

YELLOW RIVER WIND FARM

ENVIRONMENTAL IMPACT STATEMENT

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TECHNICAL APPENDICES

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B Carbon Sequestration Calculation

C Public Consultation

D Minutes of Meetings with Offaly County Council

E Minutes of Meetings with NPWS

F Statutory & Non-statutory Consultees

G Haul Route Assessment

H Pollution Control Contingency Plan

I Environmental Management Plan

J Flora, Fauna & Fisheries, Bat Assessment Report

K Soils & Geology, Peat Slide Risk Assessment

L Water

M Noise

N Shadow Flicker

O Cultural Heritage

1.0 INTRODUCTION

1.1 SCOPE

This Environmental Impact Statement (EIS) has been compiled to accompany an application for planning permission for development of a 32 turbine wind farm, on a site, in the townlands of Derryarkin, Derryiron, Coolcor, Coolville, Ballyburly, Greenhills, Bunsallagh, Derrygreenagh, Knockdrin, Wood, Killowen, Corbetstown, Carrick, Garr and Dunville, in a location just north of Rhode, on a relatively flat area of predominantly improved grasslands.

The site is located entirely within County Offaly, however, it is approximately 275m from the County Westmeath border, approximately 60m from County Meath and approximately 4,500m from County Kildare. Please refer to Figure 1.1 - Site Location Map.

The development will comprise thirty-two (32) electricity generating wind turbines with a hub height of up to 110 metres and a rotor diameter of up to 113 metres giving an overall height of up to 166 m, hardstandings, a 110 kV substation containing two (2) control buildings, an electrical compound and a wastewater holding tank, nine (9) watercourse crossings, temporary construction compound, a permanent meteorological mast, a new access road off the R400 Roundabout at Rhode and upgraded access roads, associated site roads, drainage and site works.

Environmental Impact Assessment is a process for anticipating the effects on the environment caused by a development. Where unacceptable effects are identified, these can then be avoided or reduced. It forms an interactive part of the design process, with the design being continually modified so as to mitigate negative impacts and to promote positive impacts. The Environmental Impact Statement (EIS) is a written statement of the effects, if any, which a proposed development, if carried out, would have on the environment.

1.2 NEED FOR THE DEVELOPMENT

In this context, security of energy supply is particularly important due to Ireland's lack of indigenous fossil fuel resources and we rely heavily on fuel imports. We are

vulnerable to volatile fossil fuel prices. The Yellow River Wind Farm project will provide a sustainable reliable power supply for the region.

The development will contribute towards the actions and targets for the energy policy framework up to 2020 as outlined in the White Paper entitled “Delivering a Sustainable Energy Future for Ireland” published by the Department of Communications, Marine and Natural Resources in 2007. The Paper sets a clear path for meeting the Government’s goals of ensuring safe and secure energy supplies, promoting a sustainable energy future, and supporting competitiveness. Section 3.9.5 of the Paper states that 33% of all electrical consumption will be generated from renewable energy sources by 2020. This target has since been increased to 40% from renewable energy sources (Dáil Statement, Budget 2009).

The amount of wind farm capacity connected to the Irish power system now totals 1,763 MW as of March 2013¹. The peak amount of electricity generated by wind power reached 1,540 MW for the first time on March 21st 2013². However, it is estimated that approximately 6,000 MW of installed renewable capacity will be required to meet the 2020 target. Ireland National Renewable Energy Targets and Greenhouse Gas Emission obligations are discussed in detail in Section 1.6.3 and 1.6.4 of this chapter.

1.3 THE DEVELOPER

Green Wind Energy (Wexford) Limited (GWE) is an Irish owned commercial company operating in the renewable energy business for over 10 years. The five directors have extensive experience and track record in the energy industry, land acquisition and the planning process. In addition to the Yellow River site, GWE has been involved in the preliminary development of sites in Wexford, West Cork, East Cork, Sligo and other sites in the midlands.

GWE has been engaged with the Yellow River Wind Farm for over 3 years and has acquired the necessary legal options from the 22 separate landowners of the site.

GWE applied for a grid connection for the Yellow River Wind Farm in April 2012.

¹ (IWEA <http://www.iwea.com/index.cfm/page/windenergyfacts>)

² (EirGrid, <http://www.eirgrid.com/operations/systemperformancedata/electricitystatistics/>)

1.4 PLANNING HISTORY

1.4.1 Yellow River Site

There have been no previous applications in respect of wind energy generation at the proposed Yellow River Wind Farm site. However, there have been applications in respect of quarrying and afforestation of areas of the site. Planning permissions in the vicinity of the site include: quarries, piggeries, 15 MW willow generating plant at Coolcor, waste management facility, dwellings - new builds and extension / renovations; septic tanks and percolation areas; agricultural buildings including a slurry tank and milking parlour.

1.4.2 Wind Farms in the Vicinity

The closest operating wind farms to the proposed Yellow River Wind Farm site are located at Carrig and Skehanagh in Co. Tipperary, approximately 65km south west of the proposed site. The existing wind farm at Carrig has been operational since 2006 and consists of 3 Vestas V52 850kW turbines with an output capacity of 2.55 MW. The wind farm at Skehanagh has been operational since 2006 and consists of 5 Vestas V52 850kW turbines with an output capacity of 4.25 MW.

Mount Lucas Wind Farm, consisting of 28 turbines, is currently under construction since December 2012 and is located approximately 10 km south of the proposed site. The maximum output capacity for Mount Lucas is 79.2MW.

Leabeg Wind Farm, with a maximum export capacity of 4.25 MW, has planning permission consented, however, construction of this wind farm has not, as yet, commenced. Leabeg Wind Farm lies approximately 36 km south west of the proposed development.

A conditional grant of planning permission was issued to Cloghan Wind Farm in July 2013. This wind farm is located approximately 42km southwest of the proposed development. Cloghan Wind Farm comprises of 10 wind turbines with a maximum output capacity of 25MW.

Wind Farm	Status	Output (MW)	Direction from the Site	Distance (km)
Mount Lucas	Construction	79.2MW	South	10
Leabeg	Consented	4.25MW	South West	36
Cloghan	Consented	25MW	South West	42
Carrig/ Skehanagh	Operational	6.8MW	South West	65

Table 1.1 Closest Wind Farms to Yellow River site

Please refer to **Figure 1.2** for details of closest Wind Farms to Yellow River site.

1.4.3 Power Plants in the Vicinity

This area of County Offaly has a history of industrial power production dating back to the 1950's. There are a number of power plants currently in operation in the region. These are Rhode Peaking Power Plant, Edenderry Independent Power Plant and Coola Mills Power Plant.

The Rhode Peaking Power Plant was commissioned in 2004 and has a nominal capacity of 104 MW, delivered from two generators each driven by two combustion turbines. Endesa Ltd. purchased the site from the ESB and the takeover date was January 2009. This plant has now been bought by SSE Renewables. This power plant is located approximately 50m south of the proposed substation for Yellow River Wind Farm and approximately 1.4km west of the nearest wind turbine.

Edenderry Power was commissioned in 2000. Edenderry Power station is a 128 MW (gross) baseload plant. It consumes just over 1 million tonnes (7.7PJ) of fuel each year. The station uses modern bubbling fluidised bed boiler capacity, which allows a multi-fuel capability. The station is capable of burning a wide range of 'clean' biomass materials. These include: woody materials from Irish forests, which may be supplied directly by forestry contractors or indirectly as residues from sawmills; purpose grown energy crops such as willow or Miscanthus; dry materials such as wood pellets or imported agro-industrial residues such as palm kernel or almond shells. The co-firing of biomass with peat commenced in 2008, with over 19,000 energy tonnes (ET) of peat displaced in the first year, and the co-firing rate has increased year-on-year.

Cushaling Power Plant is a new 116 MW peaking plant located approximately 6km south of Edenderry and approximately 11km south east of the proposed site. It consists of two open cycle gas turbine (OCGT) units. Cushaling Power Plant entered commercial operation in September 2010. This Power Plant can start up and reach full power output in less than ten minutes. It acts primarily as reserve capacity on the grid, and is only expected to operate for a few hundred hours per annum.

Coola Mills Power Plant is a small hydro power plant with a capacity of approximately 0.11MW. It is located in Kilbeggan in Co. Westmeath, approximately 20km west of the site.

1.4.4 Consented Wind Farms in the Vicinity

Mountlucas Wind Farm is the closest of the consented wind farms, and is located approximately 10 km south of the proposed development. Mountlucas Wind Farm (Planning Ref. 09/453) received a conditional planning grant in July 2010 for 32 3MW turbines with a hub height of up to 100 m and rotor diameter of 112m.

This decision by Offaly County Council to grant planning permission was appealed to An Bord Pleanála (Case Reference PL19.237263). The Board decided to grant permission in December 2010, subject to compliance with 22 conditions. The reasons for conditional grant are as follows:

- National policy with regard to the development of alternative and indigenous energy resources and the minimisation of greenhouse gas emissions.
- The guidelines issued by the Department of the Environment and Local Government on Wind Farm Development.
- The provisions of the current Offaly County Development Plan, including the County Offaly Wind Energy Strategy to 2015.
- The location of the proposed development on a cut away bog site, which does not come within the scope of specific restrictions with regard to development in scenic areas as set out in the current development plan for the area.
- The general topography and landscape features in the vicinity of the site.
- The existing pattern of development in the vicinity.

A conditional grant of planning permission was issued to Cloghan Wind Farm in July 2013 (Planning Ref. 12/293). This wind farm is located approximately 42km southwest of the proposed development. Cloghan Wind Farm comprises of 10 wind turbines, hub height of up to 110m and rotor diameter of up to 120m, with a maximum output capacity of 25MW.

1.4.5 Consented Renewable Generation in the Vicinity

Biotricity Ltd were granted planning permission in 2010 for a biomass processing combined heat and power (CHP) facility which includes the processing of raw biomass sourced from renewable forestry and agricultural crops into refined solid biofuel for commercial use, and as part of the process, the production of circa 15MW of renewable electricity for export to the national grid at Coolcor, Rhode, Co Offaly. (Planning Reference No.: 09537).

Bord na Mona Energy Ltd were granted planning permission in 2010 for an Electricity generating power station, comprising of two generating units and ancillary development, summarised as follows; Combined cycle gas turbine unit (CCGT) of c. 430MW and Reserve/peaking open cycle gas turbine unit (OCGT) of c. 170MW. An Bord Pleanála granted permission as Strategic Infrastructure Development in the townland of Dreeygreenagh, Co. Offaly. (ABP Planning Reference No.: PA0011).

1.4.6 Consented Waste Facility in the Vicinity

Bord na Mona were granted planning permission in 2011 for a Materials recycling and waste transfer facility at Drumman, Derrygreenagh, Co. Offaly by An Bord Pleanála. (Planning Reference No.: 2/10/93 and ABP Reference 19.237717). This facility will accept up to 99,000 tonnes per annum of non-hazardous municipal solid waste, construction & demolition waste and a small amount of hazardous household waste.

1.4.7 Cumulative Impact of Surrounding Infrastructure Developments

It is envisaged that the cumulative impact of the surrounding infrastructure developments, including the wind farm developments, electricity generating plants and waste facility, will be to enhance Rhode's economic regeneration and sustain it's strategic location as an energy producing hub.

1.5 APPLICABLE LEGISLATION AND REGULATIONS

The European Communities (Environmental Impact Assessment) (Amendment) Regulations, 1999, First Schedule, Part II, Paragraph 3, subsection (i) requires that an Environmental Impact Assessment be carried out for:

“Installations for the harnessing of wind power for energy production (wind farms) with more than 5 turbines or having a total output of greater than 5MW”.

The Planning and Development Regulations, 2001, SI No. 600 of 2001 Schedule 5, describes the developments which require an Environmental Impact Assessment and uses the same threshold for this type of development. It also requires that the relevant selection criteria introduced in Annex III of the Directive, in respect of location and its environmental sensitivity, be taken into account.

The proposed 32 turbine development exceeds the threshold levels as described above and, consequently, the project is subject to an Environmental Impact Assessment.

The Planning and Development (Amendment) Bill, 2009 - Strategic Infrastructure: Section 70 amends the Seventh Schedule of the Planning and Development Act, 2000. Specifics include the reduction of the threshold of the Strategic Infrastructure Assessment (SIA) of wind farms from 50 turbines / 100MW to 25 turbines / 50 MW. This section of the Planning and Development Bill, 2010 was enacted on the 5th of October 2010.

The proposed development consists of 32 turbines with a potential combined output of 96 MW; it therefore exceeds the thresholds as defined in the Seventh Schedule of the Planning and Development (Strategic Infrastructure) Act, 2006 (the 2006 Act) and the revised thresholds under Section 70 of the Planning and Development (Amendment) Bill, 2009.

An Bord Pleanála were consulted in relation to the suitability of the proposed Yellow River Wind Farm development to enter into the Strategic Infrastructure Development Planning Process. Please refer to Section 1.11.3 for details.

It was considered that the proposed development could be put forward as strategic infrastructure development, as it satisfies criteria (a), (b) and (c) of section 37A (2) of the 2006 Act for the reasons set out hereunder:

- (a) The development would be of strategic economic or social importance to the State or the region in which it would be situate.

The development will generate 252,288 MWh of sustainable, reliable energy each year on average. This would be enough to supply up to 50,297³ households. It will indirectly, benefit the region by virtue of providing a power supply platform on which to develop industrial sectors. By displacing fossil fuel generation, the wind farm would avoid the following annual discharges of 123,369 tonnes of carbon dioxide. This is the equivalent energy production from 53760 tonnes of oil each year.

- (b) The development would contribute substantially to the fulfilment of any of the objectives in the National Spatial Strategy or in any regional planning guidelines in force in respect of the area or areas in which it would be situate.

The development will contribute towards the actions and targets for the energy policy framework up to 2020 as outlined in the White Paper entitled "Delivering a Sustainable Energy Future for Ireland" published by the Department of Communications, Marine and Natural Resources. The Paper sets a clear path for meeting the Government's goals of ensuring safe and secure energy supplies, promoting a sustainable energy future, and supporting competitiveness. Section 3.9.5 of the Paper states that 33% of all electrical consumption will be generated from renewable energy sources by 2020. This target has since been increased to 40% from renewable energy sources (Dáil Statement, Budget 2009).

- (c) The development would have a significant effect on the area of more than one planning authority.

³ http://www.seai.ie/Renewables/Wind_Energy/Wind_Farms/Wind_Farms_and_the_Environment/

While the site is located entirely within County Offaly, the centre of the nearest turbine is some 275m from the County Westmeath border, some 60m from County Meath and some 4,500m from County Kildare.

An Bord Pleanála issued a formal decision stating that the development was Strategic Infrastructure on November 4th 2013. Please refer to **Appendix A** for a copy of this correspondence.

1.6 RENEWABLE ENERGY POLICY

1.6.1 Climate Change

The global demand for energy is increasing, linked to growing populations and the associated increase in urbanisation and industrial development. The primary source of energy remains non-renewable fossil fuels. Energy is produced by combustion of these fuels. This thermal energy is either used directly as an energy form or is used in the production of secondary energy forms, (e.g. transport, electricity). This energy production process results in the atmospheric emission of various gaseous compounds, such as carbon dioxide (CO₂), and various compounds of sulphur oxides (SO_x) and nitric oxides (NO_x). The latter compounds SO_x and NO_x have been identified as contributing to acid rain, which results in damage to forestry, watercourses and associated ecology.

Carbon dioxide (CO₂) is a greenhouse gas. The emissions of greenhouse gases are now recognised as having serious damaging effects on the environment. The effects of the gases result in increased global temperatures with consequent effects on sea levels due to ice-cap melting and altered weather patterns.

The UN sponsored Intergovernmental Panel on Climate Change (IPCC) has projected increases in sea levels leading to severe flooding and IPCC scientists expect major ecological changes to occur as a result. The IPCC has also estimated that the average global temperature will increase by up to 5.8°C over the next 100 years. The initial effects of these changes are considered by experts to be already manifesting themselves.

1.6.2 Global & EU Energy Policy

A number of international conferences have been held in order to agree limits for the emissions of CO₂. At the Rio de Janeiro conference in 1992, 154 governments agreed to adopt measures to reduce greenhouse gas emissions and combat climate change. Subsequently, at the Kyoto conference in 1997 a specific reduction of 5.2% in global greenhouse gas emissions, by the period 2008 – 2012, was agreed. This led the EU to limit maximum greenhouse gas output by the year 2010 and to source 22% of electricity consumed in the EU from renewable sources, including wind farms, also by 2010 (Renewable Energy Directive, 2001).

In turn, individual national targets for electricity supply from renewable sources were agreed and, in the case of Ireland, a target of 13.2% of energy from renewable sources was set.

At the Johannesburg summit in 2002, the general commitment to develop renewable energy was re-iterated. Russia and the EU re-affirmed their commitment to reach their emissions targets.

The Kyoto Protocol came into force on February 16th 2005 following ratification by Russia in November 2004. As of December 2006, 169 countries, including Ireland, have ratified the agreement.

In 2005, the emissions data estimated that Ireland was 25.4% above the level for 1990. The most recent emissions data shows that in 2007 we were 24.6% above the level for 1990, (the base year for Kyoto targets). Ireland's target is to limit the growth of emissions to 13% by 2007 so we were still a considerable way off the target (EPA, Annual Highlights, 2008).

In February 2008, the EU Commission imposed targets on Ireland's emissions and energy which is to come from renewables. The Commission's proposals require Ireland to reduce its greenhouse gas emissions by 20% by 2020, using 2005 figures as a base. It also dictated that 16% of all Irish energy is to come from renewables.

On the 6th of December 2009, diplomats from 192 nations assembled in Copenhagen, Denmark to discuss measures to protect the world from global warming. The aim of the conference was to reach global agreement on emissions caps and contributions of

funding for new technologies. Discussions to this effect continued at Cancun in Mexico in November 2010.

1.6.3 National Energy Policy

In the light of Ireland's commitment to reduce emissions from energy and in the context of increasing national demand for electricity, the Government introduced a number of measures. These include the efficient use of electricity and the production of electricity from non-fossil renewable sources, in particular wind energy.

On March 12th 2007, the White Paper entitled “Delivering a Sustainable Energy Future for Ireland” was launched by the Department of Communications, Marine and Natural Resources. This policy document describes the actions and targets for the energy policy framework up to 2020. The Paper sets a clear path for meeting the Government's goals of ensuring safe and secure energy supplies, promoting a sustainable energy future, and supporting competitiveness. Section 3.9.5 of the Paper states that 33% of all electrical consumption will be generated from renewable energy sources by 2020 with a 15% target for 2010. The bulk is again expected to come from wind energy.

Furthermore, in the 2009 Budget announced on October 15th 2008, the Minister for the Environment, Heritage and Local Government stated *‘Today I can confirm that the Government has now agreed, on the recommendation of my colleague, the Minister for Communications, Energy and Natural Resources, to increase this target to 40%’* (Dáil Statement, Budget 2009). The bulk is expected to come from wind energy.

The amount of wind farm capacity connected to the Irish power system now totals 1,763 MW as of March 2013⁴. The peak amount of electricity generated by wind power reached 1,540 MW for the first time on March 21st 2013⁵. However, it is estimated that approximately 6,000 MW of installed renewable capacity will be required to meet the 2020 target.

With regard to wind energy, the Government initiated a scheme, Alternative Energy Requirement, AER I, to develop specific quantities of wind energy by specific

⁴ (IWEA <http://www.iwea.com/index.cfm/page/windenergyfacts>)

⁵ (EirGrid, <http://www.eirgrid.com/operations/systemperformancedata/electricitystatistics/>)

timeframes. The AER Programme was continued and the last AER programme was AER V1.

In May 2006, the Minister for Communications, Marine and Natural Resources, announced details of a new Government support mechanism for renewable energy projects. The programme is called REFIT (Renewable Energy Feed in Tariff). This superseded the AER programme to a fixed price tariff system.

The Electricity Regulation Act 1999 provided for obligations on the ESB to purchase up until December 2019 the output of certain peat and renewable sustainable or alternative electricity generating stations in the interests of security of supply and environmental protection.

1.6.4 Emissions Targets

A decision was taken by the Irish Minister for the Environment in 1997 making a legally binding commitment, as part of an EU-wide agreement, to limit greenhouse gas emissions in the period 2008-2012 to no more than 13% above the 1990 base level. Ireland's limit in terms of the Kyoto Protocol has been set as 314.184272 million tonnes Carbon dioxide equivalent (Mt CO₂eq) of greenhouse gases for the entire five-year period 2008-2012. This equates to an average of 62.837 Mt CO₂eq per annum over the period (i.e. 13% above the baseline estimate). Ireland will face penalties if our emissions exceed the target level.

Ireland's emissions in 2007 were 6.368 Mt CO₂eq higher than the limit as an annual average, while offsets from forest sinks were 1.36 Mt CO₂eq resulting in a "current" annual distance from target of 5.008 Mt CO₂eq, (6.368 – 1.36).

The EU commission's target for 2020 imposes an emissions limit of 59Mt CO₂eq on Ireland. This is a 20% reduction on our 2005 emissions figures.

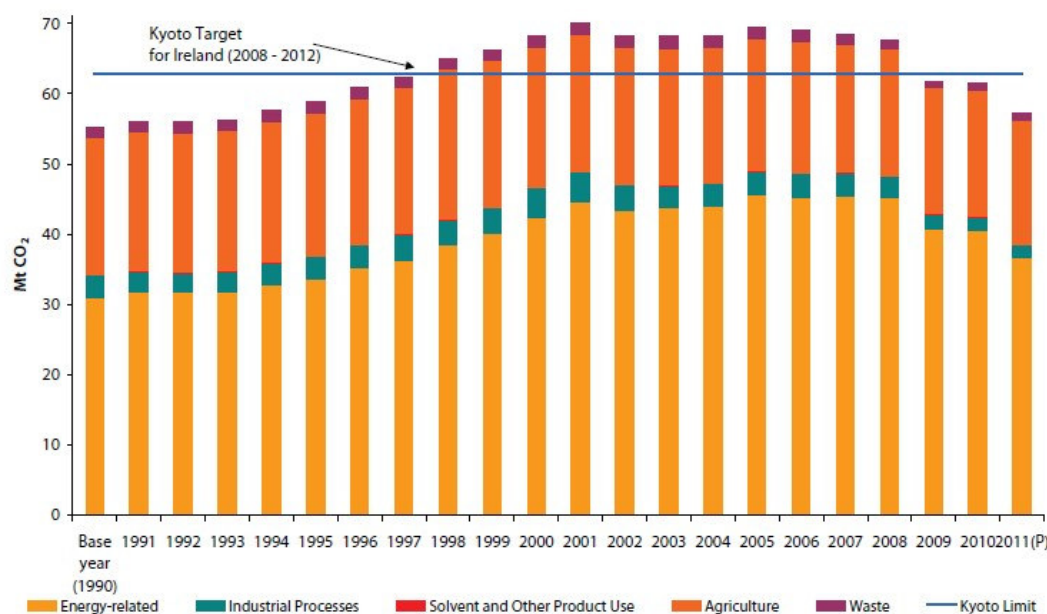
According to a report titled "Ireland's Greenhouse Gas Emission Projections, 2012-2030" published by the EPA, 25th April 2013, Ireland is on track to meet its commitment under the Kyoto Protocol. This is in marked contrast to the projection in Ireland's 2007 National Climate Change Strategy. Although the reduction in the distance to target for the Kyoto Protocol period is a positive outcome in terms of compliance, its occurrence is, primarily, a direct result of the current economic

recession and economic outlook for the future. In order to meet future targets, Ireland cannot rely on a recession and needs to develop as a low carbon economy going forward.

In October 2010, the EPA published their estimation of the total emission figure for 2009 of 62.32 Mt CO₂eq. This is 7.9% lower than the level of emissions in 2008 and was the first year when total greenhouse gas emissions (GHG) were below the Kyoto target.

The 2013 Report also states that there continues to be a significant risk that Ireland will not meet its 2020 EU targets even under the most ambitious emission reduction scenario. There is projected to be a cumulative distance to target of 7 – 24 Mtonnes for the period 2013-2020 with Ireland breaching its annual limits in 2015-2016. Strong projected growth in emissions from transport and agriculture are the key contributors to this trend.

Updated data is contained within the SEAI's "Energy in Ireland 1990 – 2011", 2012 Report. Figure 1.3 shows the trend in greenhouse gas emissions between 1990 and 2011. The figures used in that report are sourced from the EPA.



Source: Based on Environmental Protection Agency (EPA) data.

