3. SITE SELECTION AND REASONABLE ALTERNATIVES

3.1 Introduction

Article 5(1)(d) of Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) as amended by Directive 2014/52/EU (the EIA Directive) requires that the Environmental Impact Assessment Report (EIAR) prepared by the developer contains *"a description of the reasonable alternatives studied by the developer, which are relevant to the project and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the project on the environment."*

Article 5(1)(f) of the EIA Directive requires that the EIAR contains *"any additional information specified in Annex IV relevant to the specific characteristics of a particular project or type of project and to the environmental features likely to be affected."*

Annex IV of the EIA Directive states that the information provided in an EIAR should include a *"description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the Proposed Project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."*

As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described using the following references: 'the 'Proposed Project', the 'Proposed Wind Farm', the 'Proposed Grid Connection Route', the 'Site'. This section of the EIAR contains a description of the reasonable alternatives that were studied by the developer, which are relevant to the Proposed Project and its specific characteristics, in terms of site location and other renewable energy technologies as well as site layout incorporating size and scale of the Proposed Project, connection to the national grid and transport route options to the Site. This section also outlines the design considerations in relation to the renewable energy development, including the wind farm and grid connection. It provides an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects. The consideration of alternatives is an effective means of avoiding environmental impacts. As set out in the '*Guidelines on The Information to be Contained in Environmental Impact Assessment Reports' (EPA, 2022),* the presentation and consideration of reasonable alternatives investigated is an important part of the overall EIA process.

Hierarchy

EIA is concerned with projects. The Environmental Protection Agency guidelines (EPA, 2022) state that in some instances neither the applicant nor the competent authority can be realistically expected to examine options that have already been previously determined by a higher authority, such as a national plan or regional programme for infrastructure.

Non-environmental Factors

EIA is confined to the environmental effects that influence consideration of alternatives. However, other non-environmental factors may have equal or overriding importance to the developer of a project, for example project economics, land availability, engineering feasibility or planning policy.

Site-specific Issues

EPA, 2022 states that the consideration of alternatives also needs to be set within the parameters of the availability of the land, i.e., the Proposed Wind Farm site may be the only suitable land available to the

developer, or the need for the project to accommodate demands or opportunities that are site-specific. Such considerations should be on the basis of alternatives within a site, for example design and layout.

3.2 Consideration of Reasonable Alternatives

3.2.1 Methodology

The EU Guidance Document (EU, 2017) on the preparation of EIAR outlines the requirements of the EIA Directive and states that, in order to address the assessment of reasonable alternatives, the Developer needs to provide the following:

- A description of the reasonable alternatives studied; and
- An indication of the main reasons for selecting the chosen option with regards to their environmental impacts.

There is limited European and National guidance on what constitutes a 'reasonable alternative' however the EU Guidance Document (EU, 2017) states that reasonable alternatives "*must be relevant to the Proposed Project and its specific characteristics, and resources should only be spent assessing these alternatives".*

The guidance also acknowledges that "*the selection of alternatives is limited in terms of feasibility. On the one hand, an alternative should not be ruled out simply because it would cause inconvenience or cost to the Developer. At the same time, if an alternative is very expensive or technically or legally difficult, it would be unreasonable to consider it to be a feasible alternative".*

EPA, 2022 states that "*It is generally sufficient to provide a broad description of each main alternative and the key issues associated with each, showing how environmental considerations were taken into account is deciding on the selected option. A detailed assessment (or 'mini-EIA') of each alternative is not required."*

Consequently, taking consideration of the legislative and guidance requirements into account, this chapter addresses alternatives under the following headings:

- 'Do Nothing' Alternative
- Alternative Site Locations
- Alternative Renewable Energy Technologies
- Alternative Project Design Options:
    - Alternative Turbine Numbers and Model
    - Alternative Turbine Layout and Development Design
    - Alternative Road Layout
    - Alternative Construction Compound Option
    - Alternative Borrow Pit Option
    - Alternative Turbine Component Delivery Option
        - Alternative Port of Entry
        - Alternative Component Delivery Route
    - Alternative Design of Ancillary Structures
        - Alternative Meteorological Mast Location
- Alternative Proposed Grid Connection Design Options
    - Alternative Substation Location
    - Alternative Grid Connection Cabling Route Options
- Alternative Mitigation Measures

Each of these is addressed in the following sections. When considering the Proposed Project, given the intrinsic link between layout and design, the two will be considered together in this chapter.

3.2.2 'Do Nothing' Alternative

Annex IV, Part 3 of the EIA Directive states that the description of reasonable alternatives studied by the developer should include *"an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge."* This is referred to as the "do nothing" alternative. EU guidance (EU, 2017) states that this should involve the assessment of *"an outline of what is likely to happen to the environment should the Project not be implemented – the so-called 'do-nothing' scenario."*

An alternative land use option to developing a renewable energy project at the Proposed Wind Farm site would be to leave the Proposed Wind Farm site as it is, with no changes made to the current land use practices of low intensity agriculture and commercial forestry, and public road corridor. In doing so, the environmental effects in terms of emissions are likely to be neutral.

The land-uses at the site of the Proposed on-site 110kV Substation and along the Proposed 110kV Grid Connection would be left as it is, with no changes made to existing land-use practices. Current land use practices of low intensity agriculture would continue at the site of the Proposed on-site 110kV Substation and public road corridor (approx. 37.6km for the Proposed Grid Connection underground cabling route) would continue. In doing so, the environmental effects in terms of emissions are likely to be neutral.

However, by implementing the 'Do-Nothing' alternative, the opportunity to capture the available renewable energy resource would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions. The opportunity to generate local employment and investment would also be lost.

As such, on the basis of the positive environmental effects arising from the Proposed Project when compared to the 'Do-Nothing' scenario, the Do-Nothing' scenario was not the chosen option. The existing land uses can and will continue in conjunction with the Proposed Project. A comparison of the potential environmental effects of the 'Do-Nothing' Alternative when compared against the chosen option of developing a renewable energy project at this Proposed Wind Farm site are presented in Table 3-1 below.

Table 3-1 Comparison of environmental effects when compared against the chosen option of developing a renewable energy project.

Environmental Consideration	Do-Nothing Alternative	Chosen Option of developing a renewable energy project
Population & Human Health	No increase in local employment and no long-term financial contributions towards the local community. No potential for shadow flicker and noise to affect sensitive receptors. No potential for effects on visual amenity due to the construction and operation of turbines. No potential for positive effects on air quality and climate change targets.	Approximately 100-120 jobs could be created during the construction, operation, and maintenance phases of the Proposed Project. Based on the assessment detailed in Chapter 5 and the mitigation measures proposed, there will be no significant effects related to shadow flicker and noise from the Proposed Project. As detailed in Chapter 12, residual effects from Noise and Vibration are predominantly not significant for the short-term construction and decommissioning phases. For the Operational Phase, the residual

Environmental Consideration	Do-Nothing Alternative	Chosen Option of developing a renewable energy project
	No potential to supply an estimated 65,174 homes with clean renewable electricity.	effects range from not significant to imperceptible on sensitive receptors. As detailed in Chapter 14, there will be no significant residual Landscape & Visual effects. The proposed turbine locations adhere to the recommended 4 times tip height set-back distance (for non-involved sensitive receptors) set out in the draft Guidelines for the purpose of protecting visual amenity. As detailed in the assessment in Chapter 10, the overall impact will be a Long-term Moderate Positive Impact on air quality.
Biodiversity (including Ornithology)	No habitat loss. No potential for collision risk for birds and bats No potential biodiversity enhancement measures would be put in place.	As detailed in Chapter 6, the development has been designed to avoid or mitigate impacts on biodiversity. As detailed in the Bat Report in Appendix 6-2 of this EIAR, there is unlikely to be any significant effect in relation to collision risk to bats from the Proposed Project. As detailed in Chapter 7, the Collision Risk Assessment (CRA) indicates that the impact of the Proposed Project on birds corresponds to a Low effect significance.
Land, Soils & Geology	Neutral	As detailed in the assessment in Chapter 8, there is no net loss of topsoil or subsoil as a result of the Proposed Project. Topsoil and subsoil will be relocated within the Site.
Hydrology & Hydrogeology	Neutral	As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.
Air Quality	Neutral. Will not provide the opportunity for an overall increase in air quality.	As detailed in Chapter 10, there will be no significant effects on air quality during the construction, and decommissioning phases. There will be a Long-term Moderate Positive Impact on air quality during the operational phase.

Environmental Consideration	Do-Nothing Alternative	Chosen Option of developing a renewable energy project
Climate	Neutral. Will not provide the opportunity for a contribution to the reduction of greenhouse gases. No potential to assist in achieving the renewable energy targets set out in the Climate Action Plan 2025.	As detailed in the assessment in Chapter 11 Climate, over the proposed 35-year lifetime of the Proposed Wind Farm, 62,931 tonnes of carbon dioxide per annum will be displaced from traditional carbon-based electricity generation. Over the proposed 35-year lifetime of the development, therefore, 2,202,588 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation. The addition of an estimated 86.8MW clean energy to the national grid will be a positive contribution to the States renewable energy targets set out in the Climate Action Plan 2025.
Noise & Vibration	No potential for noise impacts on nearby sensitive receptors.	Based on the assessment detailed in Chapter 12 and the mitigation measures proposed, there will be no significant effects on sensitive receptors due to an increase in noise levels from the Proposed Project during the construction and operational phase.
Cultural Heritage	No potential for impacts on unrecorded, subsurface archaeology.	As detailed in Chapter 13, there will be no significant direct or indirect effects on known or unknown archaeology and cultural heritage during the construction, and decommissioning phases. During the operational phase, following an assessment of over 156 no. archaeological heritage, Built Heritage, Designated Landscapes, National Significance and cultural heritage sites, significant indirect effects are only expected to occur at three sites located within the proximity of the Proposed Wind Farm site.
Landscape & Visual	No potential for landscape and visual impacts on nearby sensitive receptors.	As detailed in the assessment in Chapter 14, overall, the Proposed Project adheres to good siting and design according to best practice wind energy development guidelines, being appropriately scaled for the landscape type and sited in a landscape of low sensitivity, with no potential for significant residual effects on key

Environmental Consideration	Do-Nothing Alternative	Chosen Option of developing a renewable energy project
		landscape and visual sensitivities. Significant residual effects on residential visual amenity are localised to a very small number of residential receptors.
Material Assets (Including Traffic & Transport)	Neutral	As detailed in Chapter 15, there will be temporary imperceptible to slight negative effect on traffic volumes on the local road network during the construction phase of the Proposed Project. A detailed Traffic Management Plan incorporating all the mitigation measures will be agreed with the roads authority prior to construction works commencing on-site. Consultation regarding the potential for electromagnetic interference from the Proposed Project was carried out with the relevant national and regional broadcasters, fixed line and mobile telephone operators and other operators. EIR and Enet were identified as operators with links and whose requested setback buffers have proposed turbines located within. Without mitigation measures, as outlined in Appendix 15-4 and Appendix 15-5, there would be no impact on EIR and Enet links, respectfully. The Proposed Project will have an imperceptible impact on telecommunication. In order to assess the potential for significant effects on built services and waste management in the vicinity of the Proposed Project, scoping requests were made to EirGrid, Uisce Éireann and numerous sections of Tipperary and Limerick County Councils including Water Services and Environment. Refer to Section 2.7 of Chapter 2 of this EIAR for details in relation to the EIA scoping exercise. There is potential for and underground services to be impacted during the construction phase, specifically during the delivery of turbine components and the laying of grid connection cables along the public road corridor. Following the

Environmental Consideration	Do-Nothing Alternative	Chosen Option of developing a renewable energy project
		implementation of the mitigation measures (listed in Section 15.3, Chapter 15), there will be a short-term imperceptible negative residual impact on services during the construction phase of the Proposed Project.
Vulnerability of the Project to Major Accidents and Natural Disaster	No potential to be affected by or to cause major accidents or natural disasters	As demonstrated in Chapter 16, the risk of a major accident and/or disaster during the construction of the Proposed Project is considered 'low' in accordance with the 'Guide to Risk Assessment in Major Emergency Management' (DoEHLG, 2010). The Proposed Project will be designed and built in accordance with current best practice and, as such, mitigation against the risk of major accidents and/or disasters will be embedded through the design. With the implementation of all mitigation and monitoring measures detailed in the EIAR, there will not be significant residual effects associated with the construction, operation and decommissioning of the Proposed Project.

3.2.3 Alternative Site Locations

To ensure that the Levelised Costs of building each Megawatt of electricity-generating capacity on a wind farm is controlled efficiently, it is incumbent on the design team to ensure that the most suitable site for development of a wind farm development is chosen. 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.

The Proposed Wind Farm site has been identified as having potential for a wind energy development as a result of a nationwide search of suitable lands. The site selection process has been constraints and facilitators led. Facilitators are factors that give an advantage to a proposed project, while constraints are restrictions that inform the location and design of a project by highlighting sensitivities. A nationwide constraints analysis was undertaken and included avoidance of environmental designations (Natura 2000 sites), review of national, regional and local policies and objectives, suitable wind speeds, adequate setbacks from sensitive receptors, proximity to national grid nodes, avoidance of direct impacts on known cultural heritage assets, access and constructability.

