will range 0.7% and +1.3% on the N63. On the R322 leading to the site it is forecast that traffic flows will increase by 3.3%. On these 9 days it is considered that the additional traffic will have a temporary imperceptible negative effect on the N63, and a temporary slight negative effect on the R339 leading to the site.

No significant traffic related effects are forecast during the construction of the Proposed Project.

Response: These numbers are based on an unsatisfactory traffic count taken during school closure period & over one-day for an SID proposal.

1.15.1.3 Other Material Assets

This section of the Material Assets chapter considers other utilities or built services in the area such as electricity supply and transmission, water, gas and underground telecommunications. This section also considers waste management during the construction, operational and decommissioning phases of the Proposed Development. The Proposed Project has been designed to avoid identified services and utilities where insofar as possible. Prior to commencement of construction detailed site investigations will be carried out to confirm design assumptions and undertake additional surveys to identify any new services and utilities and ensure they will not be impacted by the Proposed Project. **The construction of the Proposed Grid Connection would also be subject to a Road Opening License (ROL). The timing of these works would therefore be controlled by the ROL process with the relevant Local Authority.**

Response: The construction of the proposed grid connection will be subject to Land owner consent & compliant with Creminsv Derada Windfarm HC Case.

Chapter 16: Major Accidents and Natural Disasters

16.3 Baseline Conditions

Water Contamination

The Proposed Project has the potential to cause contamination and pollution of groundwater and surface water from potential release of hydrocarbons, earthworks and excavations on the Proposed Project site.

There is potential for hazardous materials in the form of hydrocarbons to be transported to and used on the Proposed Project. Mitigation measures following best practise as detailed in Chapter 9 Water and the Construction and Environmental Management Plan (CEMP) (Appendix 4-4), respectively, will **minimise the potential** for leaks and will break the potential pathways between any source and receptor therefore resulting in no residual effects. The removal of hazardous materials will be done so by licenced operators for disposal at licensed waste facilities. There will be no potential for hazardous material release during the operational phase of the Proposed Project.

The release of wastewater in relation to the Proposed Project can pose a risk to down gradient groundwater wells, groundwater quality and surface water quality. Proven and effective methods to mitigate against these potential impacts have been outlined above which will break the potential pathways between any source and receptor therefore resulting in no residual effects. Indirect impacts associated with major accidents and/or natural disasters on contamination are considered further in Section 16.4.1.

Industrial Fire / Explosion

The likelihood of fire or explosion occurring at the Proposed Project is anticipated to be low. The likelihood of fire or explosion occurring will be further lowered by the implementation of good site management practices during the construction, operational and decommissioning phases.

Bridge / Structural Collapse

Due to the transport of abnormal loads, i.e., turbine components, there is potential for bridge and/or road infrastructure collapse during turbine delivery. This impact may be exacerbated by extreme weather i.e., severe wind storms and heavy precipitation resulting from climate change.

As detailed in Chapter 4 Description, the underground Proposed Grid Connection will involve 8 No. bridge crossings, which it will involve Horizontal Directional Drilling (HDD), clear span bridge and standard formation crossing over culvert. No insteam works are proposed as part of any of these bridge crossings. Further detail on the methodology is outlined in detail in the CEMP included as Appendix 4-5 of the EIAR.

As detailed above, the avoidance of bridges or structural collapse, and structural reinforcement of bridge infrastructure has been a key consideration of the Proposed Project design. The likelihood of bridge/structural collapse will be further lowered by the implementation of good site management practices during the construction, operational and decommissioning phases.

16.4.1.5 Assessment of Effect – Summary

Table 16-7 Risk Assessment

Risk ID	Potential Risk	Possible Cause	Environmental Effect	Likelihood Rating	Basis of Likelihood	Consequence Rating	Basis of Consequence	Risk Score (Consequence x Likelihood)
Construction Phase								
G	Contamination – Fuel storage and handling General Construction	Fuel spillage during delivery to the Proposed Project. Failure of fuel storage tank or tanks in plant and machinery and vehicles. Drainage and seepage water resulting from infrastructure excavation. Stockpiled excavated material providing a point source of exposed sediment.	Release of suspended solids to groundwater. Contamination of local drinking water supplies and groundwater aquifers. Groundwater and surface water emissions from construction activities including trench excavations and HDD (track out)	2	As outlined in Chapter 4, fuel will be stored onsite at the Proposed Wind Farm but in a bunded area to ensure containment and prevent spillages of fuel. No fuels, chemicals or solvents will be stored outside of the confines of the Proposed Wind Farm. Setback distances from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures as detailed in Chapter 9. Detailed mitigation measures and methodologies for the control of emissions from Proposed Grid Connection works as described in the EIAR. Standard and specific mitigation to prevent accidents and indirect effects of accidents are included in the Proposed Project design and will be implemented.	2	The risk of a fuel spillage or impact on surround drainage during the construction will result in a limited consequence in that there would be 'a limited number of people affected' with 'localised effects of short duration' on environmental receptors through the use of bunded containment areas during construction. The Proposed Grid Connection is located in the existing road network which is of low value environmental receptor. Horizontal Directional Drilling (HDD) is planned for a limited number of locations and will be controlled to prevent significant environmental	4

		Works during the construction of the Proposed Project which may result in entrainment of sediment from the excavations or HDD.					effects should track out occur. The potential residual environmental effects are described in detail in Chapter 8 which concludes that there will be no significant environmental effects.	
H	Fire / Gas Explosion	Equipment or infrastructure failure; Fuel spillage/storage Electrical problems; and Employee negligence	Illness or loss of life; Damage to, or depletion of habitats and species; and Impacts on ambient air quality.	2	As outlined in Chapter 4, fuel will be stored on-the Proposed Wind Farm but in a bunded area to ensure containment and prevent spillages of fuel. No fuels, chemicals or solvents will be stored outside of the confines of the site. In accordance with Chapter 19 of the Safety, Health and Welfare at Work Act 2005 (the 2005 Act), the Proposed Project shall be subject to a fire safety risk assessment which would assist in the identification of any major risks of	2	Should a fire/explosion occur at the Proposed Project, a limited consequence in that there would be 'a limited number of people affected' with 'localised effects of short duration' on people and environmental receptors due to the nature of the Proposed Project and the lack of infrastructure or fuel storage during operation that would	4
					fire on site, and mitigation of the same during operation.		result in any such incident. There will be 'normal community functioning' in the area with 'some inconvenience' The 'generic command, control & co-ordination systems' as well as the 'common elements of response' detailed in the Galway County Council Major Emergency Plans will work to reduce the consequence (both on people and the environment) of potential fire/explosions at the Proposed Project.	
1	Collapse/ damage to structures	Earthquakes, extreme weather events; and Vehicular collisions due to driver	Injury or loss of life.	1	According to the Irish National Seismic Network (INSN), earthquakes measuring -2 on the Richter Scale are "normal" in terms of seismicity in Ireland. These are known as microearthquakes; they are not commonly felt by people and are	2	The risk of infrastructure collapse during the operational phase will result in a limited consequence in that 'a limited number of people affected' with 'localised effects of short duration'	2

		negligence on public roads.			generally recorded only on local seismographs. As such, buildings in Ireland are extremely unlikely to be damaged or collapse due to seismic activity. Due to the transport of abnormal loads, i.e., turbine components, there is potential for bridge and/or road infrastructure collapse during turbine delivery. This impact may be exacerbated by extreme weather i.e., severe wind storms and heavy precipitation resulting from climate change. The Proposed Project will utilise the existing road network during the construction phase. It is proposed that large wind turbine components will be delivered to the Proposed Wind Farm under Garda escort. Having regard to public speed limits within the surrounding area of the Proposed Project, it is not predicted that any collision of vehicles and any infrastructure		on people and environmental receptors due to the nature of the Proposed Project.	
					would result in significant damage/collapse. The avoidance of bridges or structural collapse, and structural reinforcement of bridge infrastructure has been a key consideration of the Proposed Project design.			
Operational Phase								
K	Contamination	A vehicular incident on the public road or	Damage to, or depletion of aquatic	2	As outlined in Chapter 4, fuel will not be stored on-site post construction therefore contamination caused by fuel	2	The risk of a fuel spillage or impact on surround drainage during the operational stage will	4
		Proposed Wind Farm internal road network involving fuel, wastewater or sewage transportation in the operational phase.	habitats and species Contamination of local drinking water supplies and groundwater aquifers.		stored on site is not considered to be a significant contamination risk. However, due to the presence of maintenance and monitoring vehicles, fuel leakage from onsite vehicle during the operational phase may occur. As such the likelihood of fuel leakages occurring is very unlikely.		result in a limited consequence in that there would be 'a limited number of people affected' with 'localised effects of short duration' through the use of banded containment areas during operation. The potential residual environmental effects are described in detail in Chapter 8 which concludes that there will be no significant environmental effects.	
L	Fire / Gas Explosion	Equipment or infrastructure failure; Fuel spillage/ storage Electrical problems; and Employee negligence	Illness or loss of life; Damage to, or depletion of habitats and species; and Impacts on ambient air quality.	2	As outlined in Chapter 4, fuel will not be stored on-site post construction therefore fuel is not considered to be a significant fire risk. In accordance with Chapter 19 of the Safety, Health and Welfare at Work Act 2005 (the 2005 Act), the Proposed Project shall be subject to a fire safety risk assessment which would assist in the	2	Should a fire/explosion occur at the Proposed Project, a limited consequence in that there would be 'a limited number of people affected' with 'localised effects of short duration' on people and environmental receptors due to the nature of the Proposed Project and the	4

					identification of any major risks of fire on-site, and mitigation of the same during operation.		lack of infrastructure or fuel storage during operation that would result in any such incident. There will be 'normal community functioning' in the area with 'some inconvenience' The 'generic command, control & co-ordination systems' as well as the 'common elements of response' detailed in the Galway County Council Major Emergency Plans will work to reduce the consequence (both on people and the environment) of potential fire/explosions at the Proposed Project site.	
M	Collapse/damage to structures	Earthquakes, extreme weather events; and	Injury or loss of life.	1	According to the Irish National Seismic Network (INSN), earthquakes measuring -2 on the Richter Scale are "normal" in terms of seismicity in Ireland. These are known as	2	The risk of infrastructure collapse during the operational phase will result in a limited consequence in that 'a limited number of people	2
		Vehicular collisions due to driver negligence on public roads.			<p>microearthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. As such, buildings in Ireland are extremely unlikely to be damaged or collapse due to seismic activity.</p> <p>Having regard to public speed limits within the Proposed Wind Farm, it is not predicted that any collision of vehicles and any infrastructure would result in significant damage/collapse.</p> <p>As outlined in Chapter 11 of this EIAR, due to Ireland's latitudinal position, the probability of extreme weather events posing a threat to the built environment are low. However, in the circumstance of such a weather event occurring at the site of the Proposed Project during the operational phase, the measures set out in the HSE (Area 2) Major Emergency Plan will be followed.</p>		affected' with 'localised effects of short duration' on people and environmental receptors due to the nature of the Proposed Project.	
					Having regard to public speed limits within the Proposed Wind Farm site, it is not predicted that any collision of vehicles and any infrastructure would result in significant damage/collapse.			

Decommissioning Phase								
R	Contamination	<p>Fuel spillage during delivery to the Proposed Project.</p> <p>Failure of fuel storage tank or tanks in plant and machinery and vehicles.</p>	<p>Damage to, or depletion of aquatic habitats and species</p> <p>Discharge to groundwater</p>	2	<p>As outlined in Chapter 4, fuel will be stored on the Proposed Project but in a bunded area to ensure containment and prevent spillages of fuel. No fuels, chemicals or solvents will be stored outside of the confines of the site.</p> <p>Setback distances from sensitive hydrological features means that adequate room is maintained for the proposed drainage measures as detailed in Chapter 9</p>	2	<p>The risk of a fuel spillage or impact on surrounding drainage during decommissioning will result in a limited consequence where 'a limited number of people affected' with 'localised effects of short duration' through the use of bunded containment areas during decommissioning. The potential residual environmental effects are described in detail in Chapter 9 which concludes that there will be no significant environmental effects.</p>	4

Table 16-8 Risk Scores

Risk ID	Potential Risk	Likelihood Rating	Consequence Rating	Risk Score
Construction Phase				
A	Critical Infrastructure Emergencies	2	1	2
B	Severe Weather	2	1	2
C	Flooding	2	1	2
D	Landslide/Peat Stability	1	2	2
E	Utility emergencies	2	1	2
F	Traffic Incident	3	1	3
G	Contamination	2	2	4
H	Fire / Gas Explosion	2	2	4
I	Collapse/ damage to structures	1	2	2
Operational Phase				
J	Severe Weather	2	1	2
K	Contamination	2	2	4
L	Fire / Gas Explosion	2	2	4
M	Collapse/ damage to structures	1	2	2
N	Traffic Incident	3	1	3
Decommissioning Phase				
O	Severe Weather	2	1	2
P	Flooding	2	1	2
Q	Traffic Incident	3	1	3
R	Contamination	2	2	4

The scenario with the highest risk score in terms of the occurrence of major accident and/or disaster during construction, operation and decommissioning was identified as 'Contamination' of the site and risk of 'Fire/Explosion' occurring at the Proposed Project.

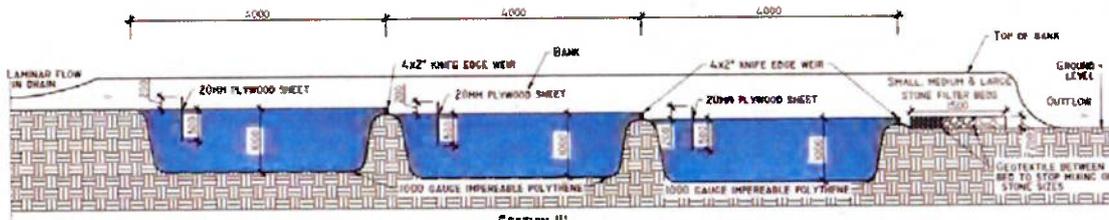
Response: Polythene will burn in a bog fire & release the carbon waters into surfacewater/underground water bodies.

TYPE B - TYPICAL ROAD SIDE SETTLEMENT POND DETAIL
SCALE 1:200 (NOTE DIMENSIONS VARY DEPENDING ON CATCHMENT SIZE - SEE ATTACHED TABLE)

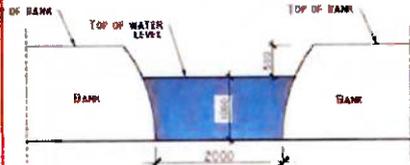
SMALL, MEDIUM & LARGE
STONE FILTER BEDS

BLOCKED

BLOCK SLOPE FORWARD DRAIN DOWN
SLOPE OF AN OUTLET TO
PREVENT POLLUTION TO
REVERSEING WATERS

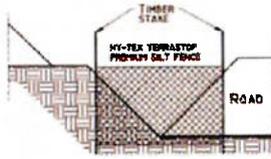


SECTION II'

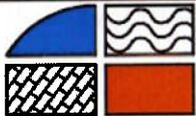


SECTION 22'

SEDIMENT FENCE/CHECK DAM DETAIL



Return Period	POND SIZE W [m] x L [m] x D [m]		TRACK/ROADSIDE CATCHMENT SIZE (ha)		
	10 YRS	STORM DURATION	500	1000	2000
SOIL RETENTION FOR COARSE SILT	6 HRS	2.4 x 4.8 x 1.0	1.2 x 11.2 x 1.0	5.2 x 15.2 x 1.0	
SOIL RETENTION FOR MEDIUM SILT	12 HRS	3.0 x 12.2 x 1.0	5.5 x 16.9 x 1.0	7.5 x 23.8 x 1.0	
SOIL RETENTION FOR FINE SILT	24 HRS	4.5 x 20.2 x 1.0	9.2 x 28.8 x 1.0	13.2 x 48.2 x 1.0	



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Client:

MKO

Job:

COOLOO WIND FARM, CO. GALWAY

Title:

PROPOSED DRAINAGE LAYOUT

Figure No:

D105

Drawing No: P1611-0-0925-A1-D105-00B

Sheet Size: A1

Project No.: P1611-0

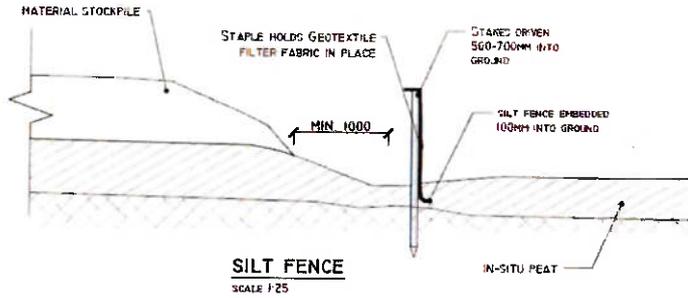
Scale: 1:2,000 (A1)

Drawn By: GA

Date: 24/09/2025

Checked By: MG

DETAIL F-I



SILT FENCE
SCALE 1:25

Date	Description	Chkd	Signed
Revisions			



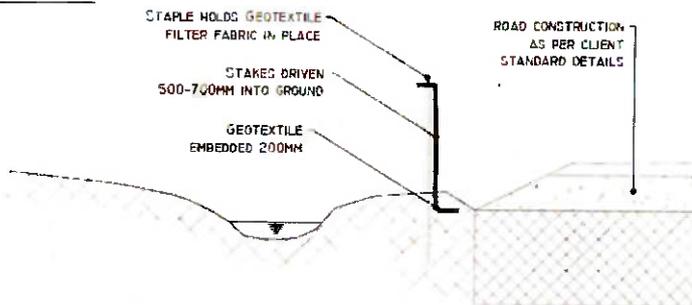
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Client	MKO
Job	COOLLOO WIND FARM CO. GALWAY
Title	DRAINAGE DETAILS 2
Figure No.	D502
Drawing No.	P1611-0-0925-A1-D502-008
Sheet Size: A1	Project No.: P1611-0
Scale: as shown (A1)	Drawn By: GA
Date: 24/07/2025	Checked By: MG

DETAIL F-II

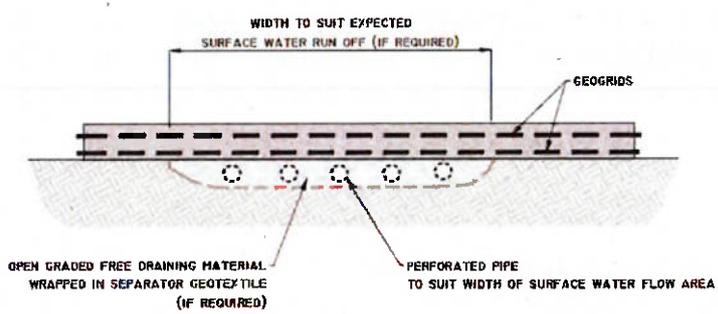


SILT FENCE FOR WATERCOURSE PROTECTION
SCALE 1:25

Date	Description	Chkd	Signed
Revisions			
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Client:		MKO	
Job:		COOLLOO WIND FARM, CO. GALWAY	
Title:		DRAINAGE DETAILS 3	
Figure No:		D503	
Drawing No: P1611-O-0925-A1-D503-006			
Sheet Size: A1		Project No.: P1611-O	
Scale: as shown (A1)		Drawn By: GA	
Date: 24/09/2025		Checked By: MG	

DETAIL K

UNDER FLOATING ROAD DRAINAGE DETAIL
SCHEMATIC - NOT TO SCALE



The Proposed Project will be designed and built in line with current best practice and, as such, mitigation against the risk of major accidents and/or disasters will be embedded through the design. A Risk Management Plan will be prepared and implemented at the Proposed Project to ensure an effective response to disasters or the risk of accidents. The plan will include sufficient preparedness and emergency planning measures. When the implementation of best practise measures and all proposed mitigation and monitoring measures detailed in the EIAR is implemented, the residual effect(s) associated with the construction, operation and decommissioning of the Proposed Project are not significant.

- Chapter 17: Interactions of the Foregoing
- Chapter 18: Schedule of Mitigation Measures

Volume 2 SUBMISSION ON COOLOO WINDFARM

Planning Reference: 323761

Date for Submission: 21st November 2025

Preamble

The Author of this Submission believes in Proper Planning & Sustainable Development. For every Mw of renewable energy, a Mw from fossil fuel or nuclear fuel will be needed as a back-up when the wind doesn't blow or the sun doesn't shine & on top of this duplication, we also have to invest in Grid upgrades costing €billions.

We don't need duplication. We just need one system with capacity. Imposing excessive costs on the Citizen is a long way away from Proper Planning & Sustainable Development. The charging & curtailment charges being paid to developers remind one of the Cash for Ash scam in nrl. Curtailment payments for energy in August 2025 would have supplied 700,000 houses, September 750,000 houses & October 750,000 houses. The squeezing of wind turbines into a restricted site to avail of such curtailment payments does not comply with the 2006 or 2019 Guidelines.

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1.2	Wind Farms & Health Literature Review- Chapman 2015 Summary of main conclusions reached in 25 reviews of the research literature on wind farms and health. Compiled by Prof Simon Chapman, School of Public Health and Teresa Simonetti, Sydney University Medical School simon.chapman@sydney.edu.au Updated 10 April 2015.	38
1.3	Balancing nature and economic interests in the European Union: On the concept of mitigation under the Habitats Directive. Lorenzo Squintani. c 2019 The Author. <i>Review of European, Comparative & International Environmental Law</i> Published by John Wiley & Sons Ltd. wileyonlinelibrary.com/journal/reel. DOI: 10.1111/reel.12292	43
1.4	Reference No: 1.4: Environmental Impact of Wind Farms. Bošnjaković, M.; Hrkać, F.; Stoić, M.; Hradovi, I. <i>Environments</i> 2024, 11, 257. https://doi.org/10.3390/environments11110257	45
1.5	The visual effect of wind turbines on property values is small and diminishing in space and time. Wei Guoa, Leonie Wenzc, and Maximilian Auffhammer. Edited by Geoffrey Heal, Columbia University, New York, NY; received June 3, 2023; accepted January 10, 2024. 121 (13) e2309372121. https://doi.org/10.1073/pnas.2309372121	47

1.6	Reference Number 1.5: Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States, Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman. <u>Energy Policy Volume 185</u> , February 2024, 113837. https://doi.org/10.1016/j.enpol.2023.113837	49
1.7	Windpro Manual: 8a.1.1 Offshore Vs Onshore optimization Manual	53
1.8	Three-dimensional effects of the wake on wind turbine sound propagation using parabolic equation. Hemant Bommidala, Jules Colas, Ariane Emmanuelli, Didier Dragna, Codor Khodr, Benjamin Cotte, Richard J.A.M. Stevens PII: S0022-460X(25)00110-5 DOI: https://doi.org/10.1016/j.jsv.2025.119036 Reference: YISVI 119036. Journal of Sound and Vibration.	62
1.9	Guidance on biodiversity Cumulative Impact Assessment for wind and solar developments and associated infrastructure 2024: Leon Bennun, Claire Fletcher, Aonghais Cook, David Wilson, Ben Jobson, Rachel Asante-Owusu, Annie Dakmejian, Qiulin Liu. IUCN, Gland, Switzerland and The Biodiversity Consultancy, Cambridge, UK. ISBN: 978-2-8317-2317-4 (PDF). DOI: https://doi.org/10.2305/EHGE6100	63
1.10	2023/2413: DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652]	63
1.11	The High Court [2024] IEHC 136 [2018 8457 P] Between: Margaret Webster and Keith Rollo Plaintiffs and Meenacloghspar (Wind) Limited Defendant and [2018 8458 P] Between: Ross Shorten and Joan Carty Plaintiffs and Meenacloghspar (Wind) Limited Defendant Judgment of Ms. Justice Emily Egan Delivered on the 8th day of March 2024	63
1.12	Victorian Supreme Court in <i>Uren v Bald Hills Wind Farm Pty Ltd</i> [2022] VSC 145 (Uren)	64
1.13	Decision of the Council of State No. 465036 of 8 March 2024 <i>On 8 March, the French Council of State issued a historic decision by making illegal permits for onshore wind turbines and fleet renewal rules. In a statement, the <u>Fédération Environnement Durable</u> and fifteen associations, which had lodged the application, stated that “the Council of State has annulled all the provisions concerning the three successive versions of the noise nuisance protocol which is supposed to protect the health of local residents.”</i> <i>Ongoing projects must start all over again</i> <i>Projects under instruction or not yet built “require a complete environmental assessment”, welcomes the Federation, while stating that “all wind farms built on the basis of now-illegal by-laws should normally no longer be allowed to operate as they are.”</i> <i>Beyond that, the Council of State noted that the ministerial noise measurement orders had not been subject to an environmental assessment, “which constitutes a violation of the law”. He also stressed that decisions to approve the acoustic protocol “have not been subject to public participation, thereby violating the principles of participation and transparency.”</i> Decision of the Council of State No. 465036 of 8 March 2024 <u>Derryadd Windfarm Sweetman v An Bord Pleanála ([2021] IEHC 390) High Court</u> The High Court has issued an important decision regarding applications for planning permission for projects, which are based on a “ <i>design envelope</i> ” approach. In <i>Sweetman v An Bord Pleanála</i> ([2021] IEHC 390) (the Derryadd decision) the Court ruled that the design envelope approach is contrary to the requirement under the Planning and Development Regulations 2001 (the PDR) to provide “ <i>plans and particulars</i> ” in relation to the relevant application. In light of the potentially significant implications of its initial decision, the High Court has given leave to appeal to the Court of Appeal on a number of questions. In the associated leave decision ([2021] IEHC 662), the High Court has also provided some clarifications on the scope and intent of its initial decision. In the meantime, the Derryadd and <i>Balscadden</i> decisions ([2020] IEHC 586) may lead to challenges for all developers of projects, in determining how	64

much detail they need to give in the planning application while still retaining the flexibility needed for tendering.

Background

An Bord Pleanála (the **Board**) granted planning permission to Bord na Móna for a windfarm in Derryadd, County Laois through the Strategic Infrastructure Development (**SID**) provisions in the Planning Acts. A judicial review challenge was taken raising a number of issues with the Board's decision.

There were some particular features of Bord na Móna's planning application that are worth noting. The application was for permission for an "envelope" of up to 185 metres blade tip height with no specific details given of the hub height or the rotor diameter being proposed. The High Court identified 3 core deficiencies with the planning application:

"Typical" details of several aspects of the development were given rather than precise details of the structures which were being proposed;

The application was for a "design envelope" rather than a structure of specified dimensions; and

There was some variation in the location of turbines/foundations and road layouts implied in the Environmental Impact Assessment Report (**EIAR**) submitted with the application.

What did the High Court Decide?

According to the High Court's initial judgment:

The PDR require developers to submit "*plans and particulars*" of their proposed development; "Plans and particulars" means something that is "*specifically measured and capable of being drawn on a plan. That cannot include a widely variable design envelope*";

It is not acceptable to assess the proposed development on a "*worst case basis*". It is not lawful for a developer to proceed on the basis that whatever is eventually constructed will have been properly assessed on the basis that the impacts of that development or indeed a development that is more impactful will have been assessed. The statutory obligation is to specify the particulars of the development for which permission is sought and "*not to seek permission for a project that is open-ended at one end of the scale and which could be anything up to a maximum specified*". Further, the Court stated that a "*worst case analysis is also hopelessly subjective. What is the worst case scenario for one person at one location may not be considered as such by another person at another location*";

There was much discussion of the so called "*Rochdale envelope*" (ie, basing the planning application and corresponding assessments on a range of potential designs and parameters).

The Court made the following points:

- The concept of the "*design envelope*" has, under English law, a written basis in national guidelines (NPS EN-1). There is no such written basis in Ireland, either in statute or in guidelines;
- The concept has no application to the statutory framework/requirement under the PDR to provide "*plans and particulars*". It instead applies only to environmental assessment of that development;
- In the Rochdale case, the consent sought was an outline planning permission only and therefore it was more appropriate to talk of parameters in that context; and
- Rochdale was decided in 2001 and planning law has become much more complex in the intervening period.

The Court was also asked to find that the "*design envelope*" approach was contrary to the EIA Directive. The Court declined to rule on that question, but could do so in a future case. Under the EIA Directive, the obligation of a developer is to identify, describe and evaluate the impacts of its proposed development on the environment. The Court may decide in a future

case that it is not possible to meet this obligation unless the developer is describing and evaluating the impacts of a certain and defined project, rather than a range of possibilities.

Subsequent clarifications and leave to appeal

The High Court granted leave to appeal its initial decision to the Court of Appeal. It accepted that the "*practical operation*" of the planning system would be assisted by clarification of certain questions raised in relation to the initial decision (set out below). In doing so, the High Court clarified a number of points from the initial decision.

The Court noted that:

The initial judgment did recognise the legitimacy of a certain limited flexibility. What that flexibility could reasonably look like might vary from context to context;

The concept of limited flexibility, applied reasonably in a context-specific way, would appropriately balance the interests of developers and others. In particular, it would allow developers a margin to refine the exact design post-consent, but would also allow other participants sufficient certainty as to what the proposal in fact is;

There is no difficulty with the general concept of a design envelope provided it is within a certain limited flexibility, and no genuine planning issue is thereby created;

What might be regarded as a reasonable zone of flexibility may vary from context to context;

An affidavit on behalf of the Developer had referred to the Developer not being able to "*finally determine ... the particular turbine design*". The Court clarified that such final determination was not required by the initial judgment. The Developer's difficulty in determining the "*exact extent of turbine foundations, hard stands and other infrastructure*" could still be accommodated within a reasonable degree of flexibility because the initial judgment did not demand advance specification of the "exact extent" of those features;

The content of an application in the SID context is not quite as exacting as that in the normal planning context;

However, the SID framework only allows a reasonable albeit limited degree of flexibility (particularly in a changing context like wind turbines). However, a completely open-ended permission at one end of the scale goes far beyond what is necessary or appropriate; and If the Board's decision or alternatively some instrument of general application were to say that the approval of plans and particulars based on a typical design had the effect that the developer could not depart substantially from such a design, then there would not be a problem. However, there was no such provision in relation to the Derryadd wind farm.