Figure 1.3 – Greenhouse Gas Emissions by Source 1990 – 2011 (SEAI Energy in Ireland 1990 – 2011)

The figure shows that Ireland's Kyoto target for the period 2008 – 2012 was first breached in 1998. By 2001, annual GHG emissions peaked at 27% above 1990 levels. In 2002, there was a reversal in the upward trend for the first time with GHG emissions dropping to 24% above 1990 levels. This downward trend continued and by 2008 there was a 3.6% reduction on the peak 2001 emissions. Between 2008 and 2011, there was an acceleration in the rate of reduction in emissions due in large part to the economic downturn, with emissions falling by 15.2% between 2008 and 2011

Provisional figures from the Environmental Protection Agency (EPA) show that total GHG emissions fell in 2011 by 6.7% to 57.34 million tonnes. As in 2010, most of the reduction in 2011 came from energy-related emissions, falling by 3.8 Mt CO₂eq. While the reduction in emissions brings Ireland below the Kyoto limit of 62.84 Mt CO₂eq, it is necessary to consider both the emissions-trading and non-emissions trading sectors in order to assess the current distance to target. The EPA estimates, based on the first four years of the Kyoto period (i.e. 2008 to 2011), that Ireland's distance to target is 1.77 Mt CO₂eq (cumulative of the four years) when the impact of forest sinks and the emissions-trading scheme are included.

As part of the study within the report titled "Ireland's Greenhouse Gas Emission Projections, 2012-2030" published by the EPA, 25th April 2013, Greenhouse gas emissions are projected to 2020 using two scenarios. The 'worst case scenario' assumes that no additional policies and measures, beyond those already in place by December 2011, are implemented (With Measures projection). Under this scenario, emissions are projected to increase by 9% by 2020. The 'best case' scenario assumes that Government targets for 2020, for example renewables targets, will be fully achieved (With Additional Measures projection). Under this scenario, emissions are projected to increase by 1% by 2020. Therefore, assuming that these two scenarios represent two possible pathways for greenhouse gas emissions in Ireland to 2020, emissions are projected to be 1-9% higher in 2020 when compared to current levels.

Figure 1.4 shows emissions for the period 1990 to 2012 for both a With Measures scenario and a With Additional Measures scenario and compares with the Kyoto Protocol limit for the period between 2008 and 2012.

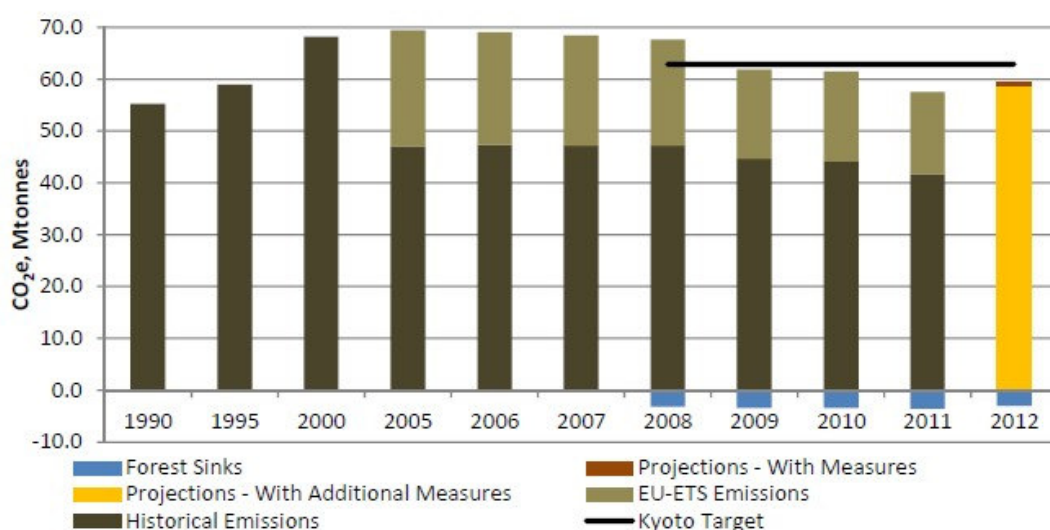


Figure 1.4 Historical and projected greenhouse gas emissions (including forest sinks) for the 2008 – 2012 period for each scenario and the Kyoto Protocol Target. (EPA, 2013)

The reduced distance to target is partly as a result of reductions in energy demand in the residential, industrial, commercial and energy industries sectors. In addition, improvements to the calculation methodologies for forest sinks resulted in an increase in the estimates of the carbon sink available for each year of the commitment period 2008-2012.

The distance to target is determined by considering the relative contributions of the ETS and non-ETS sector emissions to total national emissions. Ireland's National Allocation Plan (2008-2012) allocates 22.3 Mtonnes of CO₂ annually to those installations covered by the EU Emissions Trading Scheme. The remainder (i.e. 62.8-22.3 = 40.6 Mtonnes of CO₂eq) is compared with projected non-ETS sector emissions (including the impact of forest sinks) to assess the distance to target.

Sustainable Energy Ireland predict that 2008 levels of energy demand will be established by 2014 therefore it is essential that Ireland continue to reduce its greenhouse gas emissions to avoid future penalties.

Under the EU Commission's Climate and Energy Package, Ireland is required to deliver a 20% reduction in non-ETS greenhouse gas emissions by 2020 (relative to 2005 levels). In addition, Ireland also has binding annual emission limits for the period 2013-2020 to ensure a gradual move towards the 2020 target. The non-ETS sectors cover those sectors that are outside the EU Emissions Trading Scheme and

include agriculture, transport, energy, residential and waste sectors. The target for Ireland's non-ETS sectors is to reduce emissions by 20% in 2020 relative to 2005 levels. This limit was set in 2012 following a review of Ireland's national greenhouse gas inventory at 37.5 Mtonnes of CO₂eq⁴. It is estimated that Ireland will exceed its 2020 limit by 5 – 8 Mtonnes of CO₂eq. This is 3% – 10% below 2005 levels compared with a limit of 20%. In addition, the projections indicate that Ireland will exceed its binding annual limit in 2015-2016 and will exceed its obligations over the 2013-2020 period, cumulatively, by 7 – 24 Mtonnes of CO₂eq. The impact of forest sinks are not included in this assessment in line with EU accounting rules which stipulate that forest sinks may not be used for compliance towards EU 2020 targets.

The key contributors to emissions in the non-ETS sectors are transport and agriculture. Agriculture emissions are projected to grow on an annual basis out to 2020, which reflects the impact of Food Harvest 2020 and removal of milk quota. In total, agriculture emissions are projected to increase by 12% by 2020 on current levels. Transport emissions are also projected to show strong growth over the period to 2020 with a 12-22% increase on current levels depending on the level of policy implementation.

Figure 1.5 shows projected emission levels for non-ETS sector emissions under the With Measures and With Additional Measures scenarios. In addition, it shows the annual compliance/non-compliance in relation to the annual binding emission limits.

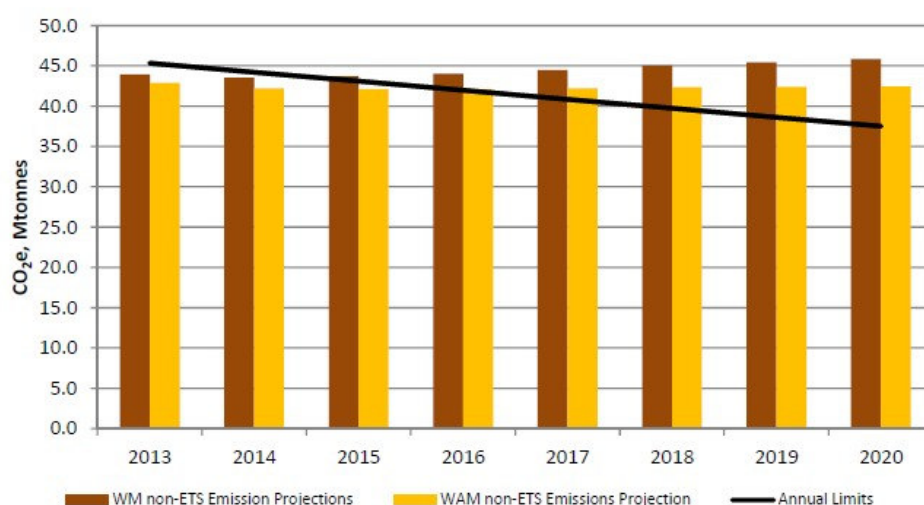


Figure 1.5 With Measures and With Additional Measures Greenhouse Gas Emissions projections and comparison with the linear reduction pathway required between 2013 and 2020. (EPA, 2013)

It is important to note that the With Additional Measures scenario assumes that all targets in Government policy documents such as the NEEAP and NREAP are met. The difficulties associated with meeting these targets should not, however, be underestimated. Failure to meet these targets will result in higher emissions levels than those projected under this scenario and result in Ireland's emission levels moving even further from its emission reduction targets.

Energy sector emissions comprise emissions from power generation, oil refining, peat briquetting and fugitive emissions. Emissions from power generation accounted for 97% of energy sector emissions in 2011 and are responsible for a similar share of emissions over the projection period.

Under the With Measures scenario, total energy sector emissions are projected to increase by 11% over the period 2011 – 2020 to 13 Mtonnes of CO₂eq. The increase in emissions is caused by a projected increase in the use of coal and reduction in the use of gas as a fuel for electricity generation. This is as a result of the current and projected low coal price (relative to gas). Renewables penetration in 2020 is projected to be 24% under this scenario.

Under the With Additional Measures scenario, total energy sector emissions are projected to increase by 1% over the period 2011 – 2020 to 12 Mtonnes of CO₂eq. In this scenario, it is assumed that renewable energy reaches 40% penetration by 2020 with the largest contribution coming from wind. It is envisaged there will be an additional expansion of renewable electricity generation (from 56 MW currently to 285 MW in 2020) from co-firing biomass, the construction of an additional waste to energy plant and the continued development of landfill gas electricity generation and biomass CHP. In addition, the construction of at least 25 MW of wave energy is included in the forecast.

In conclusion, it is essential that Ireland continues to develop its renewable energy industry so as to attain the EU 2020 targets.

1.7 WIND RESOURCES

Ireland has one of the best wind resources in Europe. The availability of high wind speeds in particular locations means that a level of power output can be achieved with a reduced number of wind turbines than would otherwise be the case. The Southwestern and Northwestern regions have been to the forefront in the development of wind energy. In particular, Counties Donegal, Cork and Kerry already have a number of operational wind farms producing electricity because of the high quality wind resource. Plans are now underway to harness wind energy from the central plains of Ireland.

Wind farms generally comprise several wind turbines. A wind turbine consists of a steel tower or steel/concrete tower, upon which a three-bladed rotor connected to a generator is mounted. At sufficiently high wind speeds the rotor will turn, resulting in electrical power output from the generator. The turbines are connected via an underground electricity cable to a substation for transfer to the National Grid.

A significant factor in locating wind farms is the prevailing wind speed pattern of the location and a mean speed of ≈ 8 m/s. The relatively uninterrupted distance over which wind travels in the central plains of Ireland gives mean speeds suitable for wind energy generation.

The conversion of wind power to electrical power is achieved without the large intermediate production process involving the thermal conversion stage needed with fossil fuels. Thus a turbine produces a fraction of the emissions associated with conventional power stations and the environmental damage caused by fossil fuel energy production is avoided.

1.8 PROJECT PREDICTIONS

Wind studies indicate that the capacity factor of the site for a range of turbine models will be greater or equal to 30% taking account of the full range of wind speeds likely to be experienced at the site. This means that the output from the proposed project will be equivalent to the turbines being at full production for greater or equal to 30% of the time.

For 32 No. ≈ 3 MW turbines, the total annual output will be at least 252,288 MWh ($32 \times 3 \times 24 \times 365 \times 0.3$) or 252,288,000 kWh.

Reference is made to the SEAI Report, 2012 titled “Energy in Ireland 1990 – 2011”. According to Figure 15, Section 2.8 of that report, the carbon intensification of electricity has dropped to a new low of 489g CO₂/kWh in 2011.

The reasons given in the report for the increase in generating efficiency and decrease in carbon intensity of electricity in 2011 are:

- A 56% increase in wind generation
- A 18% increase in hydro generation
- A 4.2% increase in electricity imports
- A 17% decrease in gas generation
- A 60% decrease in oil and 2.1% decrease in peat generation.

Thus, the positive contribution of increased wind energy generation to decreasing carbon intensity is evident.

In Section 4.3.1 of the same report, in 2011, the “average” dwelling consumed a total of 19,875kWh of energy based on climate corrected data. This was 14,858kWh in the form of direct fossil fuels and 5,016kWh as electricity.

Using this data, the proposed Yellow River Wind Farm will generate enough electricity to supply up to **50,297** households (252,288,000/5,016) and will save the discharge of some **123,369** tonnes of carbon dioxide (CO₂) per year (252,288,000 x 489/1,000,000).

A carbon sequestration calculation has been undertaken for the proposed development. This spreadsheet calculates the payback time for the wind farms i.e, compares the carbon dioxide savings from the renewable electricity against the carbon dioxide losses from the construction of the wind farm. The calculation uses methods given in Nayak et al, 2008. The spreadsheet can be found in **Appendix B**.

Calculation input data included: wind farm characteristics; in-situ peatland / bog plant characteristics; forestry characteristics; counterfactual emissions factors; and the characteristics of the overall infrastructural footprint.

1.9 FORMAT OF EIS AND METHODOLOGY

The EIS reflects the Guidelines on the Information to be contained in Environmental Impact Statements (2002) and the Advice Notes on Current Practice in the preparation of Environmental Impact Statements (2003), issued by the Environmental Protection Agency (EPA).

The proposed project is described in Chapter 2 with reference to:

- The project background.
- A description of the characteristics of the project.
- Alternative processes, locations and components investigated.
- Construction programme.

Potential impacts to the environment resulting from the proposed project are examined under the following topics:

- Human beings
- Flora and Fauna
- Soils and Geology, including Slope Stability
- Hydrology
- Air and Climate
- Noise
- Shadow Flicker & Electromagnetic Impact Assessment
- Landscape and Visual Assessment
- Material Assets
- Cultural Heritage
- The Interaction of the Foregoing

Each of these topics is discussed, with sections detailing:

- The existing environment.

- Potential impacts of the proposed development.
- Mitigation measures.
- Monitoring.

When considering the characteristics of the proposed development, reference is made to layout, design, size and scale so that projections of the likely levels of impact on any particular environmental sector can be made.

The potential impact of the proposed development allows for a description of the specific, direct and indirect impacts, which the proposed development may have. This is achieved by reference to the existing environment, the characteristics of the proposed development together with the magnitude, duration, consequences and significance of the development.

Where potential impacts are envisaged, remedial and/or mitigation measures that are practical and reasonable are recommended. Where there is a requirement for environmental monitoring during the construction and/or operational phases, such requirements are described together with the proposed methods for carrying out such monitoring.

All prescribed topics have been covered. The level of treatment for some of the topics differs depending on the likelihood of impacts when assessed in the context of the nature of the proposed development and the site.

1.10 PREPARATION

Overall responsibility for the preparation of the Environmental Impact Statement is assumed by Jennings O'Donovan & Partners (JOD), Consulting Engineers, Finisklin Business Park, Sligo. Please refer to **Table 1.3** for information on the project team.

Discipline	Team Member	Key Area
Lead Project Manager	David Kiely (JOD)	Project Manager
Project Co-ordinator	James Conlon (JOD)	Overall Co-ordinator
EIA Manager	Nuala Carr (JOD)	Management and co-ordination of Environmental Impact Assessment
Environmental Services	Conor Mc Carthy (JOD)	QA; Team Leader,
	Nuala Carr (JOD)	Senior Environmental Scientist
	James Conlon (JOD)	Civil / Environmental Engineer
	Eila McTernan (JOD)	Environmental Scientist
	Sean Molloy (JOD)	Civil / Environmental Engineer
	Senior Technician (JOD)	Survey & Drawings
Civil/Structural Engineering Services	Mel Gavin (JOD)	Team Leader / Structural
	John Doogan (JOD)	Roads / Transportation
	James Conlon (JOD)	Civil / Environmental Engineer
Electrical Engineering Services	D. Curtin (GWE) J. Hickey (GWE)	Team Leader – Electrical
	Sean Gilmartin (JOD)	Mechanical Engineer
Specialist - Wind	M. Middleton (WP) N. Hill (WP) P. Kavanagh (WPI)	Team Leader Specialist Consultant
Specialist - Grid	J. Hickey (PC)	Team Leader
	P. O'Donoghue (PC)	Electrical

Table 1.3 - Project Team

Specialist contributions were also provided by the following:

Human Beings Jennings O'Donovan & Partners, Finisklin Business Park, Sligo.

Flora & Fauna BES, Greystones, Co. Wicklow

Conservation Services, Killarney, Co. Kerry

Aardwolf Wildlife Surveys, Macroom, Co. Cork.

Soils / Geology	Whiteford Geoservices, Ballyclare, Co. Antrim
Hydrology	HydroEnvironmental Services, Dungarvan, Co. Waterford
Air Quality	Jennings O'Donovan & Partners, Finisklin Business Park, Sligo.
Noise	Noise & Vibration Consultants Ltd., Navan, Co. Meath.
Shadow Flicker	Jennings O'Donovan & Partners, Finisklin Business Park, Sligo.
Landscape & Visual	Jennings O'Donovan & Partners, Finisklin Business Park, Sligo. MosArtMosArt Ltd., Architecture Landscape Urban Design, Block 6, Broomhall Business Park, Wicklow, Co. Wicklow, Ireland
Material Assets	Jennings O'Donovan & Partners, Finisklin Business Park, Sligo.
Cultural Heritage	Irish Archaeological Consultancy, Bray, Co Wicklow
Public Affairs	Green Wind Energy (Wexford) Ltd.
Grid Connection	Power Connections Ltd, Edenderry, Co Offaly
Wake Analysis	Wind Prospect Ireland, Malahide, Co Dublin.

No difficulties, such as technical deficiencies, lack of information or knowledge, were encountered in compiling any specific information of the EIS.

1.11 CONSULTATION

1.11.1 *Public Consultation*

During the initial stages of the EIA process, a public consultation was held in Rhode Community Centre between 12pm and 7.30pm on December 10th 2012. Notification of this event was given in the local press and in the parish notes.

Invitations were issued to Offaly County Council, Meath County Council, Kildare County Council, An Bord Pleanála, An Táisce and National Parks and Wildlife Service. The evening was attended by those interested in the project including: the local community, elected members and the press.

A total of 66 people signed in at the consultation evening, and a number of others attended but did not sign in. Four representatives from Jennings O'Donovan & Partners Ltd and three directors from Green Wind Energy were present.

The principal elements of the project were explained by Green Wind Energy, and by members of the environmental / engineering team from Jennings O'Donovan & Partners Ltd.

Written submissions were invited from the public. A total of 20 feedback sheets were returned following the consultation. Eighteen feedback sheets contained positive information, 1 feedback sheet had concerns about proximity to residence and requested information on micrositing and 1 feedback sheet requested further information on noise. A summary of the feedback forms is set out in **Table 1.4**. A synopsis of the First Public Consultation and a copy of all feedback forms returned are included in **Appendix C**.

<u>Response No.</u>	<u>Response Content</u>	<u>Action</u>
1. – 20 (except 5 & 7). Local residents / business people Rhode, Enfield, Rochfortbridge and Edenderry	This is a very worthwhile project and I welcome it strongly. Development is positive in terms of employment. Energy from wind is total progress. Worthwhile consultation. Positive in terms of employment during construction / operational phase. Good presentation.	
5. Mary Dillon, Local Resident	T13 approximately 500m from house. Send on details of micrositing	T13 was moved further from resident's home.
7. Laura Lenihan, Local Resident	I live in Ballyburley and would like to know about the noise from 14+15.	GWE met to discuss concerns.

Table 1.4 - Summary of Public Consultation Feedback Forms

Apart from the open public consultation day referred to above, on an on-going basis, on request, meetings are held by GWE on an individual basis with interested parties,

eg, an informal meeting was held on June 13th, 2013, in Ballyburly, with several concerned locals. Representatives of Green Wind Energy and Jennings O'Donovan & Partners Ltd gave details of the project, showed the up-to-date layout proposal and clarified GWE processes in relation to distance from dwellings; noise; shadow flicker and access.

1.11.2 Local Authority

A scoping report was issued in January 2013, which contained information on Wind Energy Generation; Development Control; Visual Constraints; Environmental Constraints; Site Layout; Existing Access; Settlement Patterns; Tourism & Amenity; Grid Connection and Planning History. Following a number of pre-planning meetings, a formal pre-planning meeting was held with Offaly County Council on May 21st 2013. Prior to this meeting, updated information was forwarded, including draft site layout maps of the proposed development.

The following attendees were present: Mr Ed Kelly (Senior Executive Planner); Mr Joe Coleman (Senior Roads Engineer); Mr Damien Grennan (Area Engineer) Representatives from Green Wind Energy and Jennings O'Donovan & Partners. Topics discussed included: Planning & Development (Amendment) Bill 2010; Consultation process; Visual Impact; Access Roads; and EIA findings. The minutes of this meeting as recorded by Jennings O'Donovan & Partners are included in **Appendix D**. A programme of on-going meetings was conducted with Offaly County Council.

A follow-up meeting was held with Offaly County Council Senior Roads Engineer, Mr Joe Coleman and Senior Executive Planner, Lorraine Mitchell, on July 24th 2013, to discuss the final layout and related road issues. The minutes of this meeting as recorded by Jennings O'Donovan & Partners are included in **Appendix D**.

A further meeting was held with Offaly County Council Senior Executive Planner, Mr Ed Kelly, on July 31st 2013, to discuss the final layout and the photomontages taken to assess the visual impact.

A final meeting was held with Offaly County Council Mr Joe Coleman (Senior Roads Engineer) and Mr Damien Grennan (Area Engineer) on November 11th 2013, to discuss the final haul route and all related roads issues.

1.11.3 An Bord Pleanála

The first pre-application consultation meeting was held with An Bord Pleanála on September 17th 2012. The following attendees were present: Mr Des Johnson (Director of Planning); Ms Karla McBride (Senior Planning Inspector); Marcella Doyle (Senior Executive Officer); Ms Sinéad McInerney (Executive Officer); Representatives from Green Wind Energy and Jennings O'Donovan & Partners. A presentation was made to the meeting which included the following content: Introduction / Project Team; Scoping & Consultation Process; Preliminary Site Layout; Constraints; Environmental Impact topics including Noise, Shadow Flicker; Ecology, Appropriate Assessment, Hydrology, Geology and Visuals; Mitigation Measures; Substation, Turbines and Grid Connection. The minutes of this meeting as recorded by An Bord Pleanála are included in **Appendix A**.

The second pre-application consultation meeting was held with An Bord Pleanála on June 10th 2013. The following attendees were present: Mr Philip Green (Assistant Director of Planning); Ms Karla McBride (Senior Planning Inspector); Marcella Doyle (Senior Executive Officer); Ms Sinéad McInerney (Executive Officer); Representatives from Green Wind Energy and Jennings O'Donovan & Partners. A second presentation was made to the meeting which included the following content: Scoping & Consultation Process and Final Responses; EIA Findings & Constraints, EIA Mitigation Measures; Final Site Layout. Topics discussed included: meeting with Offaly County Council; Grid connection. The minutes of this meeting as recorded by An Bord Pleanála are included in **Appendix A**.

The final pre-application consultation meeting was held with An Bord Pleanála on September 4th 2013. The following attendees were present: Mr Philip Green (Assistant Director of Planning); Ms Karla McBride (Senior Planning Inspector); Diarmuid Collins (Senior Administration Officer); Mr Kieran Doherty (Executive Officer); Representatives from Green Wind Energy and Jennings O'Donovan & Partners. Items discussed included the record of a meeting, in relation to Yellow River Wind Farm, held between Offaly County Council and An Bord Pleanála on July 18th 2013. The procedures involved in a Strategic Infrastructure application were presented. The minutes of this meeting as recorded by An Bord Pleanála are included in **Appendix A**.

1.11.4 NPWS

A pre-application consultation meeting was held with the National Parks and Wildlife Service (NPWS) on April 16th, 2013. Project information including the scoping pack and a summary of the findings of the wintering bird survey and habitat survey was issued prior to the meeting.

The following attendees were present: Ms Linda Patton (NPWS); Ms Ciara Flynn (NPWS); Mr Brian Madden (Biosphere Environmental Services); Mr Don Curtin (Green Wind Energy); and Ms Nuala Carr (Jennings O'Donovan & Partners Ltd). Topics discussed included: Project Background, Project Description, findings of the ecological surveys and potential mitigation measures. The minutes of this meeting are included in **Appendix E**.

1.11.5 Statutory and Non-Statutory Consultees

A consultation letter and scoping document/feasibility report were sent to all relevant statutory and non-statutory consultees during the scoping process. A full list of the bodies consulted, the consultation letters sent and the corresponding responses can be found in **Appendix F**.

Of the 30 bodies consulted, 13 responses were received. A summary schedule of the consultees and responses received is set out in **Table 1.5**.

Follow up calls were made to all no response consultees in May 2013.

The purpose of this scoping process was to provide a focus for the Environmental Assessment of the project by identifying the key issues of relevance and to agree the scope and approach. As such, the scoping process aims to inform the various organisations of the existence of the project, thereby providing an early opportunity to submit comments and to offer information relevant to the preparation of the EIS.

All comments have been addressed within the Environmental Impact Statement, in so far as is practical.