3.2.3.1 Grid Connection

The Proposed Project intends to connect to the national grid via 110kV underground electrical cabling predominantly along the public road corridor from the Proposed Wind Farm to the existing Killonan 110kV substation, in the townland of Milltown, approximately 5.6km southeast of Limerick City, Co.

Limerick. Details regarding potential alternative grid connection options are considered and presented in Section 3.2.5.

3.2.3.2 Strategic Site Selection

As the cost of building each megawatt of electricity generating capacity in a wind farm is in the region of €1.5 million, it is critical that the most suitable site for the Proposed Project is chosen.

As set out in Section 1.3 of this EIAR, the applicant company, Carrow Renewable Energy Ltd is a subsidiary of Atlantic Infrastructure Renewables (AIR) which is an Irish-owned Limerick-based company with extensive experience in renewable energy and is responsible for projects throughout Ireland. MKO, on behalf of AIR, undertook a detailed site identification process, through Geographical Information Spatial (GIS) software, within multiple counties which has led to a number of sites which AIR wishes to bring forward to planning including the Proposed Project sites and further sites in Co. Galway and Co. Kilkenny.

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

- **Environmental Sensitivities:** Located outside of EU Natura 2000 sites; locations outside of National designations; located outside of Article 17 Annex I Habitats;
- **Grid Connection:** Access to the national electricity grid possible within a suitable 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 criteria above will be explained further below in so far as they influenced the site selection exercise undertaken.

3.2.3.2.1 *Environmental Sensitivities*

The Proposed Wind Farm is not located within any area designated for ecological protection. The Proposed Grid Connection underground cabling route crosses the Lower River Suir Special Areas of Conservation (SAC) in the townlands of Ballybrack, Shanaknock and Rahyvira in Co Tipperary and the Lower River Shannon SAC in the townlands of Cahernahallia, Co. Tipperary and Toomaline Lower, Toomaline Upper, Gortnascarry, Cappamore, Dromcluher, Eyon and Brittas Co. Limerick. At these locations, the proposed underground cabling route will cross the river via horizontal direction drilling, with the drilling commencing within the public road corridor, and finishing in the public road corridor, outside of the European designated sites.

The nearest Natura 2000 site to the Proposed Wind Farm site is the Lower River Suir SAC, which is located approximately 487m south of the Proposed Wind Farm infrastructure at its nearest point. The Lower River Suir SAC has many qualifying interests relating to both freshwater and terrestrial habitats and species.

The closest Natural Heritage Area (NHA) or proposed Natural Heritage Area (pNHA), is Aughnaglanny Valley pNHA, which is located approximately 77m east of the Proposed Wind Farm infrastructure at its nearest point.

The Proposed Wind Farm site is located primarily on lands comprising of commercial forestry, agricultural pastural land, mixed forest and transitional woodland-shrub.

3.2.3.2.2 *Article 17 Annex I Habitat*

In addition to the above, there is 1 no. Article 17 Annex I habitat recorded within the application Site approximately 122m north of the Proposed Wind Farm infrastructure at its nearest point. Comprehensive multi season site surveys have confirmed that this Annex I habitat will not be impacted by the Proposed Wind Farm. Habitats within the Proposed Wind Farm site are predominantly improved agricultural grassland, public road, commercial forestry, mixed forest and transitional woodland-shrub and are of a low ecological value. There are no Article 17 Annex I habitats within the site boundary of the Proposed Grid Connection. Please see Chapter 6 Biodiversity for further details regarding habitats within the Site.

3.2.3.2.3 Sensitive Receptors

The Applicant sought to identify an area with a relatively low population density to allow for appropriate setback distances from residential sensitive receptors. Having reviewed the settlement patterns in the vicinity, the study area has emerged as suitable to accommodate the Proposed Wind Farm. The population density of the Population Study Area of the Proposed Wind Farm as described in the Population and Human Health section of this EIAR is 37 persons per square kilometre, as described in Chapter 5 of this EIAR. This is significantly lower than the average national population density of 73.3 persons per square kilometre. The proposed turbine positions achieve the recommended setbacks in both the Guidelines (500m) and the draft Guidelines (4 x the proposed turbine tip height). The nearest settlement to the proposed turbines is the village of Hollyford, Co. Tipperary located approximately 2.3km north of T09.

3.2.3.2.4 Site Scale

The Site, covering a total of 1,564 hectares, with the Proposed Wind Farm site measuring 830 ha comprises a mix of commercial forestry, agricultural pastural land, mixed forest, transitional woodland-shrub and public road corridors. The Proposed Wind Farm site has an elevation range of 376 meters above ordnance datum (mAOD) at its highest point in the north to approximately 163 mAOD at its lowest point at its south western boundary of the Proposed Wind Farm site. Land-use in the wider vicinity of the Site comprises a mix of agriculture, low density residential, renewable energy and industrial and commercial. The Proposed Wind Farm site benefits from existing forestry and agricultural tracks (approx. 2.5km). The Proposed Wind Farm site is easily accessible via a site entrance off the L1154 local road along the southwestern boundary of the Proposed Wind Farm site in the townland of Moheragh. As discussed above, the Site comprises habitats of low ecological value and the recommended setback distance to sensitive receptors is achieved.

The constraints and facilitators mapping process is outlined in Section 3.2.5.2.1.

3.2.3.2.5 Summary

From the review of the criteria set out above, the Site is considered a suitable location for the provision of a renewable energy development of the scale proposed. The Proposed Wind Farm is located on agricultural land and commercial forestry which allows the Site to take advantage of the existing access roads (some of which will be upgraded) and highlights the suitability of the Proposed Wind Farm as it can make sustainable use of established items of infrastructure.

The Proposed Wind Farm site is not located within EU or National protected areas, nor does it contain any EU designated Annex I Habitat. The Proposed Wind Farm site is located adjacent to the Augnhaglanny Valley pNHA. The Proposed Wind Farm site is located primarily on agri-pastoral lands and mixed/commercial forestry, of low ecological value, within a rural setting. Required setbacks from sensitive receptors, as set out above are achievable. The Proposed Grid Connection underground cabling route crosses the Lower River Suir SAC in the townlands of Ballybrack, Shanaknock and Rahyvira in Co Tipperary and the Lower River Shannon SAC in the townlands of Cahernahallia, Co. Tipperary and Toomaline Lower, Toomaline Upper, Gortnascarry, Cappamore, Dromcluher, Eyon and Brittas Co. Limerick. At these locations, the proposed underground cabling route will cross the river via horizontal direction drilling, with the drilling commencing within the public road corridor, and finishing in the public road corridor, outside of the SAC.

From the review of the criteria set out above, the Proposed Grid Connection was identified for the provision of a connection of the Proposed Wind Farm to the national grid. The 110kV underground electrical cabling route is located primarily within the public road corridor and does not directly interact with any environmental designations. The 110kV underground electrical cabling route overlaps with the Lower River Suir SAC and the Lower River Shannon SAC when crossing watercourses along its route. However, there are no instream works proposed as part of the Proposed Grid Connection underground cabling route construction, so no significant impacts have been identified.

Factoring all required environmental constraints into the project design, a site of considerable scale, with an estimated installed capacity of 86.8MW, and potential to power approximately 65,174 Irish

households with renewable energy and displace 62,931 tonnes of carbon dioxide per annum (2,202,588 tonnes over the 35-year operational life), the Site is considered appropriate for wind energy development and represents a positive contribution to National and EU climate action targets.

3.2.4 Alternative Renewable Energy Technologies

The Proposed Project will be located in a site where commercial forestry and agriculture will continue to be carried out around the footprint of the Proposed Project.

Both onshore and offshore wind energy development will be required to ensure Ireland reaches the target set in the Climate Action Plan to source 80% of our electricity from renewable energy by 2030. It is not a case of 'either' 'or'. The Climate Action Plan has set out the following targets for electricity generation:

Share of electricity demand generated from renewable sources to up to 80% where achievable and cost effective, without compromising security of electricity supply;

- Onshore Wind Capacity: up to 9GW
- Offshore Wind Capacity: 5GW (minimum)
- Solar PV Capacity: 8GW

When considering other renewable energy technologies in the area, the Applicant considered offshore wind and commercial solar energy production as an alternative on the Proposed Wind Farm.

3.2.4.1 Offshore Wind

Although the screening exercise was based on identifying lands for onshore wind development; another alternative source of renewable electricity generation would be offshore wind energy.

However, it is considered that due to delays with the regulatory process for offshore development, a combination of both onshore and offshore wind farm development will continue to be required to deliver on the ambitious renewable energy targets set under the Climate Action Plan 2025 (CAP25) which include focusing on onshore wind energy developments to reach the 2030 renewable energy targets. As such, Carrow Renewable Energy Ltd's primary focus is onshore wind farms and delivering suitable sites onshore such as the Proposed Project.

The Applicant is committed to playing a key role in helping the State achieve its CAP25 objective, as such, the option of an offshore project is not considered to be a reasonable alternative at this time.

3.2.4.2 Solar Energy

Commercial solar energy production is the harnessing and conversion of sunlight into electricity using photovoltaic (PV) arrays (panels). During the initial stages of the Proposed Project design, a combination of solar energy and wind energy were considered for the Proposed Project at this Site, however, this was subject to land availability at the same time and the Proposed Project was progressed. To achieve the same electricity output from solar energy as is expected from the Proposed Project (c. 86.8MW), a larger development footprint would be required. As detailed in Section 1.1.1 in Chapter 1, the Proposed Wind Farm site boundary encompasses an area of approximately 830ha and the permanent footprint of the Proposed Wind Farm measures approximately 26.1ha which represents approximately 3.14% of the Proposed Wind Farm site. In order to achieve a c.86.8MW output using solar PV arrays, there would be a requirement of approximately 138.88ha[1], which represents approximately 17% of the Proposed Wind Farm site.

[1] *Approximately 1.6 - 2 ha are required for each MW of solar panels installed based on approximately 4000 panels per MW (taken from the Sustainable Energy Authority Solar Energy FAQ publication which can be accessed here: https://www.seai.ie/publications/FAQs_on_Solar_PV.pdf). For the purposes of comparison, a minimum value of 1.6 ha has been assumed.*

In addition, a solar development of this scale, would have a higher potential environmental effect on Traffic and Transport (construction phase), Air Quality (construction phase) and Biodiversity and Ornithology (habitat loss), a greater potential for direct impacts on unknown subsurface archaeology (construction phase) and glint and glare at the Proposed Wind Farm site (operational phase). Taking into account the factors outlined above and considering the farming and commercial forestry practices in the area, it has been determined that wind energy is the most suitable renewable energy technology for the Proposed Wind Farm site with the lesser potential for significant, adverse environmental effects.

A comparison of the potential environmental effects of the development of a solar PV array when compared against the chosen option of developing wind turbines at the Proposed Project is presented in Table 3-2 below.

Table 3-2 Comparison of environmental effects when compared against the chosen option (wind turbines)

Environmental	Solar PV Array (with up to 86.8MW Output)	Chosen Option
Population & Human Health (incl. Shadow Flicker)	Relatively lower long-term financial contributions towards the local community (i.e., community benefit fund) on a per MWh basis. Lower potential for noise and vibration effects. Lower potential for visual obstructions in the skyline due to solar farms being low lying structures No potential for shadow flicker to affect sensitive receptors. Potential for glint and glare impacts on local receptors.	Higher long-term financial contributions towards the local community (i.e., community benefit fund) on a per MWh basis. Based on the assessment detailed in Chapter 5 and the mitigation measures proposed, there will be no significant effects related to shadow flicker from the Proposed Project. Greater potential for noise and vibration during construction, operational and decommissioning phases. Greater potential for visual effects during operational phase. No material difference between the two options during construction and decommissioning. No potential for glint and glare impacts on sensitive receptors.
Biodiversity (including Birds)	Larger development footprint would result in greater potential habitat loss. No potential for collision risk for birds.	Smaller development footprint would result in a smaller habitat loss. As detailed in Chapter 6 Biodiversity, the development has been designed to avoid or mitigate impacts on biodiversity including bats and downstream aquatic receptors. With the implementation of the mitigation measures described in Chapter 7 Ornithology, the

		residual effects for collision risk are not significant.
Land, Soils & Geology	Shallower excavations involved in solar PV array developments would result in reduced volume of spoil to be excavated.	As detailed in the assessment in Chapter 8, there is no loss of topsoil or subsoil as a result of the Proposed Project. Topsoil and subsoil will be relocated within the Proposed Wind Farm site. No significant effects on soils and subsoils will occur.
Water	Shallower excavations involved in solar PV array developments would result in reduced volume of spoil to be excavated, therefore reducing the potential for silt-laden runoff to enter receiving waterbodies.	Project design specific drainage design removes the potential for significant environmental effects. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.
Air Quality	Increased potential for dust and other noxious emissions due to larger volume of transport movements to and from site and larger volume of plant and ground works on-site due to the larger footprint.	Reduced potential for dust and other noxious emissions due to smaller volume of plant and ground works on-site due to a smaller footprint.
Climate	Reduced capacity factor of solar PV array technology would result in less carbon offset	Greater capacity factor resulting in a shorter carbon payback period. As detailed in the assessment in Chapter 11 Climate, over the proposed 35-year lifetime of the Proposed Wind Farm, 2,202,588 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation. The addition of an estimated 86.8MW clean energy to the national grid will be a positive contribution to the States renewable energy targets set out in the Climate Action Plan 2025.
Noise & Vibration	Potential for short term noise impacts on nearby sensitive receptors during the construction phase. Larger traffic movements and increased plant on-site due to the larger footprint could lead to larger noise and vibration output during the construction phase.	Based on the assessment detailed in Chapter 12 and the mitigation measures proposed, there will be no significant effects on sensitive receptors due to an increase in noise levels from the Proposed Project during the construction and operational phase.