The High Court granted leave to appeal on the basis of the following questions (paraphrased):

1. Whether it is permissible to allow a variable design application that (i) goes beyond a reasonable limited degree of flexibility and/or (ii) could give rise to a genuine planning issue after the grant of development consent in the Strategic Infrastructure Development context.
2. Is it open to the Board in the present case to contend on appeal that approval of a "*typical*" design cannot be substantially deviated from, (a) not having clearly and/or effectively and/or at all made that point at the hearing; and/or (b) given that such a point contradicts the evidence before the court and the Board?
3. If the Board can make that argument, is that argument correct?
4. Insofar as a permission can lawfully allow a degree of flexibility, is the Board required to consider and assess the range of options within that flexibility as opposed to merely assessing the worst-case scenario?

The *Balscadden* decision

The High Court's decision in *Balscadden Road SAA Residents' Association v An Bord Pleanála [2020] IEHC 586* involved similar issues to those raised in Derryadd. In that case, the High Court overturned the grant of planning permission for a Strategic Housing Development

	<p>because the plans submitted with the application did not include details of the sheet piling structures to be used in the basement. The High Court made the following observations: Where any structure is of a significant size, its dimensions and location constitute necessary information;</p> <p>The PDR require the application material to show the distances of the relevant structure to the boundaries of the site, but the application had not done so;</p> <p>There were two fundamental problems with the lack of formal drawings showing the dimensions and locations of the sheet piling for subterranean structures. First, it breached the requirement to submit drawings in accordance with the PDR. Second, the actual grant of permission was "devoid of meaning" because the permission was to construct the development in accordance with the plans submitted, but those plans did not include adequate details as to the location and dimensions of the sheet piling.</p> <p>SUPREME COURT: Crofton Buildings Management CLG & Stephanie Bourke v. An Bord Pleanála and Fitzwilliam DL Ltd. On appeal from: [2022] IEHC 704 Judgment delivered on 10 April 2024 [2024] IESC 12</p> <p><i>Although the issue of which development plan ought to govern remittal was raised in the determination and in the written submissions of the Notice Party, there was no real contest challenging the correctness of the High Court's finding that the development plan applicable to a planning decision is the development plan in effect on the day that the decision is made. Donnelly J. states that this accords with a general principle of administrative law, that in terms of administrative decisions, the decision must give effect to the law at the date of the administrative decision. Moreover, nothing in any of the relevant sections which have been referred to in submissions, be it ss. 2, 9 or 34 of the 2000 Act or s. 9(2) of the 2016 Act, requires the Board to have regard to anything other than the development plan in effect on the date of the decision in respect of an SHD under the 2016 Act. The judgment proceeds on that basis.</i></p> <p><i>20. With reference to those mandatory steps, the appellants stressed the importance of engaging with the policies and objectives of the development plan in operation at the time of the application.</i></p> <p><i>25. The specific development plan to which the Board must have regard on remittal was an issue that necessitated significant attention by the trial judge. Although no appeal was taken from the trial judge's finding that the Board must take into account the 2022 development plan, this issue was raised by this Court in its determination.</i></p> <p><i>26. The Board and the appellants maintained, as they had in the High Court, that the relevant legislation envisaged that there could only be one development plan in effect in the functional area of a given planning authority at any one time.</i></p> <p><i>27. The Board specifically referred to s. 9(2) of the 2016 Act and s. 34(2) of the 2000 Act. Section 9(2) of the 2016 Act provides that the Board, in considering the likely consequence for proper planning and sustainable development in the area, should have regard to inter alia, the provisions of the development plan, including any relevant local area plan. Section 34(2) of the 2000 Act provides that a planning authority (and the Board) is restricted to considering the proper planning and sustainable development of the area, regard being had to, inter alia, "the provisions of the development plan". The Board said that this can only be the development plan which is in effect when the decision is taken. Section 12(17) of the 2000 Act states that the development plan comes into effect on the day it is made.</i></p>	
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Summary of issues including Roads: Reasons for invalidation/Refusal in red font. (not exhaustive):

- For 8m/s windspeed & for Vestas V164, we get a power output of 2,513Mw per turbine.(see below) Thus, the total output for 9 turbines is 22.617Mw and not greater than 50Mw as required for SID. This Application is invalid.
- The Separation distances between turbines do not comply with 2006 or 2019 Guidelines in order to squeeze extra turbines into the site. Providing Grid references for Wind Turbine locations does not allow the normal Citizen to assess separation distances. Failure to provide turbine setback distances to achieve noise levels below 30dba in low noise areas.

Using the Grid references provided & Pythagorean Theorem, we find that separation distances are as outlined below ranging from 520.2, 535.7, 592.8, 606, 611.7 in Column 9. These measurements indicate gross non-compliance with 2006 Wind Energy Guidelines & draft 2019 Guidelines & will create far greater noise to adjoining properties. It is simply not possible to fit 9 Turbines onto this site in compliance with the Guidelines.

Turbine No.	Easting Coordinate	Difference	Square	Northing Coordinate	Difference	Square	Sum of Squares	Sq root of sum of squares
1	555297			747613				
2	555608	311	96721	748030	417	173889	270610	520.2
3	555563	-45	2025	748640	610	372100	374125	611.7
4	556167	604	364816	748591	-49	2401	367217	606.0
5	556198	31	961	749183	592	350464	351425	592.8
6	555648	-550	302500	749699	516	266256	568756	754.2
7	555568	-80	6400	750508	809	654481	660881	812.9
8	556986	1418	2010724	749348	-1160	1345600	3356324	1832.0
9	556813	-173	29929	749855	507	257049	286978	535.7
3	555563			748640				
5	556198	635	403225	749183	543	294849	698074	835.5
3	555563			748640				
6	555648	85	7225	749699	1059	1121481	1128706	1062.4
5	556198			749183				
8	556986	788	620944	749348	165	27225	648169	805.1

- Failure to provide turbine separation distances to achieve noise levels below 30dba in low noise areas.

Sensitive Houses

- The Landscape setting effect on a Protected House.
- The Noise & Wake Windpro model or similar is not provided. Lacunea must be provided when used to generate data.

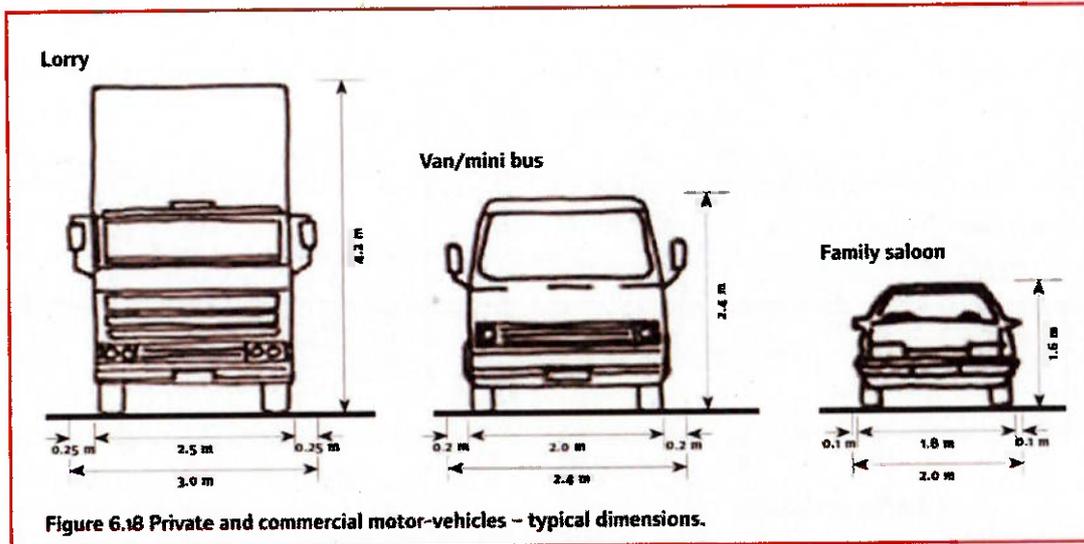
CJEU Case 258/11 at 44

"So far as concerns the assessment carried out under Article 6(3) of the Habitats Directive, it should be pointed out that it cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the protected site concerned."

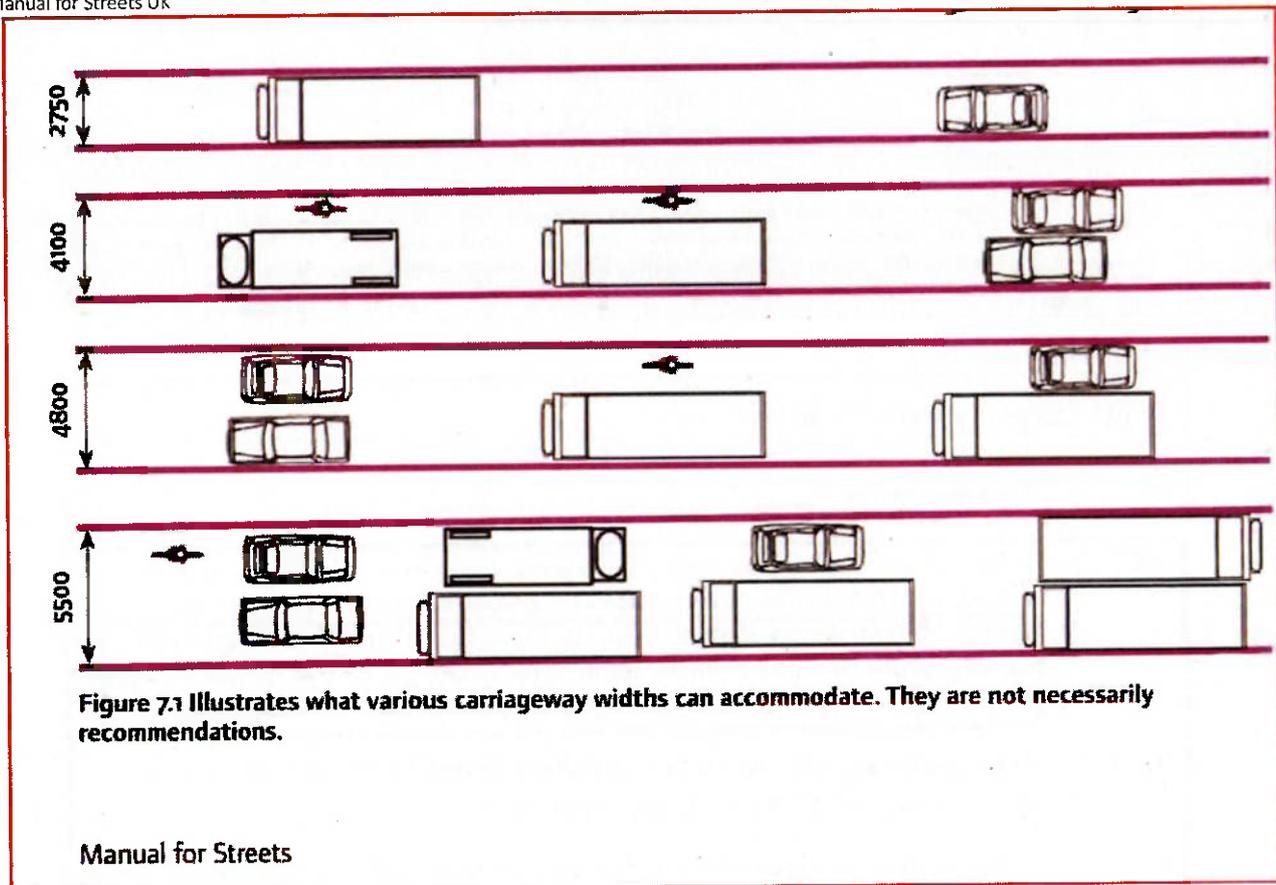
Judgement of the Court Case 258/11

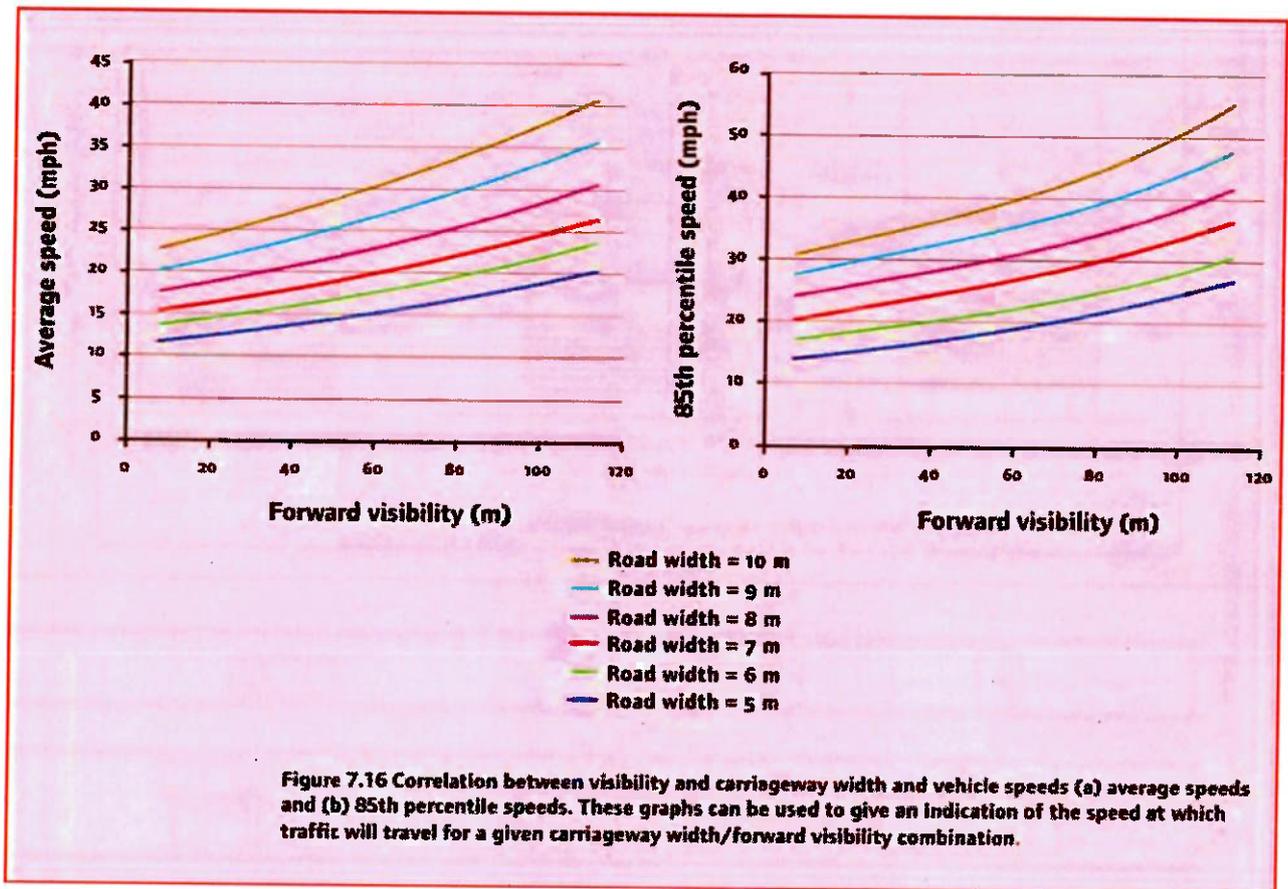
Article 6(3) of Council Directive 92/43/EEC of 23rd May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of sites of Community importance, in accordance with the Directive. The precautionary principle should be applied for the purposes of that appraisal.

- The Noise & Wake model may be a wind tunnel calculation for one turbine & ignores turbulence & noise downwind with short separation distances & rain/ice effects.
- The Existing negative effects of Infrasound/Seismic & future effects in karstic area is not addressed. The issue from noise nuisance as determined in the Webster/Rollo v Meenacloghspar Windfarm High Court Case at separation distance of c1,200m is ignored.
- Omitting seismic effect on existing wells/boreholes across the catchment.
- The seismic effects on frogs, worms & herbivores, such as badgers are not addressed.
- No up to date population health data effects is provided. Quoting from reports from 2015 & before fails to recognise that turbines have increased greatly in height in the intervening period.
- The health & property value reports submitted are pre-2016 & have no relevance. Turbines were much smaller in that period. References to reports from central America with sparse houses is not relevant. These American windfarms indicate short-term annual usage.
- Health effects. Adverse impact on human & animal health including horses. No plans or designs or noise readings related to distances or wake effects provided.
- HSE require WHO 2018 Standard & 37dBa.
- Design envelope illegal: Sweetman v ABP 2021 Derryadd Windfarm. Failure to provide Plans & Particulars of the proposed Windfarm turbines.
- Trespass on grass margin for grid connection & coloured red on application indicates an Invalid application.: Cremins v Dromada Windfarm (ROI) Ltd. ACP cannot grant permission for trespass against the Law. The colouring of the grid connection in red on local roads indicates that the applicant has control or ownership of the road, which is an invalid statement & invalidates the Application.
- The applicant has not included a 2-way sweptpath analysis to the site showing road restrictions where passing bays will be required as the existing road widths are not adequate to accommodate passing HGV's or busses.
- Local Roads L6301 & L6506 access from North/South & no passing bays not identified. The widths or horizontal alignment of these Local Roads are not provided in EIAR Chapter 15, Appendix 15.1 or Appendix 15.2.



Manual for Streets UK





Appendix A – HS2 Rural Road Design Criteria

Design approach statement - Roads	
Two-lane roads	
A.6.3	Rural road widths for diversions should generally match the existing, subject to a minimum of 5.5 metres (the minimum for two cars to pass in safety at low speed). This minimum width shall be increased to 6.0 metres for lengths with occasional use by buses or heavy goods vehicles and 6.8 metres for roads where buses or heavy goods vehicles are likely to pass each other on a regular basis.
A.6.4	The need for any increased lane width at bends shall be determined on a case-by-case basis using vehicle tracking design tools.
A.6.5	The maximum carriageway width for two-lane roads shall be 7.3 metres (plus any widening on bends that may be required).
A.6.6	Hardstrips shall not be provided on minor two-lane rural roads.

- Existing Regional & Local Roads are not Type 2 or 3 carriageways. Therefore the 8,600 & 5,000AADT do not apply. See below for definition of Type 2 & Type 3 carriageways.

Link	Link capacity (Level of Service D)
1 - N63 (south of Annagh Cross)	8,600
2 - N63 (east of Annagh Cross)	8,600
3 - N63 (south of Brierfield)	8,600
4 - R322 (leading to Proposed Wind Farm site)	5,000

- **County Development Plan Policy Objectives for Non National Roads. Not complied with in application**
No traffic count data provided with 85% speed as required by County Development Plan.
No vertical Sight Distance Triangles provided or Forward visibility as required by County Development Plan.
No Road Safety Audit provided including Night-time audits for abnormal load or HGV deliveries.
No TIA provided.
- A visual inspection is not acceptable in the context that existing road, bridge & culvert destruction will be caused by the weight & number of HGV's. The developer should have conducted a structural assessment of the proposed haul routes which should have included the following:

- Falling Weight Deflectometer (FWD) Testing and analysis.
- Ground Penetrating Radar (GPR) and cores where required.
- Road Condition Data (RCD) using a Road Surface Profiler (RSP) to include:
- Digital video (chainage and GPS referenced).
- Visual condition survey from video survey using pavement condition index (PCI).
- Ride quality survey using international roughness index (IRI).
- Transverse profile for rut depth.

Testing shall be conducted in accordance with:

- NRA "Guidelines for the use of the falling weight deflectometer in Ireland (July 2000).
- NRA HD 31/15 "Pavement assessment, repair and renewal principles (March 2015)."
- DTTAS "Guidelines on the depth of overlays to be used on rural regional and local roads (March 2014)."
- DTTAS/ RMO "Mechanical Road Condition Surveys- regional and local roads in Ireland (April 2015)."

The surveys shall be carried out in both traffic directions where the carriageway is greater than 5m. On narrow roads it is sufficient to carry out the survey in one direction only.

- Structural assessment of roads & bridges not provided.
- Oversail & overhang consents not provided. ACP cannot grant permission for trespass against the Law.

Joint bays are to be installed where required along the grid connection route in the public road or along the grass margin of the public road. Once installed they are temporarily reinstated until they are opened again to allow for pulling cables through the ducts and jointing the cables afterwards. The joint bays will then be permanently backfilled and reinstated to the satisfaction of Galway County Council

Response: Joint Bays on the R332, N63, L6234, L2115, L2125 & R347 will require road closure due to their widths.

Item 9. Noise and Vibration (EIAR)

- 9.1 You are requested to clarify if the wind farm noise calculations are based on collective / standalone turbines
- 9.2 Consideration should be given to seismic effects, seismic effects and infrasound from the karstic limestone spindles vibration, impacts of vibration on property.

Item 10. Wake effects (EIAR)

- 10.1 Please clarify if turbine wake effects would arise at dwellings, lands downwind of site due to prevailing winds, and also give consideration to wake effects on yields, livestock, and local temperature effects arising

Clonberne Windfarm SID 320089-24. Reference No. 13.5 refers.

6. You are requested to clarify if wake effects will arise from the proposed development on birds. Consideration to these issues should be given.

Abnormal Size Load Delivery Route

- An observation is on file from a landowner at the junction of the N83 and the L6466 (Junction 9a) stating that he has not given his consent to the inclusion of his land or to the lodgement of the application.
- Junction 9b (bend on L-6466) appears to require the removal of a stand of trees/vegetation on lands along northern side of the L-6466 and the run-over area for the turbine plant deliveries encroaches on lands on the southern side of the L-6466 (i.e. Figure 15-23b of Appendix 15-4). This location is not included within the application but is included in the EIAR for assessment.

You are requested to demonstrate that it has the consent of the relevant landowner(s) to include the land(s) within the proposed application. Details of alternative access arrangements should be provided should the relevant landowner(s) consent not be secured to allow for the works identified as necessary along the turbine delivery route. Alterations as necessary to the letter of consent to make the application should also be made and submitted.

Please ensure that all relevant drawings, maps and figures in the documentation accompanying the application accurately reflect the extent of the site to which the application refers and does not include lands where the consent of the relevant landowner(s) has not been secured to make the application. Any revisions/amendments to be detailed and submitted.

Wake Effects

Address the potential for wake effects including consideration of effects on agricultural lands.

6. You are requested to clarify if wake effects will arise from the proposed development on birds. Consideration to these issues should be given.

- Passing Bay consents not provided. The setback areas at existing rural houses that provide access & Sight Distance Triangles to the house are part of the Planning Approval & provided at the householder expense. These areas & sight distance triangles cannot be compromised. ACP cannot grant permission for trespass against the Law.
- Adverse impact on Traffic & Roads from a Nacelle weighing up to 400tonnes with dimensions 10.9m in length, 4.09m in width & 4.15m in height & on a 2-4 axle articulated flat-bed truck. With the weight of the

truck included, the fully laden weight will be circa 450 tonnes. A 2-4 axle articulated flat bed truck is not capable of carrying this weight or permitted by law [S.I. No. 5 of 2003 Clause 13] & would severely damage roads, bridges & culverts.

- Hedge/Tree cutting consents in front of 3rd Party properties not included. The Applicant is required to submit letters from any landowner confirming agreement to accommodation works including hedge trimming and/or pavement works. ACP cannot grant permission for trespass against the Law.
- S.I. No. 5/2003 – Road Traffic (Construction and Use of Vehicles) Regulations 2003

13. (1) Subject to Regulation 12 and to this Regulation, the weight laden of an articulated vehicle having a total of 4-axes shall not exceed 35 tonnes.
(2) The weight laden of an articulated vehicle having 4-axes may exceed 35 tonnes but shall not exceed 38 tonnes if the vehicle-
(a) consists of a 2-axle tractor unit and a 2-axle semi-trailer,
(b) is equipped with twin tyres and an air suspension system or an equivalent system on each driving axle, I is equipped with a brake system approved in accordance with the requirements of the Directive 71/320/EEC of 26 July 1971 ⁽⁴⁾ as amended by Directive 98/12/EC of 27 January 1998 ⁽⁵⁾ which includes antilock devices in addition to any other devices necessary for the satisfactory operation of the service brakes under all conditions of loading, and
(d) is equipped with a plate complying with the requirements of the Regulations of 2000.

- Birds: No assessment of Greenland Whitefronted Geese migration flypath barrier from Iceland to Wexford slob. Adverse impact on the habitats of Birds, particularly migratory birds & bats. Best practice for bat survey indicates a 2-year continuous assessment. This is not included in Application.
- Adverse impact on the habitats of Birds, particularly migratory birds & bats. Adverse impact on Biodiversity including Bats & the flypath from Iceland to the Wexford slob for migrating birds. The tip speed of the wind turbine at C92m/s indicates a speed of 331.2kph. No Bird or Bat could avoid such a speed.
- Adverse effects on birds crossing the Wake as the Wake will act as a barrier to movement, where birds won't be able to use thermal laminar winds for flying.
- Groundwater pollution effect on existing wells/boreholes & existing public water supply schemes ignored.
- Adverse impact on drinking water catchment due to biohazards & the elevated risk of a major accident arising from a landslide event or underground coalmine collapse adjoining geological fault lines, the proposal would pose a serious danger to the environment potentially causing extensive pollution of water-bodies within and in the vicinity of the site.
- Flooding effects downstream of this site have been evident in the past. Changing 4ha from peat to hardcore will shorten the time of entry & time of concentration. These will exacerbate the downstream flooding.
- Adverse effects from Blade failure due to delamination at skin & adhesive, fatigue failures from cyclic loading, use of flammable laminates in blade construction.
- Wake effects on downwind lands up to 40- 50km, where temperature decreases of c3^oC will occur without landowners' consents. The Wake effect on Climate where ground temperatures are lowered by 3^o degrees centigrade, leading to lower crop yields over the 40-50km envelope. The effect on High Nature Value grasslands is not included.

- The Windrose indicates that the prevailing wind for 59% of the year is from the South/Southwest/West direction. For a windfarm in a E-W alignment, this means lower energy generation due to wake effects, rain, turbulence & to the likelihood of noise on the houses to the North/Northeast/East.

Dispute over wake losses between developers of two huge offshore wind farms one of many currently underway in the UK planning system. Equinor and SSE 1/5/2025 say that wake losses caused by an RWE offshore wind project will cost their massive Dogger Bank arrays £582m (\$778m) over their lifetime, arguing it would be "perverse" not to require mitigation or compensation as a result. The Norwegian oil major and British power giant submitted the estimate last week in the planning proceeding for Dogger Bank South, a 3GW project that German utility RWE is developing. This indicates the similar losses to downwind property, agricultural lands & the availability of access to such data for the Wind Energy Industry to take such proceedings. This data is not included with this application.

- The Wake effects on downwind turbines & associated noise due to turbulent air is not identified. ACP questioned noise model to see if noise based on singular or multiple wind turbines.
- Effect of microclimate effects from Wake on crops, cattle & horses not identified.
- Adverse impact on property & land values plus farm viability from downwind reduced temperature Wake effects & increased costs to heat houses.
- The increasing turbine noise levels, over time with bearings wear, is not identified.
- The turbine noise numbers provided have no reference & are stated to be assumed & would seem to be wind tunnel values for a singular turbine.
- The attraction of insects to wind turbines & the attraction of bats to the insects is not addressed.
- The recent High Court decision in relation to the effect of Noise on health & property devaluation [Phase 2], plus the Victoria Supreme Court decision in Australia are ignored, while historical data, pre-2015, is quoted.
- Peat drying effects from wake & road/foundation drainage resulting in increased carbon emissions. Adverse impact on shallow soils/Bog & potential for landslides. On the basis of the information submitted with the application, ACP cannot be satisfied that the proposed development would adequately mitigate risk associated with potential landslide as a consequence of the development of the proposed wind farm in association with seismic vibration through the foundations causing liquefaction of the shallow soils plus supercharging the existing peat with excavated peat & spoil. The proposed floating road construction is not reference as being used elsewhere & over a considerable time period. In view of the above, it is considered that the proposed development would constitute an unacceptable risk of pollution of watercourses & spring drinking water sources in the area. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area. The volume of peat excavation is indicated as 89,750m³ over 4ha indicates an average excavated depth of 2.24m. However, this is not reflected in the depths of peat in the trial holes & it seems that far greater excavation is proposed outside the turbine bases & access roads.
- Habitat Restoration ignored. Adverse impact on Restoration of nature as included in EU Directive.
- Failure to comply with Survival Speed of c52-59kph as outlined in Vesta Brochure vis a vis Birr Meteorological. Station Wind Gust speeds greater than 57kph, which are over this limit on 13% of time over 160-year period & constitutes a Health & Safety hazard to adjoining properties from destruction.
- Breaches of the Precautionary Principle on numerous grounds & particularly evidenced in Geological Risk Impacts included in EIAR.

- Proximity to Residential Clusters around the site.