1.12 AVAILABILITY OF DATA

Copies of this document may be viewed by contacting the following during office hours:

- The Offices of An Bord Pleanála, 64 Marlborough Street, Dublin 1.
- The Offices of Offaly County Council, Áras an Chontae, Charleville Road, Tullamore, Co. Offaly.
- Edenderry Area Office, Edenderry Town Hall, Edenderry, Co. Offaly.
- The Offices of Jennings O'Donovan & Partners Consulting Engineers, Finisklin Business Park, Sligo, Co. Sligo.

The application may also be viewed / downloaded on the following website:

<http://www.yellowriverwind farm.com/>

NAME	DATE CONSULTED	RESPONDED	COMMENT
Johnny Evans Head of Projects & Coverage Planning 2RN, Block B, Cookstown Court, Old Belgard Road, Tallaght, Dublin 24, Ireland Phone: + 353 (0) 1 2082680 Mobile: + 353 (0) 86 8255653 Johnny.Evans@rte.ie	January 2013	October 2013	A protocol agreement has been signed by both 2RN and Green Wind Energy (Wexford) Ltd should any impacts arise as a result of the wind farm.
Louis Whelan, Civil Operations, Chorus NTL., UPC Communications Ireland Ltd., Unit 7 Broomhill Business Park, Broomhill Road, Tallaght, Dublin 24. t (01) 245 8699 f (01) 245 8681 m: (086) 254 5576 ocleary@upc.ie	January 2013	June 2013	UPC does not have any record of underground services in these locations as indicated in your drawings and UPC has no issue with the turbine locations.
Mr. John Tyrell, Radio Planning Dept., Vodafone, Mountain View, Leopardstown, Dublin 18 1800 30 80 20	January 2013	April 2013	The revised location of the wind turbine will not affect existing Vodafone transmission.

NAME	DATE CONSULTED	RESPONDED	COMMENT
Transmission Department O2 Ireland Sir John Rogerson's Quay Dublin 2 E: silvia.martinleon@o2.com T: +353 (0)86 8145590	January 2013		
Meteor Mobile Communications, 4030 Kingswood Ave., Citywest Business Park, Naas Road, Dublin 24 Email: windfarms@meteor.ie (email correspondence preferred)	January 2013 & September 2013	February 2013 & September 2013	Meteor confirmed that this proposal will have no impact on the meteor network. Based on the co-ordinates sent, there should be no issues with the Meteor TXN Network.
Corporate Affairs Division Irish Aviation Authority (IAA) The Times Building, 11-12 D'Olier Street, Dublin 2 Tel: (01) 671 8655 Fax: (01) 679 2934 www.iaa.ie	January 2013	March 2013	It is unlikely that the plan would have any adverse consequences for the safety of air navigation provided it complies with any aeronautical lighting and positional data required by IAA at the planning application stage.
The Manager, Development Applications Unit, National Parks and Wildlife Service, Department Arts, Heritage & the Gaeltacht, Newtown Road, Wexford	January 2013		

NAME	DATE CONSULTED	RESPONDED	COMMENT
Tony Smyth Director of Engineering Services, Office of Public Works, 51 St. Stephens Green, Dublin 2	January 2013	April 2013	OPW drainage channels require a 10m maintenance strip along the edge of the channel. This strip should not be planted or paved in any way, which would prevent access for maintenance. This requirement should be applied for all drainage channels where possible to assist in the prevention of flooding. New culvert/bridges on any watercourses or changes to existing structures will require Section 50 consent from The Office of Public Works.
ESB Networks Dublin North Division, Rahan Road, Tullamore, Co. Offaly.	January 2013		
Noel McGloin Inland Fisheries Ireland, 15A Main Street, Blackrock, Co. Dublin Email: noel.mcgloin@fisheriesireland.ie	January 2013	March 2013	All the sites are located in the sub-catchment of the Yellow River and its tributary the Mongagh/Castlejordan River. The Yellow River itself is a tributary of the River Boyne (a cSAC). Both rivers contain stocks of salmon and trout. IFI are anxious that stocks would be protected from the negative effects of in-stream works associated with this project (turbines, buildings, cabling, roads, ect) and that an adequate buffer zone would be set around watercourses. Please note that no in-stream works should be carried out in the closed season i.e. October to April. The main document we want you to adhere to at this stage is our guidelines <i>Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites</i> (as attached).

NAME	DATE CONSULTED	RESPONDED	COMMENT
Planning Section, Offaly County Council, Áras an Chontae, Charleville Road, Tullamore, Co. Offaly.	January 2013	February 2013	This project is under the remit of Strategic Infrastructure Development (SID) and is dealt with by An Bord Pleanála as outlined in Section 37(d) of the Planning Acts.
Ian Lumley, An Taisce, Tailors Hall, Back Lane, Dublin 8. 01 4541786	January 2013		
Sustainable Energy Authority of Ireland Wilton Park House Wilton Place Dublin 2	January 2013		
Mr Paddy Mathews Manager Environment & Planning Fáilte Ireland 88-95 Amiens Street Dublin 1 Tel: 01 8847202 Jill.Stewart@failteireland.ie	January 2013	February 2013	A copy of the Fáilte Ireland Guidelines for the treatment of tourism in an EIS was forwarded, which we recommend should be taken into account in preparing the EIS.

NAME	DATE CONSULTED	RESPONDED	COMMENT
Joanne Pender, Development Officer, Irish Wildlife Trust, Sigmund Business Centre, 93A Lagan Rd. Dublin Industrial Estate, Glasnevin, Dublin 11	January 2013		

NAME	DATE CONSULTED	RESPONDED	COMMENT
Noel O'Connor, Climate Change Section, Department of Agriculture, Food and the Marine, Environment Department, Johnstown Castle, <u>Co Wexford</u> , 053 9163467 Fax 053 9143965	January 2013	February 2013	If the proposed development will involve the felling or removal of trees, the developer must obtain a Felling License from this Dept, before trees are felled or removed. The following information should be provided in the EIS: • Reasons and rationale for all proposed felling (including timing and extent of felling) and any subsequent replanting, including pre-mature felling, where proposed, in comparison with accepted rotation lengths for species and yield classes. • Total proposed felling associated with the project to include total area (ha) to be felled, tree species, yield class, age at proposed felling and normal rotation length of crop. Maps showing all known monuments, Natura 2000 sites (including candidate and proposed sites), pNHAs and NHAs in the locality should also be included. • Total proposed forest area to be deforested (ie clearfelled and not replanted) including species, yield class, soil type, age at proposed felling time, normal rotation length of crop. The total areas proposed for deforestation in respect of (i) turbine footprints and associated infrastructure, and (ii) turbulence felling, should be detailed separately. • The developer's proposals for compensatory afforestation at alternative site/s, should be outlined in the EIS, species proposed, yield class, soil type, ground preparation, fertilizer application and normal rotation length of proposed crop. • The potential impacts of proposed tree felling operations and proposed mitigation and monitoring measures to be adopted, in respect of: (a) Soil stability (including landslides) (b) Water Quality (sedimentation and eutrophication) (c) Landscape (d) Ecology/habitats (e) Monuments The likely impact on agriculture/agricultural activities in the locality should also be assessed in the EIA, including, site separation, excavation and erection phases (examples of impacts include water quality, risk to soil stability, noise, shadow flicker).

NAME	DATE CONSULTED	RESPONDED	COMMENT
Department of Communications, Energy and Natural Resources, 29-31 Adelaide Road, Dublin 2, Ireland 01 678 2000	January 2013		
Ms Siobhan Egan, Birdwatch Ireland, P.O Box 12, Greystones, Co. Wicklow 01 2819878	January 2013		
Mr Tadhg O'Corcoran, Irish Peatland Conservation Council, Bog of Allen Nature Centre, Lullymore, Rathangan, Co. Kildare 045 860133	January 2013		
Sophie Préteseille, Geographical Survey of Ireland, Beggars Bush, Haddington Rd., Dublin 4. Email: Sophie.Preteseille@gsi.ie 01 6782000	January 2013	March 2013	The closest sites of geological interest are as follow: - Croghan Hill for its unique volcanic geology; it is recommended for NHA designation under the IGH 11 Igneous Intrusions and IGH 8 Lower Carboniferous themes. Croghan Hill lies at about 2km south west of the closest landholding; - Toberdaly (251700, 231700) comprising a warm spring is recommended for County Geolgicla Site (CGS) under the IGH 16 Hydrogeology Theme. The spring lies at about 4km south of the closest landholdings; Both sites are unlikely to be affected by the wind farm development, should it be given planning permission.

NAME	DATE CONSULTED	RESPONDED	COMMENT
EPA Headquarters PO Box 3000 Johnstown Castle Estate Co. Wexford 053 9160600 Fax:053 9160699	January 2013		
Eircom Radio Division, 1st Floor NMC Building, Bianconi Avenue, Citywest, Dublin 24. Email: wind_farms@meteor.ie 01 413 4032 / 087 412 8846.	August 2012	February 2013	Eircom confirmed that this proposal will have no impact on the eircom radio network.
Bat Conservation Ireland Ulex House, Drumheel, Lisduff, Virginia, Co. Cavan.	January 2013		
Ollwen Doyle, Eirgrid, The Oval, 160 Shelbourne Road, Ballsbridge, Dublin 4.	January 2013		

NAME	DATE CONSULTED	RESPONDED	COMMENT
Amanda Pedlow, Heritage Officer, Offaly County Council, Áras an Chontae, Tullamore, Co Offaly.	January 2013		
Senior Engineer, Environmental Department, Offaly County Council, Áras an Chontae, Tullamore, Co Offaly.	January 2013		
Senior Engineer, Roads Department, Offaly County Council, Áras an Chontae, Tullamore, Co Offaly.	January 2013		
Planning Section, Westmeath County Council, County Buildings, Mount Street, Mullingar, Co. Westmeath.	January 2013		

NAME	DATE CONSULTED	RESPONDED	COMMENT
Planning Section, Meath County Council, County Hall, Navan, Co. Meath.	January 2013	March 2013	The proposed wind farm is located 8.5km NW of Mount Heavey Special Area of Conservation and lies within the catchment of the Yellow River a tributary of the River Boyne and River Blackwater Special Area of Conservation and River Boyne and River Blackwater Special Protection Area. Meath County Council welcomes that it is proposed to carry out a full ecological impact assessment in accordance with EPA guidelines. In accordance with Article 6(3) of the Habitats Directive, it should be determined by an appropriate assessment whether the proposed development, either alone or in combination with other plans or projects, will have a significant impact on the conservation objectives of Natura 2000 sites (including those within Co. Meath). There will no impact on any Protected Structure or Architectural Conservation Areas in County Meath. It is unlikely that the site will have a major impact on of any protected view in the south-western area of the County. There is a possibility that there may be some impact on important long distance views from Sliabh na Calliaghe and Tara, and it is recommended that the applicant should determine if this is the case.
Irish Parachute Club Clonbulloge Airfield Edenderry Co Offaly	May 2013		

Table 1.5 - Summary of Statutory and Non-Statutory Consultation Response

2.0 PROJECT DESCRIPTION

2.1 SITE DESCRIPTION

The site is located in the townlands of Derryarkin, Derryiron, Coolcor, Coolville, Ballyburly, Greenhills, Bunsallagh, Derrygreenagh, Knockdrin, Wood, Killowen, Corbetstown, Carrick, Garr and Dunville, approximately 1.6 km north of Rhode, Co. Offaly. Please refer to **Figure 1.1** - Site Location.

The landholding outline of the site is approximately 1,002.234 hectares. The site is relatively flat, ranging in elevation from 75 m to 93 m OD (Malin Head). The site can be located on Discovery Series Map No.s 48 and 49 at approximate centre grid co-ordinate N 525 370. The site is irregular in outline and is bisected by the R400 and the Garr Road.

The site is predominantly improved agricultural grassland underlain with peaty soil. There has been extensive turf cutting in the western section of the site with old and new turf banks evident. Peat has been removed from considerable areas of the site and these areas have subsequently been further drained, improved and seeded with grasses for grazing of cattle and sheep. A network of existing local roads and private access tracks allow vehicular access to the various sections of the site.

The development will comprise thirty two (32) electricity generating wind turbines with a hub height up to 110 metres and a rotor diameter up to 113 metres giving an overall height of up to 166 m, hardstandings, a 110 kV substation, an electrical compound, a temporary construction compound, a permanent meteorological mast, a new access road off the R400 Roundabout at Rhode and upgraded access roads, associated site roads, drainage and site works.

2.2 DURATION OF PERMISSION

Given the scale and element of uncertainty in grid scheduling, a duration of 15 years is being sought for any planning permission issued on foot of this application. An operational lifetime of 30 years is being sought for the proposed wind farm, plus a 3 year construction/commissioning period and a 2 year decommissioning period. The DoEHLG Wind Farm Planning Guidelines state:

“Planning Authorities may grant permission for a duration of longer than 5 years if it is considered appropriate, for example, to ensure that the permission does not expire before a grid connection is granted”.

2.3 WIND FARMS IN THE AREA

There are no operational wind farms in the surrounding landscape. There are currently no operational wind farms in Co. Offaly or Co. Westmeath. The closest operating wind farm is located at Carrig and Skehanagh, approximately 65km south west of the proposed development. However, Mount Lucas Wind Farm is currently under construction in Co Offaly, approximately 10km south of the proposed wind farm and Cloghan Wind Farm received a conditional grant of planning permission in July 2013 from Offaly County Council. Cloghan Wind Farm is located approximately 42km southwest of the proposed Yellow River Wind Farm site. Leabeg Wind Farm has also been consented but has not, as yet, gone to construction.

The existing wind farm at Carrig/Skehanagh has been operational since 2006 and consists of 8 Vestas V52 850kW turbines with an output capacity of 6.8 MW.

Mount Lucas Wind Farm, consisting of 28 turbines, is currently under construction since December 2012 and is located approximately 10 km south of the proposed site. The maximum output capacity for Mount Lucas is 79.2MW.

Leabeg Wind Farm, with a maximum export capacity of 4.25 MW, has planning permission consented, however, construction of this wind farm has not, as yet, commenced. Leabeg Wind Farm lies approximately 36 km south west of the proposed development.

A conditional grant of planning permission was issued to Cloghan Wind Farm in July 2013. This wind farm is located approximately 42km southwest of the proposed development. Cloghan Wind Farm comprises of 10 wind turbines with a maximum output capacity of 25MW.

Please refer to **Figure 1.2** for details of the Operational/ Consented wind farms.

Wind Farm	Status	Output (MW)	Direction from the Site	Distance (km)
Mount Lucas	Construction	79.2MW	South	10
Leabeg	Consented	4.25MW	West	36
Cloghan	Consented	25MW	South West	42
Carrig / Skehanagh	Operational	6.8MW	South West	65

Table 2.1: Operational/ Consented wind farms in the vicinity of the proposed site.

2.4 DESIGNATED AREAS OF CONSERVATION

The site is not located within any area designated for conservation. However there are eighteen designated areas and one proposed designated area within 15km of the site. Please refer to **Figure 2.1** - Environmental Designation Map.

Site Name	Designation type	Distance from Landholding
Black Castle Bog	NHA	2.4km East
Grand Canal	pNHA	3km South
Raheenmore Bog	SAC, pNHA	4km South West
Cloncrow Bog	NHA	5km West
Rahugh Ridge (Kiltober Esker)	pNHA	7km Southwest
Murphy's Bridge Ridge Esker	pNHA	7km Southwest
Split Hills and Long Hill Esker	SAC	7km West
Milltown Pass Bog	NHA	8km North
Mount Hevey Bog	SAC/ pNHA	9km North West
Lough Ennell	SPA/ SAC/ pNHA	10km North West
Royal Canal	pNHA	10km North
Ardan Wood	PNHA	10km West Southwest
Daingean Bog	NHA	10km Southwest
Molerick Bog	NHA	10km Northeast
The Long Derries	SAC	11km Southeast
Nure Bog	NHA	12km North Northwest
Wooddown Bog	NHA	14km North Northwest
River Boyne & River Blackwater	SAC, SPA	14km Northeast

Table 2.2 - Designated Areas of Conservation within 15 km of the proposed site.

SAC = Special Area of Conservation; SPA = Special Protection Area; NHA = Natural Heritage Area; pHNA = Natural Heritage Area

Lough Ennell SAC (code 000685) and SPA (code 004040)

Lough Ennell is a large, limestone lake. The lake is classified as a mesotrophic system by the EPA though it had been eutrophic in the past. The site is an SAC due to the presence of the Annex I habitat alkaline fen.

Lough Ennell is one of the most important midland lakes for wintering waterfowl, with nationally important populations of Mute Swan, Pochard, Tufted Duck and Coot. At times, the lake is utilised as a roost (with limited feeding) by the internationally important midland lakes population of Greenland White-fronted Goose (ca.400 strong) (this flock is now centred at Lough Iron and seldom uses Lough Ennell or the other large midland lakes, O. Crowe pers comm.). The site also attracts Golden Plover (200) and Lapwing (673) though these feed mainly outside of the SPA site.

Lough Ennell is located approximately 10 km to the north-west of the Derryarkin sector of the site.

River Boyne and River Blackwater SAC (code 002299) and SPA (code 004232)

This large site consists of the freshwater stretches of the River Boyne as far as the Boyne Aqueduct, the Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers.

Overall, this SAC site is of considerable conservation significance for the occurrence of good examples of a range of habitats and of populations of plant and animal species that are listed on Annexes I and II of the EU Habitats Directive respectively.

The site is a SPA as it is of special importance of Kingfisher. A survey in 2010 recorded 19 pairs of Kingfishers in the River Boyne and River Blackwater SPA

At the closest, the designated river is at a distance of approximately 14 km to the northeast of the development site.

Raheenmore Bog SAC (code 000582)

Raheenmore Bog is a classic example of a largely intact raised midland bog. It is located approximately 4 km southwest of the Derryarkin sector of the site.

Mount Hevey Bog SAC (code 002342)

Mount Heavy Bog SAC is located to the northeast of Kinnegad and approximately 9 km northeast of the northeastern sector of the proposed wind farm. The site is a good example of a mostly intact raised bog.

Split Hills and Long Hill Esker SAC (code 001831)

This esker ridge crosses the N5 Dublin to Galway road between Kilbeggan and Tyrellspass. The main habitat is semi-natural woodland, though there are several areas of species rich calcareous grassland. The SAC is located approximately 7 km west of the development site.

The Long Derries SAC (code 00925)

Located just over 3 km southeast of Edenderry, the Long Derries, Edenderry SAC is part of a low esker ridge running from Edenderry to Rathdangan. It primarily consists of glacial gravels interspersed with loam and peat soil. The dominant habitat is dry calcareous grassland, of which this is a particularly good example and includes a number of rare plant species. The SAC is located approximately 11 km southeast of the development site.

Wooddown Bog NHA (code 000694)

This NHA is a good example of a relatively intact raised bog. It is located about 4 km east of Mullingar and approximately 14 km to the north-northwest of the development area.

Nure Bog NHA (code 001725)

This NHA is a good example of a relatively intact raised bog. It is located to the southwest of Lough Ennel about 4 km east of Mullingar and approximately 12 km to the north-northwest of the development area.

Milltownpass Bog NHA (code 002323)

This NHA is located about 1 km north-east of Milltownpass and just over 8 km north-east of the Derryarkin sector of the site. The NHA is a fine example of a relatively intact raised bog.

Cloncrow Bog (New Forest) NHA (code 000677)

This NHA is located approximately 1 km west of Tyrellspass and just over 5 km west of the development site. The NHA is a fine example of a relatively intact raised bog.

Black Castle Bog NHA (code 000570)

This NHA is a good example of a relatively intact raised bog and is notable for its easterly location. It is located about 3 km northwest of Edenderry, and approximately 3 km to the west of the proposed wind farm.

Molerick Bog NHA (code 001582)

This NHA is a fine example of a relatively intact raised bog. It is located about 4 km west of Longwood and approximately 10 km northeast of the northeastern sector of the proposed wind farm.

Daingean Bog NHA (code 002033)

This NHA is a good example of a relatively intact raised bog. It is located about 2 km south west of Daingean village and approximately 10 km southwest of the development site.

Rahugh Ridge (Kiltober Esker) pNHA (code 0918)

The pNHA lies about 9 km northeast of Tullamore and runs for about 2.5 km in an easterly direction. It is a good example of an esker ridge with woodland and calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Ardan Wood pNHA (code 01711)

Ardan Wood is a crescent shaped woodland on a steep slope located about 5 km west of Kilbeggan. It is a good example of a semi-natural woodland. It is situated approximately 10 km west-southwest of the development site.

Murphy's Bridge Ridge Esker pNHA (code 01775)

The pNHA is a good example of an esker ridge with calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Royal Canal pNHA (code 02103)

The Royal Canal pNHA passes north of the proposed wind farm site (approximately 10 km from the nearest development area). The canal supports a wide range of ecological interests.

Grand Canal pNHA (code 02104)

The Grand Canal pNHA is situated to the south of Rhode and approximately 3 km south of the nearest part of the development site. The canal supports a wide range of ecological interests.

Natura Impact Assessment

Under Article 6 of the European Union Habitats Directive, a "Natura Impact Assessment" is required where there is a possibility of significant effects of a plan or project on the integrity of a Natura 2000 Site (i.e. SAC or SPA). Stage 1 Screening identifies any likely significant impacts on a site arising from the proposed plan or project. Stage 2 Appropriate Assessment considers whether there will be a negative impact upon the integrity of the site with respect to the structure, function and conservation objectives of the site, either alone or in combination with other plans and projects. Mitigation measures are considered where negative impacts are predicted (EC, 2001).

Stage 1 screening has been carried out for all designated sites for nature conservation within 10km of the site.

No impacts are envisaged on any of these designated sites as a result of the proposed wind farm development. Please refer to Chapter 5, Flora and Fauna for further details.

2.5 PLANNING CONTEXT

2.5.1 Offaly County Development Plan 2009-2015

The Offaly County Development Plan 2009-2015 directs readers to the Offaly County Wind Energy Strategy 2009 – 2015 which sets out areas for wind energy development. The Plan acknowledges the targets set out in The White Paper on Energy of 40% of electricity to be generated from renewable sources by 2020.

It is council policy to encourage the development of wind energy in suitable locations in an environmentally sustainable manner and in accordance with Government policy, having particular regard for the wind energy strategy in the county.

It is an objective of the Development Plan:

- (a) To facilitate the promotion and construction of energy efficient developments throughout the county.
- (b) To assist in the development of a regional energy agency over the period of the plan.
- (c) To achieve a reasonable balance between responding to government policy on renewable energy and in enabling the wind energy resources of the county to be harnessed in an environmentally sustainable manner. This will be implemented having regard to the Council's Wind Energy Strategy.

2.5.2 County Offaly Wind Strategy to 2015

The County Offaly Wind Strategy accompanies the Offaly County Development Plan and was adopted on 19th January 2009. A Strategic Environmental Assessment was carried out for the County Development Plan 2009 – 2015 and associated strategies, including the Wind Energy Strategy.

The objective of the strategy is to evaluate and analyse the potential wind energy resource in the county, to define environmental and planning considerations for wind energy development and to make recommendations on Wind Energy Resource Policy and Practice. It clarifies the

council's policy towards wind energy in Co. Offaly and forms the basis of assessment methodology for planning applications.

There are currently no operational wind power developments in the County Offaly. The Wind Energy Strategy identified 12 main areas within the county as having wind energy development potential. These areas were further examined and of the 12 areas found to have development potential, 6 were designated as suitable for wind energy development.

The Yellow River site is located in an area designated as suitable for large scale wind farms. These areas are considered suitable for wind farm development because of: Sufficient wind speeds; Access to grid network; established patterns of inquiries. The site is located within the "North of Rhode" Suitable Area. The following is an extract from the Wind Energy Strategy:

NO	Considerations	Decision
1	Area North of Rhode Having regard to proximity to existing substation access, roads, cutover bog, large landholdings, precedent of existing visually intrusive infrastructure, this area is highly suitable. There is some sensitivity to the overlooking of the western portion of this area from protected views.	<u>Suitable</u> for large-scale Windfarms.

Please refer to **Figure 2.2 – County Offaly Wind Energy Strategy – Results of field analysis of potential sites for wind energy development**. Please refer to **Figure 2.3 – County Offaly Wind Energy Strategy - Areas of Wind Energy Development Potential**.

Applications for wind turbines within this area are acceptable in principle, subject to conformance with all other requirements of this plan.

The Yellow River site supports good wind speeds and a proposed substation will be located less than 0.5km north of the existing Derryiron 110kV ESB substation building. The siting, layout and environmental studies conform to all best practice guidance. Please Refer to Chapter 11 Landscape, for a detailed description of how the wind farm avoids visual clutter and will sit harmoniously with the existing landscape.

2.5.3 Wind Farm Planning Guidelines

The Wind Farm Planning Guidelines published by the DoEHLG in 2006, as revised from the 1996 edition, set out guidance for wind farms siting and design in various landscape contexts.