Cultural Heritage	Larger development footprint would increase the potential for impacts on unrecorded, subsurface archaeology.	Smaller development footprint would decrease the potential for impacts on unrecorded, subsurface archaeology. As detailed in Chapter 13, there will be no significant direct or indirect effects on known or unknown archaeology and cultural heritage during the construction, operation and decommissioning phases. Archaeological monitoring under licence of the smaller footprint will be implemented during the construction phase.
Landscape & Visual	Panelling potentially less visible from surrounding area due to the screening by vegetation and topography.	Greater visibility due to the vertical scale of the proposed turbines. As detailed in the assessment in Chapter 14, the landscape value of the Proposed Wind Farm is deemed to be of 'Low' sensitivity and the strategic siting of infrastructure will mitigate any potential for significant landscape and visual effects.
Material Assets	Potential for greater traffic volumes during construction phase due to the number of solar panels required to achieve the same output. Greater potential for impacts on waste management due to increased plant on-site giving rise to increase in hazardous waste materials. No material difference for impacts on gas, water, aviation. No potential for impacts on telecommunications.	No material difference for impacts on gas, water, aviation. Buffers implemented on telecommunication links. As detailed in Chapter 15, there will be short term negative imperceptible to slight impact on traffic volumes during the construction phase of the Proposed Project. A detailed Traffic Management Plan incorporating all the mitigation measures will be agreed with the roads authority prior to construction works commencing on-site. There will be a positive effect on electricity supply with the provision of an estimated 86.8MW to the national grid and powering of 65,174 Irish households with renewable electricity per year.

For the reasons set out above, the proposal for a wind energy development at the Proposed Project was considered to be the most efficient method of electricity production with the lesser potential for significant environmental effects.

3.2.5 Alternative Project Design Options

3.2.5.1 Alternative Turbine Numbers and Model

Modern wind turbines have a potential power output in the 4.5 – 7 megawatt (MW) range. It is proposed to install 14 no. 6.2MW turbines at the Proposed Wind Farm which will have an estimated installed capacity of 86.8 MW. Such a wind farm could also be achieved on the Proposed Wind Farm site by using smaller turbines (for example 2.5 MW machines). However, this would necessitate the installation of over 35 turbines to achieve a similar output. A larger number of smaller turbines would result in the wind farm occupying a greater footprint within the Proposed Wind Farm site, with a larger amount of supporting infrastructure being required (i.e., roads etc) and increasing the potential for environmental impacts to occur. The proposed number of turbines takes account of all site constraints and the distances to be maintained between turbines and features such as roads and houses, while maximising the wind energy potential of the Proposed Wind Farm. The 14-turbine layout selected for the Proposed Project has the smallest development footprint of the other alternatives considered, while still achieving the optimum output at a more consistent level than would be achievable using different turbines.

The turbine model to be installed on the Proposed Wind Farm will have an overall ground to blade tip height of 185m; a rotor diameter 163m; and a hub height of 103.5 metres. The use of alternative smaller turbines at the Proposed Wind Farm would not be appropriate as they would fail to make the most efficient use of the wind resource passing over the Proposed Wind Farm and would potentially require a larger development footprint. This alternative would potentially lead to additional environmental effects.

A comparison of the potential environmental effects of the installation of a larger number of smaller wind turbines when compared against the chosen option of installing a smaller number of larger wind turbines on the Proposed Wind Farm is presented in Table 3-3 below.

Table 3-3 Comparison of environmental effects when compared to the chosen option (14 turbines, higher MW output)

Environmental Considerations	Larger number of smaller turbines	Chosen option of a 14-turbine layout
Population & Human Health	Greater potential for shadow flicker and noise impacts on nearby sensitive receptors due to the increased number of turbines. However, these can be curtailed to meet threshold criteria. Smaller turbines would be less visually obstructive in the skyline; however, the larger development footprint would spread further across the landscape potentially occupying a larger portion of a viewpoint.	Decreased potential for shadow flicker due to greater setbacks from houses, greater separation between turbines thus reducing aggregated shadow flicker time. There is no potential for significant noise and vibration effects from the proposed turbines. Furthermore, noise emissions can be curtailed to meet threshold criteria. Fewer turbines may occupy a smaller portion of a viewpoint. Based on the assessment detailed in Chapter 5 and the mitigation measures proposed, there will be no significant effects on population and human health from shadow flicker, noise and vibration during the construction, operation and decommissioning phases of the Proposed Project.
Biodiversity & Birds	Larger development footprint would result in greater potential for habitat loss.	As detailed in Chapter 6 Biodiversity, the development has been designed to avoid or mitigate impacts on biodiversity including bats and downstream aquatic receptors. As per Chapter 6 of this EIAR, following the implementation of the prescribed mitigation measures, there are no significant long-term negative effects expected on biodiversity receptors. With the implementation of the mitigation measures described in Chapter 7 Ornithology, the residual effects for collision risk are not significant.
Land, Soils, & Geology	Larger development footprint would result in greater volume of spoil to be generated, excavated and sorted.	Smaller footprint would result in smaller volume of soils to be excavated and managed. As detailed in Chapter 4 and 8, the Proposed Wind Farm has been designed to utilise the existing roads to minimise ground disturbance where possible.

Environmental Considerations	Larger number of smaller turbines	Chosen option of a 14-turbine layout
		The spoil management proposals discussed in Chapter 4 sets out the optimal treatment for spoil generated on-site without creating significant impacts for biodiversity, hydrology, land use etc. As detailed in the assessment in Chapter 8, no significant effects on soils and subsoils will occur.
Water	Project design specific drainage design removes the potential for significant environmental effects. Larger development footprint, therefore, increasing the potential for silt-laden runoff to enter receiving waterbodies.	Project design specific drainage design removes the potential for significant environmental effects. Smaller footprint would result in less potential for silt laden run-off to enter a waterbody. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.
Air Quality	Increased potential for vehicle and construction dust emissions due to an increased volume of construction material and turbine component deliveries to the Proposed Wind Farm site, giving rise to a reduced air quality locally for the construction phase.	Decreased potential for vehicle emissions and dust emissions due to a decreased volume of construction material and turbine component deliveries to the Proposed Wind Farm site. As detailed in Chapter 10, there will be no significant effects on air quality during the construction, and decommissioning phases. There will be a Long-term Moderate Positive Impact on air quality by during the operational phase.
Climate	There would be an increased potential for vehicle emissions and dust emissions due to an increased volume of construction material and turbine component deliveries to the Proposed Wind Farm site.	Decreased potential for vehicle emissions and dust emissions due to a decreased volume of construction material and turbine component deliveries to the Proposed Wind Farm site. As detailed in the assessment in Chapter 11 Climate, over the proposed 35-year lifetime of the Proposed Wind Farm, 2,202,588 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation. The

Environmental Considerations	Larger number of smaller turbines	Chosen option of a 14-turbine layout
		addition of an estimated 86.8MW clean energy to the national grid will be a positive contribution to the States renewable energy targets set out in the Climate Action Plan 2025.
Noise & Vibration	Potential for increased noise impacts on nearby sensitive receptors due to reduced separation distance between sensitive receptors and turbine locations and additional turbine generators.	Potential for decreased noise levels at nearby sensitive receptors due to increased separation distance between sensitive receptors and turbine locations. Based on the assessment detailed in Chapter 12, there will be no significant effects on sensitive receptors during the construction operational and decommissioning phases from the Proposed Project.
Cultural Heritage	Larger development footprint would increase the potential for impacts on unrecorded, subsurface archaeology. No material difference between the two options for indirect effects on monuments.	Smaller development footprint would decrease the potential for impacts on unrecorded, subsurface archaeology. No material difference between the two options for indirect effects on monuments. As detailed in Chapter 13, there will be no significant direct or indirect eff
Landscape & Visual	Smaller turbines may be less visually intrusive on the landscape. Equally, a larger number of smaller turbines would be spread over a wider area, taking up a greater portion of a viewpoint	Fewer but larger turbine models would be more visually obstructive in the skyline but may occupy a narrower portion of the viewpoint.
Material Assets – Traffic and Transport	Potential for greater traffic volumes during construction phase due to larger development footprint and requirement for more construction materials and turbine components.	Potential for smaller traffic volumes during the construction phase due to a smaller development footprint and requirement for fewer construction materials and turbine components. As detailed in Chapter 15, there will be short term negative imperceptible to slight impact on traffic volumes during the construction phase of the

Environmental Considerations	Larger number of smaller turbines	Chosen option of a 14-turbine layout
		Proposed Project. A detailed Traffic Management Plan incorporating all the mitigation measures will be agreed with the roads authority prior to construction works commencing on-site.
Material Assets- Utilities, Waste Management, Telecommunications and Aviation	No material difference between the two options for gas, water, waste management, telecommunications and aviation.	No material difference between the two options for gas, water, waste management, telecommunications and aviation.

3.2.5.2 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, landowners, environmental, hydrological and geotechnical, archaeological specialists and traffic consultants. The aim being to reduce potential for environmental effects while designing a project capable of being constructed and viable.

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 to the Proposed Wind Farm layout. The design process has also taken account of the recommendations and comments of the relevant statutory and non-statutory organisations, the local community and local authorities as detailed in Chapter 2 of the EIAR, while still seeking to ensure that a viable project can ultimately be constructed and connected to the national grid.

3.2.5.2.1 *Constraints and Facilitators Mapping*

The design and layout of the Proposed Wind Farm follows the recommendations and guidelines set out in the Guidelines and the *'Best Practice Guidelines for the Irish Wind Energy Industry'* (Irish Wind Energy Association, 2012).

The Guidelines were the subject of a targeted review. The proposed changes to the assessment of impacts associated with onshore wind energy developments were outlined in the draft Guidelines. A consultation process in relation to the draft Guidelines closed on 19th February 2020. The proposed changes presented in the draft Guidelines give certain focus on the setback distance from residential properties (four times the proposed maximum tip height), along with shadow flicker and noise requirements relative to sensitive receptors. At time of writing, the draft Guidelines have not yet been adopted and the commitment within the CAP 2025 is to publish the final version of the guidelines. The relevant guidelines for the purposes of section 28 of the Act, remain those issued in 2006, the Guidelines.

The constraints mapping process involves the placing of buffers around different types of constraints so as to clearly identify the areas within which no development works will take place. The size of the buffer zone for each constraint has been assigned using guidance presented in the Guidelines. Should the draft Guidelines be adopted in advance of a decision being made on this planning application, the Proposed Wind Farm will be capable of achieving the requirements of the draft Guidelines as currently proposed.

The constraints map for the Proposed Wind Farm, as shown in Figure 3-1, was produced following a desk study of all site constraints. Figure 3-1 encompasses the following constraints and associated buffers:

- **Sensitive Receptors:** a minimum 740-metre setback from third party sensitive receptors (achieving the 4 x tip height separation distance from third party sensitive receptors in line with the draft Guidelines).
- **Designated Sites/Natura 2000:** a minimum 100-metre setback from Special Areas of Conservation, Special Protected Areas and Proposed Natural Heritage Areas.

- **Telecommunications**: Setback buffers determined following detailed assessment of telecommunication links that traverse the Proposed Wind Farm site boundary. Refer to Appendix 15-4 and Appendix 15-5.
- **Transport:** a setback of 89.65m from local roads (Blade length + 10%)
- **Hydrology:** Watercourses plus 50-metre buffer.
- **Archaeology:** Archaeological Sites or Monuments: 50-metre buffer, plus 'Zone of Notification' as required by the National Monuments Service (ROI) There are three recorded monuments within the Proposed Wind Farm site boundary
- **Ecological:** a setback of 281m from identified Bat Roost locations, areas of Devil's bit scabious that were identified on-site with the potential to support Marsh Fritillary and invasive species recorded during field surveys.

Facilitators at the Proposed Wind Farm site build on the existing advantages and include the following:

- Available lands for development;
- Acceptable wind resource;
- Opportunity to win construction materials on-site, minimising the potential for additional traffic (and associated environmental impacts) and cost generation by acquiring all materials offsite;
- Existing access points and general accessibility of all areas of the Proposed Wind Farm site due to existing road infrastructure; and
- Limited extent of constraints.