Having regard to:

- the height of these turbines (185 m),
- their proximity,
- the lack of significant screening by existing topography or mature vegetation,
- the local concentration of rural dwellings compared to other equivalent areas in the general vicinity,
- the orientation of the more-used amenity garden areas,
- the location of the turbines at a higher elevation than the dwellings, and
- the availability of alternative turbine locations and having regard to the material supplied by the applicant, it appears that the proposed development will give rise to:
 - a locally significant, avoidable, and concentrated adverse effect on the principal residential amenities of a concentration of dwellings, to such a degree as to constitute a disproportionate and unreasonable burden of avoidable impacts on residential amenity that could not reasonably be argued to constitute the proper planning and sustainable development of the area;
 - a scale and quantity of development which, having regard to the significance of effects on the sensitivities of adjoining land uses, would constitute over development; and
 - a magnitude of impact that, due to in-combination and cumulative effects, will amplify the perceived significance of other effects, such as noise, nuisance, and loss of amenity and house/land value.

- Road closures to connect grid is totally unreasonable for the local community commuting to Work & School.
- Failure to provide Plans & Particulars of the proposed Windfarm turbines.
- Adverse impact on shallow soils/Bog & potential for landslides. On the basis of the information submitted with the application, ABP cannot be satisfied that the proposed development would adequately mitigate risk associated with potential landslide as a consequence of the development of the proposed wind farm in association with seismic vibration through the foundations causing liquefaction of the shallow soils. In view of the above, it is considered that the proposed development would constitute an unacceptable risk of pollution of watercourses in the area. The proposed development would, therefore, be contrary to the proper planning and sustainable development of the area.
- Adverse impact on human & animal health. No plans or designs or noise readings related to distances or wake effects provided.
- Adverse impact on drinking water catchment due to biohazards & the elevated risk of a major accident arising from a landslide event or underground coalmine collapse adjoining geological fault lines, the proposal would pose a serious danger to the environment potentially causing extensive pollution of water-bodies within and in the vicinity of the site. Given the extent of existing wind farm activity in the wider area, to which the proposed development would add to, the Bord Pleanála cannot be satisfied that the cumulative environmental assessment of the likely effects of the proposed development on avifauna can reasonably exclude the possibility of a significant impact.
- Adverse impact on Traffic & Roads from a Nacelle weighing up to 400tonnes with dimensions 10.9m in length, 4.09m in width & 4.15m in height & on a 2-4 axle articulated flat-bed truck. With the weight of the truck included, the fully laden weight will be circa 450 tonnes. A 2-4 axle articulated flat bed truck is not capable of carrying this weight or permitted by law [S.I. No. 5 of 2003 Clause 13] & would severely damage roads, bridges & culverts
- Breaches of the Precautionary Principle on numerous grounds.

- Adverse effects from Blade failure due to delamination at skin & adhesive, fatigue failures from cyclic loading, use of flammable laminates in blade construction.

Site Notice

The proposed development will consist of the provision of the following:

- i 9 no. wind turbines with the following parameters:
- ii Total turbine tip height of 180 metres;
- iii A rotor blade diameter of 150 to 162 metres;
- iv A hub height of 99 to 105 metres;
- v Permanent turbine foundations, hard-standing and assembly areas;
- vi Underground electrical (33kV) and communications cabling;
- vii 1 no. temporary construction compound (including site offices and welfare facilities);
- viii A meteorological mast with a height of 100 metres, security fencing and associated foundation and hard-standing area;
- ix 1 no. new site entrance on the R332 in the townland Lisavally;
- x 1 no. new access and egress point off the L6056 Local Road in the townland of Dangan Eighter;
- xi 1 no. new access and egress point on to an existing access track in the townland of Dangan Eighter;
- xii 2 no. new access and egress points off the L6301 Local Road in the townland of Cooloo and Lecarrow;
- xiii Upgrade of existing site tracks/roads and provision of new site access roads, clear span crossings, junctions and hard-standing areas;
- xiv A new temporary access road from N63 national road and to R332 Regional Road in the townland of Slievegorm to facilitate the delivery of turbine components and other abnormal sized loads;
- xv Demolition of an existing derelict house and adjacent outbuilding in the townland of Cooloo;
- xvi Peat and Spoil Management Areas;
- xvii Tree felling and hedgerow removal;
- xviii Biodiversity Management and Enhancement measures;
- xix Site Drainage;
- xx Operational Stage site signage; and
- xxi All ancillary apparatus and site development works above and below ground, including soft and hard landscaping.

A 10-year planning permission and 35-year operational life of the wind farm from the date of commissioning of the entire wind farm is sought (other than temporary and permanent works specified above).

Percival (2003) Bird Collision data: Note size of turbines. Using this type of historic science has zero relevance to present wind turbine sizes.

Birds and windfarms

Table 1. Bird-windfarm collision studies: summary of findings.

Species group	Sites studied	Windfarm size	Turbine type	Exposure to collision risk	Incidence of collision	Population effect
Divers	Burgar Hill ^{1,2}	S	S/M	M	Nil	No
Cormorants	Buffalo Ridge ³	VL	M	L	Nil	No
	Blyth ^{4,5}	S	S	L	VS	No
Swans	Yukon ⁶	S	S	S	Nil	No
	Yrk ⁷	M	S	M/L	VS	No
Geese	Buffalo Ridge ³	VL	M	L	Nil	No
	Klundsike ⁸	M	M	M	S	No
	Kreekrak ¹¹	S	S	M	S	No
	Gotland ¹⁰	L	M	L	Nil	No
	Yrk ⁷	M	S	M	Nil	No
Ducks	Blyth ^{4,5}	S	S	L	S	No
	Buffalo Ridge ³	VL	M	L	VS	No
	San Geronimo ¹¹	VL	S	-	VS	No
	Kreekrak ¹²	S	S	L	M	No
Eagles, vultures, hawks	Altamont ^{11,13}	VL	S	L	S	Likely
	Tehachapi ¹¹	VL	S	-	VS	Possible
	San Geronimo ¹¹	VL	S	-	VS	No
	Tarifa ^{14,15}	VL	S	L	VS	Possible
	Navarre ¹⁶	VL	M	L	S	Possible
Harriers	Buffalo Ridge ³	VL	M	M	Nil	No
	Altamont ^{11,13}	VL	S	L	VS	No
	Foot Creek Rim ⁸	L	M	-	VS	No
Falcons	Altamont ^{11,13}	VL	S	L	S	Possible
	Burgar Hill ²	S	S	S	VS	No
	Novar ¹⁷	M	M	M	VS	No
	Tehachapi ¹¹	VL	S	-	VS	No
	Tarifa ^{14,15}	VL	S	L	VS	Possible
Upland gamebirds	Buffalo Ridge ³	VL	M	S	VS	No
	Novar ¹⁷	M	M	S	VS	No
	Tehachapi ¹¹	VL	S	-	VS	No
Owls	Altamont ^{11,13}	VL	S	L	VS	Possible
	San Geronimo ¹¹	VL	S	-	VS	No
	Tehachapi ¹¹	VL	S	-	VS	Possible
Waders	Kreekrak ¹²	S	S	L	S	No
	Gotland ¹⁰	L	M	L	VS	No
	Blyth ^{4,5}	S	S	M/L	VS	No
	Oosterbierum ¹⁸	M	S	M/L	VS	No
	Ovenden Moor ¹⁹	M	S	L	VS	No
	Buffalo Ridge ³	VL	M	L	VS	No
Gulls	Blyth ^{4,5}	S	S	L	M	No
	Kreekrak ¹²	S	S	L	M	No
	Zeebrugge ²⁰	M	S/M	L	L	Possible
	Buffalo Ridge ³	VL	M	L	Nil	No
Terns	Zeebrugge ²⁰	M	S/M	L	M	Possible
	Blyth ^{4,5}	S	S	M	Nil	No
Passerines	Blyth ^{4,5}	S	S	M/L	Nil	No
	Buffalo Ridge ³	VL	M	L	M	No
	Oosterbierum ¹⁸	M	S	L	L	No

KEY

Sources: 1. Meek *et al.* 1993; 2. Haworth 2002; 3. Johnson *et al.* 2000; 4. Stall *et al.* 1995; 5. Painter *et al.* 1999; 6. Munnop 1998; 7. Winkelman 1989; 8. Young *et al.* 2003; 9. Johnson *et al.* 2003; 10. Percival 1998b; 11. Erickson *et al.* 2001; 12. Masters *et al.* 1995, 1996; 13. Thelander *et al.* 2003; 14. *Sci-BirdLife* 1995; 15. Lekuona 2001; 16. *Jars* 2000; 17. Bosan 2001; 18. Winkelman 1992a; 19. *EAS* 1997; 20. Everaert *et al.* 2002; 21. Percival 2000.

Windfarm size: VL = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 kW-1.5 MW); S = small (<500 kW).

Exposure to collision risk (based on number of flights at rotor height in proximity to turbines per year): L = large (>10,000); M = medium (1,000-10,000); S = small (<1,000).

Incidence of collision: L = large (>10/turbine/yr); M = medium (1-10/turbine/yr); S = small (0.1-1/turbine/yr); VS = very small (<0.1/turbine/yr).

Population effect: determined on the basis of the total numbers killed in relation to the population dynamics.

Table 2. Bird-windfarm disturbance studies: summary of findings.

Species group	Sites studied	Habitat	Windfarm size	Turbine type	Disturbance distance
Cormorant	Blyth ¹	Coastal	S	S	None [*]
Swans	Urk ¹	Farmland and coastal	M	S	None (Bewick's), 300 m (Whooper)
Geese	Germany ^{4,5}	Farmland	M	S/M	Up to 600 m
	Urk ¹	Farmland and coastal	M	S	None
	Denmark ⁶	Farmland	L	M	1-200 m
	Gotland ⁷	Coastal marsh	L	M	0-25 m
	Toronto ⁸	Parkland	S	M	None
Ducks	Tano Knob ⁹	Offshore	M	M	None
	Utgrunden ¹⁰	Offshore	S	L	None
	Urk ¹	Coastal	M	S	Up to 300 m
Raptors	Bryn Tyfli ¹⁹	Upland moor	M	S	None
	Altamont ¹⁷	Grassland	VL	S	None
Waders: breeding	Ovenden Moor ¹¹	Upland moor	M	S	None
	Various UK sites ¹²	Upland	S/M	S/M	None
	Gotland ²¹	Coastal and farmland	L	M	None
	Oosterbierum ¹³	Lowland farmland	S	S	Up to 300 m
Waders: non-breeding	Germany ¹³	Lowland farmland	S/M	S/M	Up to 200 m
	Blyth ¹	Coastal	S	S	None
	Tjaereborg ²	Farmland	S	M	800 m
	Zeebrugge ¹⁷	Coastal	M	S/M	Up to 250 m
	Oosterbierum ¹³	Farmland	M	S	500 m
Gulls	Tjaereborg ²	Farmland	S	M	800 m
	Blyth ¹	Coastal	S	S	None
Terns	Zeebrugge ¹⁷	Coastal	M	S/M	None
	Blyth ¹	Coastal	S	S	None
Passerines	Various UK sites ¹²	Upland	S/M	S/M	None
	Buffalo Ridge ¹⁸	Grassland	VL	M	1-200 m
	Bryn Tyfli ¹⁹	Upland moor	M	S	None
	Burgar Hill ²⁰	Upland moor	S	S	None
	Novar ^{21,22}	Upland moor	M	M	None

KEY

Sources: 1. Still *et al.* 1995; 2. Pedersen and Poulsen 1991; 3. Winkelman 1989; 4. Kowalik & Borbach-Jaene 2001; 5. Kruckenberg & Jaene 1999; 6. Larsen & Madsen 2000; 7. Percival 1998a; 8. James 2003; 9. Gaibennette *et al.* 1998, 1999; 10. Pettersson & Stålin 2003; 11. Bullen Consultants 2002; 12. Thomas 1999; 13. Ketzenberg *et al.* 2002; 14. Everaert *et al.* 2002; 15. Winkelman 1992b; 16. Green 1995; 17. Thelander *et al.* 2003; 18. Ledy *et al.* 1999; 19. Phillips 1994; 20. Meek *et al.* 1993; 21. Bioscan 2001; 22. Percival & Percival 1998; 23. Percival 2002.

Windfarm size: VL = very large (>200 turbines); L = large (50-200 turbines); M = medium (10-50 turbines); S = small (<10 turbines).

Turbine type: L = large (>1.5 MW); M = medium (500 KW-1.5 MW); S = small (<500 KW).

Disturbance distance: none indicates no significant disturbance effect; * disturbance noted during construction but not operation.

RESPONSE FROM MARTIN LAVELLE: INTRODUCTION

Roads

The weight of the nacelle is c400tonnes & no assessments or knife edge load assessments are provided for the structural capacities of River, Stream or Culvert crossings plus watermain & gas pipeline crushing. The Applicant does not include the weight of the nacelle in his application. Bridge damage might not be immediate. This is similar to the ESB Generators locked in Dublin Port as the M50 Westlink bridge couldn't carry the weight.

The proposed development is located along a legacy narrow roadways R332, N63, L6234, L2115, L2125, R347, L6301, L6506 with limited passing facilities. The granting of this industrial facility will negate the level of safety for the local residents. The additional development is likely to lead to an over intensification of traffic on local roads without footpaths. The proposed development is premature pending major road improvement works to allow lorries to pass each other. The proposed development may also need for third party cooperation to improve the Local roads as the existing carriageway has an average width of less than 5 metres. The overuse of the substandard local roads by commercial lorries has both the potential to endanger pedestrian safety & cyclists, due to the absence of a footpath, by reason of traffic hazard and create obstruction at times when two trucks are attempting to pass. The proposed development located on such narrow Local roads is likely to constitute a risk to pedestrian safety.

The proposed development is located on Regional & Local Roads, that are substandard in terms of width and alignment. The scale of traffic generated by the proposed development over the Local roads both at construction and operational stage would render the road unsuitable to carry the increased loads arising from the development, would endanger public safety by reason of traffic hazard and obstruction of road users, Children, Pedestrians & Cyclists, would be premature having regard to the deficiency in the road network serving the rural area within which the site is located, would set an undesirable precedent for similar development of this scale and nature elsewhere & would seriously injure the residential amenities of the area and would therefore be contrary to the proper planning and sustainable development of the area.

The Development would lead to an over intensification of traffic on substandard out of capacity Local Roads. It is, therefore, recommended that the development be refused due to the hazard and obstruction concerns outlined above.

The proposed development of a windfarm facility is not serviced by a suitable transportation network.

The road network is not ideally suitable for the scale of construction traffic required to develop the Windfarm Facility. The development is totally dependent on the transport of construction materials, labour and raw materials on substandard roads.

The road network is primarily a network of "legacy roads". These roads do not have a road structure as envisaged in the design standards. Rather the network depends on the periodic replacement of a thin road surface course or courses without the necessary road capping layer and sub-base being present beneath (directly on the subgrade). This renders the road liable to significant damage from HGV traffic (especially over-weight vehicles) caused by the transfer of wheel loads to the subgrade at stress levels above that which the subgrade can support.

Turbine locations

Grid references for the 9 turbines in a E/W alignment.

Using Excel to calculate the distances between Turbines, it can be seen that the distances range from 520.2m, 592.8m, 606m, 611.7m.

The 2006 & 2019 Wind Energy Guidelines specify a separation factor of 7 for prevailing downwind & 3 crosswind.

The spacings for the E/W turbines should be 1.134km downwind & N/S should be 486m crosswind & not as indicated.

This squeezing of turbines onto a restricted site will create turbulence & noise issues. The Windpro modelling software seemingly can calculate the cumulative noise where separation distances are specified. However, this software output has not been provided, where input constraints are provided.

Squeezing in wind turbines to get over the 50Mw threshold for SID is not acceptable.

Wind Turbine Separation Distances Matter, June 2014. Peter R Mitchell, AM, BChE

"Evidence is that the manufacturer-recommended separation distances of 7 to 8 rotor diameters for turbines in line with the prevailing wind and 5 rotor diameters for turbines abreast, still allows turbulent air exiting one turbine to

retain significant turbulence when entering the next; so the manufacturers' recommended spacings can be considered as an unfortunate compromise and inadequate to contain noise.

The most efficient turbine spacing, i.e., that which allows the turbines to economically extract the most energy from the wind, has been shown to be some 15 rotor diameters. Most efficient extraction of useful energy will approximately coincide with the least production of waste energy, namely sound and vibration.

The Waubra Foundation currently considers that for a block of turbines that is likely to be subject to changing wind directions, noise will be minimised if the turbine spacing in all directions approaches the most efficient spacing of about 15 rotor diameters.". <http://waubrafoundation.org.au/resources/shepherd-khubbard-h-noise-radiation-characteristics-westinghouse-wwg-0600-wind-turbine-generator/>

The windspeed is indicated at <8m/s for this site.

Nordex N163/5.X

5,8 MW 

- X Power data
- ✓ 9 Pictures
- X Models

Pictures



Datasheet

Power

Rated power	5 800 0 kW
Flexible power ratings	4 950 0 - 5 800 0 kW
Cut-in wind speed	3 0 m/s
Rated wind speed	11 0 m/s
Cut-out wind speed	23 0 m/s
Survival wind speed	50 5 m/s
Wind zone (IEC)	-
Wind class (IEC)	S

Nordex N163/6.X

[Pictures](#)
[Datasheet](#)
[Power curve](#)
[Marketplace](#)
[Service](#)
[Models](#)

6,8 MW



- X Power data
- ✓ 3 Pictures
- X Models

Pictures



Datasheet

Power

Rated power	6 800 0 kW
Flexible power ratings	3 190 0 - 7 000 0 kW
Cut-in wind speed	3 0 m/s
Rated wind speed	12 5 m/s
Cut-out wind speed	28 0 m/s
Survival wind speed	52 5 m/s

Response: Note Survival Windspeed is less than gust speeds at Birr Met Eireann site over 150-years of records.

Table 2: Wind turbine power curves – wind turbine power output against wind speed in metres per second.

Speed (m/s)	Siemens SWT-2.3 82	Siemens SWT-2.3 93	Siemens SWT-3.6 107	Vestas V34	Vestas V80	Vestas V90	Vestas V112	Vestas V164	Repower MM82	Repower MM92	Repower 5M	Repower 6M	Nordex N60	Nordex N80	Nordex N90	Nordex N100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	104	0	0	20	0	0	0	0	0	0
4	42	98	80	4	2	75	244	101	64	94	141	120	29	15	35	50
5	136	210	238	40	97	187	451	461	159	205	343	343	73	121	175	221
6	276	376	474	93	255	348	709	902	314	391	636	666	131	251	352	431
7	470	608	802	150	459	574	1162	1595	511	645	1067	1135	241	433	580	720
8	727	914	1234	220	726	875	1666	2513	767	979	1615	1695	376	667	870	1102
9	1043	1312	1773	280	1004	1257	2269	3737	1096	1375	2289	2496	536	974	1237	1575

Response: For 8m/s & for Vestas V164, we get a power output of 2,513Mw.. Thus, the total output for 9 turbines is 22.617Mw and not greater than 50Mw as required for SID

Classification: Confidential

Product Preview Documentation Package
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General documentation

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Wind Turbine Class Nordex Delta 4000 N149/5.X

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4.3 Power Curves 5.5 MW and 5.7 MW Mode

4.3.1 Power Curve 5.5 MW Mode

Power P_{el} [kW] at air density ρ [kg/m³]
hub height $\geq 105m$

Wind speed [m/s]	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3	2	4	5	8	10	12	13	16	18	20	23	24	26	29	31	33	34
3.5	66	70	73	77	80	84	87	91	95	98	102	105	109	113	116	120	123
4	155	161	167	173	179	185	191	197	203	209	215	221	227	233	239	246	252
4.5	264	273	283	292	301	310	319	328	337	346	355	364	374	383	392	401	410
5	396	409	421	434	447	460	472	485	498	510	523	536	549	561	574	587	600
5.5	552	569	586	603	620	637	654	671	688	705	722	739	756	773	790	807	824
6	736	758	780	802	825	847	869	891	913	935	957	979	1001	1023	1045	1068	1090
6.5	952	980	1008	1036	1065	1093	1121	1149	1177	1205	1233	1261	1289	1317	1345	1373	1401
7	1204	1239	1274	1309	1344	1379	1414	1449	1484	1519	1553	1588	1623	1658	1693	1728	1763
7.5	1493	1536	1579	1622	1665	1708	1751	1794	1836	1879	1922	1965	2008	2050	2093	2136	2178
8	1824	1875	1927	1979	2031	2083	2135	2187	2239	2290	2342	2394	2446	2497	2549	2601	2652

Classification: Confidential

Product Preview Documentation Package
For Key Customers and Key Projects



General documentation

Revision 01 / 2019-03-29

4.3.2 Power Curve 5.7 MW Mode

Power P_{ei} [kW] at air density ρ [kg/m³]
hub height $\geq 105\text{m}$

Wind speed [m/s]	0.900	0.925	0.950	0.975	1.000	1.025	1.050	1.075	1.100	1.125	1.150	1.175	1.200	1.225	1.250	1.275	1.300
3.0	2	4	5	8	10	12	13	16	18	20	23	24	26	29	31	33	34
3.5	66	70	73	77	80	84	87	91	95	98	102	105	109	113	116	120	123
4.0	155	161	167	173	179	185	191	197	203	209	215	221	227	233	239	246	252
4.5	264	273	283	292	301	310	319	328	337	346	355	364	374	383	392	401	410
5.0	396	409	421	434	447	460	472	485	498	510	523	536	549	561	574	587	600
5.5	552	569	586	603	620	637	654	671	688	705	722	739	756	773	790	807	824
6.0	736	758	780	802	824	847	869	891	913	935	957	979	1001	1023	1045	1068	1090
6.5	952	980	1008	1036	1065	1093	1121	1149	1177	1205	1233	1261	1289	1317	1345	1373	1401
7.0	1204	1239	1274	1309	1344	1379	1414	1449	1484	1518	1553	1588	1623	1658	1693	1728	1763
7.5	1493	1536	1579	1622	1665	1708	1751	1794	1837	1879	1922	1965	2008	2050	2093	2136	2179
8.0	1823	1875	1927	1979	2031	2083	2135	2187	2238	2290	2342	2394	2445	2497	2549	2600	2652

Response: For the larger Nordex 5.7Mw N149, we get a power output of 2.549Mw & 22.941Mw output and not greater than 50Mw as required for SID. Output is not a figure off a Brochure. It is a function of windspeed by power output for that turbine.

CONCLUSIONS

The application should have provided up-to-date studies plus the model used for Biodiversity, Hydrology, Noise & Vibration, Social impacts, Cultural & Historic Heritage & Landscape effects to name a few.

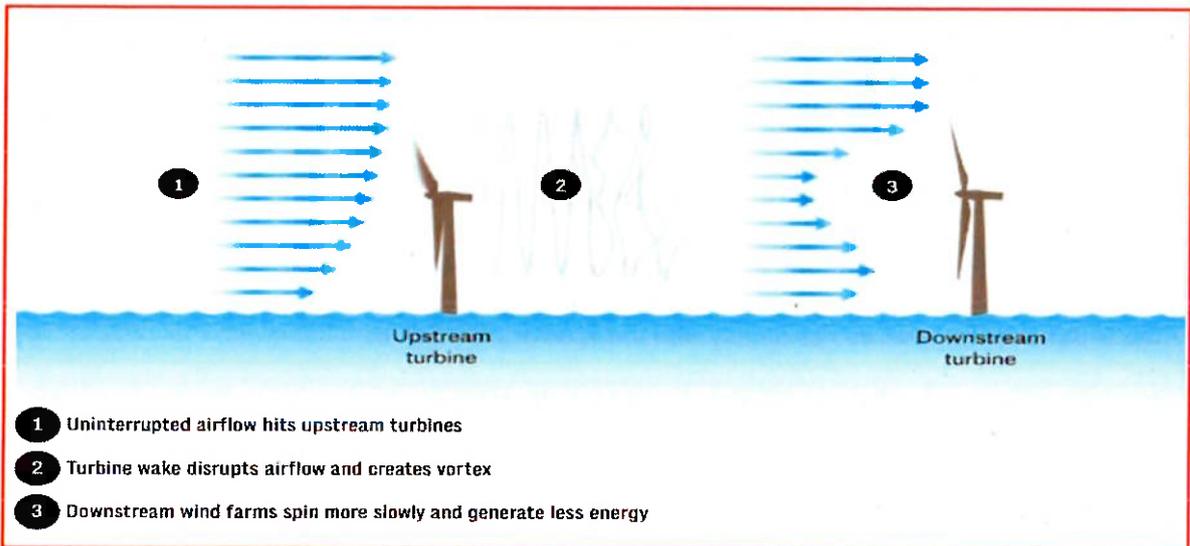
The proposal has the potential for a range of significant impacts including:

- The output is less than 50% of the 50Mw output threshold for SID.
- The Separation distances do not comply with the 2006 or 2016 WEGs.
- The windrose indicates that the prevailing wind for 59% of the year is from the South/Southwest/West direction. For a windfarm in a W/E alignment, this means lower energy generation due to wake effects, rain, turbulence on the houses to the East/Northeast.
- Dispute over wake losses between developers of two huge offshore wind farms one of many currently underway in UK planning system. Equinor and SSE 1/5/2025 say that wake losses caused by an RWE offshore wind project will cost their massive Dogger Bank arrays £582m (\$778m) over their lifetime, arguing it would be "perverse" not to require mitigation or compensation as a result. The Norwegian oil major and British power giant submitted the estimate last week in the planning proceeding for Dogger Bank South, a 3GW project that German utility RWE is developing. This indicates the similar losses to downwind property, agricultural lands & the availability of access to such data for the Wind Energy Industry to take such proceedings. This data is not included with this application.

The main problem for the wind industry is that there is currently a lot of uncertainty," says Pablo Ouro, a renewable energy expert who is leading the Manchester University study. "And uncertainty is not good news for financial projects."

Wind theft happens when air hits the turbines of one wind farm and is disrupted, leaving behind less powerful air flows for wind farms positioned further downstream. It had not been much of a problem for the offshore wind industry until relatively recently. But there is only so much seabed that is suitable for fixed wind turbines, and the turbines themselves are growing in size. As recently as the mid-2010s, a typical turbine was just shy of 200 metres tall. Now, monsters like the world's largest turbine being built in Bradenberg, Germany, can reach as high as 364 metres – higher than London's Shard skyscraper. And as the turbines grow bigger, so do their wakes. This means that for upcoming projects, the wake effect of one wind farm can easily still hit another as far as 37 miles (60km) away, says Ouro. The differences from the wake effect are not huge, in the sense that there will not be an impact of more than say 4pc to 5pc," Ouro says. "But actually, for a relatively large wind farm over more than one year, that's a lot of money.

Earlier this year, for example, Ørsted and Equinor complained that Total's proposed Outer Dowsing wind farm off the Yorkshire coast could cost them a combined £363m in lost revenues. Ørsted estimated that the scheme would affect its existing Race Bank, Hornsea 1 and Hornsea 2 projects, sapping 0.52pc, 0.67pc and 0.68pc of their outputs respectively at a total cost of up to £199m. Meanwhile, Equinor says its Dudgeon and Sheringham Shoal projects will lose 0.88pc and 0.76pc respectively, with planned extensions also set to suffer. The company predicts the cumulative impacts could amount to up to £164m in lost revenues. Elsewhere, Scottish Power owner Iberdrola alleges that RWE's proposed Five Estuaries project will reduce the output of its East Anglia 2 wind farm by as much as 2.1pc. And yet another row is raging in the Irish Sea, where Ørsted is duking it out with EnBW, BP and Flotation Energy over the effects upcoming projects could have on its existing portfolio



Martin Lavelle

Signed:

Martin Lavelle, BE.
15th November 2025

Chapter 1: PLANNING APPLICATION RESPONSE

INTRODUCTION

Reference 1.1: System impacts of wind energy developments: Key research challenges and opportunities
Russell McKenna, Johan Lilliestam, Heidi U. Heinrichs, Jann Weinand, Johannes Schmidt, Iain Staffell, Andrea N. Hahmann, Peter Burgherr, Arne Burdack, Monika Bucha, Ruihong Chen, Michael Klingler, Paul Lehmann, Jens Lowitzsch, Riccardo Novo, James Price, Romain Sacchi, Patrick Scherhauser, Eva M. Schoell, Piero Visconti, Paola Velasco-Herrejo, Marianne Zeyringer, and Luis Ramirez Camargo
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ENVIRONMENTAL IMPACTS

Impacts on ecosystems and wildlife

Onshore wind power deployment primarily affects bird and bat populations, even though wind turbines may also disturb and displace terrestrial mammals. **Although there are no global estimates of yearly bird and bat fatalities caused by wind turbines, in the United States, with an installed capacity of 112 GW as of 2021, bird fatalities from turbine collisions number in the several hundreds of thousands annually. Species at higher risk are typically migratory, soaring raptors, or bats; the additional mortality due to collisions can be particularly relevant for populations of long-lived and slow-reproducing species, and collision with rotor blades and wind turbine towers might further endanger species already threatened with extinction.** However, there are fewer bird collisions with wind turbines than with other structures like buildings, power lines, and communication towers, though some of these structures are also associated with infrastructure for wind turbines. From 2000 to 2020, wind farms had no discernible impact on bird counts in the US, whereas shale gas wells reduced numbers by 15%. But the displacement effect of new installations may in fact be specific to some species. Although previous research suggested bat fatalities caused by barotrauma, more recent studies identify direct blade and tower collisions as the main cause of fatalities.

Despite the growing body of literature on bird strikes in open landscapes, there is a significant lack of research on these impacts in shrub- and woodland environments.