A wind farm on this site would be designed with reference to a list of Aesthetic Recommendations (as set out in Chapter 6 of the Guidelines) such as siting, spatial extent and

scale, cumulative effect, spacing of turbines, layout of turbines and height of turbines. Other issues which must be taken into consideration include:

- Proximity to designated areas
- Potential effects on birds
- Potential effects on water based habitats and freshwater systems
- Effect on peat stability
- Effect on archaeology
- Noise effects
- Shadow Flicker effects
- Proximity to public roads and distraction of motorists
- Electromagnetic and telecommunications interference

2.5.4 Kildare County Development Plan 2011-2017

Chapter 8 of the Kildare County Development Plan 2011-2017 relates to Energy & Communications. The aim of Kildare's Energy & Communication Chapter is;

“To encourage and support energy and communications efficiency and to achieve a reasonable balance between responding to central Government policy on renewable energy and communications and enabling resources to be harnessed in a manner consistent with the proper planning and sustainable development of the area”.

Section 8.5.1 states:

“In general, areas in close proximity to grid connections and outside designated heritage sites may be suitable locations for the provision of wind energy. It is recognised however that certain areas, which are suitable for the exploitation of large-scale renewable energy, may also coincide with the county's designated sensitive and scenic areas”.

It is the policy of the Council:

ER 2: To support regional, national and international initiatives for limiting emissions of greenhouse gases through energy efficiency and the development of renewable

energy sources which make use of the natural resources in an environmentally acceptable manner.

WE 2: To encourage the development of wind energy in suitable locations in an environmentally sustainable manner and in accordance with Government policy.

WE 3: To ensure that the assessment of wind energy development proposals will have regard to:

- the sensitivity of the landscape;
- the visual impact on protected views, prospects, scenic routes, as well as local visual impacts;
- the impacts on nature conservation designations, archaeological areas and historic structures, public rights of way and walking routes;
- local environmental impacts, including noise and shadow flicker;
- the visual and environmental impacts of associated development such as access roads, plant and grid connections;

2.5.5 Meath County Development Plan 2013-2019

Chapter 8 of Meath County Development Plan sets out objectives for the provision or facilitation of the provision of infrastructure for energy and communication facilities in accordance with the Planning and Development Acts 2000-2012.

Section 8.1.5 states;

“The development plan must achieve a reasonable balance between responding to overall Government Policy on renewable energy and enabling the wind energy resources of the Local Authority’s area to be harnessed in a manner that is consistent with proper planning and sustainable development”.

It is the policy of Meath County Council:

EC POL1: To facilitate energy infrastructure provision, including the development of renewable energy sources at suitable locations, so as to provide for the further physical and economic development of Meath.

EC POL2: To support international, national and county initiatives for limiting emissions of greenhouse gases through energy efficiency and the development of renewable energy sources which makes use of the natural resources of the county in an environmentally acceptable manner, where it is consistent with proper planning and sustainable development of the area.

EC POL3: To encourage the production of energy from renewable sources, such as from biomass, waste material, solar, wave, hydro, geothermal and wind energy, subject to normal proper planning considerations, including in particular, the potential impact on areas of environmental or landscape sensitivity and Natura 2000 sites.

2.5.6 Draft Westmeath County Development Plan 2014-2020

Chapter 10 of the Draft Westmeath County Development Plan 2014-2020 relates to Energy & Communications. The aim of Westmeath's Energy & Communication Chapter is;

“To support and provide for the development of indigenous energy resources, with an emphasis on renewable energy supplies. To promote the development of high capacity Information Communications Technology Infrastructure, broadband connectivity and digital broadcasting in the interests of economic progress and the proper planning and sustainable development of the county”.

Section 10.5 of the CDp states:

“The Council seeks to achieve a reasonable balance between an overall positive attitude to renewable energy and enabling the wind energy resources of County Westmeath to be harnessed in a manner that is consistent with proper planning and sustainable development”.

It is the policy of Westmeath County Council:

P-EN1: To promote renewable forms of energy where it is consistent with the proper planning and sustainable development of an area.

P-EN2: To support local, regional, national and international initiatives for limiting emissions of greenhouse gases through energy efficiency and the development of renewable energy sources which make use of the natural resources in an environmentally acceptable manner, and having particular regard to the requirements of the habitats directive.

P-WIN2: To direct large-scale energy production projects, in the form of wind farms, onto cutover cutaway peatlands in the county, subject to environmental, landscape, habitats and wildlife protection requirements being addressed.

P-WIN3: To ensure the siting and development of wind turbines is carried out in accordance with the requirements of the DoEHLG Wind Energy Development Guidelines 2006.

2.6 EXISTING LAND USE

The parent material at the site is peatland. There has been extensive historic cutting and old turf banks are evident in the western section of the site. Most of the peat has been removed entirely from considerable areas of the site and these have subsequently been further drained and seeded with grasses for grazing of cattle and sheep.

A network of existing local roads and private access tracks allow vehicular access to parts of the site. Both surfaced and un-surfaced finishes have been applied. There are extensive artificial drainage networks in place throughout the site.

2.7 ALTERNATIVES CONSIDERED

The Environmental Protection Agency, in its guidance documents on EIS preparation, stipulates that alternatives, which were assessed prior to beginning the project design, be explained in the EIS. The alternatives can include:

- Alternative Electricity Generation
- Alternative locations
- Alternative designs
- Alternative processes

2.7.1 *Alternative Electricity Generation*

The current demand for electricity generation capacity in Ireland is predominantly satisfied by fossil fuel plants. However, renewable and alternative sources of power will play an increasingly important role in meeting power needs in the future. Ireland's dependence on a finite supply of imported fossil fuels raises questions over the security of supply in future years as reserves of fossil fuels are depleted. This makes the development of an energy supply from indigenous resources essential.

Wind power has become an important source of energy worldwide. Worldwide growth in the wind power sector is shown in **Table 2.3**.

Year	2004	2005	2006	2007	2008	2009	2010	2011
Installed Capacity (MW)	47,600	59,100	74,100	93,900	120,900	159,200	200,457	238,038
Annual Growth	20.8%	24.2%	25.4%	26.7%	28.7%	31.7%	25.9%	18.7%

Table 2.3: Global Deployment of Wind Power (International Energy Agency – Wind Annual Report 2010)

Worldwide wind generating capacity stood at 13,600 MW in 1999 with the capacity in 2011 representing an almost eighteen-fold increase over the intervening twelve years. Growth has been particularly strong in Europe, where industry targets for 2020 are set at 230 GW installed capacity. In Germany, the country with the most installed wind generating capacity at 31,307 MW, approximately 11 % of its electricity is supplied from wind power, while Spain in second place with over 22,796 MW of capacity has 16% of its electricity from wind. Denmark's wind capacity meets 27% of its electricity needs, the largest share in any country.

In Ireland (including Northern Ireland), approximately 2,252 MW of wind energy capacity is connected to the Grid as of January 1st 2013 (EirGrid, All-Island Renewable Connection report, Q4 2012); this figure was 525 MW in mid-2006. The national target for the renewable energy share of gross electricity consumption is 40 % by 2020. It has been estimated that between 6,000 MW of installed wind generation will be required to meet circa 37% of electricity demand in 2020. Hydro, wave and tidal energy resources in Ireland are still in the development phase, while solar and geothermal technologies are not considered commercially feasible in Ireland.

2.7.2 *Site Selection Criteria*

Green Wind Energy (Wexford) Ltd., was established in 2003. The aim of the company was to establish a sustainable wind farm in the midlands region. At an early stage in the assessment

Green Wind Energy Ltd. identified the County of Offaly as a key location for potential large wind farm development for the following reasons:

- The publication of the Offaly Wind Energy Strategy in 2009 which includes progressively identified strategic wind development zones and clear policy guidance in respect of these zones.
- The history of conventional power generation in Offaly and the resulting excellent electrical grid infrastructure to which a potential wind farm could connect.
- The low concentration of existing wind energy development in Offaly resulting in the availability of large undeveloped suitable spatial area and uncongested grid infrastructure.
- The strong road infrastructure network throughout the County.
- The infrequency of environmental designations within the County resulting in lower potential for environmental effects.

Green Wind Energy Ltd. in their assessment of potential development sites within the County of Offaly identified nine criteria under which unsuitable sites could be eliminated. These criteria area as follows:

Development Control

Table 1 of the County Offaly Wind Energy Strategy identifies 12 potential sites for wind energy development, 6 of which are deemed to be suitable areas for wind energy development within the county. Table 2.4 lists these areas suitable for wind energy development.

Area No. (As per OCC Wind Energy Strategy 2009)	Description	Classification
1	Area North of Rhode	Suitable for large scale wind farms
2	Area from Cloneygowan to Clonbulloge	Suitable for large scale wind farms
4	Area around Corracullin Bog	Suitable for large scale wind farms
5	Area around Castletown Bog	Suitable for large scale wind energy development
6	Area East of Shannonbridge	Suitable for large scale wind energy development
7	Area South of Cloghan	Suitable for large scale wind energy development

Table 2.4 - Offaly County Wind Strategy - Suitable Areas for Wind Development (Extract from Table 1 of the Offaly Wind Energy Strategy)

NOTE: Areas numbered 3, 8, 9, 10, 11 and 12 in Table 1 of the Offaly Wind Energy Strategy are NOT suitable for wind energy development.

These areas are considered suitable for wind farm development because of: sufficient wind speeds; access to grid network; established patterns of inquiries.

Please refer to **Figure 2.2** for details of Areas of Wind Energy Development Potential (Extracted Figure 8 from Offaly Wind Energy Strategy).

These six areas were subsequently examined under the following eight headings to assess their suitability.

Grid Connection

Close proximity to a suitable connection point with the electricity grid is desirable in order to minimise the impact of any overhead lines. The electricity network must be capable of absorbing the power without adverse effects on existing electrical installations or customers.

Availability of Wind

To operate a wind farm efficiently an average annual mean wind speed of ≈ 8 m/s (metres per second) is generally considered to be required.

Environment

It is preferable that a wind farm is not located in an area designated as a Special Protection Area (SPA), Special Area of Conservation (SAC) or proposed Natural Heritage Area (NHA) or where the visual aspect of the wind farm would be overly obtrusive. Preferably the site under consideration should hold no historical, archaeological or ecological interest.

Dwellings

Locations with low housing density are preferable so as to minimise any disturbance which may be caused to people as a consequence of construction activities, visual impact, shadow flicker and noise.

Accessibility

The site needs to have reasonable access to facilitate construction and the subsequent operation, maintenance and monitoring of the site. Alternative access may be provided but this should not involve excessive construction.

Terrain

The geological features and the topography of the region should be suitable to facilitate construction on site. The site should not be overly difficult to develop, and should not exhibit excessive peat depths and should not show signs of peat instability.

Electromagnetic Interference

Preferably the development should be sited in an area where there is less potential for electromagnetic interference with telecommunications, television and radio signals etc.

Aviation Interference

Wind farm development represents a potential navigational hazard to air transport. It is the policy of the IAA to request an obstruction / radar survey for all developments within 20km of a national or international airport. Wind energy developments can have an impact at distances up to 40km depending on their altitude and orientation relative to the wind farm.

2.7.3 Selected Site

The Yellow River site was deemed the most suitable for advancement to development at this juncture.

Area 1 – Yellow River Wind Farm, Rhode, Co. Offaly

Availability of Wind

The site is at an elevation of between 75 mOD and 93 mOD (Malin Head).

According to the Irish Wind Atlas published by Sustainable Energy Ireland, 2003, the site sustains winds in excess of 8.00m/s at an elevation of 100m above ground level. This would be considered good in terms of wind energy development. Please refer to **Figure 2.4 Wind Speed Map**.

Environment

The site itself is not designated at any level.

The closest designated site is Black Castle Bog NHA, 2.4km East of the Yellow River site.

Black Castle Bog NHA is a site of considerable conservation significance, comprising as it does, a raised bog, a rare habitat in the E.U. and one that is becoming increasingly scarce and under threat in Ireland. It is especially important because of its eastern location. There are a number of habitat types found on the cutover areas of the bog. Irish Hare, a Red Data Book species, has also been recorded at the site

It is unlikely that the development would have any negative effect on the habitat of the bog vegetation at this designated site, as there is no hydrological connection between the proposed wind farm site and Black Castle Bog.

Development Control

According to the County Offaly Wind Strategy, the site is located in an area deemed as Suitable for Large-Scale Wind Farms. Applications for wind turbines within this area are acceptable in principle, subject to conformance with all other requirements of this plan.

There are two large areas of the county designated as “Wind Energy Development Area”, one to the west of the county, around Ferbane, and one to the east of the county, north and west of Rhode. There are currently no wind farms within this designation.

Distance from dwellings

The nearest population centre is Rhode, located approximately 1.6 km south of the site. There is one regional road and one local road traversing the site splitting the site into three different sections. The local road, known as ‘the Garr Road’, has several houses dotted along sections of the road. When 500 metre buffers are applied to these houses, the majority of the site remains available for turbine development.

Grid Connection

The Derryiron 110kV station is located less than 0.5km south of the site area. A 110kV high voltage grid network runs through the southern part of the site.

Accessibility

The site has good access from the M6 motorway and reasonable internal road network to all sections of the site.

Terrain

The terrain is sloping with gradients between 1:40 and 1:100. This would make construction feasible at all areas of the site.

Electromagnetic Interference

There are no telecommunications masts within the site, however, there are several masts within 5km of the site. Telecoms operators were consulted and it was found that there were few links passing through the site.

Aviation Interference

The site is located over 60km from Dublin International Airport, Baldonnell Airfield is approximately 50km from the proposed development and Clonbulloge Airfield (The Irish Parachute Club) is approximately 13 km from the proposed wind farm site.

Yellow River Wind Farm has been designed in accordance with County Offaly Wind Energy Strategy, Wind Farm Planning Guidelines (2006) and IWEA best practice documents.

2.7.4 Turbine Selection

Turbines considered for the site were required to have:

- A wind class rating (IEC) of class IIa / IIIa due to estimated wind speeds and topography.
- Low noise output.
- Three blades, which have a greater aesthetic quality than two bladed or single bladed machines.
- Cylindrical type towers, which have a greater aesthetic quality than pylon or lattice type towers.

- Good financial security by manufacturer (such that operation and maintenance support and spares, are available through the full operational life of the turbine).
- Proven track record by manufacturer.

A range of turbine models which have demonstrated their effectiveness at other locations throughout Europe and are proven to be of the highest international standard were examined. Turbines from well-established manufacturers meeting the above criteria were considered. The following are examples of the options that were considered:

Turbine Type	Rotor Diameter (m)	Hub Height (m)	Individual Output (MW)	Expected Capacity Factor based on Wind Resource	Number of WTGs required to achieve approximately 95MW .
Siemens SWT 113	101, 108, 113	75, 108, 145	3	35	32
Vestas V112	112	84, 94, 119, 140	3 / 3.3	35	32
Enercon E82	82	98, 108	2 / 3	30	48
Alstom ECO 100/122	100, 110, 122	110, 119	2.7 / 3	35	35

Table 2.5 – Turbine comparison Matrix

For purposes of the EIS, a turbine type with rotor diameter no greater than 113 metres, hub height no greater than 110 metres and overall height no greater than 166m is used. These dimensions are essential to maintain good operational turbine efficiencies at the Class IIa / IIIa site and for the overall site's financial viability. For the purposes of Noise & Shadow Flicker, the technical characteristics of the Siemens SWT 113, rotor diameter 113m and maximum hub height of 122.5m, is used. For the purposes of demonstrating the impact on the landscape, a turbine with maximum hub height of 110m and maximum rotor diameter of 112m giving the overall maximum height of 166m is used.

Please refer to **Figure 2.5** for an illustration of a sample turbine model.

2.7.5 *Internal Site Layout*

Turbine Layout

The Wind Farm Planning Guidelines published by the Department of the Environment, Heritage and Local Government (DoEHLG) in 2006, set out design goals for wind farms in various landscape contexts.

Chapter 6 of the Guidelines lists a series of recommendations for the Siting and Design of Wind Energy Development. The Guidelines also discuss “Landscape Character Types”, listing six different character types. Yellow River Wind Farm site fits into the “Flat Peatland” Landscape Character Type. The Guidelines state that, *“The preferred option here is one of large-scale response. The vast visual openness with few, if any, dominant geometric elements provides a certain freedom in the siting and design of wind farms.”*

The following describes how these Guidelines were integrated into the Yellow River Wind Farm design and siting process:

1. **Siting and location of wind farms** – The site is located in a lowland area of flat peatland. The landscape has a small number of dwellings along the site’s surrounding road network. Careful planning was taken to site the turbines at the prescribed 500 m distance from the surrounding dwellings.
2. **Spatial Extent** – The Yellow River Wind Farm should appear as a single large wind energy development. The Guidelines state that *“The vast scale of this landscape type allows for a correspondingly large spatial extent for wind farms”*. The design of Yellow River Wind Farm complies with the Guidelines.
3. **Spacing of Turbines** – The Guidelines state that *“Regular spacing is generally preferred”*. The turbines have been spaced at regular uniform spacing as suitable for this site.
4. **Layout of Turbines** – The Guidelines state that a grid layout is more appropriate than a simple linear layout. The turbine locations are also based on analysis of wind measurement data from a temporary 80m wind mast located on the site. This analysis concluded with a layout which fully complies with the Guidelines.

5. **Turbine Height** – The guidelines state in relation to turbine heights in flat peatland landscapes *“Aesthetically, tall turbines would be most appropriate. In any case in terms of viability, they would certainly likely be necessary given the relatively low wind speeds available.”* The proposed hub height of up to 110m and the proposed tip height of up to 166m complies with this requirement.
6. **Cumulative Effect** – The guidelines state that *“The openness of vista across these landscapes will result in a clear visibility of other wind energy developments in the area. Given that the wind energy developments are likely to be extensive and high, it is important that they are not perceived to crowd and dominate the flat landscape. More than one wind energy development might be acceptable in the distant background provided it was only faintly visible under normal atmospheric conditions.”* There are no other wind farms currently operational in the area, however, Mount Lucas wind farm is currently under construction and should be operational before 2014. Mount Lucas will contain 28 turbines. No cumulative impact is envisaged from this wind farm.

Preliminary Site Layout

Figure 2.6 shows the preliminary site layout, which was developed prior to the results of the various scientific surveys and the consultation process. The preliminary turbine layout was largely based on the results of wind modelling, carried out in order to determine the optimum electrical output for the site. The constraints adopted were as follows:

- Turbines located within area ‘Suitable for Wind Energy Development’ (Offaly County Council Wind Energy Strategy).
- Prescribed turbulence spacing between turbines.
- Compliance with Wind Farm Planning Guidelines, DoEHLG, 2006.

The initial layout was developed purely on the basis of maximum potential of the site in terms of electricity generation and consisted of 32 turbines. Some basic turbine siting requisites and a fundamental landscape appraisal were also taken into account.

Constraints Report

The landholding area was subsequently assessed by the EIA team for wind farm development constraints. This process involved:

- Sending a scoping pack to all relevant stakeholders and consultees.
- Walkover surveys by Jennings O'Donovan & Partners.
- Walkover survey and interim report preparation by Jennings O'Donovan & Partners and the specialist consultants.

The following development constraints were identified within the available landholding:

- Area of degraded raised bog south of current T9 location. This is annexed listed habitat. It is noted that T8, 9 and 10 are not located within degraded raised bog. This area is subject to intensive peat cutting and the peat face is rapidly receding southwards. Please refer to Chapter 5 for further discussion.
- Demesne boundaries adjacent to T13 and T14 presented potential bat feeding areas therefore a 50m turbine siting exclusion zone buffer was applied. Please refer to Chapter 5 for further discussion.
- One geotechnical exclusion zone was identified corresponding to the area of degraded raised bog south of the current T9 locations. Please refer to Chapter 6 for further discussion.
- Irish Archaeological Consultancy Ltd. identified archaeologically and architecturally sensitive sites; the avoidance of these sites was incorporated into the design of the wind farm.

Please refer to **Figure 2.7 Environmental Constraints Map**.

Final Turbine Layout

An assessment of the turbulence wake effects of the combined development was undertaken by Wind Prospect Ireland Limited. This assessment identified areas of high turbulence which

would ultimately affect the energy production and operational life of the wind turbines. Turbines were relocated to minimise wake effects while accounting for the environmental constraints and recommendations from the Wind Energy Development Guidelines.

Access roads and crane platform located adopt the following constraints:

- Minimise impact on local inhabitants by avoiding transit along local public roads, where possible.
- Utilisation of existing infrastructure including internal access roads, where possible.
- Minimisation of lengths of road and land take areas to mitigate impacts to local farmers and agricultural practices.

Please refer to Figure 2.8 – Final Site Layout.

2.8 FINALISED PROJECT

2.8.1 General

The finalised proposed Yellow River Wind Farm development will comprise thirty-two (32) electricity generating wind turbines with a hub height of up to 110 metres and a rotor diameter of up to 113 metres and an overall height of up to 166 m, hardstandings, a 110 kV substation containing two (2) control buildings, an electrical compound and a wastewater holding tank, nine (9) watercourse crossings, temporary construction compound, a permanent meteorological mast, a new access road off the R400 Roundabout at Rhode and upgraded access roads, associated site roads, drainage and site works.

2.8.2 Site Layout

The proposed site layout is shown on **Figure 2.8 – Final Site Layout**. The development comprises the following elements:

- 32 no. wind turbines with concrete bases measuring approximately 18m in diameter.
- 32 no. crane hardstand areas (1,250m²) with associated splays (745m²) and laydown areas (3,600m²), placed near each turbine location to facilitate erection by mobile cranes.

-
- Approximately 25,675 metres of underground cabling to connect the turbines within the site to the proposed substation. Cabling will also be required along short sections the Regional road (R400) and short sections of three local roads.
 - An electrical compound which is to measure approximately 50 x 37 metres. This compound will contain two control buildings and ancillary electrical equipment. A wastewater holding tank will also be installed at this location.
 - Temporary compound

A schedule of the proposed wind turbines together with the met mast and substation and their corresponding grid co-ordinates is set out in **Table 2.5**.

Item Description	Dimensions of Unit	No of Units	Unit Area (m ²)	Total Area (m ²)	Total Area (ha)	Typical Depth of Stone for Fill Layer (m)	Stone Required for Base Layer (m ³)	Typical Depth of Stone for Surface Layer (m)	Stone Required for Surface Layer (m ³)	Total Stone Required (m ³)
Turbine bases	18m diameter	12	255.00	3,060.00	0.31	0.00	0.00	-	-	-
Hardstands		12	1,250.00	15,000.00	1.50	0.00	0.00	0.60	9,000.00	9,000.00
Electrical Compound, Substation + Car Parking	50m x 37m	1	1,850.00	1,850.00	0.19	0.45	832.50	0.15	277.50	1,110.00
Upgrade of existing trackway	3.5m to 5.5m Wide	2,894	2.00	5,788.00	0.58	0.45	2,604.60	0.15	868.20	3,472.80
Construction of new roads	5.5m Wide	2,964	5.50	16,302.00	1.63	0.00	0.00	0.60	9,781.20	9,781.20
Construction of site entrance splays and additional access track areas	Various	1	12,635.00	12,635.00	1.26	0.00	0.00	0.60	7,581.00	7,581.00
Meteorological Mast Foundation	5m x 5m	1	25.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00
Stilling Ponds	8m x 3.5m for 12hr retention at each turbine	24	28.00	672.00	0.07	0.00	0.00	0.15	100.80	100.80
Plus additional vegetated swales and outfall areas	0.3m ² per m	5,858	0.30	1,757.40	0.18	0.00	0.00	0.00	0.00	0.00
Temporary Compound	50m x 30m	1	-	1,500.00	0.15	0.00	0.00	0.60	900.00	900.00
TOTAL AREA / VOLUME			N/a	58,589	5.86		3,437		28,509	31,946

Table 2.4a – Schedule of land take areas (Turbines 1-12)

Item Description	Dimensions of Unit	No of Units	Unit Area (m ²)	Total Area (m ²)	Total Area (ha)	Typical Depth of Stone for Base Layer (m)	Stone Required for Base Layer (m ³)	Typical Depth of Stone for Surface Layer (m)	Stone Required for Surface Layer (m ³)	Total Stone Required (m ³)
Turbine bases	18m diameter	20	255.00	5,100.00	0.51	0.00	0.00	0.00	0.00	0.00
Hardstands		20	1,250.00	25,000.00	2.50	0.00	0.00	0.60	15,000.00	15,000.00
Upgrade of existing trackway	3.5m to 5.5m Wide	3,022	2.00	6,044.00	0.60	0.45	2,719.80	0.15	906.60	3,626.40
Construction of new roads	5.5m Wide	15,311	5.50	84,210.50	8.42	0.45	37,894.73	0.15	12,631.58	50,526.30
Construction of site entrance splays and additional access track areas	Various	1	20,282.00	20,282.00	2.03	0.45	9,126.90	0.15	3,042.30	12,169.20
Stilling Ponds	8m x 3.5m for 12hr retention at each turbine	40	28.00	1,120.00	0.11	0.00	0.00	0.15	168.00	168.00
Plus additional vegetated swales and outfall areas	0.3m ² per m	18,333	0.30	5,499.90	0.55	0.00	0.00	0.00	0.00	0.00
TOTAL AREA / VOLUME			N/a	147,256	14.73		49,741		31,748	81,490

Table 2.4b – Schedule of land take areas (Turbines 13-32)

Item Description	Dimensions of Unit	No. of Units	Total Area (m ²)	Total Area (ha)	Stone Required for Base Layer(m ³)	Stone Required for Surface Layer (m ³)	Total Stone Required (m ³)
Turbine bases	18m diameter	32	8,160.00	0.82	-	-	-
Hardstands		32	40,000.00	4.00	0.00	24,000.00	24,000.00
Electrical Compound, Substation + Car Parking	54m x 40m	1	1,850.00	0.19	832.50	277.50	1,110.00
Upgrade of existing trackway	3.5m to 5.5m Wide	5,916	11,832.00	1.18	5,324.40	1,774.80	7,099.20
Construction of new roads	5.5m Wide	18,275	100,512.50	10.05	37,894.73	22,412.78	60,307.50
Construction of site entrance splays and additional access track areas	Various	2	32,917.00	3.29	9,126.90	10,623.30	19,750.20
Meteorological Mast Foundation	5m x 5m	1	25.00	0.00	-	-	-
Stilling Ponds	8m x 3.5m for 12hr retention at each turbine	64	1,792.00	0.18	0.00	268.80	268.80
Plus additional vegetated swales and outfall areas	0.3m ² per m	24,191	7,257.30	0.73	-	-	-
Temporary Compound	Various	Various	1,500.00	0.15	900.00	0.00	900.00
TOTAL AREA / VOLUME			204,346	20.58	54,079	59,357	113,436

Table 2.4c – Schedule of total land take area

ID	Easting	Northing	Altitude
1	246732	236362	84
2	247210	236362	83
3	247123	236782	85
4	247635	236766	82
5	247635	237187	82
6	248485	237036	82
7	249366	236606	83
8	250195	236156	79
9	250565	236006	81
10	251119	235699	82
11	250724	236496	80
12	251130	236092	80
13	253795	235233	80
14	254181	235482	81
15	254359	235887	78
16	254727	237571	74
17	255114	237770	72
18	255557	237802	74
19	256771	238244	71
20	255743	238954	77
21	255885	238619	73
22	254872	238217	73
23	254874	238588	74
24	253865	239134	75
25	253350	239085	78
26	253238	239527	79
27	252501	239834	80
28	253509	239904	81
29	252924	239732	87
30	253414	240469	80
31	254509	241132	76
32	254167	241446	75
Met Mast	251841	235481	79
Substation	252422	234669	83

Table 2.5 – Schedule of proposed wind turbine co-ordinates.