The inclusion of the constraints on a map of the Proposed Wind Farm site allows for a viable area to be identified. An initial turbine layout is then developed to take account of all the constraints mentioned above and their associated buffer zones and the separation distance required between the turbines. Following the mapping of all known constraints, detailed site investigations were carried out by the project team.

The ecological assessment of the Proposed Wind Farm site encompassed habitat mapping and extensive surveying of birds and other fauna. This assessment, as described in Chapters 6 and 7 of this EIAR on Biodiversity and Ornithology, optimised the decision on the siting of turbines and the carrying out of any development works, such as the construction of roads.

The hydrological and geotechnical investigations of the Proposed Wind Farm site examined the proposed locations for turbines, roads and other components of the Proposed Project, such as the construction compound. Where specific areas were deemed as being unsuitable for the siting of turbines or roads, etc., alternative locations were proposed and assessed, taking into account the areas that were already ruled out by constraints.

The turbine layout for the Proposed Wind Farm has also been informed by the results of noise assessments, landscape and visual and the separation distance to be maintained between turbines. Thus, the baseline environmental assessment of the Proposed Wind Farm site and wind farm design was an iterative process, where findings at each stage of the assessment were used to further refine the design, always with the intention of minimising the potential for environmental impacts.

Map Legend

- EIAR Site Boundary
- Viable Area

Designated Sites/Natura 2000

- 100m Proposed Natural Heritage Area pNHA Setback
- 100m Special Areas of Conservation (SAC) Setback

Archaeological Sites/Monuments and Protected (NIAH) Structures

- National Monuments
- 50m National Monuments Buffer
- National Inventory of Archaeological Heritage
- Potential Heritage Sites

Ecology

- Confirmed Bat Roosts
- 281m Bat Roost Buffer
- Invasive Species Locations
- Devil's Bit Scabious Habitat

Hydrology

- Watercourses
- 50m Watercourse Buffer

Transport

- 90m Local Roads Buffer

Telecommunications

- Setback Buffers on Telecommunication Links

Sensitive Receptors

- Sensitive Receptors
- 740m Sensitive Receptor Buffer

N

Drawing Title
Environmental Constraints

Project Title
Carrow Wind Farm

Drawn By	Checked By
ER	EM
Project No.	Drawing No.
231102	Figure 3-1
Scale	Date
1:15,000	2026-03-04

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3.2.5.2.2 *Alternative Wind Farm Turbine Layout Iterations*

The final proposed turbine layout takes account of all site constraints and the distances to be maintained between turbines and from houses, roads, etc. The layout is based on the results of all site investigations that have been carried out during the EIAR process and the EIA scoping process with statutory and non-statutory consultees. As information regarding the Proposed Wind Farm was compiled and assessed, the number of turbines and the proposed layout have been revised and amended to take account of the physical constraints of the Proposed Wind Farm and the requirement for buffer zones and other areas in which no turbines could be located. The selection of the turbine number and layout has also had regard to wind-take and the separation distance to be maintained between turbines, as well as landscape and visual, noise and shadow flicker impacts. The EIAR and Proposed Wind Farm design process was an iterative process, where findings at each stage of the assessment were used to further refine the design, always with the intention of minimising the potential for environmental impacts.

The development of the final Proposed Wind Farm site layout has resulted following feedback from the various studies and assessments carried out as well as ongoing negotiations and discussions with landowners and the local community.

There were a number of reviews by the wind farm design team of the specific locations of turbines during the optimisation of the Proposed Wind Farm site layout. The initial constraints study identified a significant viable area within the overall study area of the Proposed Wind Farm site. Please refer to Figure 3-2, Figure 3-3 and Figure 3-4 to see the evolution of the turbine layout for the Proposed Wind Farm.

Proposed Layout Iteration No. 1

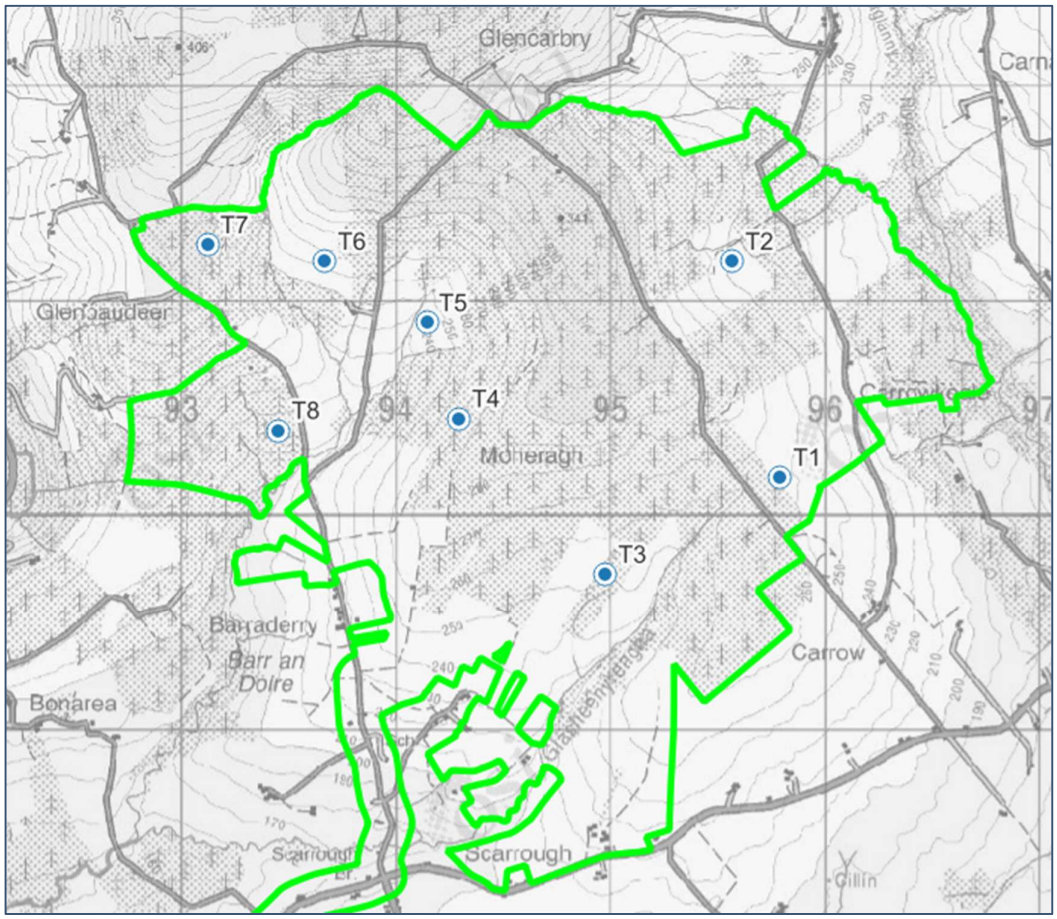

Figure 3-2 Proposed Wind Farm Layout Iteration No. 1

Iteration No. 1 which is presented in Figure 3-2 is the initial turbine layout which was based on a preliminary constraints mapping exercise and identification of a viable area for turbine siting. The initial desk-top constraints study, based on available lands within the study area at that time, identified a viable area sufficient to accommodate 8 no. turbines. A turbine blade-tip height of 185m was considered at this early stage in the design process.

Proposed Layout Iteration No. 2

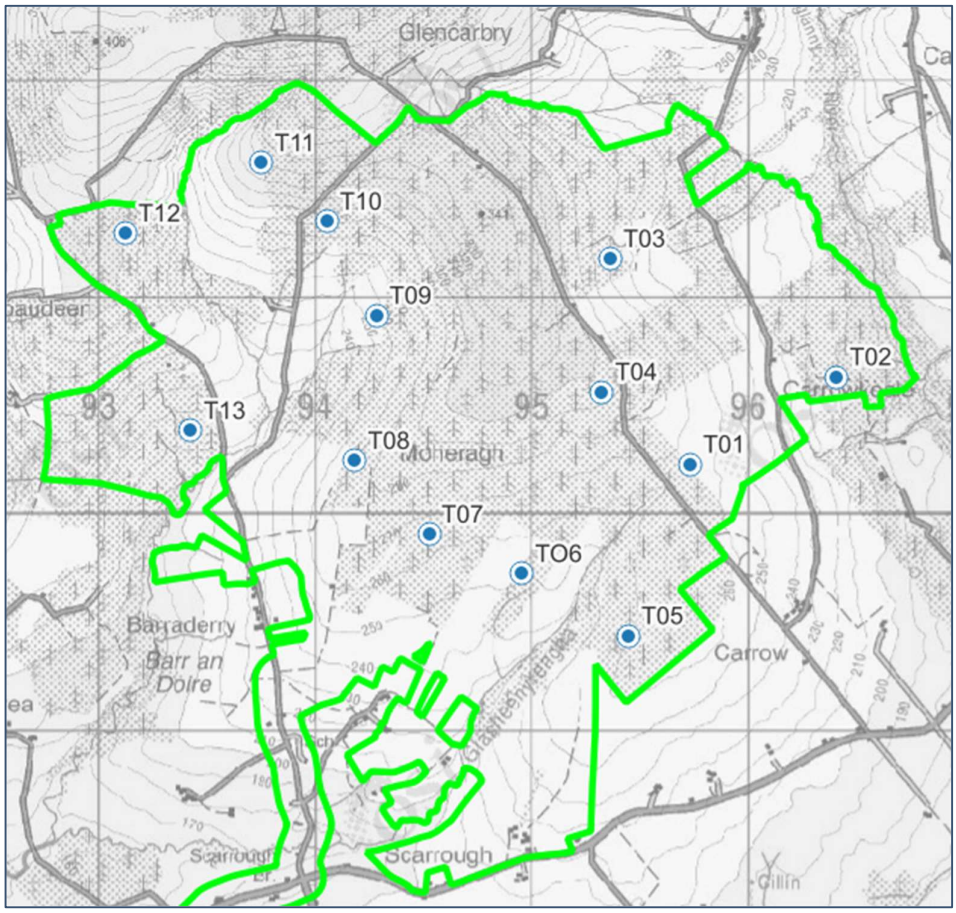

Figure 3-3 Proposed Wind Farm Layout Iteration No. 2

Iteration No. 2 which is presented in Figure 3-3 above. Following continued discussions with landowners located within the site boundary, additional lands became available. With the availability of new land it was decided to improve the economic viability of the project whilst having regard to the physical and environmental constraints previously identified. Iteration No. 2, comprised of 13 no. turbines, is a refined turbine layout which was based on updated designs, following desktop review by the design team.

Layout Iteration No. 2 was presented to the project team for detailed investigations and assessment. These investigations included detailed habitat mapping, ecological surveying, hydrological and geotechnical investigations of the Proposed Wind Farm.

Proposed Layout Iteration No. 3

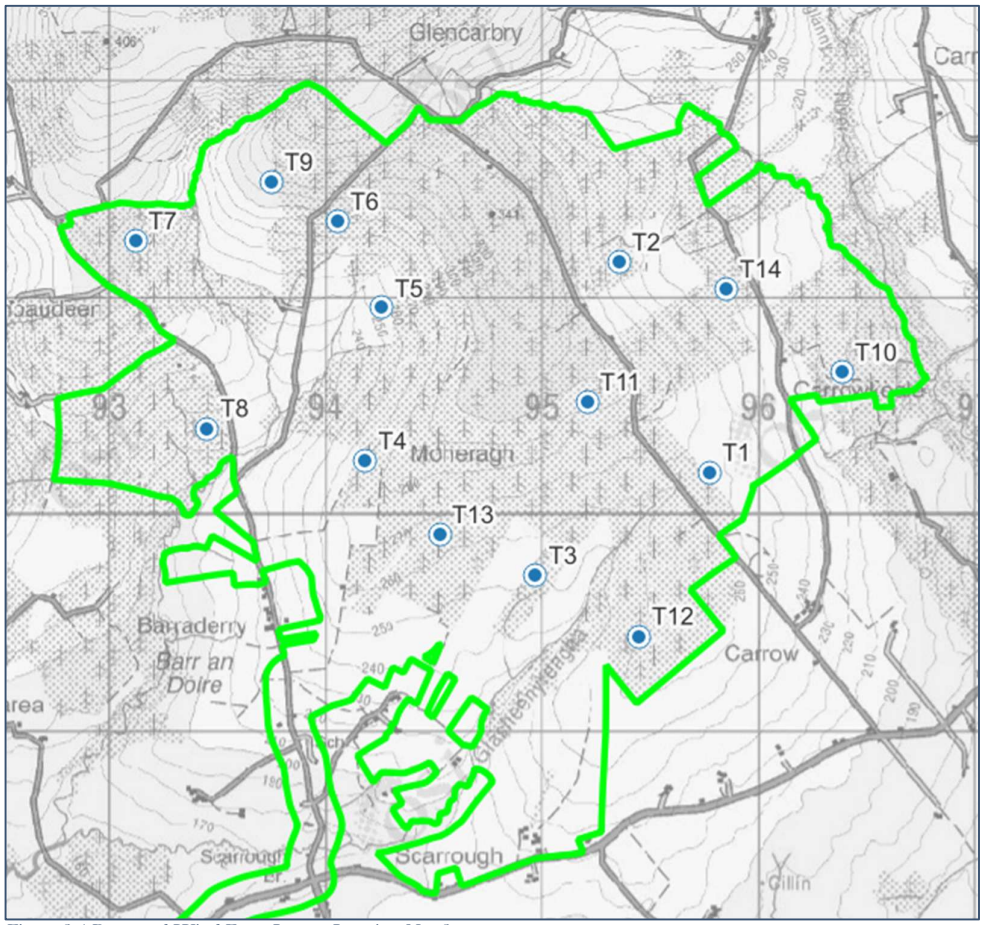

Figure 3-4 Proposed Wind Farm Layout Iteration No. 3

Iteration No. 3, as presented in Figure 3-4 above.