Furthermore, noise pollution from wind turbine operations can negatively affect birds, bats, and non-volant and marine mammals, disrupting their nesting, breeding, and movement patterns, which may result in population decline

and displacement. Some species avoid wind turbines due to noise, specifically during construction, whereas others avoid areas with shadow flicker (see section health and annoyance). Although not a bat attractant, low-frequency noise emissions can disorientate bats, which makes hunting difficult. Land transformation related to the construction of wind farms can also affect habitat suitability for wildlife species. Landscape connectivity between habitats can become disrupted if wind farms are built in existing dispersal corridors. Already-isolated populations can face a reduced gene flow if areas in the vicinity of wind farms are avoided and alternative dispersal corridors are rare. In addition, direct mortality due to collisions with wind farms can affect population dynamics on a large scale. Some species might be able to adapt to altered habitat conditions after wind farm construction, whereas others might not become habituated. However, effects on population trends are difficult to assess because effects are highly site and species specific and long-term studies are rare. Adequate siting of wind farms is a promising approach to reduce impacts on wildlife, but because many species' habitat requirements change in the course of a year, it remains a challenging task, especially when considering ecological corridors and stepping stones. Micro-siting to avoid areas with high collision risk can reduce risks for birds, but it is more challenging for bats. A promising solution for on-site impact mitigation is to increase the cut-in wind speed from 3 to 4 m/s to 6 and 8 m/s for bats and soaring birds, respectively, as these animals have the highest flight activities at low wind speeds, while the production losses would remain modest. Temporary shut-downs triggered by visual or radar observations are also effective solutions to minimize collisions. Visual cues like painting at least one rotor blade black to reduce motion-smear have had limited testing but have shown promising results.⁸¹ Lastly, ultrasonic deterrent systems can reduce bat fatalities, though effectiveness can vary by species and environmental conditions.

Impacts on wind resources and weather

The increasing number and size of wind farms can affect local weather and climate patterns, though the magnitude of these effects is debated. There is broad evidence based on photographs, satellite imagery, measurements, and modelling. Wind turbines extract kinetic energy from the wind flowing through their rotors, replenished downstream of the flow above the wind farm. In large wind farms, the latter process cannot supply enough energy to compensate for lowered wind speeds, especially offshore. Hence, a large wind farm can significantly lower the wind speeds in its vicinity, up to a distance of tens of kilometres, thereby suppressing generation from nearby wind farms, as shown in Figure 1 for a possible 2030 wind farm scenario for the North and Baltic seas. The figure shows a possible 2030 scenario of wind farm development in the North Sea and the potential reduction in wind capacity factor induced by these wind farms. Early modelling studies argued that wind farm extractable energy was finite and limited to about 1 MW/km² for massive wind farm clusters (i.e., of several gigawatts capacity spanning several thousands of km²). Still, recent research demonstrated that this limit can be considerably larger (up to 4 MW/km²) when wind speeds are high and persistent and turbulence can mix energy down from the free atmosphere above. Confirming these findings is challenging due to scarce observations and the limited sizes of presently operating wind farms. These impacts can be mitigated by strategically planning wind farm locations and sizes and limiting their capacity densities as well as during the operational phase within wind farms by so called wake steering. Thus, future wind energy development, particularly offshore, should consider potential wakes and efficiency losses and implement comprehensive international strategies for developing energy-abundant regions such as the North Sea. However, the growth of wind power will likely be restricted by economic or environmental factors rather than global geophysical limits. The operation of wind farms can also cause weather conditions to change locally. This can take the form of shifts in surface temperature (often leading to warmer surface temperatures at night and other weather parameters, such as precipitation and evaporation). The local temperature increases are occasional and typically confined to less than 1 °C when they occur and are limited to a few kilometers from the wind farm. Offshore wind farms could also affect waves, ocean currents, and sea surface temperatures. Although there is no definitive solution to mitigate the effects on the weather, it is crucial to acknowledge that, on average, they remain limited and much less significant than the global impacts of climate change. In sensitive areas, good spatial planning and coordinated approval processes can minimize the effects on weather and wind resources if they are expected to affect human activities.

SOCIAL, ECONOMIC, AND HEALTH IMPACTS

Land tenure (in)security

The transition to higher shares of wind power boosts the demand for land. The private appropriation of public land to secure access to and control over renewable (including wind) energy production has been referred to as “green grabbing.” This can come at the cost of prior land users and increase the vulnerability of traditional rural communities and Indigenous groups in particular due to the use of public land without free, prior, and informed consent, unfair contractual arrangements, and various forms of dispossession, including the prevention of access by legal means and physically by fencing. The impact of wind energy development on land tenure insecurity, especially for undesignated public and common lands, is addressed in several qualitative studies—in both the Global North and South. For instance, the installation of large-scale wind power in Norway has been described by Sámi representatives as a form of “green colonialism,” pinpointing that these developments could intensify the continuation of historical struggles over land rights and territorial autonomy due to the non-recognition of Indigenous peoples. Similarly, in Brazil, a large share of wind corridors is in undesignated public lands, historically occupied by traditional communities struggling to regularize the ownership and use of common lands. The proposal of individual land leasing contracts for installing turbines in an already ill-defined communal land tenure system has also sparked conflict between Zapotec farmers, the government, and wind farm operators in the Isthmus of Tehuantepec in Mexico as well as in North Africa and the Middle East.

The diverse impacts of wind power development on land appropriation and control, which affect the rights of traditional communities or Indigenous people to territory and livelihoods, need to be linked to a set of compliance rules. These include procedural aspects such as securing their free, prior, and informed consent, addressing information asymmetries about the project’s specific local impacts, and offering fair and legally approved land leasing contracts as well as legal advice on land use. The issue of land ownership and rights is a key challenge to a just energy transition, particularly in recognizing the historical communal use of land by traditional communities and Indigenous people. Increasing the focus of spatial energy planning on land tenure issues, as well as integrating participatory and collaborative planning, can be helpful approaches for renewable projects to better consider local community needs, interests, and rights and to provide fair compensation and manifest co-benefits for immediately affected residents.

Landscape visual impacts

Another public concern is that wind turbines negatively impact the perception of landscapes, particularly untouched nature. This visual landscape impact is one of the main reasons for local opposition to onshore and offshore wind installations.

Acceptance of wind turbines is higher when they are placed in already unattractive landscapes, far from viewpoints, and with a limited number of turbines, but the cumulative effects may vary by location. Several studies have employed national datasets of landscape aesthetic quality (so-called “scenicness”), based on survey-based ratings of representative landscape photographs, to quantify the costs incurred to power systems when excluding onshore wind potentials in landscapes with high aesthetic quality, showing a large range of impacts between countries

In addition, viewshed analyses, in which a three-dimensional space (the viewshed) within which one or more hypothetical wind turbines are visible, can aid in understanding the potential visual impact on sensitive receptors; however, these disregard people’s visual preference for certain landscapes over others. They may, therefore, be combined with measurements of visual features of landscapes, as a correlation between such metrics and rated landscape qualities has been found. Moreover, RE infrastructure such as wind turbines and power lines strongly influence the rated landscape coherence. Quantifying the landscape impact of wind turbines to improve placement decisions requires that both visibility and landscape quality are considered. Whereas the latter refer to changes in landscape quality and character, visibility impacts relate to (perceived) changes in views (of the landscape) and how these affect people. Approaches based on geographical information systems (GISs) have been proposed to estimate landscape coherence and wilderness using indicators calculated from datasets such as land cover, topography, and remoteness.

Similar approaches can be combined with visual impact assessments to develop robust, reliable, and scalable methods and tools for landscape impact assessments.

Health and annoyance

Noise emissions and the “flicker” of the rotating shadow from wind turbines are frequently discussed as negative impacts of wind farms. Although current evidence suggests that noise emissions from wind farms do not have a significant direct impact on nearby populations’ health, some studies have noted a correlation between noise-related annoyance and potential indirect effects on quality of life, such as sleep disturbance, increased stress, and related health concerns (e.g., elevated blood pressure and psychological distress). However, the causality and directionality of these effects remain unproven and require further research. The perception of noise seems higher in rural areas and around flat terrains. Although low-frequency noise emissions cannot be heard, they may still lead to annoyance, but the link between wind turbines and low-frequency noise has not yet been established. In addition, many studies show that only a small fraction of the population living near wind farms is disturbed by shadow flicker. Shadow flicker exposure does not necessarily lead to self-reported annoyance but rather subjective factors such as project appearance and general annoyance. However, the disturbance attributed to wind turbine noise emissions should be evaluated compared with other routine noise sources. In a controlled study, although subjects reported annoyance from the acoustic emissions of nearby wind turbines, health-related effects were specifically attributed to noise pollution from road traffic.

Noise impacts can be mitigated by appropriate wind farm planning and simulations, and it is suggested that a certain noise threshold be respected (e.g., 35–45 dB(a)), as is currently enforced in some countries. Likewise, for cases where high levels of modelled shadow flicker exposure and self-reported annoyance correlate, easy-to-implement solutions exist, such as curtailment after specific exposure thresholds. However, the probability of that correlation occurring is low because detailed shadow flicker simulations are an integral part of planning processes for wind farms and permission might not be granted in case thresholds would be exceeded (see, e.g., the German BImSchg). Nevertheless, the studies leading to that regulation were performed over 20 years ago when turbines were considerably smaller than today and were capable of generating a flickering effect of higher frequency.

Reference 1.2: Wind Farms & Health Literature Review- Chapman 2015: EIAR Appendix 5.1
Summary of main conclusions reached in 25 reviews of the research literature on wind farms and health.
Compiled by Prof Simon Chapman, School of Public Health and Teresa Simonetti, Sydney
University Medical School
simon.chapman@sydney.edu.au
Updated 10 April 2015.

The following Response is from the Australian Parliament in a reference to Health issues from windfarms.

Select Committee on Wind Turbines: Final report. August 2015. ISBN 978-1-76010-260-9

Wind turbines and ill-health

2.7 The committee has taken evidence from a number of people who reside in proximity to wind turbines who have complained of a range of adverse health impacts. These include tinnitus, raised blood pressure, heart palpitations, tachycardia, stress, anxiety, vertigo, dizziness, nausea, blurred vision, fatigue, cognitive dysfunction, headaches, nausea, ear pressure, exacerbated migraine disorders, motion sensitivity, inner ear damage and worst of all, sleep deprivation.

2.8 Dr Sarah Laurie told the committee:

The human cost of the failure to protect people from excessive noise pollution, especially at night, is terrible. I have personally helped to prevent a number of suicides of people who were utterly desperate because of the consequences of excessive noise pollution and who reached out for help.

From my experience there is a subset of people who are terribly impacted very early on. Those people are the ones who tend to present with acute vestibular disorder type of symptoms—dizziness and motion sickness, which can be accompanied by extreme anxiety. Those people often just cannot last very long, and they move if they can.

2.9 Ms Janet Hetherington, an adjacent landholder to the Macarthur wind farm in south-west Victoria, relayed her own experience:

At my farm, I experience severe adverse health effects such as vibration, heart palpitations, tinnitus, head pressure, headaches, sleep deprivation, anxiety, night sweats, nausea, itchy skin, cramps, and ear, nose and throat pain. Twice now I have experienced horrendous pain in my chest stabbing through to my backbone in between my shoulder blades. I contemplated calling an ambulance both times but could not move to do so because of the severity of the pain. Ten minutes later it had dissipated, leaving me with great stress and anxiety and feeling washed out. All these sensations leave me drained in the morning. I find it very hard to start work that day.

2.10 Ms Anne Gardner also attributed her and her husband's ill health to the nearby Macarthur wind farm. She described the following symptoms:

My husband experienced bolts of pressure which tallied up with pressure peaks measured by Les Houston (sic) 86 per cent of the time while my husband was blind to the acoustic measurements of the time. Refer to his recap statement. I suffer day and night from headaches, nose and ear pressure, nausea, heart palpitations and chest burning from vibrations through the floor, couch, chair and in bed all night.⁶

2.11 Mr Clive Gare and his wife host 19 towers from the North Brown Hill wind farm located 17 kilometres from Jamestown in South Australia. Mr Gare told the committee:

After a short period of living with an operating wind farm, we had these products installed. I find that, because I work and reside in close proximity to the wind farm, I suffer sleep interruption, mild headaches, agitation and a general feeling of unease; however, this occurs only when the towers are turning, depending on the wind direction and wind strength. My occupation requires that I work amongst the wind towers during the day which means I suffer the full impacts of noise for days at a time without relief. The impacts are that we are not able to open our windows because of the noise at night and we are not able to entertain outside because of the noise.

In conclusion, if we did not have soundproof batts in VLam Hush windows [special window laminate designed to dampen noise], our house would not be habitable. In my opinion, towers should not be within five kilometres of residences, and I would personally not buy a house within 20 kilometres of a wind farm.

2.12 The committee notes that the Gares have received payment of \$2 million over five years to host turbines and have reported serious adverse impacts. The committee notes, therefore, that their evidence is an 'admission against interest' and as such represents highly reliable evidence.

2.13 Mr John Pollard, a resident of Glenthompson near the Oaklands Hill wind farm in Victoria, told the committee:

The wind farm guidelines on health issues of this very serious problem have to be assessed. They will not acknowledge infrasound. I will relate one incident that happened in our home one night. My wife was sleeping in the chair beside me and I was watching television. This is after they had turned the turbines off. She was dead to the world and I was just watching the television. All of a sudden she woke up, completely startled and disorientated, and I was really worried about her because I thought she had had a stroke or something. Eventually she came to her senses and she said the turbines must be on. I said, 'No, they're not. It's 10.30. They turn off at nine o'clock.' I went outside and they were still running. So I thought that next day I would ring AGL. When I was about to ring, they rang me and said, 'I'm sorry, John. We forgot to turn the turbines off last night.'

2.14 Waubra resident Mr Donald Thomas identified hearing difficulties from the nearby Waubra wind farm turbines.⁹ He claimed that these difficulties disappeared when he left the area:

I went to the doctor with what I kept saying was a lot of ear pressure and earaches. I went to see a specialist, and my ears came back as being in good health and functioning pretty well, even though I have lost a lot of hearing. Basically, my left ear does not work too good... My ears—especially when I go to my Stud Farm Road property, I have ear pressure that can develop into a headache and rapid heartbeat. If I leave that area and go back to one of my other properties, that can settle back down.

2.15 Mr Peter Jelbart, a 25 year old who had lived with his family nearby the Macarthur wind farm in south-west Victoria, noted the difficulty of sleeping in the family home. He told the committee he had worked and slept unaffected in noisy environments outside of the family home in Victoria:

While I was working in Western Australia I used to do three weeks on, one week off and come home for a week. Over in Western Australia I was sleeping at times on the sides of busy highways and in the back of trucks with ice packs running... At home, I noticed pretty much from day one that there is a serious problem there. Something is completely different when sleeping. I would wake up after a couple of hours of sleep—at times, not even after a couple of hours—and have disrupted sleep that I have had nowhere else. There is a proper problem... Whether it is low-frequency noise and the infrasound combining with it, it seems worse when it is quiet. Around our house the yard is pretty well protected by trees. When it is relatively quiet around the house yard there is still a really soft drone that comes through and just gets into you. It is pretty hard to explain. There are probably a lot of people going through the same thing who will have the same trouble trying to explain it, especially to people who have not experienced it. The problem with it is, it also seems to affect different people over different periods of time.¹¹

2.16 The committee has had the opportunity to take evidence from researchers in the United States and Canada who expressed their concern with the health effects of turbines. Ms Lilli-Ann Green is the Chief Executive Officer of a healthcare consulting firm in the United States. In 2012, Ms Green and her husband conducted interviews with people living near wind turbines in 15 different countries. As she told the committee: We have interviewed people on three continents who live more than five miles from the nearest wind turbine and are sick since wind turbine wind turbines need to be sited from people in order to do no harm. People report to us that over time their symptoms become more severe. Many report not experiencing ill effects for some time following wind turbine construction, meanwhile their spouse became ill the day the wind turbines nearby became operational. They speak of thinking they were one of the lucky ones at first, but after a number of months or years they become as ill as their spouse. Not one person who stayed near wind turbines reported to us that they got used to it or got better; they all became more ill over time... I really believe that we just do not have enough information yet. But throughout the interviews, country by country, people described the same symptoms. Many times they used the same phrases to describe them and the same gestures—and they were not speaking English. There is a common thread here.

2.17 Dr Jay Tibbetts, a medical practitioner and vice chair of the Brown County Board of Health in Wisconsin, drew the committee's attention to the board's October 2013 finding that the Shirley wind farm was a 'human health hazard'. Dr Tibbetts described how the declaration came about:

The [Board of Health] has been studying adverse health effects for the past 4 ½ years in the Shirley Wind Project. We have reviewed many peer reviewed studies, at least 50 medical complaints including ear pain, pressure, headache, tinnitus, vertigo, nausea, chest pain, chest pressure, loss of concentration, sleep deprivation and more, as well as more than 80 other complaints from citizens of Shirley Wind. There have been 2 formal studies of infrasound/low frequency noise by acousticians in 2012 and 2014. The latter study revealed symptom generating [Infrasound/Low Frequency Noise] at a distance of 4 ½ [miles].

2.18 The committee also heard of detailed research by Professor Emeritus Robert McMurtry from Western University in Ontario, Canada. Professor McMurtry made a number of points to the committee:

- adverse health effects have been reported globally in the environs of wind turbines for more than 30 years with the old design of turbines and the new;
- the wind energy industry has denied adverse health effects, preferring to call it 'annoyance'. Annoyance is recognised and was treated by the World Health Organization as an adverse health effect, which is a risk factor for serious chronic disease including cardiovascular and cancer;
- the regulations surrounding noise exposure are based upon out-of-date standards ETSU-97, which fail to evaluate infrasound and low-frequency

Professor Chapman and his critics

2.19 Professor Simon Chapman AO, Professor of Public Health at the University of Sydney, has been an outspoken critic of those who suffer ill-effects from wind turbines. In both his written and oral submissions, Professor Chapman cited many of his own publications in support for his view that:

...the phenomenon of people claiming to be adversely affected by exposure to wind turbines is best understood as a communicated disease that exhibits many signs of the classic psychosocial and nocebo phenomenon where negative expectations can translate into symptoms of tension and anxiety.

2.20 Several highly qualified and very experienced professionals have challenged this argument. Dr Malcolm Swinbanks, an acoustical engineer based in the United Kingdom, reasoned:

The argument that adverse health reactions are the result of nocebo effects, ie a directly anticipated adverse reaction, completely fails to consider the many cases where communities have initially welcomed the introduction of wind turbines, believing them to represent a clean, benign form of low-cost energy generation. It is only after the wind-turbines are commissioned, that residents start to experience directly the adverse nature of the health problems that they can induce.

2.21 The committee highlights the fact that Professor Chapman is not a qualified, registered nor experienced medical practitioner, psychiatrist, psychologist, acoustician, audiologist, physicist or engineer. Accordingly:

- he has not medically assessed a single person suffering adverse health impacts from wind turbines;
- his research work has been mainly—and perhaps solely—from an academic perspective without field studies;
- his views have been heavily criticised by several independent medical and acoustic experts in the international community; and
- many of his assertions do not withstand fact check analyses.

2.22 Professor Chapman has made several claims which are contrary to the evidence gathered by this committee. First, he argues that the majority of Australia's wind turbines have never received a single complaint. There are various problems with this statement:

- (i) wind turbines located significant distances from residents will not generate complaints;
- (ii) many residents suffering adverse health effects were not aware of any nexus between their health and the impact of wind turbines in order to make a complaint;
- (iii) just because residents do not lodge a formal complaint does not mean they are not suffering adverse health effects;
- (iv) data obtained by Professor Chapman from wind farm operators of the numbers of complaints lodged cannot be relied upon; and
- (v) the use of non-disclosure clauses and 'good neighbour agreements' legally restricts people from making adverse public statements or complaints.

2.23 Second, Professor Chapman has argued that complaints of adverse health effects from wind turbines tend to be limited to Anglophone nations. However, the committee has received written and oral evidence from several sources directly contradicting this view. The German Medical Assembly recently submitted a motion to the executive board of the German Medical Association calling for the German government to provide the necessary funding to research adverse health effects. This would not have happened in the absence of community concern. Moreover, Dr Bruce Rapley has argued that in terms of the limited number—and concentrated nature—of wind farm complaints:

It is the reporting which is largely at fault. The fact is that people are affected by this, and the numbers are in the thousands. I only have to look at the emails that cross my desk from all over the world. I get bombarded from the UK, Ireland, France, Canada, the United States, Australia, Germany. There are tonnes of these things out there but, because the system does not understand the problem, nor does it have a strategy, many of those complaints go unlisted.

2.24 Third, Professor Chapman has queried that if turbines are said to have acute, immediate effects on some people, why were there no such reports until recent years given that wind turbines have operated in different parts of the world for over 25 years. Several submissions to the committee have stated that adverse health effects from wind turbines do not necessarily have an acute immediate effect and can take time to manifest.

2.25 Fourth, Professor Chapman contests that people report symptoms from even micro-turbines. The committee heard evidence that once people are sensitised to low frequency infrasound, they can be affected by a range of noise sources, including large fans used in underground coal mines, coal fired power stations, gas fired power stations and even small wind turbines. As acoustician Dr Bob Thorne told the committee:

Low-frequency noise from large fans is a well-known and well-published issue, and wind turbines are simply large fans on top of a big pole; no more, no less. They have the same sort of physical characteristics; it is just that they have some fairly unique characteristics as well. But annoyance from low-frequency sound especially is very well known.

2.26 Fifth, Professor Chapman contends that there are apparently only two known examples anywhere in the world of wind turbine hosts complaining about the turbines on their land. However, there have been several Australian wind turbine hosts who have made submissions to this inquiry complaining of adverse health effects.

Paragraphs 2.11–2.12 (above) noted the example of Mr Clive Gare and his wife from Jamestown. Submitters have also directed attention to the international experience.

In Texas in 2014, twenty-three hosts sued two wind farm companies despite the fact that they stood to gain more than \$50 million between them in revenue. The committee also makes the point that contractual non-disclosure clauses and 'good neighbour' agreements have significantly limited hosts from speaking out. This was a prominent theme of many submissions.

2.27 Sixth, Professor Chapman claims that there has been no case series or even single case studies of so-called wind turbine syndrome published in any reputable medical journal. But Professor Chapman does not define 'reputable medical journal' nor does he explain why the category of journals is limited to medical (as distinct, for assertion). However, the committee does note that a decision to publish—or not to publish—an article in a journal is ultimately a business decision of the publisher: it does not necessarily reflect the quality of the article being submitted, nor an acknowledgment of the existence or otherwise of prevailing circumstances. The committee also notes that there exist considerable published and publicly available reports into adverse health effects from wind turbines.

2.28 The committee also notes that a peer reviewed case series crossover study involving 38 people was published in the form of a book by American paediatrician Dr Nina Pierpont, PhD, MD. Dr Pierpont's *Report for Clinicians* and the raw case data was submitted by her to a previous Australian Senate inquiry (2011) to which Dr Pierpont also provided oral testimony. Further, at a workshop conducted by the NHMRC in June 2011, acoustical consultant Dr Geoffrey Leventhall stated that the symptoms of 'wind turbine syndrome' (as identified by Dr Pierpont), and what he and other acousticians refer to as 'noise annoyance', were the same. Dr Leventhall has also acknowledged Dr Pierpont's peer reviewed work in identifying susceptibility or risk factors for developing wind turbine syndrome / 'noise annoyance'. Whilst Dr Leventhall is critical of some aspects of Dr Pierpont's research, he does state:

Pierpont has made one genuine contribution to the science of environmental noise, by showing that a proportion of those affected have underlying medical conditions, which act to increase their susceptibility.³⁰

2.29 Seventh, Professor Chapman claims that no medical practitioner has come forward with a submission to any committee in Australia about having diagnosed disease caused by a wind farm. Again, Professor Chapman fails to define 'disease'.

Nonetheless, both this committee, and inquiries undertaken by two Senate Standing Committees, have received oral and written evidence from medical practitioners contrary to Professor Chapman's claim.

2.30 Eighth, Professor Chapman claims that there is not a single example of an accredited acoustics, medical or environmental association which has given any credence to direct harmful effects of wind turbines. The committee notes that the semantic distinction between 'direct' and 'indirect' effects is not helpful. Dr Leventhall and the NHMRC describe stress, anxiety and sleep deprivation as 'indirect' effects, but these ailments nonetheless affect residents' health.

2.31 Finally, Professor Chapman queries why there has never been a complainant that has succeeded in a common-law suit for negligence against a wind farm operator.

This statement is simply incorrect. The committee is aware of court judgements against wind farm operators, operators making out of court settlements or withdrawing from proceedings, injunctions or shutdown orders being granted against operators, and properties adjacent to wind turbines being purchased by operators to avoid future conflict. The committee also reiterates its earlier point that contractual non-disclosure clauses have discouraged legal action by victims.

Reference 1.3: Balancing nature and economic interests in the European Union: On the concept of mitigation under the Habitats Directive. Lorenzo Squintani. c 2019 The Author. *Review of European, Comparative & International Environmental Law* Published by John Wiley & Sons Ltd. wileyonlinelibrary.com/journal/reel. DOI: 10.1111/reel.12292

“THE FOUR CRITERIA TO ESTABLISH A MITIGATION MEASURE”

3.1 | Mitigation measures in context

Article 6 of the Habitats Directive gives teeth to the Directive by establishing proactive, preventive and procedural requirements for the conservation of Natura 2000 sites. This provision refers to three kinds of measures: conservation, preventive and compensatory measures. It does not refer to mitigation measures. Before discussing what the latter measures are, it is important to briefly explain what the former three measures are, in order to distinguish between them.

Conservation measures are covered by Article 6(1) of the Directive. These measures focus on positive and proactive interventions to maintain and improve the status of conservation of a Natura 2000 site. Any measure leading to deterioration therefore falls outside the realm of this concept.

Preventive measures are envisaged under Article 6(2) of the Directive and aim at avoiding deterioration, similarly to conservation measures. Yet these kind of measures do not need to take the form of positive action, as in the context of Article 6(1). Non-action is also a form of preventive measure, if it prevents damage from occurring. What matters under this provision is avoiding disturbance that is likely to affect the objectives of the Directive significantly, particularly its conservation objectives in relation to Natura 2000 sites.

Compensation measures are mentioned in Article 6(4) of the Directive, which establishes an exception to the obligation contained in Article 6(3). Together, Articles 6(3) and 6(4) describe a two-step – or, in case the derogation clause is used, a three-step – procedure for granting development consent to plans or projects likely to have a significant effect on a Natura 2000 site, based on a ‘first come, first serve’ approach. The concepts of ‘plan’ (such as land-use plans, sectoral plans, etc.) and ‘projects’ (such as construction works or other interventions in the natural environment) have to be interpreted broadly, and include also developments outside a Natura 2000 site, which are likely to have a significant effect on it (the so-called ‘external effect’). In light of the precautionary principle, the assessment of the effects of plans of projects inside or outside Natura 2000 sites – either individually or in combination with other plans or projects (so-called cumulative impacts) – is based on the likelihood of effects, not on their certainty. If the screening phase indicates the presence of a potentially significant negative effect, an appropriate assessment needs to be performed, in light of the site’s ecological functions and conservation objectives. A negative outcome should lead to the refusal of authorization.

Yet, Article 6(4) of the Directive specifies that if, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, a Member State must take all compensatory measures necessary to ensure that the overall coherence of a Natura 2000 site is guaranteed. All the constitutive elements of this derogation clause have to be interpreted restrictively, for balancing environmental protection and economic development. In particular, the concept of compensation measures entails, typically, the designation of like-for-like replacement habitat. In the view of the European Commission, what matters is that the function performed by the affected site is successfully recreated elsewhere.

Adequate implementation and enforcement of Article 6 of the Directive strengthens nature conservation. Yet the complex relationship between Articles 6(3) and 6(4) has led to uncertainty as to what ‘adequately implemented and enforced’ means, and where ‘gold-plating’ starts. In particular, in certain Member States questions have arisen on the

extent to which measures adopted to avoid damage can be taken into account in concluding that no significant adverse effect will occur.

It is here that the concept of mitigation measures enters into the legal discussion under Article 6 of the Directive, creating much uncertainty, and potential abuses.

Thanks to the judgments in the *Waddenzee*, *Sweetman*, *Briels* and *Orleans* cases, it can confidently be established that **mitigation measures are allowed under the Habitats Directive only if four cumulative requirements are met:**

- (i) the measure aims at preventing the damage caused by a specific plan/project (functional linkage criterion);
- (ii) the measure must ensure that this damage (specificity criterion);
- (iii) will be prevented (prevention criterion); and
- (iv) that there is no doubt about this preventive effect (no-doubts criterion).

In *Sweetman*, the Court clarified that the specificity criterion refers to each individual conservation objective, justifying the designation of that site in the list of Sites of Community Importance (SCIs) in accordance with the Directive. Similarly, from *Briels* it is clear that, under the prevention criterion, measures provided to replace a damaged area with another cannot be taken into account in the assessment of the implications of a project provided for in Article 6(3). In the judgment under review, the Court confirmed both criteria by stating: the case-law relating to Article 6 of the Habitats Directive requires a distinction to be drawn between protective measures forming part of the plan or project at issue and intended to avoid or reduce any direct adverse effects caused by it, in order to ensure that that plan or project does not adversely affect the integrity of the sites concerned, which are covered by Article 6(3), and measures which, in accordance with Article 6(4), are aimed at compensating for the negative effects of the plan or project on that site and cannot be taken into account in the assessment of the implications of that plan or project on that site ...