2.8.3 Micrositing

The DoEHLG Wind Energy Development Guidelines suggest that there should be some flexibility built into the planning permission for wind turbines to accommodate minor adjustments to the turbine location which may be required for geotechnical or other reasons. The extent of flexibility will be site specific but should not generally extend beyond 20 metres.

Further detailed investigation at the time of construction may lead to minor repositioning of a small number of individual turbines. Any suggested micro-siting will be agreed with the Planning Authority before commencement of construction.

2.8.4 Wind Turbine

For purposes of the EIS, a turbine type with rotor diameter no greater than 113 metres, and hub height no greater than 110 metres will be used, and an overall maximum height of 166m. A three bladed, horizontal axis machine will be used.

The wind turbines proposed are classified as upwind, horizontal axis turbines. The visible components include a cylindrical tower, nacelle and blades. The towers will be up to 110 m high. The nacelle comprises the hub where the blades meet, and housing for the stepped transmission, generator and various ancillary items of equipment. The blades will rotate in a clockwise direction when facing into the wind, and the resultant disc described in space will have a diameter of up to 113 m. The blades will begin to rotate at a wind speed of 3 m/s and will cut out at a wind speed of 25 m/s. Full power output will be reached at a wind speed of approximately 13 m/s. The maximum speed of the blades will be 13.8 revolutions per minute. Power take off is controlled by regulating the pitch on the blades and the speed of rotation.

Electricity is generated at 710 V within the turbine. However, at this voltage, electrical losses would be too high for economical and efficient transmission. Accordingly, the voltage is stepped up to 33,000 V by a transformer (which is located within the turbine tower or outside the turbine tower) for transmission by underground cable to the on site substation.

The blades will be manufactured from carbon and fibre glass and consist of two airfoil shells bonded to a supporting beam. The lightning protection system (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS will follow the general cable run between the nacelle and the base of the tower and will be earthed to the ground adjacent to the turbine base.

The towers will be constructed of welded steel, or steel & concrete, and will be protected against corrosion by a high specification, factory applied, paint finish. Paintwork will be touched up on-site after erection. While any colour is available, the colour generally provided is off white/grey typically RAL 7035 (light grey) so as to minimise visual impact, particularly colour change as a result of shadowing.

Each tower is to be fitted internally with a service lift as standard. A ladder with a fall arrest system (rigid rail) is also mounted through the tower.

The tower base will be fixed to a concrete foundation, approximately 18 m in diameter and with a depth of approximately 2 m. Exact dimensions will depend on the existing ground conditions and the depth to soil with a suitable bearing capacity. The central part of the base will be ≈ 5.5 m in diameter, will be raised from the main base but below ground level, and will encompass a cast-in insert and holding down bolts to connect to the bottom of the turbine tower. The anticipated volume of concrete required for each tower base is approximately 420 m³. The area around the base will be backfilled with compacted granular material, and the only portion exposed in the long term will be the ≈ 5.5 m diameter central base section.

Please refer to **Figure 2.5** – Typical Turbine Foundation Detail.

2.8.5 *Electrical Substation*

The design principle of the development is to develop a simple, discrete and efficient substation to best practice standards. The design is largely dictated by the EirGrid standard layout for this type of development. The land take of the development and height of the ancillary elements have been kept to the minimum acceptable tolerance to mitigate any visual impacts.

The design complies with appropriate technical and operational requirements including electrical clearance, mechanical hardstand and operational requirements as set out in appropriate National and International standards.

The electrical compound of the substation will measure approximately 50 m x 37 m. A permanent diesel generator will be located within the compound as per EirGrid requirements. The generator will be bunded to accommodate at least 110% of the diesel capacity such that no accidental spillages can occur. The compound will be surrounded by 2.6 m high palisade fence. Access to the fenced off compound shall be through similar styled palisade double gates.

The compound will comprise of a single 110kV AIS (Air Insulated Switchgear) bay which will include circuit breaker, surge arrestors, line/earth disconnects, current transducer, voltage transformer, transformer/earth disconnect and associated civil works.

The compound will drain to an installed hydrocarbon interceptor, and then discharge to the main drainage network via an attenuation tank, which is to be constructed from clean crushed stone with a minimum void ratio of 40% and with a minimum of 200mm of topsoil cover.

Please refer to **Figure 2.9** – 110kV Electrical Compound and Substation Detail.

2.8.6 Substation Control Buildings

The compound will also include two control buildings, an Independent Power Producer (IPP) substation building and separate TSO (Transmission Systems Operator) substation building, as follows:-

- ESB Control Building measuring approximately 14.5 x 8.85 metres in plan. The building will consist of a control room, battery room, storage room, toilet facilities and corridor.
- IPP Control Building measuring approximately 9 x 8.85 metres in plan. The building will consist of a switchgear room, control room, storage room and toilet facilities.

The buildings main functions are to provide housing for switchgear, control equipment and monitoring equipment necessary for the proper functioning of the substation. It will utilise Air Insulated Switchgear (AIS). Each of the buildings shall allow for the safe and efficient harvesting of energy from the wind turbine generators. Additional room will be provided to allow for the installation of power factor correction equipment if required.

The equipment to be installed within the TSO control building will include electrical switchgear, metering and monitoring equipment and a Supervisory Control and Data Acquisition (SCADA) System. The SCADA system will allow for off-site monitoring, via telephone connection, at the TSO headquarters. The installation of a SCADA System minimises the need for TSO staffing of the substation except during routine planned maintenance visits or during breakdown.

The equipment to be installed within the IPP control buildings will also include electrical switchgear for the protection of the wind turbines, metering and monitoring equipment and a Supervisory Control and Data Acquisition (SCADA) System. The SCADA system will allow for off-site monitoring, via telephone connection, both at the Developer's premises and at the headquarters of the turbine manufacturer. The installation of a SCADA System avoids the

need for staffing by the development of the wind farm except during routine planned maintenance visits or during breakdown.

A GSM network can provide communication between the SCADA System and the TSO.

Electricity transported between the turbines and the site control building will be at 33kV. In order to transport the electricity to the national grid it will be necessary to step up the voltage to 110 kV. This will be carried out in the wind farm substation by the air insulated external grid transformer.

Sewage will be collected and stored in a sealed tank on site and transported away at regular intervals for treatment at a Wastewater Treatment Works. The sealed tank will be similar in specification to Klargestor Sealed Cesspool to BS 6297:1983 and surrounded by 225mm thickness of concrete or Silotank equivalent. The general arrangement of such a tank is shown on **Figure 2.9** while the detail is shown in **Figure 2.10**. This is in preference to developing a sewage treatment works on the site.

The tank will be fitted with an ultrasonic level measurement system with signal connected to the SCADA system of the wind farm operator. Once the liquid level attains a pre-determined level, the tank will be scheduled for emptying and the contents will be taken to an approved sewage works. This work will be done under a contract with one of the Contractors who have a permit to transport Septic Tank Waste to a Wastewater Treatment Plant (e.g. Rhode) as issued by Offaly County Council.

During the construction phase, assuming each worker produces 40 litres of wastewater per day. (See Value for Open Industrial Site, excluding Canteen, in Table 3: Recommended Wastewater Loading Rates from Commercial Premises, Wastewater Treatment Manuals: Treatment Systems for Small Communities, Business, Leisure Centres and Hotels as published by the Environmental Protection Agency, 1999), then the maximum daily production of wastewater based on 45 workers is estimated to be 1.8m³/d. Assuming that the tank will be emptied once per week and assuming 5.5 working days per week then the storage volume required is 9.9m³. A tank of minimum volume of 10 m³ would suffice.

In the course of normal operation post construction, the tank would be emptied every 3 months.

The final specification of this tank will be discussed and agreed with Offaly County Council prior to the commencement of construction.

2.8.7 Electrical Cabling

Underground cabling will be provided around the site for:

- Electricity transmission at 33kV between the turbines, the Control Buildings and the Electrical Control Building Compound.
- Electricity transmission at 110kV between the Substation and the Eirgrid/ESB Substation
- Signal transmission between the turbines, the Control Buildings and the Electrical Control Building Compound.

The cable routes will be laid along the site roads and bedded in surplus excavated peat / clay material. Danger tape, incorporating a metallic strip, will be laid during backfilling. Where the cables are to cross public roads, suitable electrical ducting will be provided. Permanent posts will mark the trenches at regular intervals and at all changes in direction. A built layout plan showing the location of underground cables will be on permanent display within the control building.

Please refer to the following figures for Underground Cable Trench & Chamber Details (33kV and 110kV).

- 2.11a - 33kV Cables in Regional Road R400 and the local road L-10092-1, past the Sewerage Treatment Plant, preferred option, if possible, from Western Section.
- 2.11b - 33kV Cables across R400 at Garr Road Roundabout from the Eastern Section
- 2.11c - General 33kV Cable layout on Business Park Access Road, L-10093-1, and 110kV cable layout

Underground cabling will connect all sections of the wind farm to the proposed substation of the development. In the western section of the site cabling will run along existing trackway, improved agricultural grassland, forested areas (approximately 500 m) and cutaway bog. To connect the western section to the substation cables will run along the public road (R400) for

approximately 1.2 km, where it will turn west onto the preferred option the L-10092-1 road for approximately 650 m, before turning in a southeasterly direction to connect in to the substation. If full access cannot be gained along this preferred option the cables will travel along the R400 for just under 2km before turning west onto the L-10093-1 access road into the Business Park to connect in to the substation.

In the south eastern section of Yellow River Wind Farm site cabling will run along existing trackway and improved agricultural grasslands, although the cabling will travel along the Greenhills road (L-50112-1) for just under 800 m. Crossing from the south eastern section to the north eastern section cabling will run along the Garr road (L-1008-1) for approximately 30 m. In the north eastern section cabling will run along improved agricultural grasslands, existing trackway, forested areas (approximately 2km) and the public road, Carrick Lane (L-10081-1). The eastern section will connect to the substation by running 33kV cables across the R400 and along the L-10093-1 in to the substation.

The 110kV Cable connection from the Wind farm Substation will run for under 200m along an existing trackway lying immediately east of the proposed substation before entering Derryiron ESB/Eirgrid Substation

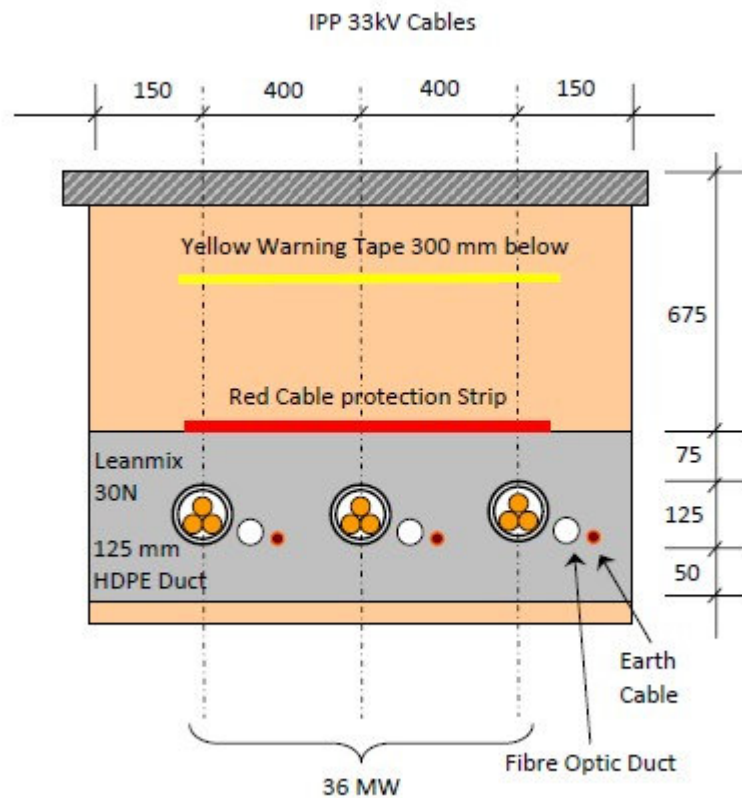


Figure 2.11a - Underground Cable Trench & Chamber Details for R400 and Garr Road

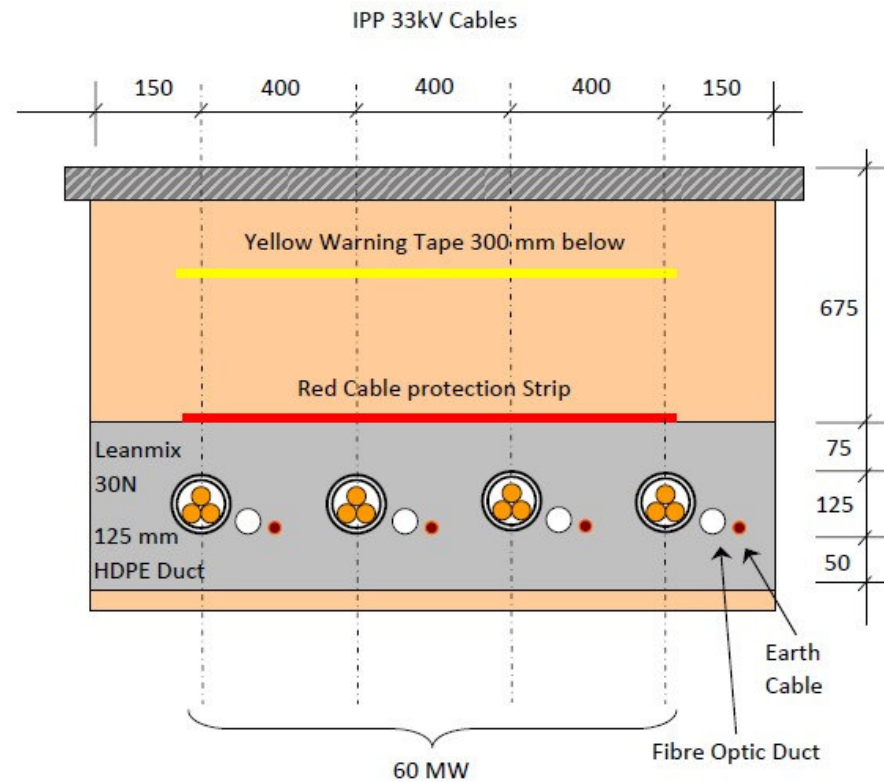


Figure 2.11b - Underground Cable Trench & Chamber Details across R400 at Garr Road Roundabout.

NOTE: Surface to be finished to Offaly County Council specification/requirement
 Similar drawing will apply for roads where the electrical load is less.

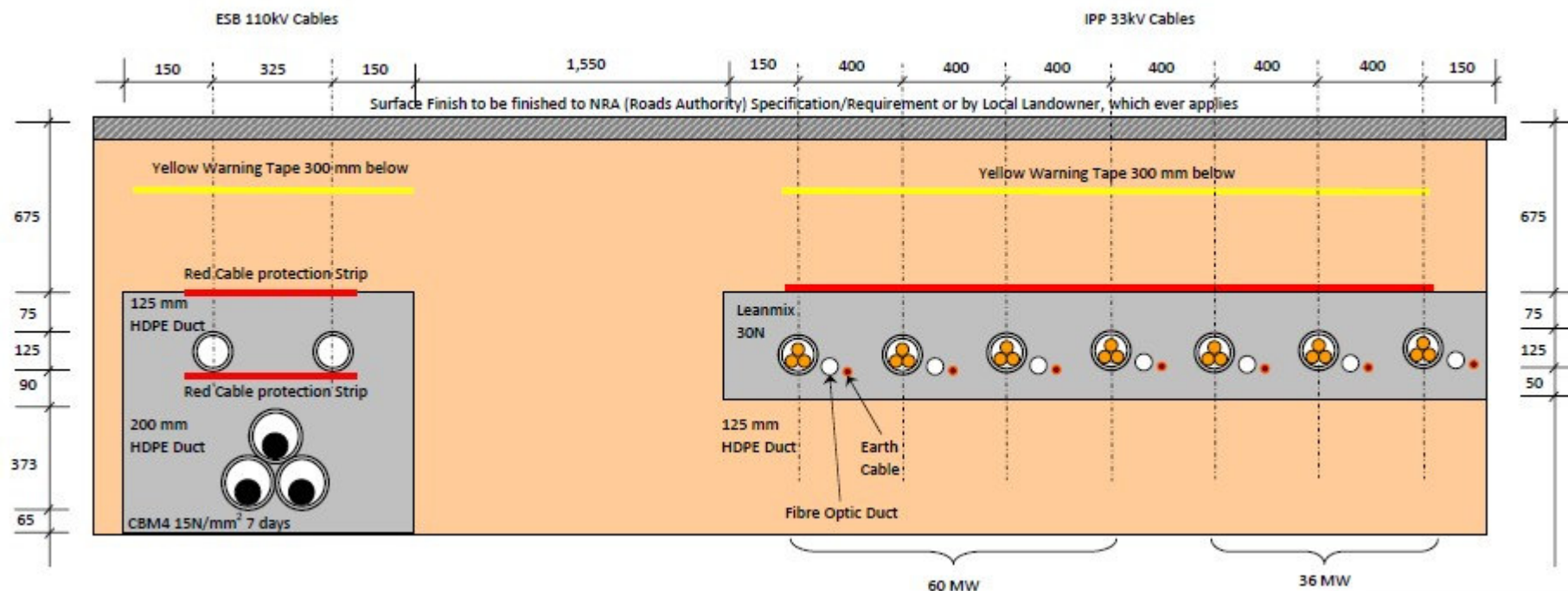


Figure 2.11c - Underground Cable Trench & Chamber Details for Substation Access Road

2.8.8 Felling and Thinning of Forestry

There are approximately 275 hectares of forestry in the vicinity of the Yellow River Wind Farm site. Four of the proposed turbines are located within forested areas: T1; T25; T26 and T27, and one turbine, T2, is partially located within forestry.

Felling and thinning will be necessary to accommodate the construction and erection of these four turbines and associated works.

Provision of the construction area at each turbine location will require approximately 1.5 hectares for turbines T1; T25; T26 and T27, and approximately 0.77 hectares for T2, which totals 6.77 hectares. These areas include all hardstanding and assembly areas. The estimated loss of forestry due to access roads is approximately 3.63 hectares based on the requirement for approximately 2,425 metres of new access road. This gives a total area for tree felling as a result of the development of approximately 10.4 hectares.

Of the total forested area of approximately 275 hectares, the total area of tree felling required for the proposed development represents approximately 3.8% of the total forested area.

It is not anticipated that there is any requirement for felling to reduce the wake effect from the trees affecting the turbine performance. Mature trees will not be allowed to exceed a height of 30 metres in the immediate vicinity of the turbine. The forested areas on site could be classified as good yield with good tree heights.

All felling works will be subject to the grant of a felling license from the Forest Service. Please refer to Chapters 12 - Material Assets for further details on forestry.

Forestry Reinstatement Areas

Areas totalling 100% of the areas clearfelled will be acquired (10.4 ha) for forestry reinstatement, in accordance with the Forest Service Policy on the Granting of Felling Licenses for Wind Farm Development.

2.8.9 *Site Roads*

The site roads are necessary to allow access for cranes and delivery trucks during construction of the wind farm and also during servicing/repairs to the wind turbines. Please refer to **Appendix G** for the Haul Route Assessment Report.

The minimum road width required is approximately 5m although this may increase at bends and junctions. The typical outer radius required for turning the delivery trailers is up to 38 m depending on the configuration of the curve. Gradients should, generally, be limited to 1 in 7 and a stone layer should be provided, so as to give a good grip during wet weather. Gradients of proposed access tracks will not exceed this value.

It is proposed to use the existing internal road network as much as possible. These roads will need widening from approximately 3.5 m to approximately 5 m (calculations were carried out for worst case scenario, 5.5m). A large proportion of these roads have a sealed surface however resurfacing will be required along the majority of the roads. Approximately 5,916 m of existing site roads will require upgrading to provide suitable access to the wind turbines and site control buildings.

It is to be noted that there is a section of approximately 2,500 m of existing track which will be utilised for internal haulage which is deemed not to require any upgrading works. The majority of this section is along the existing access to the Kilmurray quarry.

It is proposed that approximately 18,275m of new site road will be constructed to provide suitable access to the wind turbines and site control buildings.

The roads will be constructed to provide a minimum road surface width of 5.5 metres and the construction details will be as follows: 200mm of 50mm Down Quarried Rock; Gravel pavement on c.400mm down quarry floor material. The site roads will be designed to carry a 20 tonne Construction Loading.

The site road layout is shown in **Figure 2.8**.

These roads will have to be maintained during the construction phase. When weathered, the stone should not contain any constituents, which may be harmful to the environment, surface and groundwater in particular. The stone, which will be imported from nearby quarries of which there are three major quarries, all north of Rhode. Therefore the imported stone

material will be of a similar geochemistry, wherever possible. Please refer to Chapter 12 Material Assets for a further discussion of the quarry resources in the area.

At the end of the construction period, the edges of the road will be covered with peat/top soil so that the running width is reduced to 5.5m (except at bends).

The road construction detail is shown in **Figure 2.12** and details are as follows:

2.8.10 Hardstand areas

Various crane hardstand areas in addition to turning areas are required in the vicinity of each turbine location. Hardstand areas must allow two cranes to work in the vicinity of a turbine. The required hardstand pad area for both the large 1,000/750 tonne crane, the small crane (80/100 tonne) and for a delivery lorry is approximately 1,250m² plus splay area of 745m². There should also be a 5.5m wide access road to the turbine tower base to allow for the repair or replacement of any of the components inside the tower.

Hardstand areas will be covered with excavated soil and re-seeded with grass after construction.

There are two possible methods of hardstanding construction:

Excavated hardstandings

This is where hardstandings are excavated to a suitable formation width i.e., all organic matter (peat) is removed. The level of the hardstanding is then raised, enabling it to be kept above the water table, facilitating the run-off of surface water. It is anticipated that this method will be undertaken where peat depths are less than 4 metres. Therefore hardstandings will be excavated at all of the turbine locations. The walls of the excavation can be stabilised in two ways:

1. Walls are excavated with side slopes of 1:2. i.e., every 1m of excavation requires 2 metres of additional land take around the perimeter of the hardstanding.
2. Walls are stabilised through the use of gabion baskets. Therefore no additional land take is required.

Piled / Floated Hardstandings

This is where hardstandings are floated on the peat surface i.e., organic matter (peat) is retained. Four small areas at the edges of the hardstanding are then piled and a concrete cap is placed on top. These pads are required to provide adequate support to the crane. It is anticipated that this method will not be undertaken on this project.