Additional lands became available and it was decided to improve the economic viability of the project further whilst having regard to the physical and environmental constraints previously identified. Iteration No. 3, comprises of 14 no. turbines, is a refined turbine layout which was based on updated designs, following desktop review by the design team.

The additional turbine in layout Iteration No. 3 was presented to the project team for detailed investigations and assessment. These investigations included detailed habitat mapping, ecological surveying, hydrological and geotechnical investigations of the Proposed Wind Farm.

As part of the final design iteration, enhancement and replanting measures were developed in order to ensure that the Proposed Project had a positive effect on local biodiversity. Measures such as planting and management of native woodland and riparian habitat and the safeguarding, maintenance and monitoring of existing and potential marsh fritillary breeding habitats in areas of wet grassland throughout the Proposed Wind Farm site have been proposed as part of the Proposed Project, with further details being available in Appendix 6-1 Biodiversity Management and Enhancement Plan.

The revisions to the layout were found to have a positive effect on the environmental and ecological elements of the Site when compared to the other options considered.

The final proposed turbine layout as presented in Figure 3-4 takes account of all site constraints (e.g. ecology, hydrology, archaeology, 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 EIAR process.

As part of this iteration, planting and management of native woodland and riparian habitat and the safeguarding, maintenance and monitoring of existing and potential marsh fritillary breeding habitats in areas of wet grassland were developed in order to ensure that the Proposed Project had a positive effect on local biodiversity. Further detail is available in Appendix 6-1 Biodiversity Management and Enhancement Plan.

The final chosen turbine layout is considered the optimal layout given it has the least potential for environmental effects.

A comparison of the potential environmental effects of initial iterations of the turbine layout as compared against the final turbine layout are presented in Table 3-4 below.

Table 3-4 Comparison of environmental effects when compared to the chosen option

Environmental Consideration	Proposed Layout Iteration No. 1	Proposed Layout Iteration No. 2	Chosen Option of the Final 14 Turbine Layout and all associated infrastructure
Population & Human Health (incl Shadow Flicker)	Potential for shadow flicker and noise impacts on a smaller number of sensitive receptors due to smaller development footprint. However, these can be curtailed to meet threshold criteria.	Potential for shadow flicker and noise impacts on a larger number of sensitive receptors due to increased number of turbines compared to Option 1.	Based on the assessment detailed in Chapter 5 and the mitigation measures proposed, there will be no significant effects on population and human health from shadow flicker, noise and vibration during the construction, operation and decommissioning phases of the Proposed Project. Significant residential visual amenity effects are predicted for a very small number of residential receptors.
Biodiversity & Ornithology	Less potential for impact on identified sensitive ecological receptors due to smaller number of proposed turbines and development footprint.	Greater potential impact on identified sensitive ecological receptors due to larger development footprint.	As detailed in Chapter 6 Biodiversity, the development has been designed to avoid or mitigate impacts on biodiversity including bats and downstream aquatic receptors. With the implementation of the mitigation measures described in Chapter 7 Ornithology, the residual effects for collision risk are not significant.
Land, Soils & Geology	Smaller development footprint would result in lower volume of spoil to be generated, excavated and sorted. Less potential for impacts on identified soils and subsoils due to smaller to development footprint.	Larger development footprint would result in greater volume of spoil to be generated, excavated and sorted. Greater potential impact on identified soils and subsoils due to larger development footprint compared to Iteration No. 1.	As detailed in the assessment in Chapter 8, no significant effects on soils and subsoils will occur during the construction, operation or decommissioning phases. Geotechnical investigations followed by careful design would lead to no significant environmental impacts.

Environmental Consideration	Proposed Layout Iteration No. 1	Proposed Layout Iteration No. 2	Chosen Option of the Final 14 Turbine Layout and all associated infrastructure
Water	Lower potential for impacts on groundwater schemes due to smaller development footprint. Project design specific drainage design removes the potential for significant environmental effects.	Increased potential for impacts on groundwater schemes due larger development footprint compared to Iteration No. 1. Project design specific drainage design removes the potential for significant environmental effects.	Project design specific drainage design removes the potential for significant environmental effects. Groundwater loggers were also placed on-site for a period in excess of twelve months in order to determine the characteristics of the groundwater levels and flow in the area surrounding the Site.
Air Quality	Smaller development footprint would mean a decreased potential for vehicle and construction dust emissions compared to Iteration No. 2 and the chosen option. This is due to a lower volume of construction material and turbine component deliveries to the site.	Larger development footprint, compared to Iteration No. 1, would lead to an increased potential for vehicle and construction dust emissions due to an increased volume of construction material and turbine component deliveries to the site. Mitigation measures implemented would ensure that no significant effects on air quality would arise.	Larger development footprint, compared to Iteration No. 1, would lead to an increased potential for vehicle and construction dust emissions due to an increased volume of construction material and turbine component deliveries to the site. As detailed in Chapter 10, there will be no significant effects on air quality during the construction, and decommissioning phases. There will be a Long-term Moderate Positive Impact on air quality by during the operational phase.
Climate	Decreased potential for vehicle emissions due to a decreased volume of construction material and turbine component deliveries to the Site. However, there would be less carbon dioxide displaced due to the lower export capacity and a lower contribution to the State's renewable energy targets set out in	There would be an increased potential for vehicle emissions due to an increased volume of construction material and turbine component deliveries to the Site. There would be a greater volume of carbon dioxide displaced due to a greater export	Increased potential for vehicle emissions due to an increased volume of construction material and turbine component deliveries to the Site compared to Iteration No. 1. As detailed in the assessment in Chapter 11 Climate, over the proposed 35-year lifetime of the Proposed Wind

Environmental Consideration	Proposed Layout Iteration No. 1	Proposed Layout Iteration No. 2	Chosen Option of the Final 14 Turbine Layout and all associated infrastructure
	the Climate Action Plan 2025.	capacity compared to Iteration No. 1 and therefore, a greater contribution to the State's renewable energy targets.	Farm, 2,202,588 tonnes of carbon dioxide will be displaced from traditional carbon-based electricity generation. The addition of an estimated 86.8MW clean energy to the national grid will be a positive contribution to the States renewable energy targets set out in the Climate Action Plan 2025.
Noise & Vibration	Slightly lower potential for increased noise impacts from larger turbines on nearby sensitive receptors due to lower number of turbines and a slightly greater separation distance between sensitive receptors and turbine locations compared to Iterations No. 2 and No. 3.	Potential for increased noise impacts on nearby sensitive receptors due to greater number of turbines. The separation distance still complies with the requirements within the draft Guideline.	Potential for increased noise levels at nearby sensitive receptors due to greater number of turbines compared to Iteration No. 1. The separation distance still complies with the requirements within the draft Guideline. Based on the assessment detailed in Chapter 12, there will be no significant effects on sensitive receptors during the construction, operational and decommissioning phases from the Proposed Project.
Landscape & Visual	The smaller number of turbines would have a lower potential for significant landscape and visual effects. The initial layout adhered to the relevant setback from Sensitive Receptors as set out in the draft Guidelines (740m) for the protection of residential visual amenity.	A larger number of turbines would be spread over a wider area, taking up a greater portion of a viewpoint, with a turbine located closer, and thus appearing more visually prominent. This layout adhered to the relevant setback from Sensitive Receptors as set out in the draft Guidelines (740m) for the protection of	As detailed in the assessment in Chapter 14, overall, the Proposed Project adheres to good siting and design according to best practice wind energy development guidelines, being appropriately scaled for the landscape type and sited in a landscape of low sensitivity, with no potential for significant residual effects on key landscape and visual sensitivities. Significant residual effects on residential visual amenity are localised to a very

Environmental Consideration	Proposed Layout Iteration No. 1	Proposed Layout Iteration No. 2	Chosen Option of the Final 14 Turbine Layout and all associated infrastructure
		residential visual amenity.	small number of residential receptors. However, this layout adhered to the relevant setback from Sensitive Receptors as set out in the draft Guidelines (740m) for the protection of residential visual amenity.
Cultural Heritage	Smaller development footprint would reduce the potential for impacts on unrecorded, subsurface archaeology.	Larger development footprint would increase the potential for impacts on unrecorded, subsurface archaeology Potential views of additional turbines increase the potential for indirect effects on the setting of monuments, as it is more likely that greater numbers of turbines will be seen from monuments.	Larger development footprint would increase the potential for impacts on unrecorded, subsurface archaeology Potential views of additional turbines increase the potential for indirect effects on the setting of monuments, as it is more likely that greater numbers of turbines will be seen from monuments. As detailed in Chapter 13 of the EIAR, archaeological testing will be carried out prior to the construction phase and monitoring of all groundworks will be undertaken during the construction phase.
Material Assets	Potential for smaller traffic volumes during the construction phase due to a smaller development footprint and requirement for fewer construction materials and turbine components. No material difference between the three options for gas, water, waste management, telecommunications and aviation.	Potential for greater traffic volumes during construction phase due to larger development footprint and requirement for more construction materials and turbine components. No material difference between the three options for gas, water, waste management,	As detailed in Chapter 15, there will be short term negative imperceptible to slight impact on traffic volumes during the construction phase of the Proposed Project. A detailed Traffic Management Plan incorporating all the mitigation measures will be agreed with the roads authority prior to construction works commencing on-site.

Environmental Consideration	Proposed Layout Iteration No. 1	Proposed Layout Iteration No. 2	Chosen Option of the Final 14 Turbine Layout and all associated infrastructure
		telecommunications and aviation.	No material difference between the three options for gas, water, waste management, telecommunications and aviation.
Vulnerability to Major Accidents Natural Disasters	No material difference between the two options	No material difference between the two options	No material difference between the two options

3.2.5.3 Alternative Road Layout

Access tracks are required on-site in order to enable transport of infrastructure and construction materials within the Proposed Wind Farm. Such tracks must be of a gradient and width sufficient to allow safe movement of equipment and vehicles. Approximately 12.9km of new internal tracks are required for the Proposed Wind Farm along with approximately 2.6km of existing farm/forestry tracks, which is currently used by the landowners in their daily activities, and approximately 1.6km of existing public roads which will be utilised and maintained as part of the Proposed Project. These tracks will be utilised where possible; however, some require upgrading/widening to facilitate the movement of abnormal loads through the Proposed Wind Farm site.

As the turbine layout was finalised, the most suitable routes between each component of the Proposed Wind Farm were identified, taking into account the shortest routes and existing farm/forestry tracks and filtering out the physical and environmental constraints of the Proposed Wind Farm site and the associated buffers, and utilising the most direct route between turbines in order to minimise the footprint. Additionally, turning areas were designed and sited for minimum environmental effect along internal roads.

An alternative option to the chosen Proposed Wind Farm site roads layout would be to maximise the use of the public road network within the Proposed Wind Farm site. There is approximately 8.7km public roadway within the Proposed Wind Farm site. Ten of the 14 no. turbines are accessed directly off a public roadway via either existing or proposed new access points. It is proposed to use and maintain approximately 1.6km of public roadway during the construction phase of the Proposed Wind Farm. As part of the alternative roads layout option, this would increase to 6.2km. This could potentially reduce the extent of proposed new wind farm access roads to be constructed by up to 2.7km.

This alternative option would reduce the extent of habitat loss (primarily agricultural grassland and forestry) and the volume of material to be excavated, and therefore managed, during the construction phase. There would also be a reduction in the volume of crushed stone required during construction.

However, this alternative option would require the widening of 6.2km (approximately 390% increase) of public roadway as the approximate running width of the public roads within the Proposed Wind Farm site range from 3m to 3.5m which is not sufficient to allow for the passing of HGVs heading in opposite directions. The widening and use of 6.2km of public roadway would significantly increase the potential for traffic disruption for local residents. Traffic disruption would also occur due to the regular maintenance of a significant extent of public roadway throughout the construction phase. It would also increase the potential for noise and air quality (exhaust and dust emissions) impacts on local residents as works areas would be brought closer to a greater number of residential dwellings.