Moreover, according to the Court's case-law, it is only when it is sufficiently certain that a measure will make an effective contribution to avoiding harm to the integrity of the site concerned, by guaranteeing beyond all reasonable doubt that the plan or project at issue will not adversely affect the integrity of that site, that such a measure may be taken into consideration in the 'appropriate assessment' within the meaning of Article 6(3) of the Habitats Directive

The use of the adverb 'likely' in Article 6(3) of the Directive was clearly linked to the precautionary principle by the Court of Justice already in the *Waddenzee* case. Since then, the requirement that there should be no scientific doubt about the ability to prevent the specific damage of a specific project has gained clarity. The Court of Justice made clear that there are two ways of complying with this criterion.

First, a proposed measure can qualify as a mitigation measure under Article 6(3) of the Directive if, at the moment of the authorization of the plan or project, 'the procedures needed to accomplish the alleged mitigation measures have already been carried out'. Clearly, the implementation of a mitigation measure makes it easier to analyse whether the significant negative effects of a plan or project have been avoided or not.

The concept of 'project' must be interpreted broadly. The PAS (Dutch Programma Aanpak Stikstof 2015–2021, PAS) judgment clarifies that this concept is probably even broader than originally thought. Indeed, not only the Court of Justice defines this concept without linking it to that used in the EIA Directive, that is, by covering activities not covered by the EIA Directive. Most importantly, the Court defines it by linking its meaning to the effects of the activities on the protected site. Indeed, the Court states that it is important to examine whether such activities are likely to have a significant effect on a protected site. This is an effects-based test, which is capable of covering any kind of activity, even the spreading of fertilizers.

In the context of the establishment of mitigation measures, following *Briels*, it remained unclear whether mitigation measures have to be 'functionally' linked to a project development, that is, whether the proposed measures are part of the scrutinized project or of a mitigation scheme or restoration programme that does not take into account the specific project under scrutiny. Following *Orleans*, the present judgment confirms that a proposed mitigation measure must aim at avoiding the damage caused by the plan or project under scrutiny specifically. Management plans and generic restoration measures taken under Articles 6(1) and 6(2) of the Habitats Directive can be taken into account under the

concept of mitigation measures when scrutinizing a specific project only if they specifically address the negative effects of that project.

What matters is that there is no reasonable scientific doubt as to the absence of adverse effects of each plan or project on the integrity of the site concerned. Therefore, there is no de-linking effect, meaning that the conservation goals of the Directive can be used to review the appropriateness of the assessment of a specific plan, differently than in other fields of EU environmental law, such as under the Nitrates Directive

The approach to the no-doubts criterion is a very stringent one. It stems from the Orleans case, in which the Court of Justice ruled that only those measures which are completed at the moment of the appropriate assessment can be taken into account as mitigation measures. Orleans concerned the development of a large part of the port of Antwerp (Belgium), affecting a Natura 2000 site. The Court found that the Belgian Regional Development Implementation Plan allowing the project only did so after the sustainable establishment of habitats and habitats of species in core ecological areas. Second, the Court ruled that a decision would have to declare that habitats in the nature reserves had in fact been sustainably created, and the application for a planning permit relating to implementing the intended use of the area concerned would also have had to include that decision. Accordingly, the negative effects would have taken place only after that certainty regarding the effectiveness of the positive effects had been proven.

Yet, the Court ruled that such certainty would have been acquired only after the plan had been adopted, and thus that the proposed measures could not qualify as mitigation measures under Article 6(3) of the Directive.

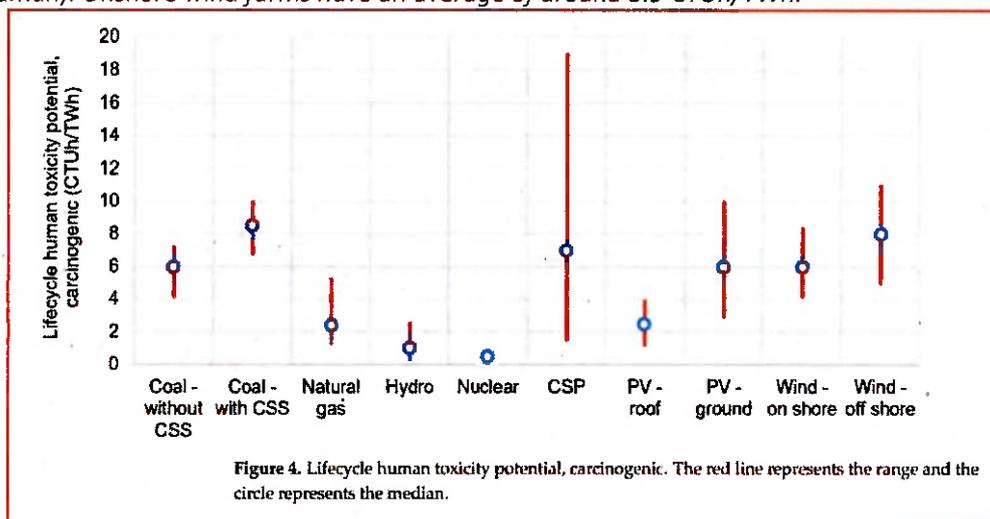
The second way in which a measure could qualify as a mitigation measure under Article 6(3) of the Directive is when there is no scientific doubt about the effectiveness of the proposed measure.

This means that, even when a measure has not been carried out yet, it is still possible to speak of a mitigation measure. What matters is that there is scientific certainty about the effectiveness of such a measure, thus avoiding the significant damage that would otherwise occur. This criterion is clearly less demanding than the previous one. Still, the question is when scientific certainty exists about the effectiveness of a measure. This criterion could therefore be more difficult to fulfil in practice than it seems. It is still unclear what burden of proof the Court would consider to be sufficient under this approach. In the present judgment, the Court left this matter to the national court to decide, in an exercise of judicial subsidiarity. Yet, it cannot be discounted that the Court of Justice will formulate some guidance in future case law if called upon to clarify this issue

Reference No: 1.4: Environmental Impact of Wind Farms. Bošnjaković, M.; Hrkač, F.; Stoić, M.; Hradovi, I. *Environments* 2024, 11, 257. <https://doi.org/10.3390/environments11110257>

Toxicity

The toxicity of substances to humans can be expressed in different ways and is often expressed in CTUh (Comparative toxic unit for human). Onshore wind farms have an average of around 3.9 CTUh/TWh.



Danger of Ice Flying off the Blades

Ice build-up on the rotor blades of wind turbines can pose a serious threat to people and objects in the immediate vicinity. It is, therefore, important to assess the dangers associated with ice shards falling and flying from the rotor blades. Icing can also lead to the failure of wind turbines because the structural integrity is impaired. The hazard posed by ice depends on the severity of the icing, the type of icing, the wind, the rotor speed and other environmental conditions. **A piece of ice with a weight of 0.2 kg and a density of 500 kg/m³ falling from a height of 30 to 50 m is considered fatal if the impact has a kinetic energy of more than 40 J.**

Danger of Blade Parts Flying Off

A "blade failure" can have a number of causes and can result in either whole blades or parts of blades being thrown from the turbine. **A total of 537 separate incidents have been recorded. It has been documented that parts of the blades have travelled up to 1.6 km.** In Germany, parts of the blade penetrated the roofs and walls of nearby buildings. For this reason, a law was passed in Germany (Bavaria) in 2016 requiring a minimum of two kilometers to be kept between dwellings or workplaces and wind turbines, and Ireland is considering a similar measure.

Impact on Radio Waves and Air Traffic

Offshore wind turbines can interfere with radar systems on board ships and on land as well as radars used to monitor air traffic. Wind farms located near weather radars can cause false echoes that can be misinterpreted as weather phenomena such as precipitation or thunderstorms. The reason for the interference lies in the structure of the turbines, the height of the turbines and the displacement of the rotors, which can reflect radar signals. In addition, telecommunication and data transmission signals can be weakened when wind turbines are in the line of sight (LOS) for radio communications. In general, two types of effects of wind farms on radar systems can occur:

- Formation of radar shadows behind wind turbines, which can result in lower targets being poorly recognised or not recognised at all. The relatively high frequencies used by the radar are attenuated when the signal passes through the wind farm, i.e., they shorten the range of the radar.
- Reflection of the radar beams from the wind turbines can lead to false radar targets (false echoes).

Radar systems work by recognising weak reflections that are often in motion. In addition, the rotor blades of wind turbines produce false reflections in the direction of the receivers, causing the radar to misinterpret the signals. While the wind farm industry is growing rapidly, they are causing serious interference problems in critical civil and military radio systems, degrading radar detection range and increasing the complexity of air surveillance and navigation missions.

Habitat Destruction

Based on 84 studies of onshore wind farms in 22 countries, (Tolvanen et al). presented data on the average distance of habitat displacement from the edge of wind farms. The predominant height of wind towers in the studies was 50–99 m.

For birds, bats and mammals, habitat displacement accounted for 63%, 72% and 67% of cases, respectively. Cranes, owls and semi-wild reindeer showed consistent habitat displacements of up to 5 km on average. Gallinaceous birds showed movements of up to 5 km on average, but "no movement" was reported in 40 cases. Bats were displaced by an average of up to 1 km in most cases. Waders, birds of prey, sparrows and black-winged stilts moved their habitats by up to 500 m on average.

Furthermore, human-caused forest landscape fragmentation may lead to a rise in the number of predators (Pasanen-Mortensen and Elmhagen, 2015). For instance, infrastructure like buildings and maintenance roads could attract fox activity (Hradsky et al. 2017), so the risk of predation may be higher near wind farms. Grouse are known to be sensitive to human disturbance (Coppes et al 2017). Many grouse species are site-loyal and therefore highly vulnerable if their habitat overlaps with areas that are suitable for wind turbine installation, particularly in the absence of another suitable habitat (Braunisch et al. 2015).

Collision with a Wind Farm

For some bat species, the installation of wind turbines creates new habitats because there are more insects to feed on in the vicinity of the wind turbines. **Direct causes of bat death at wind turbines are well recognised and include barotrauma (Rollins et al. 2012) and collisions with rotating blades (Horn et al. 2008) or a combination of both.**

The potential threats of wind farms to birds are well documented in the literature, for example. Research suggests that mortality rates (although they may be relatively high in certain areas) are highly variable and depend on a number of factors such as the bird species, the size and the location of the wind farm and others. (Barclay et al. 2007) reported a mortality rate of 0.00–9.33 birds per year per turbine and a mortality rate of 0.00–42.7 for bats. The selective shutdown of wind farms along the bird migration route using radar is very effective in reducing collision rates (Tomé et al 2017).

Noise Onshore Wind Farm

Noise pollution has a negative impact on wildlife as it disrupts mechanisms that are crucial for their survival. According to studies, noise can result in the following:

- Result in physiological trouble, such as genuine hearing loss or persistently elevated stress hormone levels.
- Be viewed as a direct danger, which would lead to an increase in predatory behaviour at the expense of foraging or the departure of the afflicted region, which would result in the loss of habitat.
- Distract attention during foraging and reduce foraging efficiency.
- Interfere with animal communication by reducing the distance from which the signal can be perceived and lowering the quantity of information that can be taken out of the signal, such as the sound of a predator or approaching potential prey.
- Influence the reproductive process. Taubmann et al. reported that noise disturbs grouse up to a distance of 865m. Increasing turbine noise, turbine visibility, and turbine shadow during the breeding season reduced the likelihood of selecting a breeding site.

The roles that these processes play in determining the effects of noise pollution on different species are not mutually exclusive. Different species respond differently to noise as they have different sensitivities to noise. In general, noise pollution alters animal communities. The effects of noise can contribute to the reduction in biodiversity and also threaten the sustainability of local ecosystems.

The Effects of Vibrations from Wind Turbines on the Ecological System

The impact of vibrations is one of the aspects to be considered when analysing the impact of wind turbines on the environment. Vibrations are mechanical oscillations that can be caused by the operation of the wind farm and its components. In this chapter, the effects of vibrations on the environment are analysed, taking into account the possible consequences for living beings, structures and the surrounding space.

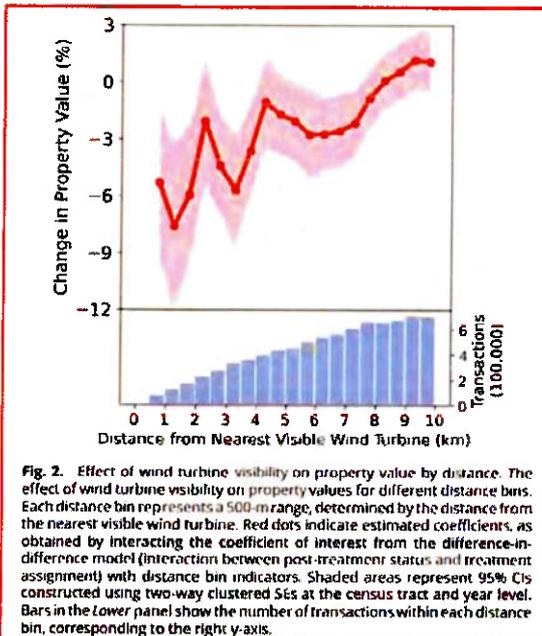
The source of vibrations in wind farms is the rotating parts of the turbines, such as rotor blades and generators. The rotation of these parts generates periodic vibrations that are transmitted to the ground via the foundations of the wind farm. These vibrations can have a negative impact on the animals in the surrounding area, especially on their sensitive acoustic perception. A study by Estefania Velilla and colleagues from 2021 shows how vibrations from wind farms affect the abundance of earthworms in the soil. The relative intensity of vibrations in the soil was measured and the results showed a decrease in the number of earthworms near the wind turbines, which is considered a negative impact on soil organisms. A decrease in earthworms was found in a radius of about 200 m around the wind turbines, where the noise level decreased by an average of 23 ± 7 dB. Earthworms are considered important engineers of the ecosystem, and interference with their abundance, survival and reproduction can indirectly affect important processes such as water filtration, nutrient cycling and carbon sequestration. In addition, the vibrational noise generated by the wind turbine can mask the vibrational signs of approaching moles, making earthworms in noisy areas more vulnerable to predation (Dominoni et al. 2020).

Wind farms generate noise that can have harmful effects on humans and animals, especially in the vicinity of the wind farm. Problems noted in humans include insomnia, headaches and the like. For animals, there is a wide range of potential impacts: from possible hearing damage to interference in foraging, predator marking, habitat abandonment and more. The moving rotor blades of the wind farm can pose a risk of collision and death for birds and bats.

Reference 1.5: The visual effect of wind turbines on property values is small and diminishing in space and time. Wei Guoa, Leonie Wenzc, and Maximilian Auffhammer. Edited by Geoffrey Heal, Columbia University, New York, NY; received June 3, 2023; accepted January 10, 2024. 121 (13) e2309372121. <https://doi.org/10.1073/pnas.2309372121>

Results Property Value Impacts.

We find that having at least one wind turbine in a home's viewshed (10 km radius) reduces the sales price of such a property on average by 1.12%.



The impact of visual disamenity created by wind turbines may also vary depending on the distance from the nearest visible turbine. To test how the effect varies by distance, we re-run the baseline specification with the indicators of interest interacted with 500-m (\approx 0.3-mile) distance bin indicators for the proximity of the closest wind turbine. The effect of wind turbine visibility decreases as distance increases (Fig. 2). **The effect is largest in immediate proximity of wind turbines—with the visual disamenity reducing property values by up to 8% within a neighborhood range of 1.5 km (\approx 0.9 miles).** Even though this number is economically large, there are two noteworthy caveats. First, the CI is sizable including reductions in property value between 3 and 13%. Second, the number of properties within this distance bin is small. Nationally, there are fewer than 250,000 transactions within 1.5 km of the nearest wind turbine, as opposed to approximately 8.5 million transactions within 10 km.

Moreover, we find that properties within 10 km from wind turbines are 1.16 to 1.7% lower in sales price than those 10 to 50 km away. These gaps are not driven by differences in the housing characteristics of properties located in different communities. Therefore, the cross-sectional difference in property value between visible and non-visible areas as well as between proximate and distant areas indicates a potential selection effect that is consistent with the siting of wind turbines in places with lower property values.

We investigate whether the visual impact of wind turbines varies with the intensity of visibility using two measures: The number of wind turbines in view and the intensity classified by whether there are more than 20 turbines in sight. We find that the capitalization of the visual disamenity increases with the treatment intensity, with every additional 10 wind turbines in view reducing the property value by an additional 0.2% [Table 1, column (2)]. Furthermore, wind farms with more than 20 turbines reduce the property value in visible areas by an average of 2.48%, whereas those with less than 20 turbines have a reduction effect of only 1.02% on visible areas [Table 1, column (3)]. These findings suggest that the density of wind turbines in view plays a role in driving the magnitude of the visual disamenity valuation.

The findings indicate that wind turbines have a negative effect on property value in locations where they are visible. On average, across the whole sample, house prices decrease by up to 8% after the construction of a wind turbine within viewshed and close neighborhood range from the property, with the effect decaying as the distance increases. The average effect falls to a 1% reduction for houses within 10 km of visible wind turbines. It also diminishes over

time—both in terms of more recent installations having a smaller disamenity effect and in the sense that the reduction in value a property experiences peaks 3 y after the installation and then becomes smaller the more years pass. These findings are consistent with a cognitive model where people get used to new structures in their environment over time.

The reduction in property values resulting from wind turbine installations raises questions about how this might affect siting decisions for future wind farms. This paper highlights the externality of wind power developments as they are capitalized in the housing markets. These estimates could also serve as a future basis for calculating compensation to local homeowners for placing a new wind turbine within their viewshed.”

U.S. Energy Information Administration, 1000 Independence Ave., SW, Washington, DC 20585

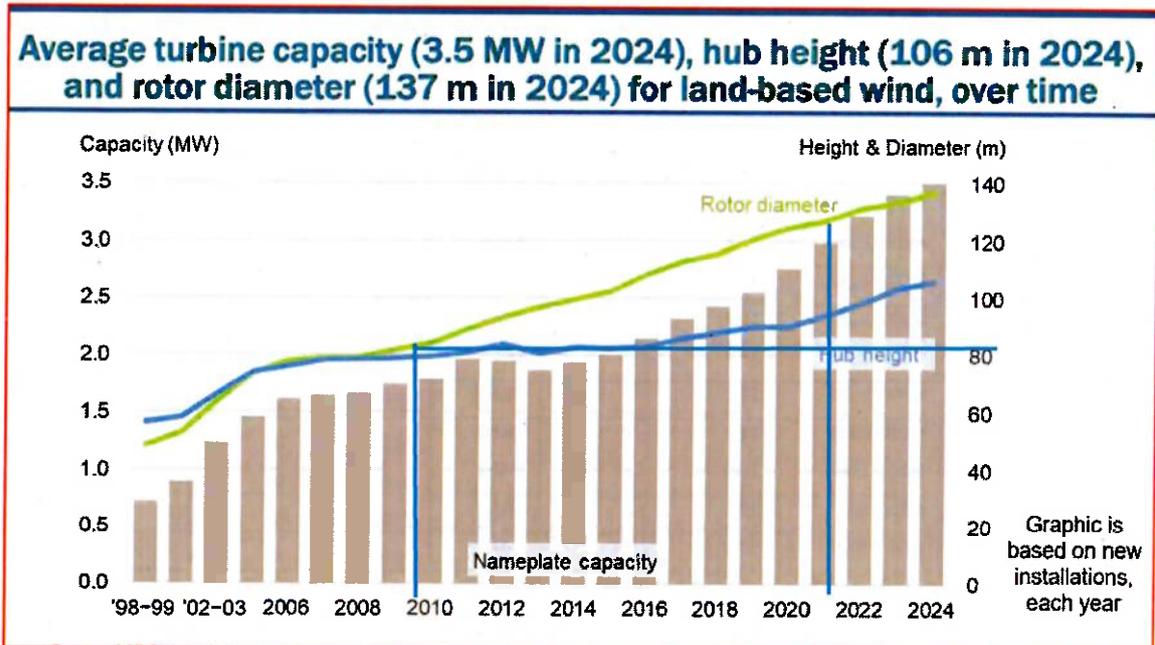
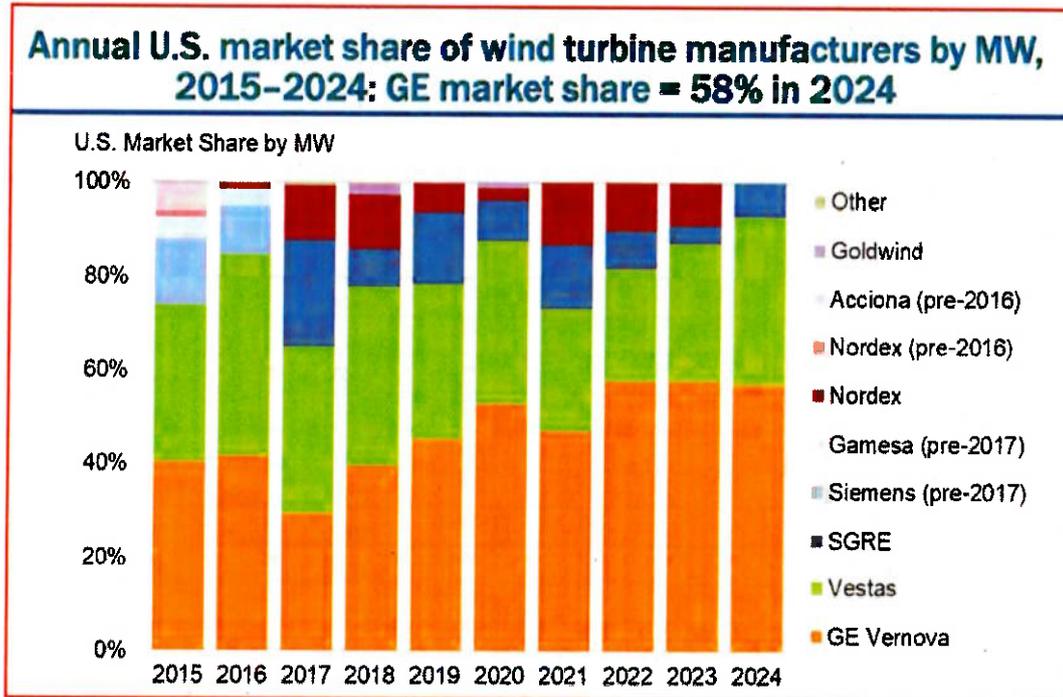
2024 Form EIA-860 Data- Schedule 3, 'Wind Technology Data' (Operable Units Only)

Predominant Turbine Manufacturer	No of Turbines	Predominant Turbine Model Number	Design Wind Speed (mph)	Wind Quality Class	Turbine Hub Height (Feet)	Operating Year	State	Summer Capacity (MW)	Winter Capacity (MW)	Operating Month
Nordex	63	N149/4.0-4.5	12.0	3	354.3	2021	Tx	351.8	351.8	2
Nordex	74	N149/4.0-4.5	16.7	3	354.3	2024	Tx	350.2	350.2	8
Nordex	79	N149/4.0-4.5	18.6	2	489.0	2022	Tx	302.4	302.4	1
Nordex	38	N149/4.0-4.5	27.0	2	344.0	2021	Tx	298.8	298.8	1
Nordex	38	N149/4.0-4.5	21.5	2	351.0	2021	Tx	297.6	297.6	12
Nordex	62	N155/4.5	19.0	2	345.0	2024	Tx	200.0	200.0	12
Nordex	32	N149/4.0-4.5	17.5	2	324.0	2023	Tx	196.8	196.8	10
Nordex	42	N155/4800	17.4	2	354.0	2003	Tx	182.4	182.4	7
Nordex	71	N149/4.0-4.5	12.3	2	354.3	2021	Tx	182.4	182.4	12
Nordex	30	N149/4.0-4.5	20.6	2	351.0	2021	Tx	153.6	153.6	5
Nordex	12	N117/3000	16.6	2	305.1	2021	Tx	124.0	124.0	7
Nordex	20	N100/2500	17.9	2	263.0	2015	Tx	107.5	107.5	12
Nordex	17	N117/2400	13.5	3	298.6	2012	Tx	81.6	81.6	12
Nordex	16	N100/2500	19.0	2	328.1	2012	Tx	75.0	75.0	3
Nordex	15	N90/2500	15.0	1	262.4	2009	Tx	62.5	62.5	8
Nordex	41	N117/2400	13.7	3	299.0	2014	Tx	50.4	50.4	12
Nordex	37	N100/2500	19.0	2	328.0	2012	Tx	50.0	50.0	8
Nordex	21	N117/3000	17.9	2	298.6	2018	Tx	48	48.0	10
Nordex	34	N100/2500	19.0	2	328.0	2011	Tx	40.8	40.8	12
Nordex	16	N90/2500	19.0	2	262.0	2011	Tx	40.0	40.0	12
Nordex	8	N100/2500	17.3	2	328.0	2014	Tx	40.0	40.0	8
Nordex	43	N100/2500	19.0	2	328.0	2012	Tx	34.0	34.0	10
Nordex	25	N100/2500	19.0	2	262.4	2012	Tx	30.0	30.0	11
Nordex	12	N100/2500	17.7	2	328.1	2015	Tx	30.0	30.0	12
Nordex	16	N100/2500	17.2	2	262.0	2011	Tx	22.5	22.5	12
Nordex	9	N100/2500	17.2	2	262.0	2011	Tx	22.5	22.5	12
Nordex	9	N100/2500	16.5	2	272.0	2010	Tx	20.0	20.0	11
Nordex	4	N90/2500	19.0	2	262.0	2011	Tx	10.0	10.0	8
Nordex	1	N54/1000	19.0	2	229.0	2012	Tx	1.0	1.0	10

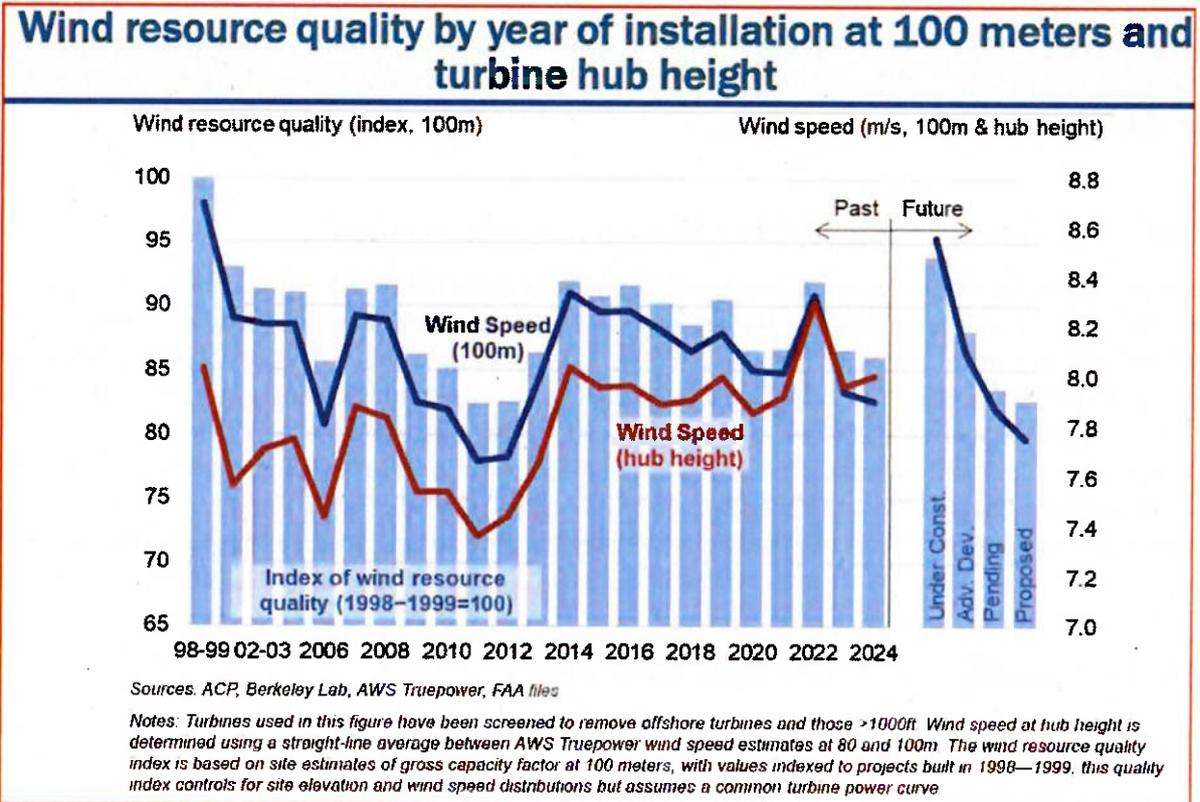
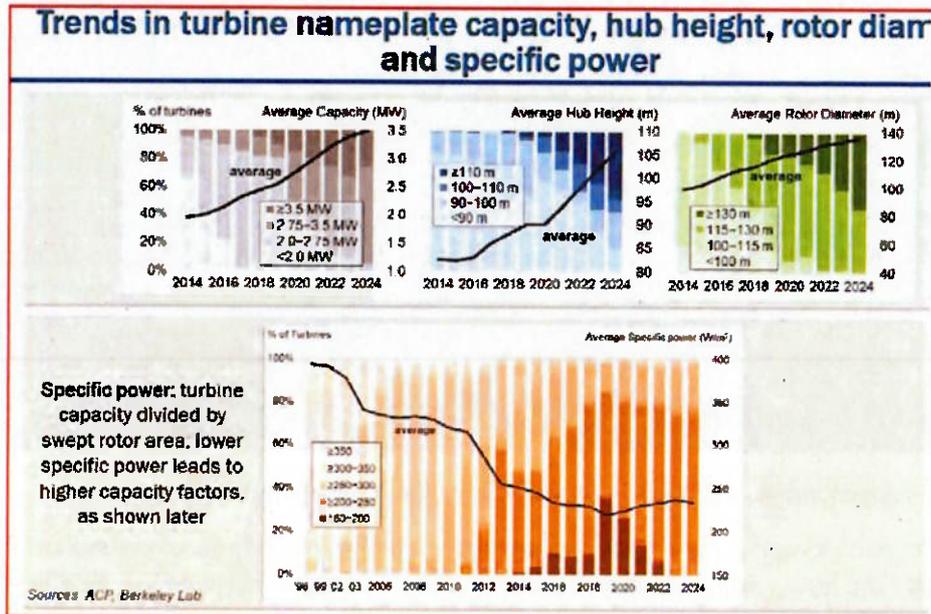
Note the operating months above & not consistent power. The following numbers indicate that the windfarms in the USA are mainly in the unpopulated west. Using data from these States is not referable to Ireland.