The exact method of hardstanding construction will not be determined until detailed pre-construction site investigation works are conducted on the site and a detailed design is prepared. For the purposes of the EIS a worst-case scenario will be assumed, i.e. excavated hardstands. Please refer to Section 3.2.7.

2.8.11 Meteorological Mast

It is proposed to erect a permanent meteorological mast approximately 600 metres northwest of the existing temporary meteorological mast. This structure is essential to achieve compliance with ESB grid code as the wind conditions must be independently monitored.

The mast will be up to one hundred metres tall steel lattice tower structure. It will measure approximately 4 metres at its base. Please refer to **Figure 2.13** for details.

2.9 YELLOW RIVER DRAINAGE DESIGN

2.9.1 Introduction

Scope

The approach to drainage design is to use Sustainable Urban Drainage Systems (SuDS). Through the utilization and implementation of this approach, JOD&P have determined that the proposed design for the development and associated infrastructure will minimise risk to the hydrology regime of the site and to the receiving environs of the Yellow and Mongagh Rivers.

Development Description

The development comprises the following elements:

- 32 no. wind turbines with concrete bases measuring approximately 18m in diameter.

- 32 no. crane hardstand areas (1,250m²) with associated splays (745m²) and laydown areas (3,600m²), placed near each turbine location to facilitate erection by mobile cranes.
- Approximately 25,675 metres of underground cabling to connect the turbines within the site to the proposed substation. Cabling will also be required along short sections the Regional road (R400) and short sections of three local roads.
- An electrical compound which is to measure approximately 50 x 37 metres. This compound will contain two control buildings and ancillary electrical equipment. A wastewater holding tank will also be installed at this location.
- Temporary compound

Scoping Responses

A consultation letter and scoping document/feasibility report were sent to all relevant statutory and non-statutory consultees during the scoping process. A full list of the bodies consulted, the consultation letters sent and the corresponding responses can be found in **Appendix F**. Of the 31 bodies consulted, 2 responses were received relating to water and drainage aspects of the development.

OPW

OPW drainage channels require a 10m maintenance strip along the edge of the channel. This strip should not be planted or paved in any way, which would prevent access for maintenance. This requirement should be applied for all drainage channels where possible to assist in the prevention of flooding.

New culvert/bridges on any watercourses or changes to existing structures will require Section 50 consent from The Office of Public Works.

Inland Fisheries Ireland

All the sites are located in the sub-catchment of the Yellow River and its tributary the Mongagh/Castlejordan River. The Yellow River itself is a tributary of the River Boyne (a cSAC). Both rivers contain stocks of salmon and trout. IFI are anxious that stocks would be

protected from the negative effects of in-stream works associated with this project (turbines, buildings, cabling, roads, ect) and that an adequate buffer zone would be set around watercourses. Please note that no in-stream works should be carried out in the closed season i.e. October to April.

Inland Fisheries Ireland referenced guidelines entitled, “Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites”. This document has been adhered to in the proposed drainage design for the site.

2.9.2 Purpose of a SUDS Drainage Design

There is increased potential for water pollution, in particular sedimentation to local watercourses due to large volumes of spoil and emplacement of stone materials during the construction stage of the project.

The purpose of incorporating a SuDS design is to provide sufficient detail to ensure that water pollution will not occur as a result of construction activities at the site and to minimise the risk of any such occurrence.

The drainage design adopts temporary SuDS for the drainage of the temporary works during the construction phase. The following elements in series are proposed:

- Swales;
- Check dams and;
- Settlement ponds.

These measures provide a surface water management train that will mitigate any adverse impact on the hydrology of the site and surrounds during the construction phase of the project. Other pollution preventative measures include silt fences where necessary. Please refer to Figure 2.12 Road Construction Detail & Swales, Figure 2.16 Check Dam Detail, Figure 2.17 Settlement Pond Detail.

A 50m buffer zone has been adopted from turbine bases and hardstandings to watercourses, however, works are proposed in the vicinity of watercourses including access roads and crossings, Where such works are proposed appropriate mitigation measures are identified to prevent the pollution of the these watercourses.

2.9.3 Reference Information

Relevant EIS Studies

Hydro-Environmental Services undertook an assessment of the potential impacts of the proposed wind farm at Yellow River, Co. Offaly on water aspects (hydrology and hydrogeology) of the receiving environment.

The primary objectives of the assessment include:

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the proposed wind farm development;
- Identify likely positive and negative impacts of the proposed development on surface and groundwater during construction and operational phases of the development; and,
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts.

This report is included as Chapter 7 of the Environmental Impact Statement.

Conservation Services - Ecological & Environmental Consultants to carry out a freshwater ecological assessment for the proposed wind farm at Rhode, County Offaly. The aims of the assessment are:

- To assess the present fishery value, invertebrate fauna, aquatic flora, water quality, habitat value and general ecological condition of streams and rivers in the vicinity of the proposed development and provide baseline data against which any future changes can be assessed
- To assess the general status of the streams from an ecological and fisheries perspective in the context of their wider catchment based on survey data, published sources, EPA data, and on consultation with Inland Fisheries Ireland, NPWS and Marine Institute
- To assess the potential impact of the proposed development on water quality and aquatic flora and fauna
- To recommend mitigation measures where potential negative impacts are predicted

This report is included as Chapter 5 of the Environmental Impact Statement.

Legislative Background

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 600 of 2001 Planning and Development Regulations, 2001;
- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988 Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are

ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;

- S.I. No. 41 of 1999 Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);
- S.I. No. 439 of 2000 Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations;
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010; and,
- European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

Construction Industry Research and Information Association (CIRIA) – Guidance Manuals

- CIRIA (Construction Industry Research & Information Association) Report C502 Environmental Good Practice on Site
- CIRIA 521 - Sustainable Urban Drainage Systems; Design Manual for Scotland and Northern Ireland

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- CIRIA Report C532 Control of Water Pollution from Construction Sites
 - CIRIA Report C648 Control of Pollution from Linear Construction Project. Technical Guidance
 - CIRIA Handbook C650 Environmental good practice on site
 - CIRIA Handbook C651 Environmental good practice on site checklist
 - CIRIA Report C609 - SuDS – hydraulic, structural & water quality advice
 - CIRIA Report C697 – The SuDS Manual

2.9.4 SuDS Drainage Design Criteria

The design criteria for the SuDS are:

- To minimize alterations to the ambient site hydrology and hydrogeology. To provide attenuation and treatment controls as close to the site footprint as possible and to replicate where possible the existing hydrological environment of the site.
- To minimize sediment loads resulting from the development run-off during the construction phase.
- To preserve Greenfield runoff rates and volumes.
- To provide appropriate retention times.
- To provide settlement ponds to encourage sedimentation and storm water runoff attenuation
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally.
- To manage the problems of erosion and allow for the effective revegetation of bare surfaces.

- To control water within the site and allow for the discharge of runoff from the site within the limits prescribed in the Salmonid Regulations.

These design criteria can then be translated into an outline design philosophy.

2.9.5 SuDs Design Philosophy

The approach to treatment and attenuation of storm water is as follows:

- Additional drainage measures will only be added as necessary. The dimensions of these features will avoid intercepting large volumes of water.
- Storm water runoff from hardstandings and roads will be managed via swales. Roads and hardstandings will crossfall downslope to mimic the natural drainage patterns of the site.
- Swale vegetation used will be appropriate to the local area.
- Temporary erosion protection together with silt fences may be required until the vegetation becomes established (coire matting or similar).
- Roads and hardstandings are constructed from aggregate and will not be surfaced with bitumen materials, thus helping to reduce runoff volumes. Therefore a reduced runoff coefficient of 70% is applicable.
- A large portion of the hardstanding construction will be of single sized stone therefore the pore spacing in the hardstanding and road will also act to store and attenuate water.
- Swales will be primarily used to attenuate water and to encourage discharge into the ground locally.
- Outflow points will be taken from the swales into the existing onsite drainage channels. Silt fences will be maintained at the interface between the proposed and existing drainage channels for the duration of the construction phase.

-
- No direct discharge from swales to natural watercourses. This avoids concentrating large volumes of water into point discharges.
 - Stormwater runoff within the swale will be treated through the provision of small Silt fences at approximately 40m centres along the swales. The stone used for the construction of the check dams will be washed graded stone with a size range between approximately 5mm and 50mm.
 - It is noted that swales will not be used along floated sections of road.
 - Swales will provide a flow route in extreme events to carry water to the existing surface water channels across site. It will be necessary to increase the cross sectional area of the swales further downstream of the footprint as larger volumes of stormwater are conveyed.
 - Discharging directly back to the surrounding area will assist in maintaining the hydrological characteristics of the site.
 - Vegetation will be reinstated on slopes as early as possible.
 - Under track drainage will be provided with associated sumps and silt fences. The under track drainage will provide a means for flows to pass from a swale on the uphill side of the slope to the downhill side of the slope.
 - Under track drainage will be provided under the floated roads at all locations where existing land drainage passes under the proposed roads. Conventional cross drains will be 150mm diameter, and increased to 300mm diameter (minimum) at points for land drainage or natural drainage paths crossing under the section of floated road. The spacing of the cross drains will be dependant upon whether the roads run parallel or tangential with the general contours of the site.
 - Sumps will be required for each turbine location to collect dewaterings, water will subsequently be pumped into settlement ponds and allowed to settle prior to discharging into the swales. The general location of the small concrete sumps will ensure that they pose minimal health and safety risk to site personnel, particularly whilst constructing the wind turbine rotor blades during the installation process (as this process takes place adjacent to the crane hard standing).

- All swales and ponds will be kept as shallow so that they pose no health and safety risk to plant or personnel. Maximum depth of standing water will be limited to 0.5m within the ponds and 0.3m within the swales.
- The settlement ponds will be designed to cater for infilling and rehabilitation post construction phase of the project.
- The use of large balancing ponds is to be avoided and there will be no merit in using other methods such as filter drains or hard permeable surfacing due to the lack of infiltration capacity and high groundwater levels across the site.
- The level of silt in runoff during construction will be monitored and if it is excessive in any area this can be managed by the provision of additional silt attenuation features such as silt fences or silt traps. The low gradient nature of the site allows for slow water velocities therefore settlement of particles should occur readily throughout the site. If the suspended solids levels remain high, water can be pumped from settlement ponds into tankers and transferred off site to a suitable water treatment facility subject to agreement with the Local Authority.
- Field drains/streams will be piped directly under the track through appropriately sized drainage pipes.
- Where ditch or stream crossings cannot be avoided, the design of the crossing, either culvert or bridge, shall be prepared in line with IFI Fisheries guidelines.
- Appropriate site management measures will be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages. Please refer by Section 3.5 of the EIS for further details.
- There will be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse system or ditch.

2.9.6 Detailed Design Considerations

The following issues have been identified in the preliminary SUDS design of the development.

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- The development of suitable mitigating measures will be given further consideration during detailed design stage of the project.
 - Watercourse crossing identification and sizing
 - Detailed design of track drainage
 - Detailed design of turbine and hardstanding drainage
 - Peat storage and handling measures
 - Requirement for attenuation storage
 - Definition of buffer-zones

Watercourses and Watercourse Crossings

There are nine new stream crossings on site, three of which cross the Yellow River, five of which are tributaries of the Yellow River and one is a tributary of the Mongagh River. An existing bridge, (C3, Derryiron Stream East) will require upgrading. Please refer to **Figure 2.14 for River / Stream Crossing Location Map** and to Chapters 5 & 7 for further discussion on these watercourses.

The nine proposed crossing points and bridge upgrade are as follows:

Crossing No.	Stream/River	Grid Ref.	Salmonid Spawning Habitat	Salmonid Nursery Habitat	Salmonid Adult Habitat
C1	Yellow River	250444, 236339	Poor - Fair	Poor - Fair	Fair - Good
C2	Derryiron Stream West	250839, 236275	None	None	None
C3	Derryiron Stream East	251775, 235747	Poor - Fair	Poor -Fair	Fair
C4	Corbetstown Bridge Stream	253800, 239124	None	None- Poor	None
C5*	*Corbetstown Bridge Stream	254354, 238857	Poor	Fair	Poor
C6	Wood Stream West	255006, 237548	None	Poor	Poor
C7	Yellow River	255054, 237857	Fair - Good	Poor - Fair	Poor - Fair
C8	Wood Stream East	255456, 237778	None	None	None
C9	Yellow River	255982, 238270	Fair - Good	Poor - Fair	Poor - Fair
C10	Killowen Stream	256552, 238276	Fair	Fair - Good	Fair

*Existing road crossing to be upgraded

Table 2.7 River / stream crossings and existing bridge upgrades.

In the context of the SuDS drainage proposals, a “natural watercourse” will encompass the following:

- Natural rivers and streams as normally perceived and charted by OS 1:50,000 series mapping;
- Watercourses recorded on the EPA rivers dataset.

It should be noted that a significant number of the smaller uncharted drains / watercourses are normally dry and are effectively drainage paths in periods of wet weather only.

Works to watercourse crossings will be subject to authorisation by OPW through a Section 50 application.

2.9.7 Design of Watercourse Crossings

As part of the drainage design, detailed mapping of drainage paths across the site has been undertaken; utilising topographical surveys, contour mapping and aerial photography. Detailed mapping aided the accurate definition of catchment extents for each of the water crossing locations.

The following guidance was used in the sizing of watercrossings;

- Hydrological assessments made using EPA Hydronet Tool.
- CIRIA Culvert design and operation guide (C689)
- Requirements for the Protection of Fisheries Habitats during Construction and Development Works at River Sites, Eastern Regional Fisheries Board (Inland Fisheries Ireland)

It is proposed to construct free span reinforced concrete bridges to avoid any instream works which could cause siltation or reduce the hydraulic efficiency of these watercourses.

Please refer to **Figure 2.15** – Bridge Crossing Design. The method of construction is discussed further in Chapter 3.

2.9.8 Water Buffer Zones

Buffer (exclusion) zones have been preliminarily defined by HydroEnvironmental Services in Table 7.11. The following buffer zone rules will apply in the development of the site;

Areas not acceptable for construction work or stockpiling of excavated material:

- 10m buffer zone around manmade drainage channels
- 50m buffer zone around minor watercourses
- 50m buffer zone around major watercourses and other sensitive surface water features

Areas which will be acceptable for construction activities with mitigation:

- Areas within the respective surface water buffer which have previously been passed through by existing tracks which will be updated as part of the Wind farm development.
- Additional water crossing points to facilitate the crossing of watercourses (manmade drainage, minor and major watercourses).

The remainder of the site outside these areas would be suitable to accept proposed site infrastructure.

2.9.9 Linear Track Drainage (Swales)

Where linear track drainage swales are utilised, it is proposed that rock filled check dams will be installed at a regular frequency, in order to reduce flow velocities and improve conditions for the settlement of solids in transit. Check dams will be constructed from 5-40mm crushed rock locally won, and will constitute the majority of the check dams. It is intended that these dams will be relatively simple to construct but will provide treatment of construction runoff at source. There will be outflow points (spillways) from the swales to the existing onsite drains to preserve the hydraulic efficiency of the site and to prevent ponding of water. No outflows will be permitted into natural watercourses. Please refer to Figure 2.12 for details of swales.

2.9.10 Wastewater Discharges

It is to be noted that no sewage will be discharged or treated on site as part of the development. Wastewater discharges from the substation toilet facilities will be collected and stored in a sealed tank on site and transported away at regular intervals for treatment at a Waste Water Treatment Works. The sealed tank will be similar in specification to Klargesteer Sealed Cesspool to BS 6297:1983 and surrounded by 225mm thickness of concrete or Silotank equivalent. This work will be done under a contract with one of the Contractors who have a permit to transport Septic Tank Waste to a Waste Water Treatment Plant (e.g. Rhode) as issued by Offaly County Council.

2.9.11 Runoff Attenuation

Runoff from large hardstanding areas such as the site compound, turbine hardstandings, and substation will be attenuated to mimic natural runoff patterns. Attenuation will utilise shallow

primary and secondary settlement ponds to aid removal of suspended solids. Calculations for the determination of storage requirements have been undertaken and are as follows:

- A 1 in 100 year rainfall return design.
- The largest hardstanding area of 0.0025 hectares.
- The rational method⁶ is subsequently applied to calculate the flow volumes into the settlement pond over these respective periods.
- An initial outlet weir overflow rate is applied of 5l/s which approximate to Greenfield run-off rates.

Please refer to **Table 2.8** for a breakdown of this calculation.

1 in 100 year return						Weir Overflow Rate 5L/s		
Duration	Rainfall (mm)		C	A (km ²)	(m ³ /s)	Volume (m ³)	Discharge (m ³)	Residual Volume (m ³)
5min	13.2	0.278	0.95	0.0025	0.1046	31.3751	1.500	29.9
10min	18.4	0.278	0.95	0.0025	0.0729	43.7350	3.000	40.7
15min	21.6	0.278	0.95	0.0025	0.0570	51.3410	4.500	46.8
30min	26.2	0.278	0.95	0.0025	0.0346	62.2748	9.000	53.3
60min	31.6	0.278	0.95	0.0025	0.0209	75.1100	18.000	57.1
2hr	38.3	0.278	0.95	0.0025	0.0126	91.0353	36.000	55.0
4hr	46.4	0.278	0.95	0.0025	0.0077	110.2882	72.000	38.3
6hr	51.8	0.278	0.95	0.0025	0.0057	123.1234	108.000	15.1
12hr	62.8	0.278	0.95	0.0025	0.0035	149.2693	216.000	-66.7
24hr	76	0.278	0.95	0.0025	0.0021	180.6444	432.000	-251.4
48hr	85.3	0.278	0.95	0.0025	0.0012	202.7496	864.000	-661.3

Table 2.8 – Settlement Pond Volumes Calculations

The largest residual volume requirement is 57.1 m³. It is to be noted that ponds will be removed on completion of the construction phase of the project.

A set of dimensions of approximately 9m in length, 3m in width and 1m in depth for the primary and secondary settlement ponds are derived which account for the storage and

⁶ Rational Method is expressed by the formula $V = 2.78 \cdot C \cdot A \cdot I \cdot t$, where V is the volume of water generated in the stilling pond, C is the run-off co-efficient which is assumed to be 0.95 across all hardstanding areas, A is the area of the hardstanding / catchment, I is the rainfall depth and T is the duration of rainfall occurrence.

attenuation of the residual volume. The Length: Breadth ratio of the ponds must be a minimum of 3:1 as recommended by COFORD⁷. Please refer to Figure 2.17 - Settlement Pond Detail.

2.9.12 Peat Storage/Spoil Management

It is understood that excavated peat is to be side cast adjacent to proposed access track alignments. Areas of stored peat:

- Will not be permitted within previously denoted watercourse buffer zones;
- Will not be permitted to obstruct the flow of overland surface water.
- Where areas of peat storage other than side casting is proposed, formal drainage will be designed on a bespoke basis to allow controlled dewatering and prevent washout of suspended solids to the receiving water environment.

Mitigation proposals for spoil management are detailed in **Section 3.8** of the EIS.

2.9.13 Construction Phase - Detailed Considerations

A process of mitigation by avoidance has been adopted by the design team. A number of best practice SUDS mitigation measures are also proposed to minimise impacts to water quality.

It is critical that an environmentally responsible contractor/sub-contractor is appointed to carry out construction works. The following measures should be enforced by the clients engineer on site:

- All site personnel should be made aware of their environmental responsibilities at the site.
- Method Statements will be prepared at an early stage in the project, outlining Environmental
- Requirements for contractors, which will include contingency plans to deal with spillages, should they occur.

⁷ Mulqueen and Others. 1999. Forest Drainage Manual. COFORD, National Council for Forest Research and Development.

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- Site visits by the SuDS Engineer will be agreed in advance and will be undertaken at various stages of the construction process to ensure that the proposed SuDS scheme is being constructed in line with the design.
 - Land disturbance will be kept to minimum and disturbed areas will be stabilised as soon as possible.
 - In principle, soil excavation should be undertaken during dry periods whenever possible.
 - A Spoil management plan will be further developed for the site by the contractor which will detail the placement of excess spoil across the site and will be based upon the recommendations from Whiteford Geoservices.

All drainage recommendations from the soils, geology and water reports have been considered and incorporated into the SuDS design.

Working in the vicinity of Water or Buffer Zones

The following mitigation measures apply when working within the watercourses or in the vicinity of watercourses.

- Ensure roads are built to the layout design and therefore remain outside the relevant buffer zones to rivers and watercourses.
- Avoid construction near streams in wet weather whenever possible.
- Stone will be of a local geochemistry i.e. be sourced from one of the nearby quarries.
- Plan so that roadside drains do not discharge directly into watercourses, but rather are profiled back towards existing field drains e.g. T16, 17 and 18.
- No concrete will be used in watercourses. .
- Runoff from excavations will not be pumped directly to watercourses. Where dewatering of excavations is required, water shall be pumped to the head of a

treatment train (swale or concrete sump in the case of turbine bases) in order to receive full treatment prior to re-entry to the natural drainage system.

- In a precautionary approach buffer zones will be set out at a minimum of 10m to all land drainage channels, with a 50m buffer zone defined on minor and major watercourses.

Watercourse Crossings

Nine new water crossings (i.e. a watercourse identified on a 1:50,000 scale map) have been identified at preliminary design stage, one upgraded water crossing on the Garr Road. All of these crossings will be carried out by free span concrete bridges. Therefore:

- Flow will not be restricted
- Fish passage will not be restricted
- Instream works will be avoided
- Risk of sedimentation or pollution control will be reduced.

Crossings of a number of cut drains and minor drainage path crossings will be required, whose exact locations will be determined at detailed design stage. The final detailed design of each of the crossing points will be discussed and agreed with Inland Fisheries Ireland. The designs will also be subject to Section 50 authorisation from the OPW.

Settlement Ponds

The following design criteria shall apply to the construction of settlement ponds at the site:

- Install interceptor drains upslope of the works areas, where gradient requires to separate uncontaminated surface runoff and divert it around and away from the works; Post completion of the scheme the interceptor drains can be in filled.
- All flow depths to be kept to a normal depth of 0.3m with a maximum depth of 1.0m maximum.

- Settlement ponds will be lined with geotextile material.
- Side slopes to be shallow, nominally at a 1 in 3 side slope (maximum).
- Material excavated from the settlement pond will be compacted around the edge of the pond, which will prevent site personnel from falling into the pond.
- Settlement ponds will be removed on completion of the construction phase of the project. Settlement ponds should be subject to regular inspection and maintenance by both the contractor and SUDS engineer.

Please refer to Figure 2.17 - Settlement Pond Detail.

Turbine Bases

Drainage and dewatering from turbine base excavations will be pumped to a separate concrete sump. Water will be allowed to settle prior to discharging into the settlement ponds. The general location of the small concrete sumps will ensure that they pose minimal health and safety risk to site personnel, particularly whilst constructing the wind turbine rotor blades during the installation process (as this process takes place adjacent to the crane hard standing). Please refer to Figure 2.17 Hardstand Concrete Sump.

Delivery trucks, tools and equipment will be cleaned at designated concrete washout area located within the temporary compound. In addition the following drainage measures will apply;

Installation of cut-off drains around the working areas to intercept uncontaminated surface runoff and divert it around and away from the works.

The base of the excavation will be constructed level, and water will be gathered in a sump, and pumped at a low flow rate into a concrete sump.

The foundation working areas will be re-vegetated as soon as possible after construction.

Substation and Temporary Compound Area

The following shall apply to the construction of the substation and temporary compound at the site:

- During construction of the substation and temporary compounds, similar measures to those implemented during turbine/crane pad construction will be used to limit water ingress, sediment erosion and concrete pollution.
- French drains or similar will be constructed around the substation to ensure ground water levels around the building can be managed and that internal sumps within the building do not become waterlogged.

2.9.14 Operational phase - Detailed Considerations

Collection of surface water for the 20.58 ha footprint of the proposed development will be through open vegetated swales. No direct discharge to streams is proposed as part of the development. Discharge will be via existing drainage channels.

3.0 POST-PLANNING STAGES

3.1 PROGRAMME

Assuming that the proposed development progresses favourably and planning permission is granted, it is estimated that construction could begin, at the earliest, in the second quarter of 2015. An estimated timescale for the completion of construction for a project of this size is in the region of 26 months i.e. inclusive of all works to site roads, access routes, substation building and construction and commissioning of turbines. This allows a total of 16 months for civil works construction. Turbine erection would take 8 months and turbine commissioning would take 6 months. There will be some overlap with civil works and turbine erection, and also with turbine erection and commissioning.

It is estimated that the following civil and electrical works will take approximately 16 months to complete (excluding turbine delivery and erection):

- Temporary Site Compound;
- Site Entrances 1 - 9;
- New River Crossings 1 - 9;
- Upgrade of Corbetstown Bridge;
- New Site Roads;
- Upgrade to local roads;
- Cable ducting;
- Turbine Bases and Hardstands 1 - 32;
- Electrical Compound and Control Buildings.

It is estimated that turbine erection will take approximately 8 months and turbine commissioning will take 6 months.

The final programme will be developed in consultation with the turbine manufacturer based on projected turbine delivery dates.