The chosen roads layout option ensures that construction vehicles and abnormal load delivery vehicles are taken off the public road network at the proposed main site entrance in the townland of Moheragh and only require to use public roads for very short distances to access the northwestern and northeastern areas of the Proposed Wind Farm site. This will significantly reduce the level of traffic disruption

potentially experienced by local residents. The potential impacts on local residents arising from exhaust, dust and noise emissions during the construction phase will also be reduced as works will be located at greater distances from residential dwellings.

For the reasons outlined above, the chosen roads layout option is considered the more practical option. The alternative road layout is presented in Figure 3-5 below.

Map Legend

- EIAR Site Boundary
- Proposed Turbine Locations
- Proposed New Roads
- Existing Roads to be Upgraded
- Existing Public Roads to be Maintained
- Proposed Borrow Pits
- Proposed 110kV Substation

Drawing Title
Alternative Road Layout

Project Title
Carrow Wind Farm

Drawn By	Checked By
ER	EM
Project No.	Drawing No.
231102	Figure 3-5
Scale	Date
1:14,000	2026-03-24

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3.2.5.4 Alternative Borrow Pit Option

The use of an on-site borrow pits represent an efficient use of existing on-site resources and reduces the need to transport large volumes of construction stone materials along the local public road network to the Proposed Wind Farm site. The use of an on-site resource, that would only be developed for the Proposed Wind Farm, reduces the use of off-site existing quarry material assets.

A review of potential construction phase borrow pit locations was carried out by hydrological experts Hydro Environmental Services. Site surveys were undertaken and existing GIS data and environmental constraints were also considered, namely aerial photography, soil and subsoil cover, biodiversity (habitats), on-site drainage, proximity to the existing and proposed internal road network, and proximity to sensitive receptors.

Trial pits were undertaken to determine potential suitable locations for borrow pits. The findings of the geological site investigations concluded the identification of 2 no. borrow pits within the Proposed Wind Farm site, Borrow Pit A, north of T04, measuring approximately 16,910m^2 with a potential of providing the majority of construction stone material for the Proposed Project and Borrow Pit B, north of T09, measuring approximately 7,390m^2 with a potential of providing the remainder of construction stone material for the Proposed Project. The location of the proposed borrow pits is shown on Figure 4-1b and cross section details are shown on Figure 4-14 and Figure 4-15. The extraction of material from the borrow pits will be during the construction phase of the Proposed Wind Farm only and will be a temporary operation carried out over a short period of time. Rock breaking will be used for extracting material from the borrow pits. Processing and crushing of stone material will also be required at the borrow pits to achieve the grading requirements for use in construction. The final volumes to be removed from the borrow pits will be confirmed at the time of construction and following detailed pre-construction site investigation works. In addition to the material to be extracted from the borrow pits, it is anticipated that engineering fill and higher quality, surfacing granular fill and sand will be sourced from local, authorised quarries (approx. 20,000m^3). Licenced quarries located within 20 km of the Proposed Wind Farm site which could provide some construction material for the construction of the Proposed Wind Farm are shown in Chapter, Figure 4-31, of this EIAR.

An alternative to using an on-site borrow pits was the option of sourcing all stone and materials from a licensed quarry or quarries in the vicinity of the Proposed Wind Farm site. The movement of the volume of material required for the construction of a 14-no. turbine wind farm would result in a significant increase in construction traffic and heavy loads, in combination with a potential for an increase in noise and dust emissions along the haul routes and was therefore considered a less preferable option. The cost of importing the required volume of crushed stone was also a factor in choosing to obtain stone from the on-site borrow pits.

A comparison of the potential environmental effects when comparing the sourcing of all stone from local, off-site quarries against the chosen option (majority from on-site borrow pit) is presented in Table 3-5 below.

Table 3-5 Comparison of environmental effects when compared against the chosen option (Deliveries of Materials from Nearby Quarries)

Environmental Consideration	Sourcing all stone from local, off-site quarries	Use of on-site borrow pit along with offsite quarries
Population & Human Health	Potential for increased vehicular, noise and dust emissions from increased traffic movements, along construction haul routes due to the volume of rock to be transported to the site along the public road network, which could be a nuisance to local residents along the haul route.	Lower dust and noise emissions, and traffic volumes along construction haul routes due to reduced requirement for daily HGV presence on-site during the construction phase. Temporary dust and noise emissions related to borrow pit extraction however, due to vegetation screening and distance from sensitive receptors, the residual effects are not significant.

Environmental Consideration	Sourcing all stone from local, off-site quarries	Use of on-site borrow pit along with offsite quarries
Biodiversity & Ornithology	Reduced habitat loss and ground disturbance for flora, fauna and birds.	Increase in habitat loss due to borrow pit footprint however, as assessed in the Biodiversity chapter, this is habitat of low ecological value which is comprises the majoring of the site and surrounding landscape. Furthermore, the borrow pit will be reinstated with excavated spoil and will be reseeded post construction.
Land, Soils & Geology	Reduction in volume of spoil to be excavated however, additional large spoil placement areas would be required as an on-site borrow pit would not be available for the placement of excavated spoil.	Increased volume of spoil to be excavated and managed in order to access usable rock. The on-site borrow pits will be used for spoil management, reducing the requirement for management elsewhere on the Proposed Wind Farm site.
Water	Less potential for effects on groundwater quality.	Greater potential for effects on ground water quality due to extraction of bedrock from borrow pit area.
Air Quality	Potential for increased vehicular and dust emissions from increased traffic movements to and from the Proposed Wind Farm site, due to the volume of rock to be imported.	More ground disturbance due to on-site borrow pit which can give rise to dust emissions however, lower traffic volumes arriving and departing site per day and reduced on-site traffic volumes therefore reducing dust and noxious emissions overall.
Climate	No material difference between the two options.	No material difference between the two options.
Noise & Vibration	Increased potential for noise and vibration effects on local sensitive receptors along construction haul routes due to arrival and departure of heavy goods vehicles during the construction phase and reduced potential for noise and vibration effects on local sensitive receptors due to no breaking or crushing of materials won from on-site borrow pit.	Potential for increased noise and vibration effects on some residential receptors due to the extraction of bedrock from the borrow pit area. Mitigation measures presented in Chapter 12 of this EIAR will ensure that no significant effects occur.
Archaeological, Architectural & Cultural Heritage	Slightly smaller development footprint would reduce the potential for impacts on unrecorded, subsurface archaeology.	Slightly larger development footprint would increase the potential for impacts on unrecorded, subsurface archaeology.
Landscape & Visual	Potentially reduced landscape and visual effects temporarily as no open rock face would be visible from	Potential for increased landscape and visual effects temporarily due to open rock face which may be visible from

Environmental Consideration	Sourcing all stone from local, off-site quarries	Use of on-site borrow pit along with offsite quarries
	certain viewpoints during the construction phase.	certain viewpoints during the construction phase. However, excavated soil and subsoil will be used to reinstate the borrow pit area at the end of the construction phase.
Material Assets	Significantly higher HGV traffic volumes on the public road network during construction phase due to the volume of crushed stone required to be transported to the site and empty HGVs leaving the site. No material difference between the two options in potential for impact on waste management, telecoms, aviation, electricity, water or gas.	Reduced volume of HGVs traffic volumes on the public road network during construction as a considerable portion of materials will be won on-site. Decreased potential for noise, dust and emissions due to the reduced volumes of HGV traffic on the roads. No material difference between the two options in potential for impact on waste management, telecoms, aviation, electricity, water or gas.

3.2.5.5 Alternative Turbine Delivery Route

With regard to the selection of a transport or haul route to the Site, alternatives were considered in relation to ports of entry, turbine components, general construction-related traffic, and site access locations.

3.2.5.5.1 *Alternative Ports of Entry*

The ports considered for the port of entry of wind turbine components into Ireland for the Proposed Wind Farm include Belview Port, County Waterford, Dublin Port, Shannon-Foynes Port, County Limerick, Cork and the Port of Galway. All of the aforementioned ports have been used for the importing of turbine components. As stated, all ports mentioned above have a proven track record in the handling and subsequent transport of large turbine components. The final selection will be driven by commercial, availability and scheduling considerations. There are clear access routes for all five ports utilising the motorway network to the proposed haul route to the site. Regardless of which port is chosen, the components will approach the Proposed Wind Farm site via the M8 to the south. The delivery of turbine from the M8 to the Proposed Wind Farm site has been assessed in detail in Chapter 15 of this EIAR.

3.2.5.5.2 *Alternative Component Delivery Route*

The Proposed Wind Farm site is located approx. 16km northwest of the M8/N74 junction (Junction 9) and, as such, delivery of turbine components from this direction were considered as part of the iterative design process for the Proposed Project. The alternative delivery route considered, exited Junction 6 on the M8, then traveling north along the N62 national road for a short distance before turning west onto a local road and then joins the R661 regional road travelling through Hollycross village and travelling southwest towards the Proposed Wind Farm site. The vehicles will travel over the Dublin-Cork railway line in the townland of Cloghane, southwest of Holycross. Progressing along the R661, the vehicle leaves this regional road in the townland of Gorteennamona. In the townland of Gorteennamona, the vehicle turns west onto an unnamed local in an area known as Lacey's Cross, travelling over the Carrow bridge and turning north onto an L-5206 local road in the townland of Carrow to enter the Proposed Wind Farm site.

After review by the Traffic Consultant and subsequent autotrack assessment, it was concluded that this route would require substantial accommodating works along the route, to facilitate the delivery of abnormal loads to the Site. In particular, it was determined that it would be difficult facilitate the delivery of turbine components through the village of Holycross without considerable accommodation works in the village.

Therefore, the optimal delivery route is considered as the one that utilises the M8/N74 junction which has been subject to autotracks assessment and shows that limited accommodation works are required along the delivery route itself.

All construction traffic will use designated haul routes only, as agreed with the local authority. An alternative to this would be to allow for more direct access to the Proposed Wind Farm site using multiple approach routes; however, this is more likely to give rise to additional traffic and road impacts.

The delivery of turbine components including blades, tower sections and nacelles is a specialist operation owing to the oversized loads involved. As detailed in Section 15.1 of this EIAR, turbine blades will be delivered to site using a Super Wing Carrier. When considering turbines transport routes, alternative modes of transport were also considered. Depending on the selected turbine delivery route and the turbine manufacturer, a blade adapter or blade transporter may also be used, if deemed appropriate, for delivery of turbines to the Proposed Wind Farm site.

It should be noted that all component deliveries (abnormal loads) will be undertaken as described in the Traffic Management Plan which will be submitted and agreed with the local authorities and roads authorities upon consent of this application. All component deliveries will be subject to garda escort. All manoeuvres around junctions and into site entrances will be supervised by a qualified team of turbine delivery experts. The abnormal load entrance will be temporary in nature, over a short period of the construction phase only. The abnormal load entrance will be reinstated after all abnormal loads have been delivered to site. However, should replacement components be required, this entrance will be temporarily reopened to facilitate such works. Please see Section 15.1 Material Assets- Traffic and Transport for further details.

3.2.5.6 Alternative Design of Ancillary Structures

The ancillary structures required for the Proposed Project include underground electrical cabling and an on-site meteorological mast.

3.2.5.6.1 *Alternative Internal Site Cabling Route*

The internal 33kV site cabling will follow the internal road network throughout the Proposed Wind Farm site, connecting all 14 no. turbines to the Proposed on-site 110kV Substation. While this means that a longer cable route will be needed, it was considered the more environmentally prudent option. The alternative to this would be to lay the cables 'as the crow flies' between the turbines and the Proposed on-site 110kV Substation, however, this would lead to a greater environmental disturbance and a greater volume of spoil created.

3.2.5.6.2 *Alternative Meteorological Mast Location*

The meteorological mast is located in the southwest of the Proposed Wind Farm site, adjacent to an area of new road. A proposed new road will be used to access the proposed met mast location. The met mast is located in low agricultural value land, which was shown to be an area of low ecological value.

While other locations to situate the proposed met mast within the Proposed Wind Farm site were examined, the above location was deemed to be most suitable due to its proximity to existing roadways and the low ecological value of the habitat.

3.2.5.7 Alternative Grid Connection Cabling Route Options

3.2.5.7.1 *Alternative Substation Location*

The Proposed on-site 110kV Substation is located in the middle of the western side of the Proposed Wind Farm site and is sited within an agricultural grassland field. This grassland is of low ecological value. Given its location relative to the proposed turbines, the Proposed on-site 110kV Substation location is in a suitable position for the collection of the internal electrical cabling from the turbines. The Proposed on-site 110kV Substation is located an appropriate distance from the nearest proposed turbine (greater than 185m) and is located close to the public road network along which the Proposed Grid Connection underground cabling route will run for approximately 37.6km.

This location was deemed to be suitable due to the habitats it is located on, its position within the overall Proposed Wind Farm site and relative to the public road network.

3.2.5.7.2 *Alternative Grid Connection Cabling Route Options*

The Proposed Wind Farm will connect to the national grid via underground electrical cabling, located primarily within the public road corridor, with some small sections passing through private agricultural land. Underground electrical cables will transmit the power output from each wind turbine to the Proposed on-site 110kV Substation, and from there to the existing Killonan 110kV substation, via an underground electrical cabling route, measuring approximately 37.6km in length.