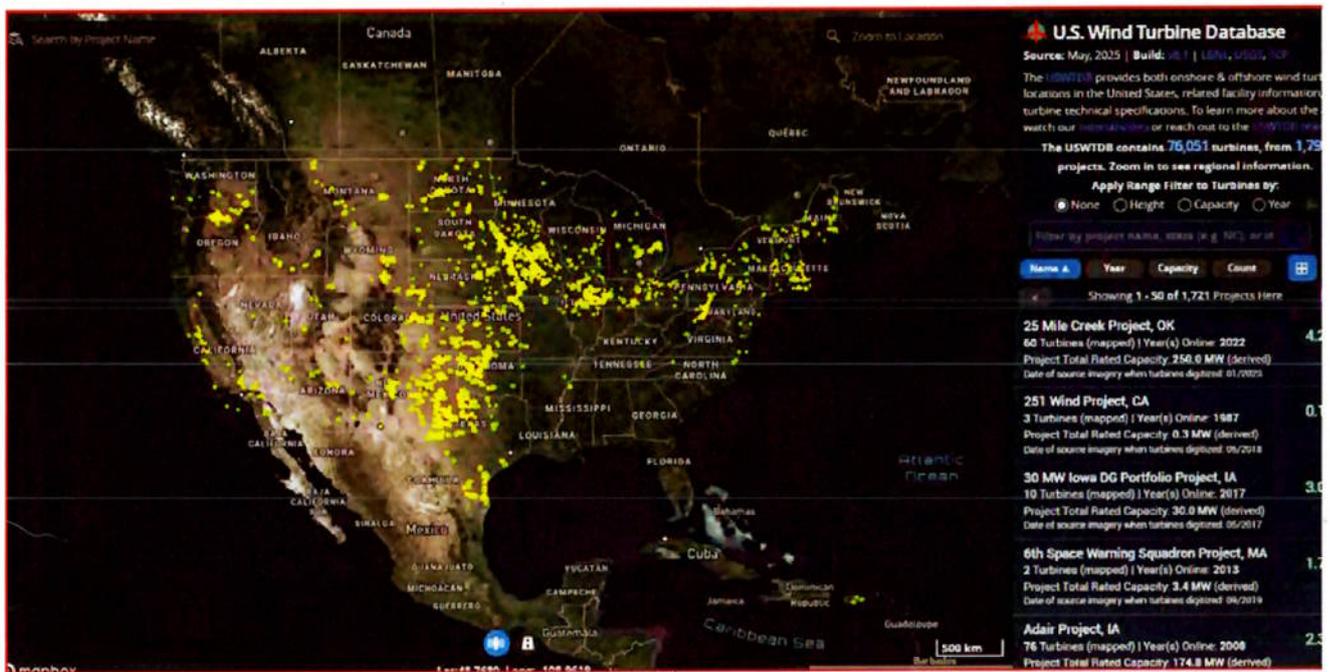
Reference Number 1.6: Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States, Eric J. Brunner, Ben Hoen, Joe Rand, David Schwegman. *Energy Policy Volume 185*, February 2024, 113837. <https://doi.org/10.1016/j.enpol.2023.113837>

We examine the impact of proximity to land-based commercial [wind turbines](#) on residential home values in the United States using data on the universe of commercial [wind turbines](#) and residential property transactions from 2005 to 2020. Using [event study](#) and difference-in-differences identification strategies we find that, on average, homes located within 1 mile of a commercial wind turbine experience approximately an 11% decline in value following the announcement of a new commercial [wind energy](#) project, relative to counterfactual homes located 3 to 5 miles away.



Note wind turbines in 2010 had a Capacity of 2Mw, Hub height of 80m & Rotor diameter of 85m. The height to the tip of the wind turbine would have been $80+42.5=122.5\text{m}$. The present application is for a 7.2Mw capacity with a tip height of 185m. These are not comparable. The 2016 scenario for Scotland is similar. Comparing property prices from 2016 is irrelevant to present day sizes.





Note future wind speed between 7.0 & 8.6m/s with c8m/s for pending applications.

Response: Attymon is a low noise rural location that is affected from recently erected windfarms surrounding the present proposal. As a result of the effect of these windfarms on baseline noise, this application tries to justify higher noise emissions.

The use of Windpro Software Model programming or similar & the failure to provide the background data used invalidates this application. The neighbouring residents have to be informed of the underlying assumptions used in the design.

Reference 1.7: Windpro Manual: 8a.1.1 Offshore Vs Onshore optimization Manual

The New Optimizer in windPRO covers both onshore and offshore optimization. For offshore layouts the geometry is not fixed, for this functionality the user is referred to as the Classical windPRO optimizer. The key differences between onshore and offshore optimizations lie in the setup of the wake decay constant for the annual energy production (AEP) calculation and in the model for calculating the cost of building the wind farm (if costs are included in the objective). Hence, for pure optimizations of AEP there is no difference in the way that the Optimizer operates. However, the performance will of course be guided by the user-provided information such as WTG area and resource, which typically have distinct characteristics offshore and will be reflected in the resulting optimization solutions. A feature that is particularly useful for offshore applications is the integration of cost surfaces. This feature allows to better integrate costs that change over space into the cost analysis. Further details of onshore and offshore cost models are given in section 8a.4.2.

8a.1.2 The GUI tree-structure and its levels: Site>WTG>Size>Run

A flexible graphical user interface (GUI) has been developed for the New Optimizer to accommodate several different scenarios of use (see section 8a.2 for a description of the scenarios). This flexible GUI is represented by a tree located on the left side of the Optimizer window. The tree will be gradually built-up by the user with the required input information and with the different optimization scenarios run by the user. A lot of information needs to be defined and setup prior to running the optimizations. This setup of pre-defined data and pre-calculated information is a prerequisite for gaining sufficiently fast, yet accurate, optimization results. Building the tree, setting up and preparing the optimization, different information and decisions must be defined and entered.

8a.1.2.1 Site

The Site level is the fundamental level of the optimization, but there can be multiple Sites in the tree to allow studying the effect of different basic assumptions. In the Site, the following information and settings must be defined:

Site Climate/Resources- here the pre-calculated wind resource across the site must be defined by selecting an 'rsf' or 'siteres' file. Ideally, the resource has a grid resolution of 0.5 times the turbine rotor diameter or less as this leads to a good balance between resolution and performance.

Objective – this is the choice of what the user wants to optimize: AEP (annual energy production), LCOE (cost of electricity) or NPV (profit of project). These are described in detail in section 8a.4. For each choice of objective several associated decisions are required. For instance, Wake Decay constant in the PARK calculation (all objectives), setting up a Cost Model (LCOE and NPV) including cost map configurations, or setting the expectation for the future average Electricity Price.

Constraints- The particular requirements for the site must be defined and ALWAYS requires definition of a WTG Area. This defines the limits of the site area or sub-areas where turbine placement is allowed, any requirements for minimum and maximum turbine numbers or capacity in each sub-area. It also defines exclusion zones and set-back buffers as well as minimal spacing requirements for turbines in each sub-area. Logically, the WTG area must be fully covered by the defined site climate/resource data, which is checked with maximum accuracy upon clicking Coverage Check, which also allows a visual inspection on a map. In addition to this the spacing or interturbine Distance defined in the WTG area may be activated or deactivated. Finally, constraints on turbine component Lifetime, turbine noise at noise sensitive areas, and Wake constraints for new and existing WTGs may be activated (see section 8a.5 for further details).

Connection points – Objectives which require cost calculation (LCOE and NPV) may include known connection points for external grid and road connection. These points must be pre-defined as Control points and selected here.

Existing WTGs – If there are known turbines in the area from other projects which will create wakes on this project they must be defined as existing WTGs and selected here. Their wake effect on the new turbines will be included and the additional wake that they might experience can be considered.

Noise sensitive areas – If noise constraint is activated one or more noise sensitive area (NSA) points must be selected here.

8a.1.2.2 WTG

At the WTG level the required data must be defined for the objective and constraints selected on the Site level. All new turbines in optimizations in this branch of the tree will use the selected turbine and data.

WTG & Mode- Any optimization requires the selection of a turbine model from windPRO's WTG catalogue, a Hub height, and a Turbine Configuration for that turbine model. For traditional power curve data the appropriate power curve is selected, which is the basis for the AEP and wake loss calculations. From windPRO 4.2 onward, the Turbine Configuration can be selected instead that contains the available operation modes with the pairings of power curves with noise curves and load response files. One mode must be selected for the optimization from the list of available modes. It remains an option to use the Power Matrix format, too.

The noise and the load data from the Turbine Configuration or the Power Matrix are used for constraint validations if the site is set up to account for those constraints.

Lifetime/Loads – If lifetime constraint is activated the turbine Design Standard and Design Class must be defined as well as the Load Response Model for use in the calculation of loads and lifetime.

Noise Data – When noise constraint has been activated, the noise data must be selected from the Noise curves provided in the WTG catalogue. When a Turbine Configuration or a Power Matrix is selected, the noise data is retrieved from those via the selected mode.

Use individual WTG cost model- When multiple WTG types are defined for the same Site, it might be relevant to define different cost models for each WTG type individually. In that case this option must be activated and the cost model for the current WTG type defined here. This will override the cost model selected on the Site level

Introduction 5 Figure 6:

8a.1.2.3 Size (and 'Add Sizes & Runs' button)

The Size level has no setting up on the window to the right. Instead, it is created in a single step together with at least one Run at its sub-level (child). This is done via the Add Sizes & Runs button (see green highlight in Figure 6).

Once the Sizes and Runs have been created this window shows an overview of all the runs for this size. In this regard a run is simply an optimization for the park size in question and subject to optimization settings.

The benefit from adding Sizes & Runs in a single step is mainly efficiency, so that more park sizes can be created at once with identical optimization settings without further effort.

Define Park size(s)- Here the user can define the park sizes of interest. Note that ALL sizes from minimum through to maximum will be created once the button Create & queue runs is pressed after which a separate optimization will be run for each size. It is therefore recommended to limit the range of sizes such that it results in a reasonable number of optimizations. The table above the size selection summarizes the requirements for minimum and maximum turbine numbers in the WTG area. Limits on capacity are automatically converted to turbine numbers given the selected WTG. Alternatives, to defining a range of sizes are either to define a User layout where the user must select the initial positions for the optimization or Fill max which will seek to fill the maximum number of turbine units (see section 8a.3 for further details).

Run setup for each Size -- This setup defines the optimization strategy for each created optimization run. Default is Smart with the alternatives Random and Custom. The latter unlocks the lower section of the window unleashing the full flexibility of the optimization solution (see section 8a.3 for details). The Realizations setting available for Random simply defines how many times to repeat the experiment of starting an optimization run from a random initial layout. Setting realizations to 5, for example, will yield five different random runs for each size.

When setup is done in the Setup & Run window the optimizations can either be put in the queue directly by pressing Create & queue runs or be parked for now to be run later by pressing Create & park runs.

8a.1.2.4 Run

The deepest level of the GUI tree is the Run level. At this level each optimization run is presented and when they are completed a resulting optimized layout can be created in the windPRO object list and map window by pressing Realize Final Layout. Through the course of the optimization the positions of WTGs at the current step of the optimization run are visible and updated in the Layout plot. Similarly, the Steps list will show the current and history of the Objective. Alternatively, the Wake loss (available for all objective) or AEP, Wake loss or Cost1 are plotted (only available for LCOE and NPV objectives). This information is also available in the Convergence plot. At the top of the view is a detailed summary of the settings for the run, including a Status indication whether it is running, done or failed.

Details of constraints and/or individual turbine production and wake loss information may be viewed via the buttons Show AEP/Wake and Show Constraints to the lower left of the Optimizer window.

The current status of a run is indicated in the Status line in the Summary when the run is selected in the tree. The status is also in the tree itself on the level of the run and via the icons shown to the left on that line. The legend for these icons and a summary status of all current runs within the tree are shown just below the tree.

8a.1.3 Copy-pasting of levels in GUI structure

As a new feature of windPRO 4.2., it is now possible via a right click on the respective level to copy and paste all levels of the tree-structure, be it a Site, WTG, Size, or Run level. It is both possible to select the level and all children, or only the right-clicked level. This enables faster setups for comparing different WTG types or different run configurations. For

example, optimization results from site setup with a desired lifetime of 20 years can be compared to a site with 30 years in just three clicks: Copy site with all children, paste all, start all parked runs.

8a.2 Which decision to optimize?

Many important decisions need to be taken when developing a wind farm. Several of these decisions can benefit from an optimization approach but may not fit well into a traditional optimization setup. In some of the cases the variables on which the decisions are based on (the objective) such as AEP, or financial metrics as cost-of-energy (COE) may not be suitable or sufficiently sensitive to the decisions in question. One such example is the size of a wind farm. The relation between the number of WTGs in the farm and the associated AEP, is simply an increase with the number of WTGs. COE on the other hand typically decreases smoothly with the number of WTGs. This makes AEP and COE unsuitable for determining the optimal size of a wind farm on their own [1]. To accommodate these additional and important decisions in the optimization setup, but not directly in the actual algorithmic optimization process, the decision of these variables is supported by the structure of the GUI. The main use-scenarios are described in the following and includes the following key decisions in wind farm development:

- Design of a layout
- Number of WTGs in the park
- Choice of turbine model
- Fulfillment of constraints

Section 8a.1.2 has described how to establish the tree with a Site, WTG and one or more optimization runs and the settings and inputs needed at each level of the GUI tree. All these settings are done on the Setup & Run tab (cf. Figure 8), which basically is the action mode of the Optimizer, where optimizations can be added and setup and details can be viewed.

To compare multiple finalized optimizations the Optimizer has a 'comparison mode' which is available via the Compare tab (cf. Figure 10). In compare mode, the GUI allows for easy comparison across results for different WTGs, sizes and runs mainly showing the results and some overall settings. Once in compare mode (i.e. on the Compare tab) the GUI tree will behave slightly differently as it will start highlighting the runs which are being compared in mustard color (cf. Figure 11). The highlight shows the level selected by the user below which runs will be compared. When a site is selected results will be compared for WTGs defined for that site. For each WTG the best run across all sizes will be chosen and highlighted in mustard color. When selecting a WTG all sizes below that level will be compared, for each size the best run will be chosen if there is more than one run. Selecting a size will simply compare all runs for that size. At the current stage it is not possible to compare across sites, as they may have different objectives and constraints which cannot easily be compared.

8a.2.1 Design of layout (given park size)

Designing a layout with a single fixed number of WTGs is the basic and simplest mode of use for the Optimizer. Just one optimization needs to be set up and run once the data and settings on the Site and WTG levels have been defined. The flexibility of the GUI tree helps to compare different strategies for the optimization, described in further detail in section 8a.3. Such strategies could include the default, which is called Smart, a user defined initial layout (via User Layout), or perhaps relying more on stochasticity by including random runs. In the last case, several random runs can be started via Realizations. Once a single run has been added for the park size in question more runs can be added by selecting the size in the tree and pressing the button Add Runs, which in this case has replaced the Add Sizes & Runs button (shown when the WTG level is selected). If, on the other hand, a particular run in the tree is selected, then the button renames to Clone Run – this will allow to use the result of that run at starting point for another run. This can be useful for continuing an optimization or doing an optimization with multiple stages. The three variants of the 'Add...' button are shown in Figure 12.

An example of a size with several runs is demonstrated in Figure 13 showing the view on Setup & Run tab. Figure 14 shows the view on the Compare tab, which is more focused on comparing the objective for the final layout across the runs.

8a.2.2 Number of WTGs (park size)

The New Optimizer can be used to analyze parks with different sizes, but it does not optimize for the number of turbines since the objectives are not well suited to optimize the park size: If the objective is to maximize the AEP, it is generally best to place as many wind turbines as possible into the park. In such case the Fill max option can be used. On the contrary, if the objective is to minimize the costs, it would be optimal to place none. In practice, the problem is often to find the wind turbine positions that are optimal for the specified objective with a given park size, and it is more useful to analyse different set-ups per park size and for different park sizes. To analyze the park size, simply set the appropriate range of sizes from min to max in the Add Sizes & Runs setup as shown in Figure 15. Then choose the preferred setup of the runs which will be created for each size (see section 8a.1.2.3 for further details). The Optimizer uses parallelization so several runs will start and run simultaneously to speed-up performance.

Once completed, the results can be visualized and analyzed on the Compare tab and by selecting the relevant WTG in the tree.

In some cases, the runs for the largest park sizes will fail before all turbines could be placed by the start model. This can indicate the maximum number of turbines which is possible to place, but care must be taken as several factors influence this outcome. One thing is making sure that the grid resolution is not too coarse, generally around 0.5 RD ensures good performance. Another possibility is that the default start model (Smart) places turbines according to the objective – but that the maximum is determined by a constraint, hence placement may not be ideal regarding minimizing constraint exceedance. Section 8a.2.4 describes a procedure that improves chances of finding a valid layout in such cases.

8a.2.3 Choice of turbine model

To analyze the choice of WTG model, simply add all the relevant WTG models to the Site. In such cases setting the maximum allowed capacity of the grid in the WTG area is beneficial as this will automatically influence the maximum number of turbines for each model, given its capacity. It may also be relevant to set individual cost models for each WTG if detailed cost information is available. However, this is not required as the default cost model will automatically account for the difference in rotor size and generator capacity of each WTG type.

The results across the WTGs may be compared on the Compare tab by selecting the relevant site in the tree. If there are more sizes and runs for each WTG the best run (with regard to the selected objective) is chosen to represent each WTG type.

8a.2.4 Fulfillment of constraints (spacing, noise, lifetime, wake)

In some cases, the optimization is more driven by the constraints (noise or loads) than by the objective (AEP, LCOE or NPV). This does not mean that the objective is irrelevant, but rather that the design space is very difficult to navigate in for the Optimizer because large parts are invalid due to the constraints. In some cases, this may lead to runs failing for particular sizes because the start model cannot generate a valid layout, i.e. place all turbines without violating the constraints. If this happens it can be beneficial to add several runs with the Random run setup for a failed size and with the setting Allow invalid start model activated. This will allow the start model to place all the required turbines but disregard the constraints (except the WTG area). The step model will then seek to minimize the constraint exceedance first, and if that succeeds then optimize the objective function.

8a.3 Optimization algorithm

The wind farm optimization problem is a difficult problem mainly due to the occurrence of several local minima and so-called non-linearity and interaction in the objective functions, chiefly arising from the turbine wake interaction. If one turbine is moved the optimum position for all other turbines in the park may change or they may exceed a constraint they did not before. These effects may be accentuated by too coarse a resource grid and too coarse a directional resolution in the wake model or simply by multi-directional wind roses. When constraints are included, these may also prevent otherwise beneficial layout changes and effectively split the solution space into many smaller un-connected “islands” (in a high dimensional sense), which are extremely difficult to navigate for an optimization algorithm. The supported objectives and constraints are described in section 0.

The structure of the New Optimizer reflects the structure of the underlying solution approach, which is a classical iterative search, but with many built-in smart features that improve its performance and efficiency. In this framework, an optimization needs a Start model, an initial 'first guess' and then a Step model that subsequently seeks to make iterative, incremental improvements to further improve and optimize the Start model. As the final optimal model is not known a priori, one or more Stop criteria are needed to decide when to halt the search of the Step model. This could be once a maximum time or a maximum number of fruitless attempts to take a new step improvement have been tried.

The better the initial Start model the more focused the iterative Step model can perform its search. In fact, the wind farm optimization problem is so complex that with many turbines it is very difficult for an iterative solution to find a good optimum. Increasing the likelihood of ending up in an only modestly good local optimum. In this sense the old saying "Well begun is half done" is extremely pertinent and the reason for the development of the Smart Start models described in section 8a.3.1.

Figure 20 shows the basic options available for setting up optimization runs. The Optimizer includes multiple options both for the Start model, Step model and Stop criteria and is quite flexible in this sense. However, the basic options shown represent the main recommended combinations of Start and Step models.

The full flexibility is available when choosing the Custom option where all the Start, Step and Stop options become available. These options are summarized in the bullet points below including the two additional options, Seed and Realization, which are explained in their respective parentheses.

- Custom
 - o Start: Fill; Manual; Resource Greedy; Random; Smart
 - o Step: Random, Local; Random, Regional; Random, Global
 - Resolution: Discrete (Limit to grid points), Continuous
 - o Stop: Max runtime, Max fruitless tries, (exhausted neighborhood)
 - o Stochastic (use of random numbers)
 - o Seed (to ensure reproducibility of stochastic methods)
 - o Realizations (how many runs to generate for a stochastic method)

The last listed Stop criterion, exhausted neighborhood, is in parentheses as it is never selectable for the enduser and always applied when the optimization runs with the Discrete resolution setting, where turbine positions are limited to the grid points in the resource grid. This Resolution setting with options Discrete or Continuous is a property of the step model as it is referred to as Limit to grid points in the basic options setup (i.e. not Custom).

To keep the GUI user-friendly, we have pre-defined combinations of Start model and Step model (cf. Figure 20) that are known to perform well together. Above all the Smart option which is the default option will perform the best in the majority of cases. The pre-defined (default) combinations are listed below indicating the Start and Step models

- User Layout
 - o Start: Manual (i.e., user defined)
 - o Step: Random, Regional
- Fill max
 - o Start: Fill
 - o Step: Random, Local
- Best location subset
 - o Start: Fill
 - o Step: Random, Local
- Smart
 - o Start: Manual (i.e., user defined)
 - o Step: None
- Random
 - o Start: Random
 - o Step: Random, Regional

The following sections describe the Start, Step and Stop options in further detail.

8a.3.1 Start model

The purpose of the Start model is to define the initial guess of the optimization solution and to make that guess as good as possible. As described earlier, for complex optimization problems “well begun really is half done”, and most likely much more than just half done. A poor starting model will be more likely to end up in modest local optimal solutions. All the start models operate strictly on the resource grid. If this grid is excessively coarse relative to the rotor diameter of the turbine model, that is to say $>1RD$, the performance of the Start models may deteriorate, in particular the more advanced ones like the Smart Start model. The optimal trade-off between speed and resolution lies around $0.5RD$ for the resource grid spacing relative to the turbine rotor diameter.

Unless the Allow invalid start model is activated the Start model will respect all activated constraints. The option can only be activated for the Random start model. See section 8a.2.4 for further information.

The Smart Start model picks the optimal position (approximately) for each new WTG it places, regarding the actual chosen objective and the effects of already-placed turbines. If stochastic is activated, a measure of randomness is added in the placement of each individual turbine.

The Random Start model is fully stochastic and picks the positions at random across the entire grid. More than one Realization is recommended for this model, typically 7-8 or more, which simply means doing several similar runs with different sets of random numbers. This model can be beneficial particularly if the optimization is strongly influenced by restrictive constraints. A fixed Seed may be set to exactly reproduce random numbers as this seed is used both for the start and step models to ensure full consistency. A fixed seed cannot be used with multiple realizations.

The Resource Greedy option is mainly included for historic reasons and for comparisons with the Classical windPRO Optimizer. It picks each turbine position according to the best available resource position disregarding wake effects and any objective function. This option performs well for sites with strong resource variation (e.g. a ridge) using the AEP objective.

The Fill Start model will simply disregard the resource and start filling turbines from one corner only respecting the constraints until the required number have been placed. If selected via the Fill max option, the filling will continue until no more turbines can be placed due to the constraints. The Fill algorithm has been improved in 4.2.

The Manual Start model is defined by the user who selects the turbine’s starting positions.

The Best location subset model allows the user to identify the optimal subset of locations from a defined set of turbine locations, which can be useful in repowering decision making. This model requires an additional configuration since the set of turbines must be defined from which the best subset is selected from. Note that only WTGs that are positioned within the defined WTG area are available for that selection.

8a.3.2 Step model

The Step model iteratively seeks to improve the Start model until a Stop criterion is met. All the Step models are stochastic, which means that they rely on random numbers. This means that both a turbine is selected at random and that a new position for that turbine is selected at random. The main difference between the Step models is the pool of positions from which these new positions are drawn.

The Random, Local Step model assumes that the current layout and turbine positions are relatively close to the optimum. The assumption is typically valid for Smart Start models and Manual user defined Start models. The local step model draws random positions from a local area around the turbine.

The Random, Regional Step model draws the random positions from a relatively large region around the turbine, expecting improvements to be found further away, and the optimum position is not in the direct neighborhood.

The Random, Global Step model draws new positions from the entire domain. It is not utilized in any of the standard options as convergence is inefficient. However, as a first broad search phase it can be useful followed by a Random, Regional step model initiated via a Clone run, for example.

When grid spacing is finer than the expected optimal trade-off at around $0.5D$, the default option is Limit to grid points (Discrete). When grid spacing exceeds $0.5D$, the default option is Continuous, which will allow turbines to move away

from grid points and prevent local optima due to a grid that is too coarse which is important. The drawback is that the most natural Stop criterion cannot be used as will be described in the next section.

The main difference between the local, regional, and global set-up is the areas around the turbines considered for steps. In a local step, the local area is $5D$ at the start of the optimization run and becomes iteratively smaller until it reaches $1D$ at the end of the run in the discrete case or $0.5D$ in the continuous case. The distance that defines the regional area is a square root of the vertical and horizontal distance of the whole WTG area, but at least $5D$ in case of small WTG areas, at the start of the optimization run. It also ends up at $1D$ in the discrete case and $0.5D$ in the continuous case. In the global step, the whole area is constantly considered during the run.

8a.3.3 Stop criteria

The purpose of the Stop criteria is to detect if an optimization is converged or so close to being converged that further improvement will be insignificant. Another purpose is to give the user a chance to set a maximum waiting time (with the risk of stopping prematurely far from an optimum).

Max runtime is the maximum time Step model is allowed to run. When the time is up the optimization is stopped. The time to generate the starting model is not included in the timing.

Max fruitless tries simply defines the maximum number of unsuccessful attempts to take a step which accepted before stopping. Both invalid steps (i.e., failed constraints) and steps without improved objective values are counted.

Exhausted neighborhood is an option hidden from the user which is the most efficient stopping criterion. It can only be used for runs with the resolution set to Limit to grid points (Discrete). It is a memory that tests if all possible positions in the search neighborhood for all turbines have been tried in vain – and if so, the current layout is by definition an optimum and the run is stopped. For continuous runs the search neighborhood is always infinite no matter how small it is, and this Stop criterion cannot be employed.

8a.3.4 Objective & Constraints

Put simply, the Objective of an optimization is what we seek to optimize. The design variables are the degrees of freedom given to the Optimizer, which are allowed to be modified to find the best possible objective. In this Optimizer only the turbine positions, their X and Y coordinates are explicit design variables. The number of turbines and the turbine models are implicit design variables which the user can analyze and optimize via the flexible structure of the GUI-tree. The choice of objective may differ for different users, the supported objectives are described in next section.

Constraints are known limitations which must be fulfilled for a solution to be accepted, hence, we call a solution which fulfills all constraints Valid. A solution where at least one constraint is violated is Invalid (and will not be accepted).

8a.4 Objectives

An optimization needs a quantity that must be optimized, the Objective, given a set of design variables that may be varied. For some objectives optimization implies maximization, which is the case when wind farm production (AEP) or project profit is the objective. For other objectives optimization implies minimization, which is the case for cost-of-energy optimization.

8a.4.1 AEP

AEP is simply the Annual Energy Production including wake losses. The AEP calculation is based on the resource data in the selected .rsf or .siteres file, containing sector-wise Weibull parameters (A and k) and frequencies (f). Wake effects are calculated using the PARK2 wake model and the user-defined wake decay constant. Wind farm layout optimizations using AEP as the objective have a drawback, particularly if the available WTG area is large: The optimization may lead to very spread-out layouts that would incur excessive costs for building roads and grid connection. This is the main motivation for choosing other objectives, in particular, objectives which include the costs of building the wind farm.

8a.4.2 Costs

Costs are not included as an objective on its own in the New Optimizer, at least not directly. However, the estimation of costs is an important input to financial objectives such as cost-of-energy (COE) or profit (NPV), to account for the balance between the created value (i.e., AEP) and the expected costs required to realize that potential. Costs in the New Optimizer are estimated using the windPRO Cost tool. This tool estimates costs using parameterized formulas fitted to a large amount of real historic costs and based on extensive literature reviews. As an example, turbine costs scale with generator capacity (MW), specific capacity (MW/m²), rotor size (m²) and hub height (m) via an elaborate regression expression. The cost tool comes with six predefined cost models, three price levels 'high', 'mid' and 'low' for onshore and offshore, respectively.

In the cost tool, the costs are divided into four main categories as listed below.