Any recommendations/mitigation measures relevant to the construction phase as identified in this EIS, or by the Department of the Environment, Community and Local Government, Wind

Farm Planning Guidelines and recommended by the Planning Authorities will be implemented.

3.2 OVERVIEW OF CONSTRUCTION METHODOLOGY

The proposed construction methodology is summarised under the following headings:

- Site Entrance
- Temporary Site Compound
- Concrete Washdown Area
- Drainage System
- Upgrade of Existing Road
- New Site Roads
- Bridge Construction
- Crane Hardstands
- Turbine Bases
- Control Buildings and Compound
- Cable Trenching
- Electrical Works
- Turbine Erection
- Turbine commissioning

3.2.1 Site Entrances

Prior to the commencement of any other works, the Site Entrance layouts will be constructed in accordance with **Figure 3.1a, 3.1b, 3.1c and 3.1d – Yellow River Wind Farm Site Entrance Details**, in conformance with NRA – Road Geometry Handbook TD 41-42/09 – Vehicular Access to All Public Access Roads.

Visibility splays will be provided for a design speed of 85km/hr, i.e. a 160m visibility splay from carriageway edge. It is not envisaged that there are any obstructions which will need to be removed.

3.2.2 Temporary Site Compound

There will be one temporary contractor's compound located adjacent to the substation site. The compound will be constructed as follows:

- The area to be used as the compound will be marked out at the corners using ranging rods or timber posts.
- Drainage runs and associated settlement ponds will be installed around the perimeter.
- A layer of geo-grid will be installed and layers of well graded granular material will be spread and compacted to provide a hard area to site offices and storage containers.
- Areas within the compound will be constructed as site roads and used as vehicle hardstandings during deliveries and for parking. The size and location of the hard standings will be at the discretion of the site manager.
- A concrete bunded area with an associated oil interceptor will be provided within the compound for the storage of lubricants, oils and site generators and coalescing media oil water separator will be installed to mitigate against any hydrocarbon spillages.
- Depending on the location of the compound, it may be fenced all round and secured with locked gates, fencing would only be utilised where significant risk of danger to third parties or vandalism was envisaged.
- Self contained port-a-loos with an integrated wastewater holding tank will be used, maintained by the providing contractor, and removed from site on completion of the

construction works. These will be located in the temporary compound, as well as in several areas throughout the site due to the dispersed nature of the site.

- Potable water will be delivered to site in suitable canisters on a daily basis for drinking, for tea and coffee as well as for use in the temporary site facilities compound.

Upon completion of the project the contractors compound will be decommissioned. The hard core stone and geo-grid will be removed from site and the area will be reinstated by backfilling with the material arising during excavation, landscaping with topsoil as required.

3.2.3 Concrete Washdown Area

A concrete washdown area will be constructed in the temporary compound. Every concrete truck delivering concrete to the site must use this facility prior to leaving the site. The concrete washout will be constructed as follows:

- The topsoil will be stripped out and placed in the peat reinstatement area adjacent to the temporary compound area.
- A filtration membrane will be installed directly onto the subsoil. The filtration membrane will conform to national and international quality standards.
- Graded granular material will be laid and compacted in layers above the membrane.
- All concrete wash down at the site will be completed in a dedicated proprietary concrete washing unit (<http://www.siltbuster.com/sheets/RCW.pdf>). This unit catches the solid concrete and filters and holds wash liquid for pH adjustment and further solids separation. The residual liquids and solids can be disposed of off-site at an appropriate waste facility.

Upon completion of the project the concrete washdown area will be decommissioned by removing the stone and filtration membrane and backfilling the area with the material arising during excavation, landscaping as required.

Wheel wash facilities will be located at each site entrance to reduce construction traffic fouling public roads. Each wheel wash will come with an additional water tank which will be filled regularly. These units will be self-contained and will filter the waste for ease of

disposal. Waste will be removed from each unit and from site by a licensed waste disposal company.

3.2.4 Upgrade of Existing Roads

There is an internal excavated road network currently on the site. It is proposed to utilise this road network as much as possible. This will require the road to be upgraded and widened from approximately 3.5m to approximately 5.5m. The typical road widening details of the site roads are detailed on **Figure 2.12 –Road Construction Detail**.

3.2.5 New Site Roads

All site roads have been designed taking account of the loadings required by the turbine manufacturer, and will consist of a compacted stone structure. All roads on the site will be constructed using the traditional road construction method from suitable load bearing strata.

This system will consist of either one or two layers of stone depending on the load bearing capacity of base layer. Where the underlying layer is mineral subsoil, two layers of stone are used; a stone capping layer and running layer. In areas where the load bearing layer is rock, the capping layer is omitted, and the running layer is installed directly onto the rock surface.

The layout and typical construction details of the site roads are detailed on **Figure 2.12 –Road Construction Detail** and will be constructed as follows:

- Establish alignment of the new site roads from the construction drawings and mark out the centrelines with ranging rods or timber posts.
- The access roads will be of single-track design with an overall width of approximately 5.5m. There will be some local widening on the bends, junctions and around turbine bases for the safe passage of large vehicles. All bends have been designed to suit the requirements of the delivery vehicles.
- The excavated road section, where practicable, will have the turve stripped over the area of the excavation and stored growing side up for reuse.
- All machinery shall work within the construction corridors that will be indicated on the contract drawings. Vehicle movement will be restricted to site tracks except

during track and base construction. Construction activities will be kept discrete and minimal in order to retain where practical, heather and bog habitat.

- Top soil excavation shall be observed by a qualified archaeologist, in accordance with an approved scheme of archaeological monitoring.
- The soil will be excavated down to a suitable formation layer of either firm subsoil or rock.
- Well-graded granular fill will be spread and compacted in layers to provide a homogeneous running surface. The thickness of layers and amount of compaction required will be decided by the Site Manager based on the characteristics of the material and the compaction plant to be used.
- Batters will have a slope of between 1:1 and 1:2 (depending on depth and type of material) and will be left as cut to re-vegetate naturally with local species.
- At bends or steep inclines within the new internal site roads, reflective snow poles will be erected to warn traffic on dark mornings and evenings that there is a turn in the road or a sharp incline beyond the site road.

3.2.6 Crane Hardstands

All crane pads and associated splays will be designed taking account of the loadings provided by the turbine manufacturer, and will consist of a compacted stone structure.

All crane pads will be formed from a suitably stiff layer and the finished crane pad surface will provide a minimum strength of 200kN/m². Piled / floated construction using geo textiles will be used where the depth of peat exceeds 4m. Please refer to Section 2.7.9 for further details.

Crane pad and associated splay formation will consist of either 1 or 2 layers of stone depending on the properties of the underlying load bearing layer. Where the underlying layer is soft soil, 2 layers of stone formation are used, the stone capping layer and, the running layer. In areas where the load bearing layer is rock, the capping layer is omitted, and the type 3 running layer is installed directly onto the rock surface. The crane pads are approximately 50m x 25m and have a maximum cross and longitudinal fall tolerance of 2%.

Crane hardstand areas will be covered with excavated soil and re-seeded with grass after construction.

The crane hardstands will be constructed in one of two following ways:

- Typical excavation method, areas where peat is less than 4m deep.
- Piled / Floated Hardstand method, peat deeper than 4m.

The typical excavation method can be summarized as follows:

Typical Excavation Method:

- Establish alignment of the hardstands from the construction drawings and mark out the corners with ranging rods or timber posts.
- The excavated material will, where practicable have turf stripped over the area of the excavation and stored growing side up for reuse
- Soil excavation shall be observed by a qualified archaeologist, in accordance with an approved scheme of archaeological monitoring in order to identify any significant remains should they come to light.
- The soil will be excavated down to a suitable formation layer of either firm clay or rock.
- Well-graded granular fill will be spread and compacted in layers to provide a homogeneous running surface.
- Batters to have a slope of between 1:1 and 1:2 (depending on depth and type of material) and will be left as cut to re-vegetate naturally with local species.

Piled / Floated Hardstanding Method:

Floating construction will be adopted to mitigate against the excavation of peat and thereby avoiding the risk of sediment release. This system involves:

- Installing a layer of geo-grid directly onto of the existing organic layer;
- Placement of a layer of well graded course stone;
- Application of further layers of geo grid (if required);
- Laying the final layer of a finer well graded stone for the running surface.

It is envisaged that four piled crane support pad will be constructed. Precast concrete piles will be driven down to rock. A 4m x 4m x 0.6m deep reinforced concrete pad will be constructed on top of the piles. Shuttering will be used lined with polythene and an anti-bleeding admixture used to prevent any concrete leachate.

3.2.7 Turbine Bases

The wind turbines foundation will be either:

- A standard excavated reinforced concrete base where peat depths are less than 4 metres. They will likely be formed 1 metre below the base of the peat layer on stiff subsoil material or rock.
- A reinforced concrete buoyant base where peat depths exceed 4 metres.

Turbine bases will be designed to Eurocode Standards. Foundation loads will be provided by wind turbine supplier, and factors of safety will be applied to these in accordance with European design regulations. The turbine will be anchored to the foundation using a bolt assembly which shall be cast into the concrete. Bases will measure approximately 18 metres in diameter depending on subsoil conditions and ground water level.

The turbine foundations will be constructed as follows:

Standard Excavated Reinforced Concrete Base:

- (a) The extent of the excavation will be marked out and will include an allowance for trimming the sides of the excavation to provide a safe working area and slope batter.

-
- (b) Where practicable the turf will be stripped over the area of the excavation and stored growing side up for reuse, the vegetable soil will be excavated and stored to one side for reuse during the landscaping around the finished turbine.
 - (c) No material will be removed from site and storage areas will be stripped of vegetation prior to stockpiling in line with best working practises.
 - (d) Soil excavation shall be observed by a qualified archaeologist in accordance with a scheme of archaeological monitoring, in order to identify any significant remains should they come to light.
 - (e) A layer of concrete blinding will be laid approximately 75mm thick directly on top of the newly exposed formation, tamped and finished with a screed board to leave a flat level surface, to the same level as the top of the pile where piles exist. The concrete should be protected from rainfall during curing and all surface water runoff from the curing concrete should be prevented from entering surface water drainage directly.
 - (f) High tensile steel reinforcement will be fixed in accordance with the designer's drawings & schedules. The foundation anchorage system will be installed, levelled and secured to the blinding using steel box section stools.
 - (g) Ductwork will be installed as required, and formwork erected around the steel cage and propped from the backside as required.
 - (h) The foundation anchorage system will be checked both for level and line prior to the concrete being installed in the base. These checks will be passed to turbine manufacturer for their approval.
 - (i) Concrete will be placed using a concrete pump and compacted when in the forms using vibrating pokers to the levels and profile indicated on the drawings.
 - (j) Upon completion of the concreting works the foundation base will be covered with wet hessian in summer and an insulation blanket in winter and allowed to cure.
 - (k) Steel shutters will be used to pour the circular chimney section.

- (l) The foundation will be backfilled with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetable soil set-aside during the excavation. A gravel footpath will be formed from the access road to the turbine door and around the turbine for maintenance.

Reinforced Concrete Buoyant Base:

Follow Items (a) to (c) as above then for buoyant bases:

- A piling platform for the piling rig will be constructed. This can be done in two ways depending on the bearing capacity of the underlying soil.
 - The first method is to lay geo-textile on the existing surface and a stone layer will then be placed on top of the geo-textile by an excavator and compacted in order to give the platform sufficient bearing capacity for the piling rig.
 - The second method is to excavate the soils to a suitable intermediate mineral subsoil and backfill to the formation level.
- The piling rig, fitted with an auger, will then bore through the peat with a sleeve fitted around the auger to prevent the sidewalls of the peat from collapsing. The borehole is then extended to a suitable depth into the subsoil/bedrock.
- When the auger and the sleeve are removed high tensile steel cages will be lowered into the boreholes. These steel cages will extrude above the level of the top of the concrete pile.
- As the auger is removed concrete is pumped into the borehole.

Base construction is then undertaken as per items (e) to (l) above.

3.2.8 Control Buildings and Compound

The compound surrounding the substation will measure approximately 50 m x 37 m. The compound will be constructed as per the details in Section 3.2.2.

The compound will also include two control buildings, measuring approximately 14.5 x 8.85 metres (TSO Control Building) and 8.85 x 8.85 metres (Client Control Building) in plan. The buildings main functions are to provide housing for switchgear, control equipment and monitoring equipment necessary for the proper functioning of the substation. It will utilise Air Insulated Switchgear (AIS). The control building will be constructed by the following methodology:

- The area of the Control Buildings and Compound will be marked out using ranging rods or wooden posts and the vegetable soil stripped and removed to the nearby storage area for later use in landscaping. No material will be removed from site and storage areas will be stripped of vegetation prior to stockpiling in line with best working practises.
- Soil excavation shall be observed by a qualified archaeologist in accordance with an approved scheme of archaeological monitoring, in order to identify any significant remains should they come to light.
- The dimensions of the Control Building and Compound area will be set to meet the requirements of Eirgrid / ESB and the necessary equipment to safely and efficiently operate the wind farm.
- The foundations will be excavated down to the level indicated by the designer and concreted.
- Excavated material will remain on site at all times.
- The blockwork walls will be built up from the footings to DPC level and the floor slab constructed, having first located any ducts or trenches required by the follow on mechanical and electrical contractors.
- The blockwork will then be raised to wall plate level and the gables & internal partition walls formed. Scaffold will be erected around the outside of the building for this operation.
- The concrete roof slabs will be lifted into position using an adequately sized mobile crane.

- The wooden roof trusses will then be lifted into position using a telescopic load all or mobile crane depending on site conditions. The roof trusses will then be felted, battened, tiled and sealed against the weather.

Control Building finishes will be in keeping with the local area as follows: -

- Walls to be rough cast and painted off white
- Roof to be slate effect tiles
- Guttering and rainwater goods to be of an alternative to uPVC (subject to availability) and finished in white
- Doors to be made of steel or timber with steel sheeting for security
- The doors will be fitted and the external and internal finishing's applied including any fitted furniture.
- A 2.6m pallisade fence will be erected around the compound and the area surrounding the building landscaped as required, returning it as far as practicable to near original condition.

3.2.9 Cable Trenching

The transformer in each turbine is connected to the substation through a network of buried 33kV electrical cables. The Substation is connected to the Eirgrid/ESB Substation by a 110kV Cable. The ground is trenched typically using a mechanical digging machine. These machines will be regularly inspected for safety and condition and will be well maintained. The operators will have the required certification. The top layer of soil is removed and saved so that it is replaced on completion. The cables are bedded with suitable material unless the ground conditions are such that no bedding is required. The depth of the cables is to meet all national and international requirements. A suitable marking tape is installed between the cables and the surface. On completion the ground will be reinstated as previously described above.

Another option for installing the underground cables is by utilising trenchless technology. This is done by digging two pits along the cable route, an entrance pit and a receiving pit.

The first stage is to drill a pilot hole from the entrance pit to the receiving pit, along the proposed cable route. The hole is then enlarged by passing a back reamer, a larger cutting tool, along the pilot hole. The ducting for the cable is attached to the rear of the back reamer which pulls the ducting along the cable route.

The cables are terminated on the transformers at each turbine location. These terminations are located within / without the base of the turbine towers. On decommissioning the cables will be cut away below ground level and sealed.

3.2.10 Electrical Works

Substation and switchgear: - The substation will have a domestic electrical system including lights, sockets, fire alarm and intruder alarm. This would be designed, installed and commissioned by registered electrical contractors. The high voltage switchgear is installed using a truck mounted hydraulic crane. The indoor equipment is then connected, wired tested and commissioned typically by engineers supplied by the switchgear manufacturer. The operation of this equipment is by suitably authorised operators who have undergone extensive training. The equipment will be decommissioned in the reverse of the above, removed from site, dismantled and disposed of in an approved manner.

Transformers: - The transformers are delivered by the manufacturer and will be placed directly onto the turbine foundation. The units will be placed directly onto the turbine foundation prior to the installation of the turbine towers. The transformers will be of the sealed type and will be inspected for any damage prior to offloading.

The units will be installed using a small mobile all-terrain crane and will be tested, commissioned and energised by suitably trained and authorised persons. The accessible MV and LV sections of the transformer will be protected within an enclosure which shall be locked at all times displaying appropriate warning signs. The units will be decommissioned in the same manner, removed from site and disposed of by a company certified to handle such materials. This specialist company will also dispose of any oil or residual waste products.

3.2.11 Turbine Erection

The turbine will be supplied with a light grey semi-matt finish and installed with a height not exceeding 166m measured from existing ground levels to the blade tip in the vertical position.

The turbines will be delivered in sections to the site. The sections are lifted by adequately sized mobile cranes (1 main crane and a smaller tail crane to assist with the initial lift free of the transport) and positioned on the foundations / other turbine sections until the entire turbine is erected.

Upon completion of the erection, all fasteners will be tightened to the correct torque and the internal fit out of the turbine undertaken, and finally the mains power will be connected to the turbine controller.

When the controller is 'booted up', the turbine commissioning will commence, and following the successful execution of the 'tests on completion' the turbines will be handed over as complete.

3.2.12 Bridge Construction

The bridges will be constructed so as to avoid any instream works or any disturbance to the riverbed. The general methodology is as follows:

- (a) Roads will be constructed to either side of the River/Stream in accordance with the detail in Figure 2.12 as far as the bridge footings.
- (b) The abutment locations will be set out such that they are set back from the Stream edge.
- (c) Mini-piles will be utilised in the bridge footings to reduce excavation volumes. These will be steel lined Odex or equivalent piles. Concrete will be placed inside each pile.
- (d) Reinforced steel bars for the abutments will be fixed in accordance with the detailed design which will take place post-planning. Ducting will also be fixed.
- (e) Marine plywood (or better quality) shuttering will be erected around the reinforced steel cages. All joints will be sealed.
- (f) Concrete with anti-bleeding admixture will be placed from the delivery truck.
- (g) The shuttering will be removed when the concrete has cured sufficiently and working space will be backfilled with soil.
- (h) Pre-stressed concrete bridge beams will be lifted by a mobile crane from the delivery truck to span the Stream/River.

-
- (i) A pre-cast edge beam/parapet beam will be placed at both edges of the bridge. These beams should extrude at least 50mm above the final finished road level.
 - (j) Polysulphide sealant will be used to seal any gaps between the beams.
 - (k) Reinforcing steel and ducting will be fixed.
 - (l) Infill concrete will be placed between the beams by concrete pump and allowed to cure.
 - (m) The concrete finished road will be overlain by a bridge deck water proofing membrane which will be overlain by 100mm of dense bitumen macadam (60mm base course plus 40mm wearing course).
 - (n) An aluminium handrail will be erected along the edge beams.

Bridge construction details are shown in Figure 2.15.

3.3 MACHINERY TO BE USED DURING CONSTRUCTION

The items of construction plant and machinery, which will typically be used during the course of construction, are as follows:

- 8 – 12 No. Hydraulic Excavators
- 4 – 12 No. Dump Trucks
- 1000 tonne Crane (1)
- 100 tonne Crane (1)
- Concrete Pump (Lorry mounted)
- 4 No. 2 tonne Dumpers
- 150 mm Dewatering Pumps
- Site Generators
- 8 – 12 No. Four-Wheel Drive Vehicles
- Cement Mixer
- Miscellaneous Power Tools

3.4 LABOUR

It is anticipated that up to 75 construction jobs will be created during the construction period of this project with a maximum anticipated total number of 45 on site at one time. The number of people employed will be at its highest during turbine foundation construction and turbine erection.

3.5 TEMPORARY SITE FACILITIES

A temporary site compound will be required for the duration of the construction phase. The temporary compound will be constructed by the method described in Section 3.2.2. Upon completion of the project the compound will be decommissioned by backfilling the area with the material arising during excavation, landscaping with topsoil as required. The temporary compound will cover an area of approximately 50m x 30m (1,500m²). Located in the temporary compound will be:

- 7 No. Pre-Fabricated Site Offices/Meeting Room
- 2 No. Prefabricated Changing Rooms/Drying Room
- 2 No. Prefabricated Units for eating packed lunches
- 2 No. Prefabricated Toilet blocks with Male/Female toilets
- 6 No. Lock up steel containers for storage of tools and small components
- 4 First Aid Units

There will be a coalescing media oil water separator installed where the surface water from the temporary compound will drain into the on-site drainage network.

Provision of Potable Water

Potable water will be delivered to site in suitable canisters on a daily basis for drinking, for tea and coffee as well as for use in the temporary site facilities compound.

The Discharges of Wastewater

A sanitation area which is to be located in the temporary compound for use by site workers during the construction phase will consist of temporary port-a-loo units. Additional port-a-loo units will be placed at various locations throughout the site as construction work progresses. These units will be self contained and will be managed and serviced on a weekly basis (or more frequently if required) during the construction phase, and removed from the site on completion of the construction phase.

Telephone

Telecommunications will be provided using mobile phones.

Temporary Power Supplies

Power will be provided using both electrical connection and 1-2 diesel driven generators.

Storage of Hydrocarbons

No diesel will be stored on site. The contractor will be responsible for bringing fuel to site in a bunded fuel bowser to re-fuel the mobile generators that will provide power to the temporary site facilities and also to fuel the excavators and various items of plant on site.

Refuelling

The issue of accidental spillage of hydrocarbons such as diesel and lubrication oil during refuelling of plant machinery is a potential risk during the construction phase.

Fuel will be brought to site in a bunded fuel bowser. Since July 1st 2003, European Regulations came into force, which govern, the design, testing and manufacture of containers for dangerous goods. The carriage of Dangerous Goods by Road Regulations now classifies diesel as a dangerous substance.

If dangerous goods are being transported by road then they must now be conveyed in a container which complies with the ADR. ADR is the European Agreement on the international and national Carriage of Dangerous goods by Road under Directive 95/55/EC. The manufacturer of the bunded fuel bowser must supply with each bowser;

- a copy of the IBC approval certificate,
- a test certificate for the leakproofness test,
- An identification plate attached to the container.

They are suitable for diesel and kerosene and are designed to help companies comply with current and pending EU Environmental Regulation by eliminating accidental spillage. The outer container bund has in excess of 110% capacity of the inner container. For loads in excess of 1000 litre or 220 gallon transported by road, the vehicle driver must have undergone training and hold a special licence.

All the machinery will be refuelled, where possible, within the temporary compound. In all cases, a purpose designed, removable, drip tray will be provided beneath connection points to catch any residual oil during filling and disconnection of the flexible tanker hose. The drip tray will be regularly emptied and disposed of off site by a specialist licensed contractor.

Vehicle refuelling will not occur within 100 m of any watercourse and all machinery will be maintained in good working order, free from leakage of fuel or hydraulic fluid.

Oil booms and oil soakage pads will be maintained on-site to enable a rapid and effective response to any accidental spillage or discharge.

An Outline Pollution Contingency Plan has been prepared for the site. Please refer to **Appendix H** for details of this Pollution Contingency Plan.

Servicing

Where it is necessary to service machinery on-site due to breakdown, this will occur, where possible, within the temporary compound. In all cases, drip trays will be used and no vehicle maintenance will occur within 100 m of any natural watercourse and 20m of drainage channels. All machinery will be maintained in good working order, free from leakage of fuel or hydraulic fluid.

Parking of vehicles overnight or in periods of cessation of operations will be on hardstand areas and never close to open excavations or surface watercourses.

On site discharge of wash water from concrete mixers will be avoided at all times.

Disposal

Oily water condensate and recovered oil from any accidental spillage will be disposed of by recycling and the services of a specialist, licensed, waste oil recycler will be engaged for this task.

Any contaminated surface soils, (in the unlikely event that contamination occurs), will be removed and similarly disposed of by a specialist, licensed contractor. Disposal will be undertaken with prior approval from Offaly County Council.

Mitigation Measures

Construction Phase:

- No fuel will be stored on site. Lubricating oils, greases and hydraulic fluids will be stored in bunded containers 100 m from any natural watercourse and 20m from drainage channels.
- Refuelling of machinery will be carried out as described under the 'Refuelling' section.
- It is recommended by the Best Practice Guide (Enterprise Ireland, BPGCS005), that oil filling areas are located at least 10 m from surface watercourses. For reasons of mitigation by avoidance, a 100 m buffer zone around any natural watercourses and 20m from any drainage channels will be implemented.
- A construction phase Environmental Management Plan will be in operation to audit equipment, materials storage and transfer areas, drainage structures and their attenuation ability on a regular basis. It is proposed that this Plan will be agreed with the Planning Authority.
- Monitoring of streams and drains will be carried out on a regular basis during the construction phase so that construction works are not significantly impacting on-site streams/drains or watercourses down gradient of the site.

- Truck rutting will be kept to a minimum by confining plant and machinery movement to the development footprint area.

Operational Phase:

- All vehicles visiting the site will be refuelled off site during the operational phase.
- Trained personnel will carry out greasing or oiling of turbine components when necessary. Lubricants will not be stored on site and will be handled with care at all times.
- Regular environmental auditing, maintenance and checking of the drainage network and their ability to take run-off and attenuate suspended solid loading, regular cleaning of drainage and stilling ponds, checks of on-site storage of materials, control of vehicle access and mobility will all take place.
- The offices, canteen, drying room, toilets and any temporary storage container will be removed from site at the end of the construction period. The hardcore area will be removed and the area reinstated by adding further layers of peat and topsoil.