A key consideration in determining the grid connection method for a proposed wind energy development is whether the cabling is underground or run as an overhead line. An alternative to the approximately 37.6km underground cabling route would be to construct an overhead line from the Proposed on-site 110kV Substation to the existing 110kV Killonan substation following a similar route to that of the Proposed Grid Connection. While overhead lines are less expensive and allow for easier repairs when required, underground cabling will have no visual impact. For this reason, it was considered that underground cabling would be a preferable alternative to overhead lines. The Guidelines also indicate that underground cables are the preferred option for connection of a wind energy development to the national grid. The underground electrical cabling will follow the route of existing public road insofar as possible in order to minimise the amount of ground disturbance required.

An entirely, off-road grid connection route was considered at an early stage of the design process, however, this was discounted due to requirement to construct significant lengths of access and maintenance tracks to access joint bays along the route, increasing the potential for environmental effects compared to a route that predominantly follows existing roads. In addition, the requirement for a significant number of landowner agreements along the length of the route would have significantly increased the time required to confirm the final proposed, design of the Proposed Project and driven up the overall costs associated with the project.

The Megawatt (MW) output of the Proposed Wind Farm is such that it needs to connect to a 110kV Substation, 2 no. existing 110kV electricity substations were assessed for the Proposed Wind Farm to connect to the national grid, the 110kV electricity substations included:

- Cauteen 110kV Substation
- Killonan 110kV Substation

The Proposed Grid Connection to Killonan 110kV substation and the proposed underground electrical cabling route has been revised and refined to take account of the findings of the site investigations and baseline assessments, which have informed the Proposed Grid Connection design as presented in Figure 3-11. The alternative options considered are shown Figures 3-6 to Figure 3-11.

Grid Connection Option A to Cauteen 110kV Substation

Grid Connection Option A, as presented in Figure 3-6 below, is an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Cauteen 110kV substation in the townland of Seskin, Co. Tipperary. The Cauteen substation is approximately 9.1 kilometers (km) to the southwest of the Proposed Wind Farm site. The grid connection cabling route utilises the local and regional road network, in addition to the final section of the route, which is off-road, in private agricultural land. The cabling route measures approximately 16.8km in length. Approximately 13% (2.1km) of the cabling route is located in third party-owned agricultural lands which would require the consent of 7-no. landowners. Option A is located entirely within the public road corridor and is the shortest of the five options considered, however, the Cauteen 110kV substation does not have the connection capacity, nor it is likely to have in the future, that would allow the Proposed Project to export its maximum electricity output to the national grid. It was therefore not the chosen option for connection to the national grid.

County Limerick

County Tipperary

Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Potential Grid Route - Option A
- County Boundary

Drawing Title: Proposed Grid Connection - Option A

Project Title: Carrow Wind Farm

Drawn By	Checked By
ER	EM
Project No.	**Drawing No.**
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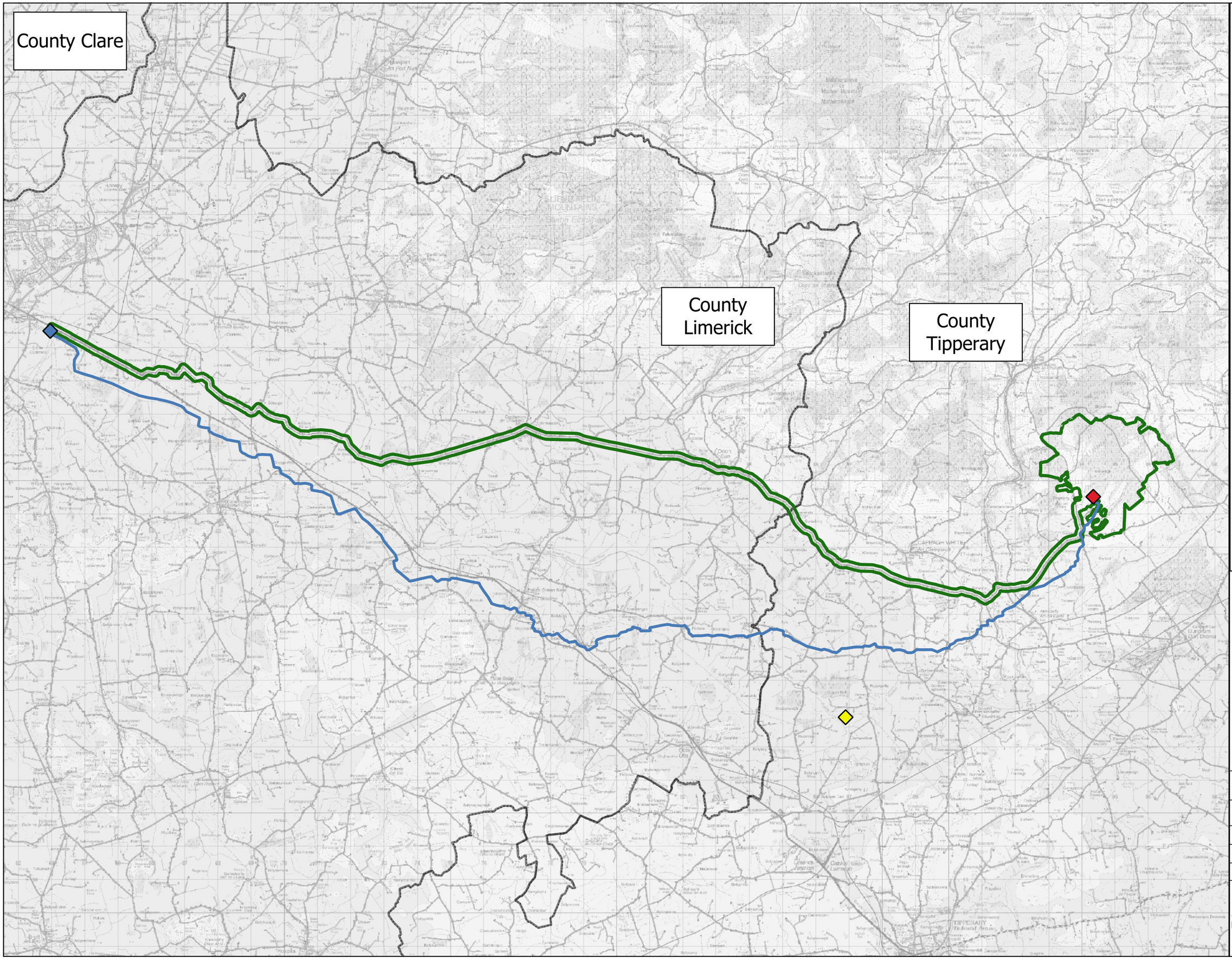
Grid Connection Option B – Off-Road Connection Route – Either Underground or Overhead

As mentioned above the Cauteen 110kV substation does not have the connection capacity, nor it is likely to have in the future, that would allow the Proposed Project to export its maximum electricity output to the national grid. It was therefore not the chosen option for connection to the national grid. The existing Killonan 110kV substation in the townland of Milltown, Co. Limerick has the capacity to allow the Proposed Project to export its maximum electricity output to the national grid. Grid Connection Option B, as presented in Figure 3-7 below, is either an overhead or an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Killonan 110kV substation. The Killonan substation is 30km to the west of the Proposed Wind Farm site. Option B is an entirely off-road grid connection route to Killonan. The cable route is approximately 41.7km in length running through private agricultural lands. Over 150 landholdings would be crossed requiring individual agreements to be entered with each landowner. Statutory Undertakers, such as ESB or Eirgrid, would normally negotiate with the landowners but would employ their compulsory purchase powers, as a Statutory Undertaker in cases where it was unable to reach agreements. Private developers do not have such powers, making cross-country routes impossible.

The Wind Energy Guidelines (DoHLG, 2006) and the Draft Wind Energy Guidelines (DoHPLG, 2019) also indicate that underground cables along the public road corridor are the preferred option for connection of a wind energy development to the national grid.



Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Killonan 110kV Substation
- Potential Grid Route - Option B
- County Boundary

Drawing Title
Proposed Grid Connection - Option B

Project Title
Carrow Wind Farm

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Grid Connection Option C to Killonan 110kV Substation

Grid Connection Option C, utilising the maximum length of the primary road network, as presented in Figure 3-8 below, is an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Killonan 110kV substation in the townland of Milltown, Co. Limerick. The grid connection cabling route utilises the local, regional and primary national road network and off-road private lands. The cabling route measures approximately 42.7km in length. Of the cable route that is located within the public road network, 40% (17km) is located in the local road network, 2% (868m) is located within the regional road network and 56% (23.7km) is located within the national primary road network. The option was disregarded from further consideration due to the length of the route and the 23.7km footprint along the national primary road network.

County Clare

County Limerick

County Tipperary

Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Killonan 110kV Substation
- Potential Grid Route - Option C
- County Boundary

Drawing Title
Proposed Grid Connection - Option C

Project Title
Carrow Wind Farm

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Grid Connection Option D to Killonan 110kV Substation

Grid Connection Option D, avoiding regional roads where possible, as presented in Figure 3-9 below, is an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Killonan 110kV substation in the townland of Milltown, Co. Limerick. The grid connection cabling route utilises the local, regional and primary national road network and off-road private lands. The cabling route is approximately 38.4km in length. Of the cable route within the public road network, 73.6% (32.6km) is located within the local road network, 8.6% (3.8km) is located within the regional road network and 2.4% (1.1km) is located within the N24 National Primary Road. The grid connection option would result in the proposed cable crossing the Irish rail network at two locations within the townland of Killonan. This option was discounted due to the length of the route and the requirement to cross the national rail line network at two separate locations.

County Clare

County Limerick

County Tipperary

Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Killonan 110kV Substation
- Potential Grid Route - Option D
- County Boundary

Drawing Title
Proposed Grid Connection - Option D

Project Title
Carrow Wind Farm

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Grid Connection Option E to Killonan 110kV Substation

Grid Connection Option E, as presented in Figure 3-10 below, is an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Killonan 110kV substation. Option E is a grid cabling route that utilises the local, regional and primary national road network and off-road private lands. The cabling route is approximately 37.6km in length. Of the cable route within the public road network, 38% (14.4km) is located within the local road network, 41% (15.4km) is located within the regional road network and 18% (6.9km) is located within the N24 National Primary Road. This option was discounted due to the length of the route along the N24 National Primary Road.

County Clare

County Limerick

County Tipperary

Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Killonan 110kV Substation
- Potential Grid Route - Option E
- County Boundary

Drawing Title
Proposed Grid Connection - Option E

Project Title
Carrow Wind Farm

Drawn By	Checked By
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Project No.	Drawing No.
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Grid Connection Option F– Chosen Grid Connection

Grid Connection Option F, as presented in Figure 3-11 below, is an underground grid connection cabling route, connecting the Proposed on-site 110kV Substation to the existing Killonan 110kV substation. Option F is a grid cabling route that utilises the local, regional and primary national road network and off-road private lands. The cabling route is 37.6km in length. Of the cable route within the public road network, 45% (16.9km) is located within the local road network, 41% (15.5km) is located within the regional road network and 8% (3.2km) is located within the N24 National Primary Road.

Approximately 67% (25.1km) of the cable route is located within Co. Limerick. Of the cable route that is located in Co. Limerick, 12% (3.1km) is located within the N24 National Primary Road, 57.8% (14.5km) is located the R505 Regional Road, 25.5% (6.4km) is located within the local road network and 4.8% (1.2km) is located in private lands. The proposed route within Co. Limerick crosses Limerick Junction to Limerick Colbert railway line in the townland of Sandylane along the L1154 Local Road.

As part of the detailed design process, every effort has been made to locate the grid connection cabling trench off the existing road carriageway and within the hard shoulder or soft margin/grass verges. The exact location of the grid connection cabling within the curtilage of the public road network may be subject minor modification following confirmatory site investigations, to be undertaken prior to construction of the proposed wind farm development as part of the Road Opening Licence process. However, it is acknowledged that detailed surveys will be required to ground-truth the information provided by the service providers mentioned above and to identify any other existing services such and underground gas, telecommunications and private water supply. It is considered that Option F is a good balance in terms of optimum grid length and secondary roads and limiting the use of regional roads.

A comparison of the potential environmental effects of the Grid Connection Options, as compared against the chosen Grid Connection Options (Option F) is presented in Table 3-6 below.