- Devex: development expenditure
- Capex: capital expenditure
- Opex: operational expenditure
- Abex: abandonment expenditure

Development expenditures (Devex) quantify the cost associated with developing the project, getting permissions to build the wind farm etc. Capital expenditures (Capex) represent the main investment of building the wind farm. Operational expenditures (Opex) represent the costs of keeping the wind farm running through its lifetime, and abandonment expenditures (Abex) quantify the estimated amount of money to eventually remove the wind park. Capex is the only cost category which depends on the actual design of the layout via the costs for the internal grid connection between the turbines (and roads for onshore).

When costs vary over space, cost maps can be imported to account for that via the Add cost map button. These costs are functionally handled as other costs but instead of fix input parameters the cost values are retrieved from the cost map.

For each cost a Cost Index may be defined to account for expected future trends in the price development. This index should exclude the effect of the general baseline inflation.

In Figure 25 please note the possibility to insert adjustments to the baseline costs via entries in the table column Cost function value. It is via values in this column that the high and low alternative cost models are defined, by an increase or decrease of these factors.

In the Optimizer the wind farm is assumed to be built and put into operation the year after the current year, which for 2024 would be 2025. Devex is assumed to occur the year before the installation, i.e. the current year. When the reference year defined in the cost tool deviates from the year that a cost occurs the price index (if set) will be used to adjust the costs accordingly. The default cost index is zero through the lifetime.

Note that the total cost values shown in the optimizer are not discounted only index corrected (if set by the user) and summed over the lifetime.

For the grid (offshore and onshore) and road connection costs (onshore only) an additional sub-optimization is solved for finding the shortest possible way to connect the turbines in the layout. Either to each other or to any of the Connection points if defined for the Site. The resulting inter-connection distance is what enters the cost calculation. The solution to this sub-optimization relies on graph theory and the optimization problem is referred to as the minimum spanning tree. The connections of the minimum spanning tree are visualized in the Layout plot for each run as the black connection lines between the WTGs (and connection points, if any).

As a final remark it is important to stress that the cost model is deliberately kept relatively simple with a minimum of assumptions which are calibrated against actual project costs. Hence, the user does not need, in fact cannot, set a large range of particular cost items such as the cost of crossing a stream or railway. Although that degree of flexibility might appear beneficial, if the input quantities are not known the values will be associated with a very large uncertainty, as will the resulting overall cost estimates. The current cost tool seeks to strike an ideal balance between accuracy and detail/flexibility, but with a preference for accuracy over detail. In the end what is important is getting the right order of magnitude of costs as input to the financial objectives.

8a.5 Constraints

The following sections describe the constraints supported by the New Optimizer. The supported constraints are shown in Figure 27. Note that including Lifetime or Noise constraints are subject to additional windPRO license requirements as they draw on calculation functionality in the LOAD RESPONSE and DECIBEL modules, respectively.

8a.5.1 Area & distance (sub-areas)

Defining a WTG area object is a prerequisite for all optimizations. The WTG area object serves the purpose to define the area limitations for turbine placement. A site may be split into arbitrarily many sub-areas and each sub-area may have individual limitations on minimum and maximum numbers of turbines or installed capacities. Sub-areas may also have individual requirements for turbine spacing typically defined as an elliptical constraint in terms of rotor diameters oriented along the prevalent wind direction. The Optimizer will always adhere to the areal requirements defined in the selected WTG area, whereas minimum requirements for inter-turbine distances must be separately activated via the Distance constraint. Even if no distance constraint is activated the Optimizer will not accept a turbine spacing below 1D. Some tips and considerations to the WTG area import are available in section 8a.6.2, and detailed information about the WTG area object is available at Appendix 8 OPTIMIZE Classic in section 8.0.1.5.

8a.5.2 Wake loss

The maximum wake loss constraint (cf. Figure 27) allows to define maximum wake losses for both new WTG and existing WTG objects; the maximum wake losses can be specified independently from each other.

8a.5.3 Noise

The noise constraint requires an activated license for the DECIBEL module. The calculation is a stripped-down version of the ISO 9613-2 standard. The noise constraint is defined for a single wind speed selected in the Model settings for the noise requirement (Figure 28). Noise sensitive areas must be selected on the Site level (Figure 29) and WTG source noise data on the WTG level (Figure 30).

8a.5.4 Component Lifetime (loads)

The lifetime constraint requires an active license for the LOAD RESPONSE module and sets a constraint on required minimum lifetimes for selected turbine components for each WTG position. The calculation of lifetimes and activation of the lifetime constraint requires a resource file including all the siting parameters for fatigue calculation, i.e., a .siteres file. Such a file may be calculated using the RESOURCE calculation in windPRO drawing upon the IEC61400-1 ed. 4 calculation functionality in SITE COMPLIANCE, or can be downloaded from the free online GASP dataset. The calculation options are a stripped-down version of LOAD RESPONSE as can be seen from the Model settings in Figure 31.

The lifetime calculation also requires the setup of the wind turbine Design Standard and Class as well as selection of the Load Response Model which can be either a generic model or a specific model provided by a manufacturer. For the response model, a set of sensors must be selected for the constraint, here it is recommended to focus on the key components such as blade root and tower bottom, and perhaps low speed shaft (LDD).

8a.6 Practical recommendations

8a.6.1 Run setting recommendations

As default setting, we recommend:

- Interval — this allows a specific number of WTG's to be placed.
- Smart start — this algorithm excels to maximize the objective when there are not many constraining conditions, e.g. limited space.

For sites where it is difficult to allocate the desired number of turbines and only distance constraints are activated, we recommend:

- Fill Max — this places as many WTG as possible.

For sites where it is difficult to allocate the desired number of turbines and constraints in addition to distance constraints are activated, we recommend:

- Interval
- Random + Allow invalid start model — this allows a specific number of WTG's to be placed when there are multiple constraining factors that complicate to place the desired number of turbines (it is often helpful to increase the run time when both random and allow invalid start model options are selected).

For sites with fix locations for WTGs and an optimal subset of WTGs shall be selected, e.g. for Repowering, we recommend:

- Best location subset

For large sites, high resolution resource data or many turbines that leave to long computation times, we recommend

Limit to grid points — This often yields a good starting point in much shorter time, and the solutions can then be further optimized in a consequent step, e.g. using Manual start 6) For layouts where a good layout has already been found and it shall be refined, we recommend:

Manual start 8a.6.2 WTG Area import

A convenient approach is to import pre-defined WTG Areas (cf. Figure 33: WTG area Import from file.) as shapefile format (.shp). Each feature of the shapefile a WTG area is handled separately for which properties can be defined, e.g., whether the area is an exclusion zone or a WTG area, the minimum and maximum number of WTGs to be placed, the minimum distance between WTG (cf. Figure 33). Moreover, a buffer zone can be specified (cf. Figure 34) for the optimization.

8a.6.3 Example projects

Three sample projects are provided to show the range of utilities of the optimizer tool: a sample on-shore project, a sample off-shore project, and a sample project for the new noise curtailment optimizer.

The onshore sample project Aparados da Serra.w42p provides a variety of optimization scenarios. These include runs with AEP, LCOE and NPV objectives, runs with different constraints and on different WTG area structures. Lastly, it shows a performance comparison for different turbine types and a performance comparison for different optimization configurations.

The offshore sample Cost model offshore.w42p showcases the new option of including cost maps in the cost set-up that can be used to represent a whole variety of costs, e.g., bathymetry-based costs, soil structure foundation costs, or travel costs.

The noise curtailment Curtailment optimizer demo project.w42p shows how a non-compliant wind farm layout can be made compliant with noise regulations while still obtaining the maximum possible energy yield from optimal curtailment strategies.

Reference Number 1.8: Three-dimensional effects of the wake on wind turbine sound propagation using parabolic equation. Hemant Bommidala, Jules Colas, Ariane Emmanuelli, Didier Dragna, Codor Khodr, Benjamin Cotte, Richard J.A.M. Stevens PII: S0022-460X(25)00110-5 DOI: <https://doi.org/10.1016/j.jsv.2025.119036> Reference: YJSVI 119036. Journal of Sound and Vibration.

The influence of three-dimensional (3D) wind turbine wake effects on sound propagation is investigated. To study this, numerical simulations are conducted using a 3D parabolic equation model at low frequencies, with comparisons made to a two-dimensional (2D) approach that neglects transverse horizontal propagation. Three atmospheric stability conditions are investigated using analytical wind profiles that incorporate the wake effects. The wind turbine noise source is specified using an aeroacoustic extended source model. 3D effects due to the wake are shown to be significant, especially for the stable atmosphere. Indeed, horizontal refraction induces focusing that a 2D approach fails at predicting. As the wind turbine blades are rotating, the focal zones are moving accordingly, yielding large variations of the sound levels. Downstream the turbine, amplitude modulation can locally reach values as high as 16.5 dB over long distances. In addition, higher average SPL are predicted by 3D simulations compared to 2D ones, with deviations up to 4.5 dB. For neutral and unstable conditions differences in 2D and 3D sound propagation approaches are smaller, as velocity gradients in the wind turbine wake are smaller.

Reference Number 1.9:

Guidance on biodiversity Cumulative Impact Assessment for wind and solar developments and associated infrastructure 2024: Leon Bennun, Claire Fletcher, Aonghais Cook, David Wilson, Ben Jobson, Rachel Asante-Owusu, Annie Dakmejian, Qiulin Liu. IUCN, Gland, Switzerland and The Biodiversity Consultancy, Cambridge, UK. ISBN: 978-2-8317-2317-4 (PDF). DOI: <https://doi.org/10.2305/EHGE6100>

Reference Number 1.10

The proposed development is not in compliance with [2023/2413: DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652]

Reference number 1.11: The High Court [2024] IEHC 136 [2018 8457 P] Between: Margaret Webster and Keith Rollo Plaintiffs and Meenacloghspar (Wind) Limited Defendant And [2018 8458 P] Between: Ross Shorten and Joan Carty Plaintiffs and Meenacloghspar (Wind) Limited Defendant Judgment Of Ms. Justice Emily Egan Delivered on The 8th day Of March 2024

It should be noted that the 2016 WEG were never adopted properly as no SEA was undertaken, while the 2019 EEG are only draft Guidelines. The High Court has determined the law in relation to noise & this is binding over and above Guidelines.

The AM (Amplitude Modulation) impact has not been assessed. The 2006 Noise Guidance arguably may be considered outdated due to the passing of time and does not account for AM noise impact.

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. Notwithstanding same, this low frequency noise impact was tested in the recent court case, ref [2024] IEHC136 - Margaret Webster and Keith Rollo (Plaintiffs) and Ross Shorten and Joan Carty (Plaintiffs) and Meenacloghspar (Wind) Ltd (Defendant). The Judge's ruling states that 'the fact that AM and thump AM remain to be regulated does not mean that the court should ignore these characteristics and 'existing planning guidance effectively (WEDG 2006) is not responsive to the issues complained of - AM, thump AM etc'

The judgement also states that 'Low frequency noise (sound up to approximately 150 hertz) only slightly above the threshold of audibility can cause considerable disturbance and is more difficult to mask and get used to than other types of noise.....on the balance of probabilities that whilst low frequency noise is not the dominant characteristic of the WTN, there is a significant element of audible low and lower frequency noise which manifests as thump AM' It is considered that these 2006 noise guidelines therefore do not include sufficient guidance, particularly in relation to AM (Amplitude Modulation) and 'thump' AM noise which creates the 'whoosh' or 'thump' sound which has been found to cause nuisance.

The "thump" AM noise from a wind turbine is a type of sound characterized by fluctuating amplitude, specifically the modulation of the turbine's aerodynamic noise. This modulation is often described as a "thump," "swish," or "whoosh" sound and is related to the frequency at which the turbine blades pass by. (<https://iea-wind.org/wp-content/uploads/2021/05/IEA-Wind-TCP-Task-39-FactSheet-Amplitude-Modulation-20181006.pdf>)

In relation to the proposed substation, which will operate on a 24-hour basis, a night time criterion of 35 dB LAeq,T is considered appropriate for the operation of the substation. The substation design will ensure that the noise emissions do not contain audible tones or impulsive characteristics at the nearest NSLs. The report goes on to state that significant vibration impacts are not associated with the proposed development. However, given the lack of clarity and assessment in relation to major elements of the proposed development such as blasting or rock breaking at the borrow pit, it is considered that this claim has not been substantiated.

Furthermore, according to Met Eireann, prevailing wind in Ireland comes from the South and West. In this regard, dwelling houses in the immediate vicinity of the proposed windfarm area located just in excess of 700m to the east and north east of the site, ie 'down wind' of the site and are more likely therefore to suffer from noise and nuisance

noise. Having regards to the potential noise and nuisance impacts of AM and thump AM on residential amenity, as highlighted in the recent Court ruling set out above, it is considered that the potential significant impacts of noise have not been adequately addressed so as to rule out the potential for impact.

Reference Number 1.12: Victorian Supreme Court in *Uren v Bald Hills Wind Farm Pty Ltd* [2022] VSC 145 (Uren)

Reference Number 1.13:

Decision of the Council of State No. 465036 of 8 March 2024

Reference Number 1.14: SITE SUITABILITY

distance from Turbine m	dba Sound power (These numbers do not include for an extra 5dba for downwind crest of hill or humidity/cold weather increases. Wear & Tear friction noise increases & Turbulence						
1	104	105	106	107	108	109	110
2	98	99	100	101	102	103	104
4	92	93	94	95	96	97	98
8	86	87	88	89	90	91	92
16	80	81	82	83	84	85	86
32	74	75	76	77	78	79	80
64	68	69	70	71	72	73	74
128	62	63	64	65	66	67	68
256	56	57	58	59	60	61	62
512	50	51	52	53	54	55	56
1024	44	45	46	47	48	49	50
2048	38	39	40	41	42	43	44
4096	32	33	34	35	36	37	38

This Table indicates a setback distance of over 2,048m from the turbines to meet WHO Standards of 37dbA. The 4.2MW turbine generates 106dbA plus 5dbA for top of hill plus 2dbA for climate factors plus turbulence effects from wake plus wear/tear. This means a setback of 4,096m & not 500m. The operational windspeed noise will be increased to cater for wake effect turbulence, separation distances of turbines, bearing wear & friction from insect detritus.

The following information was answered from various sources with difficulty. It is noted that the Applicant failed to include any such information with the application.

It would seem that the applicant is selecting turbines for c7m/s in order to reduce noise levels to give the appearance of compliance with Standards. This ignores the effects of higher windspeeds & the noise generated above the WHO Standard of 37dbA.

None of these curves have been provided by the Applicant & the application should be rejected.

Winds on the Beaufort scale

Wind	Designation	From Winds				Effect
		km/h	m/s	Knots	mph	
0	Calm	< 1	< 0,3	< 1	< 1	Nothing
1	Light air	1 - 5	0,3 - 1,5	1 - 3	1 - 3	Diversion of smoke
2	Light breeze	6 - 11	1,6 - 3,3	4 - 6	4 - 7	Contractions of leaves
3	Gentle breeze	12 - 19	3,4 - 5,4	7 - 10	8 - 12	Movement of branches
4	Moderate breeze	20 - 28	5,5 - 7,9	11 - 15	13 - 17	Movement of limbs
5	Fresh breeze	29 - 38	8,0 - 10,7	16 - 21	18 - 24	Movement of small trees
6	Strong breeze	39 - 49	10,8 - 13,8	22 - 27	25 - 30	Movement strong branches
7	High wind	50 - 61	13,9 - 17,1	28 - 33	31 - 38	Movement of trees
8	Gale	62 - 74	17,2 - 20,7	34 - 40	39 - 46	Difficulty in walking
9	String gale	75 - 88	20,8 - 24,4	41 - 47	47 - 54	House damage
10	Storm	89 - 102	24,5 - 28,4	48 - 55	55 - 63	Uprooting of trees
11	Violent storm	103 - 117	28,5 - 32,6	56 - 63	64 - 73	Storm damage
12	Hurricane	> 118	> 32,7	> 64	> 74	Devastation

It would seem that the upper limit for the Nordex 7.2Mw, as identified above is 17.1m/s & not 25m/s as stated in application

Birr Met Eireann data is available by month from 1850 to 2010 & shown below in metres/second Table 1 & knots in Table 2. The speeds in m/s above the 57m/s Survival speed are coloured yellow.

These breaches above Survival speed are regular over the period (13%) & it would be grossly negligent to grant permission in such circumstances as the application does not comply with Proper Planning or Sustainable Development. The blade tip speeds, as above, are given as 92m/s [331.2kph]]. In a survival failure, this speed could cause fatalities & damage at large distances.

These speeds are considerably faster than a F1 Grand Prix racing car. Any suggestion that a Bat or Bird could avoid such a blade at this speed is simply not possible.

Reference Number 1.15-Table 1: Birr Wind gust speeds 1850 to 2010 in metres per second

Met Eireann Birr maximum wind gusts 1850 – 2010 in m/s. converted from Knots -											Factor[1/1.944]	
Survival wind speed for Vesta V117-4.2 is ≤57m/s												
Note all cells highlighted in yellow ≥57m/s. It should be also noted that Birr data is at ground level plus 10m, which would be far lower than Seskin top of turbine heights.												
Birr m/s WIND GUST SPEEDS												
Year	Jan	Feb	March	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
1850	48	21.3	5.3	42	37.1	21	41.7	24.4	35.2	20.3	36.4	31.9
1851	74.4	9.5	37.5	17	14.9	45.3	46.8	29.2	15.6	46.9	20.8	26.9
1852	57.9	38.1	15.7	16.7	22.6	93.6	45.9	43.1	10.4	22.2	92.1	82.1
1853	51.2	15.6	35.9	38.1	13.4	35.2	44.5	39	25.5	75.1	40.3	9
1854	44.1	10	14.9	2.9	72.8	55.8	41	29.2	14.9	21.5	26.2	33.7
1855	5.3	19.9	45.5	13.4	29.5	28.4	40.9	43.9	18.7	38.9	16.5	20.3
1856	41.9	27.8	8.3	42.6	75.1	37	29.5	41	39.2	33	13.2	47.2
1857	33.5	20.9	33.9	54.8	28.6	39.6	19.3	21.2	41.6	31.3	35.2	14.3

1858	24.9	16.5	20.3	52.5	36.3	11.7	36.3	27.1	36.5	39.5	21.5	54.6
1859	27.8	17.6	33.3	45.9	4.6	20.9	21	27.5	63.1	22.6	46.8	44.2
1860	62.5	18.6	39.5	34.1	44.2	67.7	39.8	75.8	20	32	36.1	28.2
1861	24.3	27.2	50.4	11.3	4.2	48.4	108.2	66.4	67.2	48.4	43.9	25.3
1862	52.4	14.8	50.2	38.4	50.6	37	45.3	38.2	19.8	63.5	25.5	37.9
1863	40.7	21.6	33.1	16.3	13.2	11.8	4.3	49.3	47.9	55	53.2	36.6
1864	23.7	8.9	34.5	15.3	21.6	42.4	10.6	22.6	43.6	49	56.6	28
1865	50.7	35.4	23.5	13.7	48.2	11.1	41.4	36.8	6.3	52.7	55	40.4
1866	54.1	33.8	31.7	23.4	14.9	33.6	11.9	48.1	60	28.3	38.5	46.2
1867	34.4	31.2	29.4	38.8	40.1	13.3	49.9	37.8	17.2	61.4	16.6	14.9
1868	41.4	32	40.7	28.8	28.6	20.3	31.6	64	36.8	29.9	30.2	54.4
1869	53	33.7	23.3	36.6	48.6	19.8	28.1	27.1	80.2	8.1	38.2	67
1870	38.5	22	28	12.3	28.9	10.2	21.5	21.3	45.9	95.1	18.1	23.9
1871	37.3	27.4	26.5	27.3	26.5	37.7	68.2	28.8	8.4	45.7	22.2	31.4
1872	45.1	31.4	28	30	26.9	43.1	28.6	63.5	42.8	58.6	48.6	68.9
1873	69.9	11.8	54.9	23.4	27.6	18.7	54.9	64.1	53.3	51	26.6	14.9
1874	35.8	21.3	22.8	23.4	29.8	22.8	37.9	67.7	50.6	51.9	47	54.7
1875	63.4	15.4	13.7	10.3	25.4	41.8	33.8	40.1	85.6	39.9	34.2	25.6
1876	15.8	54.4	58	26.9	9.8	20.5	22.2	44.8	57.9	41.8	32.7	64.4
1877	61.9	30.3	34.6	39.4	27.1	48.7	30.3	57.1	33.7	45.7	71.1	43.8
1878	37.3	21.5	15.8	18.7	44.7	67.5	33.4	49.5	40.7	37.7	23	16
1879	22	43	20.8	29.3	33.3	64	39.2	59.3	60.1	16.2	11.2	24.3
1880	12.8	35.1	46.4	53	18.2	37.1	95.9	22.1	27.3	33.1	46.9	40
1881	8.9	43.4	30.3	17.6	32.5	53.7	24.6	61.7	51.7	32.7	53.4	62.9
1882	29.9	30.6	32.8	40.5	35.9	39.5	56.7	43	21.5	43.8	69.5	44
1883	64.7	47	8.2	22.6	33.6	22.5	51	51.9	44.4	46.8	55	24.3
1884	46.5	44.2	37	20.5	28.2	11.1	41.9	17	23.3	32	42.2	54.2
1885	28.9	38.2	21.3	42.2	28.1	15.5	28.1	40.7	66.5	49.1	24.6	12.6
1886	52.7	23.8	37.1	26.1	41.3	23.7	31.2	28.8	40.6	56.2	40.5	64.3
1887	36.7	16.3	17.1	24.7	18.1	4.4	38	32.5	21.8	34.5	28.5	34
1888	28	8	40.5	21.3	27.3	63.1	58.4	31.5	9.3	17.9	32.2	50.4
1889	28.9	22.2	18.7	24.2	42.8	16	24.8	63.1	11.5	40.9	20.1	40.5
1890	76.4	10.6	40.7	9.1	19.7	32.7	29.1	43.2	42.4	30.9	69.7	25.3
1891	24.7	2.2	18.8	24.6	40.6	39.7	28	91.3	26.5	44.7	35	78.2
1892	22.9	38.1	7.6	13.2	61.7	24.9	48.1	102.4	57.3	30	50.8	16.9
1893	37.8	38.8	10.1	10.7	35.4	34.3	28.6	49.2	30	41.1	24.6	52
1894	51.3	42.6	27.3	63.8	32.7	24.9	52.9	40	4	43.1	45.6	37.8
1895	28.9	11.2	38.9	25.2	9	10.7	46.8	63.5	5.8	37.4	57.4	48.4
1896	13	19	60.3	11.8	4.4	27.8	69.9	33.7	72.6	32.5	13.7	55.8
1897	23.8	21.4	60.3	56.7	17.4	49.5	30.5	55.1	29.1	34.6	67.3	51
1898	24.3	21	10.5	46.7	34.8	42.9	14.5	82.9	39.4	27.4	67.6	32
1899	45.2	29.8	16.6	38.7	43.9	24.2	44.8	57.5	30.7	20.8	36.8	50.9
1900	53.7	30.7	9.7	28.2	30	50.6	23.5	97.9	18.3	57.3	53.8	52.9
1901	35.9	17.1	37.9	26.2	23.7	37	15.9	36.2	50.8	34.4	53.8	39
1902	39.7	26.2	30.2	26.1	26	19.9	25.7	32	20.5	22	60.9	38.1

1903	62	42.3	71.7	18.2	21.8	15.5	66.4	68	41.7	58.3	32.8	34.2
1904	46.1	57.9	36.5	26.2	42.5	21.2	48.5	42.7	30.7	32.4	31	25
1905	30.1	20.6	55.4	24.3	11.9	19.2	17.6	70.6	18.6	17.5	32.4	24.8
1906	52.1	34.8	29.6	22.3	46.2	29.5	45.6	45.5	15.3	60.5	21.7	30.9
1907	15	22.5	35.8	32.6	37.7	39	64.1	42.8	13.6	63	36.9	46.2
1908	39.4	30.6	38.4	22.7	36.8	20.5	33.4	49.1	70.9	20.5	32.3	41.6
1909	36.3	12.7	39.8	55.3	34	22.5	25.8	15.4	27.4	56.3	25.8	48.4
1910	46.8	55	25.7	35.5	27.8	48.9	39.3	58	9.1	22.1	37.7	40.4
1911	21.9	35.1	17.2	21.3	16.5	28.9	37.5	31.1	21.8	53.3	53.4	66.8
1912	35.2	41.7	46.8	13	17.4	64.8	62.4	60.4	5	28.3	22.2	53.6
1913	62.3	16.5	51.5	51	45.3	42.8	13.4	16.9	41.8	47.4	40.2	33.1
1914	16.1	58.8	44.7	27.3	20.7	11.9	31.2	53.9	22.1	23.9	46	69.5
1915	52.8	54.2	10.4	22.5	6.4	25.7	60.3	51.7	19	38.2	39.5	55.6
1916	33.1	54.2	26.3	39.1	65	37.4	36.2	41.4	31.7	77.7	48.9	38.9
1917	12.8	23.8	32.1	15	43	20.2	33.9	117.9	22.8	51	32.5	18.9
1918	28.6	49	27.9	13.5	26.7	15.6	45.4	31	68.9	47.3	40	62
1919	36.2	17.8	24.3	19.7	33	49.1	23.1	30.7	33.5	12	27.1	68.2
1920	58.2	48	36.9	38.8	34	15.7	56.8	27.8	22.1	75.6	39.1	34.6
1921	48.4	12	37	10.3	26.3	9.9	52.4	43.9	28.7	34.5	36.8	54.9
1922	37	51.5	21.5	29.6	24.1	17.9	34.4	41.5	49.9	15.1	11	52.4
1923	38.3	62.4	30.8	37.9	17.4	12.2	36.9	70.2	43.7	58.7	38.6	41.7
1924	51.6	16	10.1	43.3	55.3	37.7	38.5	49.3	88.2	45	53.4	70.1
1925	43.1	68.8	6.1	49.6	62.1	7.2	51.9	23.9	24.1	28.3	28	22.5
1926	59.4	28.4	13.5	24.4	33.6	34.1	65.3	38.3	27	28.7	43.6	12.9
1927	44.2	31.7	45	20.1	10.3	36.3	38.7	56.1	63.8	24.9	32.5	28.2
1928	50.8	50.9	42.3	24.1	28.3	56.9	27.5	53.5	20.2	70.9	51.1	46
1929	19.2	43	6.9	11.8	33.6	22.1	45.4	64.8	10.8	53.1	52	84.9
1930	64.3	7.3	48.9	23.9	21.5	23.6	41	74.6	50.5	60.6	38.5	45.1
1931	24.2	33	27.6	39.6	36.8	52.4	51.2	33.3	32.7	25.8	80.5	28.3
1932	51.5	3	16.5	29	35.9	7.4	48.3	19.1	48.5	43.1	16.8	56.9
1933	37.3	30.3	43.4	12.9	26.4	32.8	40.7	30.5	18.3	27.6	15	25.2
1934	58	2.2	38	24.7	26.1	25.2	23.6	59.8	65.6	45.3	17.8	67.1
1935	16.2	39.4	17.8	23.1	13.6	62.4	12.3	42.2	74	50.6	52.6	19.3
1936	51.7	23.3	20.1	29.8	12.9	38.7	80.2	25.1	61	25.5	40.1	40.9
1937	58.5	54.3	26.9	34.7	35.9	26.7	50.3	43.5	52.3	25.2	19.2	25.4
1938	57.4	18.9	17.7	2	47.4	45	87.6	53.4	26.6	95.1	61.1	43.2
1939	65.7	35.8	35.2	14.1	17.4	29.8	47	18.9	29.4	11.3	96.6	29
1940	32.4	50.5	27.7	32.9	11.8	14	44.2	6.6	27.6	81.2	54.7	45.8
1941	28.9	47.8	30	21.8	34.3	9.8	36.4	40.4	12.7	34.9	63.4	30.2
1942	54.4	12.3	36.5	24.2	45.7	4	50.5	71.1	57.4	32.7	8.6	48.9
1943	65.6	23	11	19.7	42.1	39.3	26.1	58.1	32.7	49.2	35.5	28.9
1944	52.2	18.1	7.2	20.4	41.8	23	39.9	49.7	57	58.1	66.2	50.5
1945	26.3	40.8	22.2	17.2	42.4	47.6	54.9	30.6	47.2	38	8.7	54.3
1946	64.5	67.9	18.9	13.7	26.4	46.4	60.4	88.2	68.7	17.2	47.2	63.2
1947	46.1	24.7	59.5	50.5	60.2	58.5	37.8	10.9	48.9	49.6	56.7	37.7