County Clare

County Limerick

County Tipperary

Map Legend

- EIAR Site Boundary
- 110kV Onsite Substation Location
- Cauteen 110kV Substation
- Killonan 110kV Substation
- Potential Grid Route - Option F
- County Boundary

Drawing Title
Proposed Grid Connection - Option F

Project Title
Carrow Wind Farm

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Table 3-6 Comparison of environmental effects when compared against the chosen Grid Connection Option (Option F)

Environmental Consideration	Option A – Cauteen 110kV Substation (16.8km)	Option B – Off-Road Connection Route – Either Underground or Overhead (41.7km)	Option C to Killonan 110kV Substation (42.7km)	Option D to Killonan 110kV Substation (38.4km)	Option E to Killonan 110kV Substation (37.7km)	Option F – Chosen Grid Connection (37.6km)
Population & Human Health	Potential for temporary visual impact but over a shorter construction phase considering the shorter route, from presence of plant machinery on-site during the construction period. Potential for temporary noise and dust impacts but over a shorter construction phase considering the shorter route, from plant machinery on-site during construction phase. This route also passes through the village of Toem and the fewest sensitive receptors.	Potential for temporary visual impact over a longer construction phase considering the longer route, from presence of plant machinery on-site during the construction period. Greater potential for temporary noise and dust impacts for a longer construction phase considering the longer route, from plant machinery on-site during construction phase.	Potential for temporary visual impact over a longer construction phase considering the longer route, from presence of plant machinery on-site during the construction period. Greater potential for temporary noise and dust impacts for a longer construction phase considering the longer route, from plant machinery on-site during construction phase. This route passes by a greater number of sensitive receptors compared to Option A given that it runs through the villages of Toem, Oola and Pallas Grean New	Potential for temporary visual impact over a longer construction phase considering the longer route, from presence of plant machinery on-site during the construction period. Greater potential for temporary noise and dust impacts for a longer construction phase considering the longer route, from plant machinery on-site during construction phase. This route passes by a greater number of sensitive receptors compared to Option A given that it runs through the villages of Toem, Doon and Cappamore.	Potential for temporary visual impact for a longer construction phase considering the longer route, from presence of plant machinery on-site during the construction period. Potential for temporary noise and dust impacts for a longer construction phase considering the longer route, from plant machinery on-site during construction phase. This route passes by a greater number of sensitive receptors compared to Option A given that it runs through the villages of Toem, Doon and Cappamore.	Potential for temporary visual impact for a longer construction phase considering the longer route, from presence of plant machinery on-site during the construction period. Potential for temporary noise and dust impacts for a longer construction phase considering the longer route, from plant machinery on-site during construction phase. This route passes by a greater number of sensitive receptors compared to Option A given that it runs through the villages of Toem, Doon and Cappamore.

Environmental Consideration	Option A – Cauteen 110kV Substation (16.8km)	Option B – Off-Road Connection Route – Either Underground or Overhead (41.7km)	Option C to Killonan 110kV Substation (42.7km)	Option D to Killonan 110kV Substation (38.4km)	Option E to Killonan 110kV Substation (37.7km)	Option F – Chosen Grid Connection (37.6km)
Biodiversity (including Birds)	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 1 no. mapped SAC (Lower River Suir SAC) in the townland of Ballybrack and the townland of Shanaknock, Co. Tipperary. However, no instream works are proposed as part of the crossing methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated.	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 1 no. mapped SAC (Lower River Suir SAC) in the townland of Rossarow, Co. Tipperary. However, no instream works are proposed as part of the crossing methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 1 no. mapped SAC (Lower River Suir SAC) in the townland of Ballybrack and the townland of Shanaknock, Co. Tipperary. However, no instream works are proposed as part of the crossing methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 2 no. mapped SAC (Lower River Suir SAC and Lower River Shannon SAC). The Proposed Grid Connection crosses the Lower River Suir SAC in the townlands of Ballybrack and Shanaknock in Co Tipperary. The Proposed Grid Connection crosses the Lower River Shannon SAC in the townland of Gortaderry, Co. Tipperary and in the townlands of Gortnascarry, Dromcluher and Eyon in Co. Limerick. However, no instream works are proposed as part of the crossing	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 2 no. mapped SAC (Lower River Suir SAC and Lower River Shannon SAC). The Proposed Grid Connection crosses the Lower River Suir SAC in the townlands of Ballybrack and Shanaknock in Co Tipperary. The Proposed Grid Connection crosses the Lower River Shannon SAC in the townland of Gortaderry, Co. Tipperary and in the	Low potential for impact on sensitive ecological receptors during the construction phase. As detailed in Chapter 6, the Proposed Grid Connection underground cabling route passes through 2 no. mapped SAC (Lower River Suir SAC and Lower River Shannon SAC). The Proposed Grid Connection crosses the Lower River Suir SAC in the townlands of Ballybrack and Shanaknock in Co Tipperary. The Proposed Grid Connection crosses the Lower River Shannon SAC in the townland of Gortaderry, Co. Tipperary and in the

Environmental Consideration	Option A – Cauteen 110kV Substation (16.8km)	Option B – Off-Road Connection Route – Either Underground or Overhead (41.7km)	Option C to Killonan 110kV Substation (42.7km)	Option D to Killonan 110kV Substation (38.4km)	Option E to Killonan 110kV Substation (37.7km)	Option F – Chosen Grid Connection (37.6km)
				methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated	townlands of Gortnascarry, Dromcluher and Eyon in Co. Limerick. However, no instream works are proposed as part of the crossing methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated	townlands of Gortnascarry, Dromcluher and Eyon in Co. Limerick. However, no instream works are proposed as part of the crossing methodology for this SAC. Therefore, as detailed in the Natura Impact Statement no adverse impacts on the SAC are anticipated
Land, Soils, & Geology	Lowest volume of earthworks required due to shorter route. The Proposed Grid Connection underground cabling route will be primarily located within the public road corridor, with approximately 1.8km passing through private agricultural land. Of the 1.8km approximately 1.1km	Greatest volume of earthworks required due to longer route. This underground cabling route option is proposed to be located cross over 150 landholdings, before connecting with the Killonan substation.	Greater volume of earthworks required due to longer route. This underground cabling route option is proposed to be located primarily within the public road corridor, with an approximately 750m stretch passing through private agricultural land and passing through the	Greater volume of earthworks required due to longer route. This underground cabling route option is proposed to be located primarily within the public road corridor, with an approximately 750m stretch passing through private agricultural land and passing through the villages or settlements of Toem Doon and Cappamore before	Greater volume of earthworks required due to longer route. This underground cabling route option is proposed to be located primarily within the public road corridor, with an approximately 750m stretch passing through private agricultural land and passing through the	Greater volume of earthworks required due to longer route. This underground cabling route option is proposed to be located primarily within the public road corridor, with an approximately 750m stretch passing through private agricultural land and passing through the

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	stretch through agricultural fields adjacent to Cauteen substation. As detailed in the assessment in Chapter 8, no significant effects on land, soils or geology will occur.		villages or settlements of Toem, Oola and Pallas Grean New before connecting with the Killonan substation.	connecting with the Killonan substation	villages or settlements of Toem Doon and Cappamore before connecting with the Killonan substation	villages or settlements of Toem Doon and Cappamore before connecting with the Killonan substation
Water	Option A has 11 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.	Option B has 28 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.	Option C has 25 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.	Option D has 23 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.	Option E has 36 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.	Option F has 35 no. EPA mapped watercourse crossing. There are no instream works proposed as part of the crossing methodologies for the watercourse crossing. As detailed in the assessment in Chapter 9, no significant effects on surface water or groundwater quality will occur.
Air Quality	As a result of the shorter route, this option has a lower	As a result of the longer route, this option has a greater	As a result of the longer route, this option has a greater	As a result of the longer route, this option has a greater potential for effects	As a result of the longer route, this option has a greater	As a result of the longer route, this option has a greater

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	potential for effects from dust, and vehicle emissions during construction compared to the other Options. As detailed in Chapter 10, no significant effects on air quality will occur.	potential for effects from dust, and vehicle emissions during construction.	potential for effects from dust, and vehicle emissions during construction.	from dust, and vehicle emissions during construction.	potential for effects from dust, and vehicle emissions during construction.	potential for effects from dust, and vehicle emissions during construction.
Climate	This option would result in reduced vehicle emissions, compared to the other options during construction given the reduced length.	This option would result in increased vehicle emissions during construction given the longer route.	This option would result in increased vehicle emissions during construction given the longer route.	This option would result in increased vehicle emissions during construction given the longer route.	This option would result in increased vehicle emissions during construction given the longer route.	This option would result in increased vehicle emissions during construction given the longer route
Noise & Vibration	All options would have similar noise and vibration emissions during construction. However, this option will pass through one village or settlement and therefore would impact on fewer sensitive receptors.	All options would have similar noise and vibration emissions during construction. However, this option is travelling off road for a longer length than Option A and therefore would potentially impact a number of sensitive receptors when	All options would have similar noise and vibration emissions during construction. However, this option does pass through the villages or settlements of Toem, Oola and Pallas Grean New therefore would potentially impact a greater number of	All options would have similar noise and vibration emissions during construction. However, this option does pass through the villages or settlements of Toem Doon and Cappamore therefore would potentially impact a greater number of sensitive receptors when compared to Option A.	All options would have similar noise and vibration emissions during construction. However, this option does pass through the villages or settlements of Toem Doon and Cappamore therefore would potentially impact a greater	All options would have similar noise and vibration emissions during construction. However, this option does pass through the villages or settlements of Toem Doon and Cappamore therefore would potentially impact a greater

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		compared to Option A.	sensitive receptors when compared to Option A		number of sensitive receptors when compared to Option A.	number of sensitive receptors when compared to Option A.
Landscape and Visual	Neutral – once constructed, there is no material difference of environmental effect between all options considered.	Neutral – once constructed, there is no material difference of environmental effect between all options considered.	Neutral – once constructed, there is no material difference of environmental effect between all options considered.	Neutral – once constructed, there is no material difference of environmental effect between all options considered.	Neutral – once constructed, there is no material difference of environmental effect between all options considered.	Neutral – once constructed, there is no material difference of environmental effect between all options considered
Archaeological, Architectural & Cultural Heritage	Low potential for impacts on unrecorded, sub-surface archaeology given that this option is located almost exclusively within existing roads.	Greater potential for impacts on unrecorded, sub-surface archaeology given the length of this route that passes through agricultural land. As detailed in Chapter 13 of this EIAR, archaeological monitoring of all groundworks will take place during the construction phase.	Lower potential for impacts on unrecorded, sub-surface archaeology given that this option is located almost exclusively within existing roads.	Lower potential for impacts on unrecorded, sub-surface archaeology given that this option is located almost exclusively within existing roads.	Lower potential for impacts on unrecorded, sub-surface archaeology given that option is located almost exclusively within existing roads compared to Option A.	Lower potential for impacts on unrecorded, sub-surface archaeology given that option is located almost exclusively within existing roads compared to Option A.

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Material Assets	Grid Connection Route Option A measures approximately 16.8km in length, of which 15km is located within the public road corridor. Road closures are proposed during the construction of this grid connection route given the width of the Regional (R505 and R497) and the local road corridors. Therefore, it would result in traffic impacts	Greater potential for traffic impacts given that this option will be crossing over 150 landholdings and would likely require road closures along narrower section of public road corridor along its route.	Greater potential for traffic impacts given that this option passes through the villages or settlements of Toem, Oola and Pallas Grean New and would likely require road closures along narrower sections of public road corridor	Greater potential for traffic impacts given that this option passes through the villages or settlements of Toem, Doon and Cappamore and would likely require road closures along narrower sections of public road corridor	Greater potential for traffic impacts given that this option passes through the villages or settlements of Toem, Doon and Cappamore and would likely require road closures along narrower sections of public road corridor.	Greater potential for traffic impacts given that this option passes through the villages or settlements of Toem, Doon and Cappamore and would likely require road closures along narrower sections of public road corridor All construction of the underground cable will be undertaken as described in the Traffic Management Plan which will be submitted and agreed with the local authorities and roads authorities upon consent of this application. As detailed in Chapter 15, no

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						significant effects on traffic will occur.

3.2.6 Alternative Mitigation Measures

Mitigation by avoidance has been a key aspect of the Proposed Project's evolution through the selection and design process. Avoidance of the environmental constraints within the site limits the potential for environmental effects. As noted above, the layout aims to avoid any environmentally sensitive areas. Where loss of habitat occurs in the Proposed Wind Farm site, this has been mitigated with the proposal of planting and management of native woodland and riparian habitat and the safeguarding, maintenance and monitoring of existing and potential marsh fritillary breeding habitats in areas of wet grassland throughout the Proposed Wind Farm site.

It is proposed to manage and bolster approximately 3.3 ha of semi-natural woodland habitat within the Proposed Wind Farm site. This measure will create additional habitat for commuting and foraging fauna, including bats, badger and other protected fauna, within the Proposed Wind Farm site. It is proposed to plant riparian woodland either side of mapped watercourses within the Proposed Wind Farm site. Planting will occur over a 10m wide strip either side of the selected watercourses. This measure will create a linear feature for commuting and foraging fauna, including bats, badger and other protected fauna, within the Proposed Wind Farm site. Approximately 30.2 ha of high-quality wet grassland habitat will be managed to enhance marsh fritillary habitat, as this species is listed as an Annex II species on the EU Habitats Directive, and known to occur within the Proposed Wind Farm site. Further detail on this biodiversity enhancement can be found in Chapter 6 of this EIAR.

The best practice design and mitigation measures set out in this EIAR will contribute to reducing any risks and have been designed to break the pathway between the Site and any identified environmental receptors. The alternative is to either not propose these measures or propose measures which are not best practice and effective and neither of these options is sustainable.