1948	91.6	28.4	36.9	26.6	31.2	50.3	26.3	37.4	43.1	49.3	38.1	74.5
1949	26	34	29.6	29.9	22.9	9.4	38.3	50.6	13.2	83.2	42.3	53
1950	16.7	51.7	22.1	34.1	15.9	24.3	70.3	57.8	71	41.1	36.3	29.4
1951	48.9	33.4	50.4	23.5	23	18.1	21.2	53.2	59.5	25.4	40.5	74.4
1952	58.1	11.3	14.6	25.3	49.7	29	20.9	38	27.7	67.6	26.5	38.5
1953	20.7	20.3	5.6	37.7	22.5	12.9	43	62.3	35.3	40.5	35.5	36.5
1954	28.2	53.3	30.7	15.6	52.2	31.9	46.6	53.7	63.9	64.8	51.3	50.1
1955	34.8	31	19.2	35.9	42.5	54	6.9	17.1	45.3	20.2	33.3	56
1956	38.4	11.2	25.8	11.5	17.4	30.7	59.8	66.2	61.4	31.6	24.7	55
1957	54.4	40	47.8	20.7	26.8	10.8	59.4	22.6	44.7	55.2	9.2	35.8
1958	49.2	44.7	20.3	19.3	52.1	43.8	51.5	78.9	52	23.7	26.5	45.6
1959	27.4	14.7	28.7	45.2	23.5	29.9	33.7	9.5	18.6	73.4	41.9	92.5
1960	43.6	22.9	21.6	30.5	35.4	40.5	74.8	57.9	66.9	34.5	78	65.6
1961	68.1	39.8	6.9	61.5	29.8	24.7	50.3	32.7	49.1	43.2	30	30.5
1962	44.8	16.9	28.2	25.5	35.3	18.7	27.2	59.4	75.7	16.7	39.6	39.3
1963	4.8	15.8	43.5	22.6	29.2	29.3	32.2	41.3	26.3	61.3	59.2	12.2
1964	22.4	12.8	39.2	37.9	36.2	26.8	37.4	52.1	24.7	39.2	29.7	70.7
1965	57.3	4.1	46.1	35.4	46.4	40.5	48.6	45.4	35.1	17.4	42.6	60.2
1966	37	38.8	22.1	48.5	40	58.3	22.8	50.9	35.2	70.9	23.4	43.7
1967	31.7	45.9	19.7	16.7	59.6	10.3	18.2	36.2	47.6	74.5	33.2	28.1
1968	54.6	7.1	32.2	26.7	38	29.5	12.7	43.8	56.5	42.6	52.7	65
1969	53.7	16.9	21.1	29.7	24.1	27.9	16.3	16.1	13.3	17.5	43	39.2
1970	24.4	45.5	19.4	50.7	15.5	21	39	26.6	47.2	36.4	69.3	17.5
1971	22.3	24.7	30.7	20.4	30.9	26.6	22.7	29.5	15.2	35.6	36.2	22.6
1972	42	22.8	32.8	32.2	45.6	27.5	33	24.9	5.6	22.7	53.7	37.6
1973	28.7	20.5	11.9	20.9	34.1	9.3	49.5	46.4	39.6	33.1	61.2	32
1974	74.3	28.7	14.8	15.3	30.8	24	50.5	45.8	61.7	26	30.6	39.5
1975	68	18.8	13.7	20.2	14.7	3.7	38.9	14.3	63.8	42.2	24.2	21.9
1976	36.2	22	28.9	13.6	35.5	15.2	28	3.2	41.3	66.7	31.9	29
1977	26	60.4	30.1	37.2	11.8	39.6	18.4	55	25.6	49.2	39.6	36.4
1978	37.6	26.6	40	25.6	7.6	25.8	34.3	31.4	21.6	23.5	40.9	57.2
1979	24.2	21.5	33.7	40.3	48.8	23.9	13.9	53.8	20.8	46.3	47.9	59.7
1980	28.1	35	41.5	18.6	14.2	25.1	53.1	36.4	50.9	47.2	35.4	45.1
1981	19.8	29.9	44.8	6.9	59.7	33.1	29.1	11.9	58	42.5	30.6	30.9
1982	34.3	33.1	43.7	12.2	26.5	44.1	7.7	56.6	32	59.5	55	47.4
1983	51.7	20.6	46.8	33.8	62.2	26.5	26.7	33.2	52.2	51.1	13.6	65.2
1984	66.2	28.7	30.3	18.3	9.4	13.8	18.7	50.7	41.9	40.4	48.6	43.7
1985	11.9	13.1	31.8	25.8	36.8	35	51.6	91.6	28.1	30.8	23.9	44.8
1986	41.3	1.2	45.3	28.5	52.5	52	28.5	71.8	1.2	51.7	48.4	65.4
1987	14	24.2	28.5	32.2	6.6	59.6	13	28.1	48.9	47.3	33	25.2
1988	63.3	31	51.6	6	39.9	24.3	49.4	45.2	28.1	43.6	22.2	19.2
1989	30.9	38.3	49.4	27.2	10.5	30.9	6.3	46.3	32	44.7	14.4	29.5
1990	53.9	86.9	7.8	24.8	12.4	32	28.5	22.5	10.5	73.3	32	49.9
1991	39.9	31.3	28.1	54.3	2.3	46.9	32.9	38.1	25.8	50.1	45.3	17.1
1992	33.6	21.1	44.7	38.9	25.8	16.7	33.5	59.8	44	25.3	43.4	35.2

1993	41.3	7	22.1	56.7	44.1	55.9	25.5	18.4	47.3	18.4	29.9	79.7
1994	55.4	40.9	49.4	51.6	29.8	21.7	32.9	33.1	43.6	28	30.3	71.6
1995	76.9	58.5	35.3	15	19.3	9.1	30.3	18	23	72.4	43.6	24.6
1996	40.1	46.4	51.4	31.8	28.2	13.5	26.9	49.7	14.5	71	44	13.4
1997	13.7	63.5	9	20.1	38.6	59.3	39.6	87.9	17.2	59.7	39.9	36.8
1998	52.1	13.4	43.7	45.3	13	84.8	40.7	26.1	32.2	67.1	50.6	47.1
1999	57.6	17.1	29	24.9	28.8	34.4	19.7	21.8	70.2	24.7	46.9	85.3
2000	27.9	50.1	16.1	23.9	29.2	21	32.8	34.8	51.3	70.8	67.8	38.6
2001	14.4	21	33.7	44.2	20.6	29.8	18.9	48.4	27.4	46.1	21.2	15.9
2002	58.2	64.4	21.9	37.3	56.4	52.1	33.8	26.5	12.1	63.7	67	39.6
2003	22.1	13.2	18.8	22.9	52.1	36.1	37.1	4.2	19.7	15.6	32.9	28.8
2004	41.7	14.2	29.8	26.1	15.4	25.8	21.6	36.8	36.4	74.6	29.3	40.1
2005	59.8	21.1	32.5	38	27.5	15	43.5	27	29.8	49.8	36.6	25.3
2006	16.6	19.2	62.1	23.6	43.8	13.7	33.8	59.5	55.4	68.6	52.3	62.1
2007	39.2	32.6	31.6	4.9	24	97.7	87.2	55.2	12.7	16.5	45	44
2008	95.8	17.4	42.5	7	7	28.2	63.6	105.3	55.1	56	27.4	30.8
2009	41.3	12	19.8	43.2	38.6	23.8	65	63	21	28.1	84.7	27
2010	39	30.2	36.6	19	16.7	23.1	76.3	22.8	67.7	32.3	74.6	6.4

Summary of Birr Wind gusts greater than 57kph by Decade: 13% (1 failure in every 7.7 months) of months above SURVIVAL SPEED is not proper planning or sustainable development

Decade	Number of Months with wind gusts > 57kph	% of monthly failures over 120 months per decade & over 1,920 months per 150 years
1850 – 1859	9	8
1860 – 1869	12	10
1870 – 1879	20	17
1880 – 1889	9	8
1890 – 1889	19	16
1900 – 1909	14	12
1910- 1919	14	12
1920 – 1929	15	13
1930 – 1939	19	16
1940 – 1949	21	18
1950 – 1959	17	14
1960 – 1969	19	16
1970 – 1979	10	8
1980 – 1989	11	9
1990 – 1999	18	15
2000 – 2009	20	17
Total over 160 years	247	13

Table 2: Birr Wind gust speeds 1850 to 2010 in knots

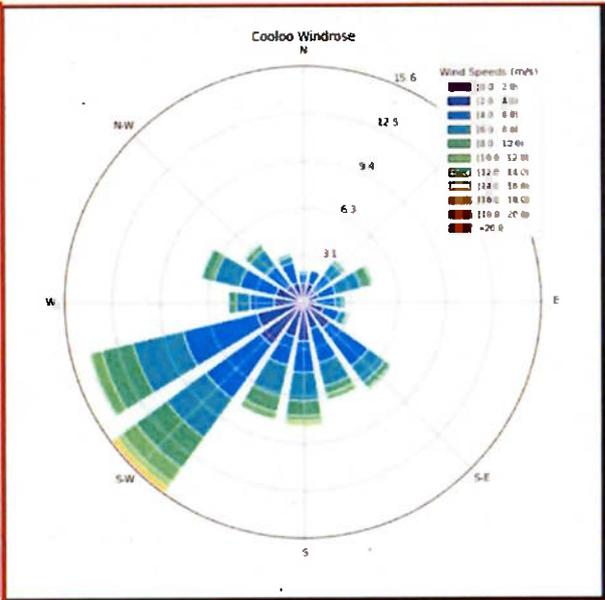
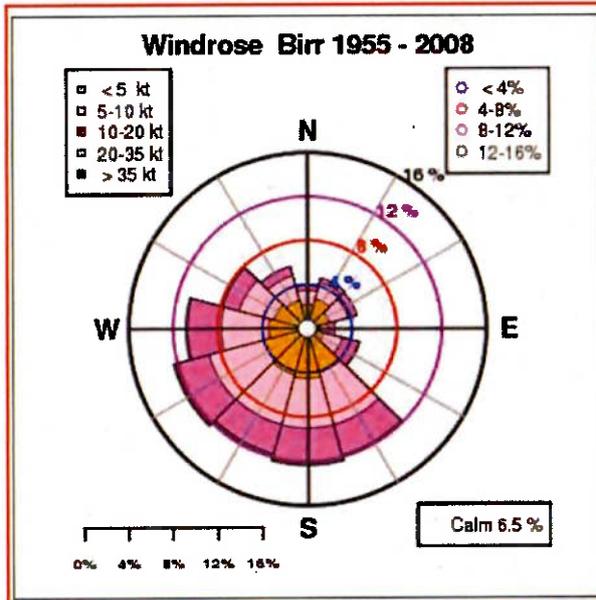
Easting	Northings	Latitude	Longitude	elevation (metres)	Station	County							
208016.8	203400.5	53.08143	-7.88109	73	Birr	Offaly							
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1850	93.3	41.5	10.3	81.7	72.2	40.9	81	47.5	68.4	39.5	70.8	62	

1851	144.7	18.4	72.9	33.1	28.9	88	90.9	56.7	30.3	91.2	40.5	52.2
1852	112.6	74	30.6	32.5	43.9	181.9	89.3	83.7	20.3	43.1	179.1	159.6
1853	99.6	30.3	69.8	74	26.1	68.4	86.5	75.9	49.5	146	78.4	17.5
1854	85.7	19.5	28.9	5.6	141.6	108.5	79.8	56.7	28.9	41.7	50.9	65.6
1855	10.3	38.7	88.4	26.1	57.3	55.3	79.5	85.4	36.4	75.7	32	39.5
1856	81.5	54	16.1	82.9	146	72	57.3	79.8	76.2	64.2	25.6	91.8
1857	65.1	40.6	65.9	106.5	55.6	77	37.5	41.2	80.9	60.9	68.4	27.8
1858	48.4	32	39.5	102.1	70.6	22.8	70.6	52.6	70.9	76.8	41.7	106.2
1859	54	34.2	64.8	89.3	8.9	40.6	40.9	53.4	122.7	43.9	90.9	85.9
1860	121.5	36.2	76.8	66.2	85.9	131.6	77.3	147.4	38.9	62.3	70.1	54.8
1861	47.3	52.8	97.9	22	8.1	94	210.3	129.1	130.7	94	85.4	49.2
1862	101.9	28.7	97.5	74.7	98.3	71.9	88.1	74.2	38.4	123.4	49.5	73.7
1863	79.2	41.9	64.3	31.7	25.7	22.9	8.4	95.8	93.2	106.9	103.4	71.1
1864	46	17.3	67.1	29.7	41.9	82.5	20.6	43.9	84.8	95.2	110	54.4
1865	98.6	68.8	45.7	26.7	93.7	21.6	80.5	71.6	12.2	102.4	106.9	78.5
1866	105.2	65.8	61.7	45.5	29	65.3	23.1	93.5	116.6	55.1	74.9	89.9
1867	66.8	60.7	57.1	75.4	78	25.9	97	73.4	33.5	119.4	32.3	29
1868	80.5	62.2	79.2	55.9	55.6	39.4	61.5	124.5	71.6	58.2	58.7	105.7
1869	103.1	65.5	45.2	71.1	94.5	38.4	54.6	52.6	156	15.7	74.2	130.3
1870	74.9	42.7	54.4	23.9	56.1	19.8	41.7	41.4	89.2	184.9	35.1	46.5
1871	72.6	53.3	51.6	53.1	51.6	73.2	132.6	55.9	16.3	88.9	43.2	61
1872	87.6	61	54.4	58.4	52.3	83.8	55.6	123.4	83.3	114	94.5	133.9
1873	135.9	22.9	106.7	45.5	53.6	36.3	106.7	124.7	103.6	99.1	51.8	29
1874	69.6	41.4	44.4	45.5	57.9	44.4	73.7	131.6	98.3	100.8	91.4	106.4
1875	123.2	30	26.7	20.1	49.3	81.3	65.8	78	166.4	77.5	66.5	49.8
1876	30.7	105.7	112.8	52.3	19	39.9	43.2	87.1	112.5	81.3	63.5	125.2
1877	120.4	58.9	67.3	76.5	52.6	94.7	58.9	111	65.5	88.9	138.2	85.1
1878	72.6	41.7	30.7	36.3	86.9	131.3	65	96.3	79.2	73.2	44.7	31.2
1879	42.7	83.6	40.4	56.9	64.8	124.5	76.2	115.3	116.8	31.5	21.8	47.2
1880	24.9	68.3	90.2	103.1	35.3	72.1	186.4	42.9	53.1	64.3	91.2	77.7
1881	17.3	84.3	58.9	34.3	63.2	104.4	47.8	119.9	100.6	63.5	103.9	122.2
1882	58.2	59.4	63.8	78.7	69.8	76.7	110.2	83.6	41.7	85.1	135.1	85.6
1883	125.7	91.4	16	43.9	65.3	43.7	99.1	100.8	86.4	90.9	106.9	47.2
1884	90.4	85.9	71.9	39.9	54.9	21.6	81.5	33	45.2	62.2	82	105.4
1885	56.1	74.2	41.4	82	54.6	30.2	54.6	79.2	129.3	95.5	47.8	24.4
1886	102.4	46.2	72.1	50.8	80.3	46	60.7	55.9	79	109.2	78.7	125
1887	71.4	31.7	33.3	48	35.1	8.6	73.9	63.2	42.4	67.1	55.4	66
1888	54.4	15.5	78.7	41.4	53.1	122.7	113.5	61.2	18	34.8	62.5	98
1889	56.1	43.2	36.3	47	83.3	31.2	48.3	122.7	22.4	79.5	39.1	78.7
1890	148.5	20.6	79.2	17.6	38.3	63.5	56.6	84	82.4	60	135.5	49.2
1891	48.1	4.3	36.5	47.8	79	77.1	54.5	177.5	51.6	86.9	68.1	152
1892	44.5	74	14.8	25.7	120	48.5	93.6	199	111.4	58.4	98.8	32.8
1893	73.5	75.5	19.7	20.8	68.9	66.7	55.6	95.6	58.3	79.9	47.9	101
1894	99.7	82.8	53.1	124	63.6	48.4	102.9	77.7	7.8	83.7	88.6	73.4
1895	56.1	21.7	75.7	49	17.4	20.8	90.9	123.4	11.3	72.8	111.6	94.1
1896	25.3	36.9	117.3	23	8.6	54.1	135.9	65.6	141.2	63.2	26.7	108.5
1897	46.2	41.6	117.3	110.2	33.8	96.2	59.3	107.1	56.5	67.2	130.9	99.2

1898	47.3	40.9	20.4	90.8	67.6	83.4	28.1	161.1	76.6	53.2	131.5	62.3
1899	87.8	58	32.3	75.3	85.3	47	87	111.7	59.7	40.4	71.6	99
1900	104.4	59.7	18.8	54.9	58.4	98.3	45.7	190.4	35.5	111.3	104.6	102.9
1901	69.7	33.3	73.7	51	46	71.9	31	70.3	98.7	66.8	104.5	75.9
1902	77.1	50.9	58.7	50.7	50.5	38.7	49.9	62.2	39.8	42.8	118.4	74
1903	120.6	82.2	139.4	35.3	42.4	30.1	129	132.1	81	113.3	63.8	66.4
1904	89.7	112.5	70.9	51	82.7	41.3	94.3	83	59.7	63	60.2	48.6
1905	58.5	40.1	107.7	47.2	23.1	37.3	34.2	137.3	36.1	34	63	48.2
1906	101.3	67.6	57.6	43.4	89.8	57.4	88.7	88.4	29.8	117.7	42.2	60
1907	29.1	43.7	69.5	63.4	73.3	75.9	124.7	83.2	26.4	122.5	71.7	89.8
1908	76.6	59.4	74.7	44.2	71.6	39.8	64.9	95.5	137.8	39.9	62.7	80.9
1909	70.6	24.6	77.4	107.6	66	43.7	50.1	29.9	53.3	109.5	50.1	94
1910	90.9	106.9	50	69	54	95	76.4	112.7	17.6	42.9	73.2	78.6
1911	42.6	68.2	33.5	41.4	32	56.1	72.9	60.4	42.4	103.6	103.9	129.8
1912	68.5	81	90.9	25.3	33.8	125.9	121.3	117.5	9.7	55.1	43.2	104.2
1913	121.2	32	100.1	99.2	88.1	83.2	26	32.9	81.3	92.2	78.2	64.3
1914	31.3	114.3	86.9	53	40.2	23.1	60.7	104.7	42.9	46.5	89.4	135.2
1915	102.7	105.3	20.3	43.8	12.4	50	117.2	100.5	37	74.2	76.8	108
1916	64.4	105.3	51.2	76	126.3	72.8	70.3	80.4	61.7	151.1	95.1	75.6
1917	24.8	46.3	62.4	29.2	83.6	39.2	65.9	229.2	44.3	99.1	63.2	36.8
1918	55.6	95.2	54.2	26.2	51.9	30.3	88.3	60.2	133.9	92	77.7	120.5
1919	70.4	34.7	47.2	38.3	64.1	95.5	45	59.7	65.1	23.3	52.6	132.5
1920	113.1	93.3	71.8	75.5	66.1	30.5	110.4	54	42.9	146.9	76	67.2
1921	94.1	23.4	71.9	20.1	51.1	19.3	101.9	85.4	55.8	67.1	71.5	106.8
1922	71.9	100.2	41.8	57.5	46.9	34.8	66.9	80.6	97.1	29.3	21.3	101.8
1923	74.4	121.4	59.8	73.7	33.8	23.7	71.8	136.5	85	114.1	75	81.1
1924	100.3	31.1	19.7	84.1	107.5	73.2	74.8	95.8	171.5	87.4	103.9	136.2
1925	83.8	133.7	11.9	96.5	120.8	13.9	100.9	46.4	46.8	55.1	54.4	43.8
1926	115.5	55.2	26.3	47.4	65.3	66.2	127	74.4	52.5	55.7	84.8	25
1927	85.9	61.7	87.5	39.1	20.1	70.6	75.3	109.1	124	48.5	63.1	54.9
1928	98.7	98.9	82.3	46.8	55	110.6	53.5	104.1	39.3	137.9	99.4	89.4
1929	37.4	83.5	13.4	23	65.3	42.9	88.2	126	21	103.2	101	165
1930	125	14.1	95	46.5	41.8	45.8	79.8	145	98.1	117.8	74.8	87.6
1931	47	64.2	53.7	77	71.5	101.8	99.5	64.8	63.5	50.1	156.5	55.1
1932	100.1	5.9	32.1	56.4	69.8	14.4	93.8	37.2	94.3	83.8	32.6	110.6
1933	72.6	59	84.3	25.1	51.3	63.7	79.2	59.2	35.6	53.6	29.2	49
1934	112.7	4.2	73.9	48.1	50.7	49	45.8	116.2	127.6	88.1	34.7	130.5
1935	31.4	76.6	34.6	44.9	26.5	121.4	23.9	82.1	143.9	98.4	102.3	37.5
1936	100.5	45.3	39	58	25	75.2	156	48.8	118.5	49.5	77.9	79.6
1937	113.7	105.5	52.3	67.5	69.7	52	97.8	84.6	101.7	48.9	37.3	49.3
1938	111.6	36.7	34.4	3.9	92.2	87.5	170.3	103.9	51.7	184.9	118.8	84
1939	127.7	69.6	68.5	27.4	33.8	57.9	91.3	36.8	57.1	22	187.8	56.4
1940	62.9	98.1	53.8	63.9	23	27.3	85.9	12.8	53.6	157.9	106.3	89.1
1941	56.1	93	58.4	42.4	66.7	19.1	70.8	78.6	24.7	67.9	123.3	58.7
1942	105.8	24	71	47.1	88.8	7.7	98.2	138.2	111.6	63.6	16.7	95.1
1943	127.6	44.7	21.4	38.3	81.9	76.4	50.8	112.9	63.5	95.7	69.1	56.1
1944	101.4	35.1	14	39.7	81.2	44.7	77.5	96.7	110.9	113	128.7	98.2

1945	51.1	79.4	43.1	33.4	82.4	92.6	106.8	59.5	91.8	73.9	17	105.6
1946	125.3	132	36.7	26.6	51.4	90.2	117.4	171.4	133.5	33.4	91.7	122.9
1947	89.7	48	115.6	98.2	117	113.8	73.5	21.2	95	96.4	110.2	73.2
1948	178	55.2	71.8	51.8	60.6	97.8	51.2	72.8	83.7	95.9	74.1	144.9
1949	50.6	66	57.6	58.1	44.5	18.2	74.4	98.3	25.7	161.7	82.2	103
1950	32.4	100.5	42.9	66.3	31	47.2	136.6	112.3	138.1	79.9	70.6	57.2
1951	95.1	64.9	97.9	45.6	44.8	35.2	41.3	103.5	115.6	49.3	78.8	144.6
1952	112.9	21.9	28.4	49.2	96.6	56.3	40.7	73.9	53.8	131.4	51.5	74.8
1953	40.2	39.4	10.9	73.2	43.8	25.1	83.5	121.2	68.6	78.7	69.1	71
1954	54.8	103.7	59.7	30.4	101.5	62.1	90.5	104.4	124.3	125.9	99.7	97.3
1955	67.6	60.2	37.3	69.7	82.6	105	13.5	33.2	88	39.3	64.7	108.9
1956	74.6	21.7	50.2	22.3	33.8	59.6	116.3	128.6	119.4	61.4	48	107
1957	105.7	77.7	93	40.2	52.1	21	115.4	43.9	86.8	107.4	17.9	69.5
1958	95.6	86.9	39.5	37.5	101.2	85.1	100.2	153.3	101	46.1	51.6	88.7
1959	53.3	28.5	55.7	87.9	45.6	58.2	65.5	18.4	36.1	142.7	81.4	179.9
1960	84.7	44.6	42	59.3	68.9	78.7	145.4	112.5	130.1	67.1	151.7	127.6
1961	132.4	77.4	13.4	119.5	57.9	48.1	97.8	63.6	95.4	83.9	58.3	59.3
1962	87.1	32.8	54.8	49.5	68.6	36.4	52.8	115.4	147.2	32.4	76.9	76.4
1963	9.3	30.8	84.6	44	56.7	56.9	62.5	80.2	51.1	119.2	115.1	23.8
1964	43.6	24.8	76.3	73.6	70.3	52.1	72.8	101.2	48.1	76.3	57.7	137.5
1965	111.3	7.9	89.6	68.8	90.2	78.7	94.4	88.3	68.2	33.9	82.8	117.1
1966	72	75.5	42.9	94.3	77.8	113.3	44.4	99	68.5	137.8	45.4	84.9
1967	61.6	89.2	38.3	32.5	115.8	20	35.4	70.4	92.5	144.8	64.5	54.6
1968	106.1	13.8	62.5	51.9	73.8	57.3	24.6	85.2	109.8	82.9	102.4	126.4
1969	104.4	32.9	41.1	57.8	46.8	54.2	31.7	31.3	25.8	34.1	83.5	76.3
1970	47.4	88.5	37.7	98.5	30.2	40.9	75.9	51.7	91.8	70.7	134.7	34.1
1971	43.3	48	59.7	39.7	60	51.7	44.2	57.3	29.6	69.3	70.3	44
1972	81.6	44.4	63.7	62.6	88.6	53.4	64.1	48.5	10.8	44.1	104.4	73.1
1973	55.7	39.8	23.2	40.6	66.2	18	96.2	90.2	76.9	64.3	119	62.3
1974	144.4	55.8	28.7	29.8	59.8	46.6	98.1	89.1	119.9	50.5	59.5	76.7
1975	132.2	36.5	26.7	39.2	28.6	7.1	75.7	27.8	124	82	47	42.5
1976	70.4	42.7	56.2	26.4	69	29.5	54.4	6.2	80.3	129.7	62.1	56.4
1977	50.6	117.4	58.5	72.4	22.9	77	35.7	106.9	49.8	95.7	76.9	70.7
1978	73	51.7	77.7	49.8	14.8	50.1	66.7	61.1	41.9	45.7	79.5	111.1
1979	47.1	41.8	65.6	78.3	94.8	46.5	27	104.6	40.5	90.1	93.2	116
1980	54.7	68.1	80.6	36.1	27.7	48.7	103.2	70.8	98.9	91.7	68.8	87.6
1981	38.4	58.2	87.1	13.4	116	64.4	56.5	23.2	112.7	82.7	59.4	60.1
1982	66.7	64.4	84.9	23.8	51.6	85.7	14.9	110	62.2	115.6	106.9	92.2
1983	100.5	40	90.9	65.7	121	51.5	52	64.6	101.4	99.4	26.5	126.7
1984	128.6	55.7	58.9	35.6	18.3	26.9	36.3	98.6	81.5	78.6	94.4	85
1985	23.2	25.4	61.8	50.2	71.5	68.1	100.4	178	54.6	59.9	46.4	87.1
1986	80.3	2.4	88.1	55.4	102.1	101	55.4	139.5	2.3	100.5	94.1	127.1
1987	27.3	47.1	55.4	62.6	12.8	115.8	25.2	54.7	95	92	64.2	48.9
1988	123.1	60.3	100.4	11.6	77.5	47.3	96	87.9	54.7	84.8	43.1	37.4
1989	60	74.5	96.1	52.8	20.5	60	12.3	90	62.2	86.8	27.9	57.4
1990	104.8	168.9	15.2	48.3	24.1	62.2	55.4	43.8	20.5	142.5	62.3	97
1991	77.5	60.9	54.6	105.6	4.4	91.2	63.9	74.1	50.1	97.4	88.1	33.2

1992	65.4	41	86.8	75.7	50.2	32.5	65.1	116.2	85.5	49.1	84.3	68.5
1993	80.2	13.6	43	110.2	85.8	108.6	49.6	35.8	91.9	35.7	58.2	155
1994	107.7	79.5	96	100.4	57.9	42.2	64	64.4	84.7	54.5	59	139.2
1995	149.5	113.7	68.7	29.2	37.6	17.7	59	35	44.8	140.7	84.8	47.9
1996	78	90.2	100	61.9	54.8	26.2	52.2	96.7	28.1	138.1	85.5	26
1997	26.6	123.5	17.5	39	75.1	115.2	76.9	170.9	33.4	116.1	77.6	71.5
1998	101.2	26	84.9	88	25.3	164.8	79.1	50.8	62.5	130.5	98.4	91.6
1999	111.9	33.3	56.3	48.5	56	66.9	38.2	42.3	136.5	48	91.1	165.8
2000	54.3	97.3	31.3	46.5	56.7	40.8	63.7	67.7	99.8	137.6	131.8	75
2001	27.9	40.9	65.6	86	40	57.9	36.7	94.1	53.3	89.6	41.2	30.9
2002	113.1	125.1	42.6	72.6	109.6	101.2	65.8	51.6	23.5	123.8	130.2	77
2003	42.9	25.6	36.5	44.6	101.3	70.1	72.1	8.2	38.3	30.3	63.9	55.9
2004	81.1	27.7	57.9	50.7	29.9	50.1	41.9	71.5	70.8	145.1	56.9	78
2005	116.3	41	63.2	73.9	53.5	29.1	84.6	52.5	58	96.9	71.1	49.2
2006	32.3	37.3	120.7	45.9	85.1	26.6	65.7	115.7	107.7	133.4	101.7	120.8
2007	76.3	63.4	61.4	9.6	46.7	190	169.6	107.3	24.6	32.1	87.4	85.5
2008	186.2	33.8	82.7	13.6	13.7	54.8	123.7	204.8	107.1	108.8	53.2	59.8
2009	80.2	23.4	38.5	83.9	75	46.2	126.3	122.5	40.8	54.7	164.7	52.4
2010	75.9	58.7	71.1	36.9	32.4	44.9	148.3	44.4	131.7	62.8	145.1	12.4



This Cooloolo Windrose indicates prevailing winds from SW & WSW

The NS alignment of the wind turbines indicated above shows that turbulence, noise & wake effects will be exacerbated beyond the data provided by the Applicant to downwind property owners.

The prevailing winds are from the W/SW directions. This means that the Wake will primarily be to the East/Northeast, which has a huge impact on the low-lying farmlands to the East. These include a lowering of the ground temperature by 3° Centigrade together with turbulent air that restricts flying birds. Additionally, this Wake would create a barrier to migration Iceland to the Wexford slob. This barrier would interfere with foraging for food & would create massive displacement to the detriment of a range of at risk species & protected species.

This drop in temperature will have an effect on the food source for birds in association with an economic cost on all existing houses, with increased heating costs & colder enjoyment values.