3.6 CONSTRUCTION MATERIALS

During the construction of site roads, crane hardstands, turbine foundations and substation building, a worst case scenario estimates that the maximum number of loads to be delivered to site would be approximately **13,989** (total for Civil Works). This includes loads of stone, concrete, reinforcing steel, geo-textiles, electrical cable, switchgear and general building materials. It is proposed to source all imported stone from local quarries.

Due to the underlying ground conditions of the site, there is no possibility that on-site borrow pits will be used to source road making materials. These materials would be delivered to site over a period of 16 months i.e. approximately **876** loads per month or an average of **40** loads per day excluding weekends and bank holidays. All civil construction material would be delivered to site using standard rigid lorries, low-loaders and ready-mix lorries etc.

Turbine parts would be delivered to site over a period of 8 months, after civil works are completed. It is estimated that approximately **304** loads of the various turbine and crane parts would be delivered during this period. The majority of these loads would be classified

abnormal loads, and the relevant approvals and permits will be obtained by the developer or appointed haulage contractor in advance of the delivery period.

Following the completion of all construction works, it is estimated that a maximum of **100** loads will be required to remove all temporary on-site equipment and materials e.g. temporary compound, fencing, cabins, storage containers etc.

Therefore, the total number of delivery vehicle visits to the site during the construction phase is estimated to be **14,393**. It is to be noted that this is a 'worst case scenario', based on the assumption that all stone to be used for construction is to be imported. In practice, there may be some localised areas where surplus excavated material (e.g. gravel) can be used for road construction. Please refer to *Tables 3.1a, 3.1b and 3.1c*, for the detailed delivery loads calculation.

Prior to the delivery to site of the turbine components, the Developer would consult with the Offaly and Westmeath County Council Roads Departments, An Garda Siochana, and the National Roads Authority to discuss the requirement for the provision of a Garda escort and any other requirements the various statutory bodies may have. The Developer would also make known the intended timescale for deliveries, and all efforts would be made to avoid school bus runs, church services, peak traffic times etc. Furthermore, all local residents along the affected route would be notified of the timescale of deliveries.

Material	Quantity	No. of truck deliveries
1. CIVIL WORKS MATERIAL		
Concrete Each turbine foundation will be of approximately 18.3 metre in diameter and 2.15m in depth. The bottom 1m will be cylindrical while the top 1.15 will taper in the form of a truncated cone. There will then be an upstand of 0.5m	16,320 m ³	2,720
Reinforcing Steel Each base will require approximately 110kg of reinforcing steel per m ³ of structural concrete or 52.8 tonnes per base delivered in 20t loads.	1,690 tonne	85

Material	Quantity	No. of truck deliveries
Crane Deliveries to site, including ballast, booms, etc. A crane of 750 to 1,000 tonnes lifting capacity will be required to correctly position the nacelles. The weight of a crane would be 96 tonnes for a 750 tonne lifting capacity crane. Cranes will be delivered to the site in 4 loads. Ballast is also normally employed for craneage. This usually comprises some 4 loads of concrete slabs for the large crane. A second crane will also be required to assist with the removal of tower sections from delivery trailers. This crane would typically be rated at 150 to 200 tonnes.	3 Cranes	9
Transformers, Panels and Cabling 32 turbine transformers are required, one for each turbine. 32 loads using 12 metre trailers each are allowed for the transformers and turbine switchgear. Cabling will be along the internal access tracks, connecting each turbine to the electrical control building. In total this will be a maximum of 33.1 km in length. This includes double lengths required in some areas where two circuits may be laid. Cables can be laid singly with multiple cables in same trench or as a multicore cable. Assume 18.2t/km, the total mass of cables	-	75
Substation Building electrical equipment Delivery of electrical switch gear to be installed within the electrical control building and at the site itself.	-	8
Electrical Control Building and Sub Station Compound - stone, blocks, roofing One electrical control building measuring approx. 215m ² . Building materials will be mainly composed of local building materials for the construction of the small control building. Some 20 loads are apportioned for concrete blocks, roofing, ducting and general materials with 14 loads for concrete foundations for this building. Another 60 loads in total are apportioned to the electrical equipment contained within the control buildings and the sub station compound. A hard stand compound for the sub station with a total area of 2,160 m ² must also be constructed. This will require an approximate total of 1,296m ³ of imported stone and gravel, based on an average road depth of 0.6m. Delivery of this material will require approximately 118 loads of 11m ³ each. Fencing materials will require a further 20 loads to deliver.	-	232

Material	Quantity	No. of truck deliveries
Palisade fencing for temporary compound, temporary facilities including removal etc.	-	25
Construction of Temporary Compound & Car parking Areas A construction compound plus area to accommodate the vehicles of visitors to the site and workers is required. The area of the compounds is 1,500m ² . This area will require approximately 900m ³ of hardcore material. This will require 82 loads at 11m ³ each.	1,500m ³	82
Rock for Site Road Construction For a 5.5m useful width of carriageway, an average width of 6.0m is assumed to include side slopes etc. The construction of 18,275m of new access tracks will cover an area of 109,650 m ² . Some 5,916m of existing access track will be upgraded. These currently range from 2.8m to 4.5m wide. An average width of 3.5m wide is assumed and these will have to be widened to 5.5m wide covering an area of 11,832m ² . The total will be approx. 72,889m ³ of imported stone and gravel, based on an average road depth of 0.6m. Delivery of this material will require approximately 6,626 loads of 11m ³ each	72,889m ³	6,626
Rock for Site Access Splays and Additional Access Track Areas The construction of these items will cover an area of 32,917 m ² . This will require an approximate total of 19,750m ³ of imported stone and gravel, based on an average road depth of 0.6m. Delivery of this material will require approximately 1,795 loads of 11m ³ each.	19,750m ³	1,795
Rock for Crane Hardstand and Associated Splays, Construction and Backfilling of Turbine Bases. Each turbine will have adjacent hard cored areas for craneage each with an area of 1,250m ² . These will cover an area of some 40,000m ² total. At a depth averaging 0.6m, this would be 24,000m ³ of material required for 32 turbines. This development will require 2,182 loads of 11m ³ each.	24,000m ³	2,182
Other Equipment This will include the delivery of geo-textile matting for access tracks and, hardstands, tools, temporary fencing, silt fencing, drainage materials and excavation plant and will constitute no more than 150 loads .		150
SUB -TOTAL (i) - TOTAL TRAFFIC FOR CIVIL WORKS		13,989

Table 3.1a Estimated quantity of construction materials and deliveries to site 'Worst Case scenario'

2. WIND TURBINE COMPONENTS	Quantity	No. of truck deliveries
Steel Towers Each of the 32 steel turbine towers will be transported in five sections (one cast-in section and four above ground). The cast-in sections for two turbines can be transported in one load while all other sections will be in individual loads. Using steel towers, the loads are thus 144 loads of tractor units pulling 12 - 33 metre long trailers.		144
Rotor Blades Each of the rotor blades would be up to 55 m maximum length (54.65m long plus packing) and will be delivered individually on a 50 m trailer. Each rotor blade will weigh approximately 9 tonnes. Delivery of blades will require a total of 96 loads .		96
Turbine nacelles The nacelle components for each turbine would weigh approximately 70 tonnes maximum for transportation. Each nacelle will be delivered in two partial loads and will require a 27-metre trailer with a tractor. Delivery of 32 nacelles will require a total of 64 loads .		64
SUB -TOTAL (ii) - TRAFFIC FOR WIND TURBINE DELIVERIES		304

Table 3.1b Estimated quantity of wind turbine components and deliveries to site 'Worst Case scenario'

3. OTHER LOADS	Quantity	No. of truck deliveries
Removal of 'Other equipment' This material will include removal of temporary fencing, temporary site cabins and storage containers and excavation plant following the completion of construction activities and will constitute no more than 100 loads .		100
SUB -TOTAL (iii) - TRAFFIC FOR REMOVAL OF EQUIPMENT		100

Table 3.1c Estimated other loads and deliveries to site 'Worst Case scenario'

4. OVERALL TOTAL LOADS	Quantity	No. of truck deliveries
OVERALL TOTAL FOR CONSTRUCTION PHASE [Total of Sub-Totals (i) & (ii) & (iii)]	-	14,393

Table 3.1d Estimated total quantity of construction materials and deliveries to site 'Worst Case scenario' for Civil Works and Turbine Installation Phase of Works

During the course of the construction, the following items will be imported, stored and used on site:

- Hydrocarbons fuels for mechanical plant.
- Lubricating oils for mechanical plant.
- Shutter release oils, paints and curing agents.

Please refer to Section 3.5 for mitigation measures relating to refuelling and servicing. An outline Environmental Management Plan has been prepared for the site. Please refer to **Appendix I** for details of the Environmental Management Plan.

3.7 PEAT REMOVAL & RE-USE

The indicative volume of peat removal has been established as being 41,082.8m³. This is based on the average of peat depths recorded at each turbine location by Whiteford Geoservices Ltd. Please refer to Table 3.3 – Indicative Peat Excavation Volumes.

Peat reinstatement will be possible through the following methods:

- Saving the top layer of the peat excavated for landscaping uses over any backfilled areas.
- Placing the excavated peat along roadside berms.

The peat reinstatement areas have been sized to take at least 110% of the indicative volume of peat to be removed. The peat management proposals are discussed further in Section 3.8.

In the unlikely event that excess peat is encountered, which cannot be reused on site, this peat will be disposed of in an environmentally sensitive manner in consultation with Offaly County Council.

Turbine	Deepest peat depth in Turbine Vicinity (m)	Area of Base (m ²)	Area of Hardstand (m ²)	Area of splays (m ²)	Total Volume of Peat Excavated from Base (m ³)	Total Volume of Peat Excavated from Hardstand (m ³)	Total Volume of Peat Excavated from Splays (m ³)	Total Volume of Peat Excavated (m ³)	Method of Hardstand Construction
T1	0.25	255.0	1250.0	745.0	63.8	312.5	186.3	562.5	Excavated
T2	0.05	255.0	1250.0	745.0	12.8	62.5	37.3	112.5	Excavated
T3	0.10	255.0	1250.0	745.0	25.5	125.0	74.5	225.0	Excavated
T4	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T5	0.00	255.0	1250.0	745.0	0.0	0.0	0.0	0.0	Excavated
T6	0.48	255.0	1250.0	745.0	122.4	600.0	357.6	1080.0	Excavated
T7	3.00	255.0	1250.0	745.0	765.0	3750.0	2235.0	6750.0	Excavated
T8	0.52	255.0	1250.0	745.0	132.6	650.0	387.4	1170.0	Excavated
T9	1.50	255.0	1250.0	745.0	382.5	1875.0	1117.5	3375.0	Excavated
T10	0.05	255.0	1250.0	745.0	12.8	62.5	37.3	112.5	Excavated
T11	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T12	0.03	255.0	1250.0	745.0	7.4	36.3	21.6	65.3	Excavated
T13	0.48	255.0	1250.0	745.0	122.4	600.0	357.6	1080.0	Excavated
T14	1.00	255.0	1250.0	745.0	255.0	1250.0	745.0	2250.0	Excavated
T15	1.00	255.0	1250.0	745.0	255.0	1250.0	745.0	2250.0	Excavated
T16	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T17	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T18	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T19	0.21	255.0	1250.0	745.0	53.6	262.5	156.5	472.5	Excavated
T20	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T21	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T22	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T23	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T24	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T25	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T26	0.50	255.0	1250.0	745.0	127.5	625.0	372.5	1125.0	Excavated
T27	0.22	255.0	1250.0	745.0	56.1	275.0	163.9	495.0	Excavated
T28	0.18	255.0	1250.0	745.0	45.9	225.0	134.1	405.0	Excavated
T29	0.14	255.0	1250.0	745.0	35.7	175.0	104.3	315.0	Excavated
T30	1.46	255.0	1250.0	745.0	372.3	1825.0	1087.7	3285.0	Excavated
T31	0.64	255.0	1250.0	745.0	163.2	800.0	476.8	1440.0	Excavated
T32	0.95	255.0	1250.0	745.0	242.3	1187.5	707.8	2137.5	Excavated
Substation	0.0	0.0	1850.0		0.0	0.0		0.0	Excavated
TOTAL					4,656	22,823.8	13,603.0	41,082.8	

Table 3.3 – Indicative Peat excavation volumes

3.8 PEAT STORAGE MANAGEMENT AND RESTORATION

The majority of the site consists of improved grasslands and cutover bog. Existing land uses at the site include peat extraction and agriculture i.e. grazing. Please refer to Chapter 6 for further discussion.

A Detailed Peat Management Plan will be prepared prior to the commencement of construction at the site. The preparation, application and documentation of this Detailed Peat Management Plan should enable all parties – including contractors, designers and competent authorities – to learn from the systematic implementation and assessment of best practice, particularly through the recording of summary information on performance outcomes.

The Detailed Peat Management Plan will also cover the storage and restoration of all peat excavated during the construction phase. Peat with a volume of approximately **41,082.8m³** will be re-used during the construction phase as follows;

- Resurfacing of hardstanding and splay areas.
- Reinstatement of splays, stilling ponds, etc
- Roadside berms and landscaping
- Landowner land reclamation/improvement activities

Peat will not be placed:

- Within 100 m of a natural watercourses.
- Within 20 metres of a major arterial drain or 10m of any minor drain or drains containing dry weather flows greater than 1 litre/second.
- Within areas of gradient greater than 1:20.
- Within gully channels, hags, pool systems, and wet flushes.
- Within areas of deep peat depth and containing little fibrous content and high humification values.
- Within areas designated as sensitive habitat (e.g. areas of intact active bog).

3.9 PEAT EXCAVATION AND REINSTATEMENT METHODOLOGY

The following methodology is proposed for such work:

- Prior to excavation, all grass areas to be cut into turves which are to be carefully stacked and re-used within one week of cutting during the period 1st April to 31st August or within two weeks of cutting during the remainder of the year. Turves not used within these periods shall be regarded as topsoil.
- Peat will be spread in thin layers over a large area. Depths will not exceed the height of the bund wall / bank containing it.
- Bund walls will be constructed using mineral subsoil/peat where no natural peat bank exists to constrain the viscous peat.
- Outfall locations within the storage areas will be diverted or damned, where possible" using plastic lumber or a rock dam and suitable impermeable geotextile. This action will also encourage the phreatic table to rise, encouraging peat formation.
- Acrotelm peat, which has been excavated during the construction phase will be placed on top of the thin layers to encourage rapid re-vegetation and bog regeneration. The acrotelm layer typically extends 0.3 metres into the peat.
- All reinstatement areas will be suitably fenced and signs warning the public will be erected.
- Any bare areas to be grassed shall be covered with topsoil to a minimum depth of 100mm which shall be reduced to a fine tilth, free from stones and debris with any dimensions greater than 35mm. The topsoil shall be graded and lightly compacted to a 100mm thickness or existing thickness-whichever is greater. Any upstanding debris or stones exceeding 25mm dimension shall be removed.
- Prior to seeding or turfing, an approved fertilizer shall be evenly distributed on the topsoil at a rate of not less than 100g per sq. metre.

- Due regard will be paid to the season and weather condition before sowing grass seed. Immediately prior to sowing the grass seed, the topsoil shall be reduced to a fine tilth. Sowing the grass seed shall be carried out by an even distribution, using a blend of (per hectare) 170kg Manhattan Rye Grass and 13kg Dwarf Clover or other similar approved mix. For slopes in excess of ten degrees, these quantities shall be increased by 50%. The seed shall be covered by lightly raking into the surface of the topsoil.
- All work will be carried out in an environmentally sensitive manner in consultation with the Local Authority and the National Parks and Wildlife Service.
- A waste license will be obtained from the Local Authority / Environmental Protection Agency prior to any disposal of peat as per the Waste Management Regulations 2006 and the Waste management Act 1996 to 2008.

The proposed method of disposal will not create a significant environmental impact. The proposed measures and methodology will help in the reinstatement of worked out areas of peat and aid in the attenuation of run off at these locations. If managed responsibly, it will help in the regeneration and landscaping of the bog and result in no threat to existing drains, streams or their aquatic habitats.

3.10 AVOIDANCE OF RAISED BOG DISTURBANCE

The proposed Yellow River Wind Farm turbine layout was designed in such a way as to have minimal impacts on raised bog and according to the recommendations specified by the ecologist for the site. Ecological feed back has been incorporated in to the wind farm design and has helped in the identification of suitable ground, minimising crossings of watercourses and avoiding wet and deep peat areas.

The final footprint has been designed to avoid the following:

- Areas of deep peat
- Areas of excessive gradient

- Natural and man-made drainage channels within the peat

The following mitigation by avoidance measures are proposed:

- Flow will be maintained in all existing drains
- Peat excavation will be avoided (where possible)

In order to minimise the disturbance of raised bog the following design features have been incorporated into the internal site layout:

- Existing site drainage should be maintained.
- Construction works will be confined to the minimum area possible.
- Minimum removal of vegetation will take place so as to reduce the area of bare peat. When the foundations for turbines are being excavated, the surface vegetation will be removed in sods which can be stored (vegetation side up) and later replaced around the foundation platform. This will allow a more rapid re-vegetation of bare peat and this will help reduce potential soil erosion.
- Once stripped, acrotelm peat will be carefully stored in suitable areas and kept moist.

3.11 SITE MANAGEMENT AND HABITAT ENHANCEMENT

In order to maintain the site for biodiversity, disturbance will be kept to a minimum and the site restored following the construction period. The following measures are proposed:

- In laying out the road network, the proposed route of new roads will be pegged out ahead of construction preparations. This will also define the construction corridor that will be offset to a maximum of 15m either side of the centre line of the road. The construction corridor will be marked out and once defined construction vehicles or personnel will not be allowed outside the corridor.

- Access onto areas outside of the proposed hardstand area will be confined to temporary roadways. Within any area of peat along the proposed access road network, access during stripping of the vegetation will be undertaken on temporary roadway.
- Reinstatement of vegetation on exposed soils will also be undertaken immediately following completion of construction (or in tandem where feasible) using a combination of techniques, turving, artificial planting and reseedling.
- Sediment traps and stilling ponds will be put in place to prevent the potential siltation of downstream watercourses.

3.12 COMMISSIONING

All individual parts of the wind turbine and the associated electrical infrastructure within the site control building will have passed stringent factory tests prior to delivery. Once the turbines have been fully assembled on site and the construction and installation completed, the wind farm and the wind turbines will go through a thorough period of commissioning and operational tests prior to being handed over from the construction team.

A typical turbine commissioning would take 2 – 4 days per turbine, a maximum of approximately 128 days in total. Another week will be required for system testing including grid connection testing. Thus, the total time period for commissioning will be approximately six months. Some fine-tuning will be necessary during the first three months of the operational period. Various site finishing works will be carried out concurrent with the commissioning phase.

3.13 OPERATIONAL PHASE

A service contract will be entered into with the turbine manufacturer to facilitate the proper operation and maintenance of the turbines. While routine operation and monitoring will be carried out remotely via the SCADA System, the following visits to site are envisaged: -

Scheduled

- Six-month service, three week visit by four technicians
- Annual service, six week visit by four technicians
- Weekly visit by Developer or agents to check over the site, notices etc.

Unscheduled

- Visits which may arise as a result of malfunction, damage by lightning or vandalism.

During the six-month and annual service visits, some waste lubricating and cooling oils will arise. These will be recorded, drained into designated storage containers, brought off site and delivered to a suitable independent commercial facility for treatment/re-use/disposal in accordance with The European Communities (Waste Oils) Regulations, 1992 (S.I. No. 399 of 1992).

As part of the annual service visits, the condition of paintwork will be inspected and documented. It is anticipated that a major touch up and repainting will be necessary to the towers after 10 – 15 years. This will be carried out using access from mobile cranes.

3.14 DECOMMISSIONING

At the end of the useful life of the turbines, both a commercial and an environmental appraisal of the site will be carried out. The commercial appraisal will assess whether or not the turbines should be replaced in their entirety by new turbines or if the site should be terminated in relation to electricity generation.

If the site is to be decommissioned, then the environmental appraisal will provide the background as to the extent of the facilities to be removed. It is anticipated that in any decommissioning, the turbines and towers will be removed from site. However, it is not envisaged that turbine bases, cables, crane hardstandings and access roads be dug up. However, the upstand section from each turbine base will be removed. Consideration would be given to providing a topsoil/peat covering to these items in any decommissioning phase. Consideration could also be given to any potential uses

for the control building. Consultation will be made with Offaly County Council at this stage.

Any materials (e.g. turbine components) removed from site can be disposed of in an environmentally friendly manner, for example:

- The steel turbine towers can be re-cycled and used again for manufacturing.
- Generator components can be broken down and sent for re-use/re-cycling where appropriate.

On decommissioning the cables will be cut away below ground level and sealed.

4.0 HUMAN BEINGS

4.1 INTRODUCTION

This chapter examines the potential impacts that the proposed Yellow River Wind Farm may have on Human Beings, during the construction phase and during the operational phase. Where a negative impact can be foreseen it is reduced or removed by way of practical mitigation measures.

The effect of a development on Human Beings is also known as the Socio-Economic Impact and as such includes the following broad areas of investigation: -

- Population
- Employment
- Settlement Patterns
- Health and Safety
- Land Use
- Tourism

Other effects of the development on Human beings include: air quality; noise; shadow flicker; visibility and traffic. These effects are discussed in detail in the following respective Chapters 8; 9; 10; 11 and 12

4.2 EXISTING ENVIRONMENT

4.2.1 Population

Ireland has seen a rapid population growth in recent years with improved standard of living and infrastructure growth. The country has seen a population surge since 1951 from 2,960,593 to 4,588,252 (55 % increase) as per the national census 2011⁸.

County Population

The population of County Offaly represented approximately 1.7 % of the Irish population at the time of the 2011 Census at 76,687. This figure is a substantial increase of 8.2% on the 2006 figure of 70,868. The population was at its lowest in

⁸ <http://cso.ie/en/census/>

1936 when a population of 51,308 was recorded. The population trend from 1926 to 2011 in County Offaly is displayed on **Figure 4.1**.

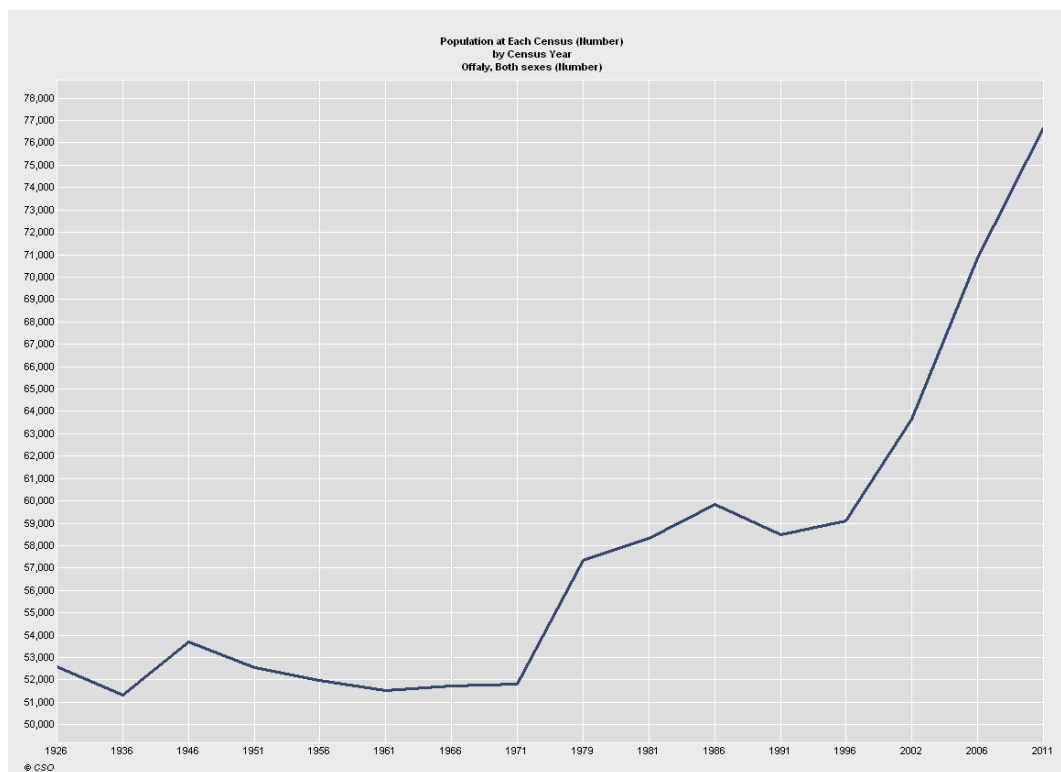


Figure 4.1 Population Trend in County Offaly 1926 – 2011 (CSO, 2011)

The population of County Meath represented approximately 4 % of the Irish population at the time of the 2011 Census at 184,135. This figure is a substantial increase of 13.1 % on the 2006 figure of 162,831. The population was at its lowest, since 1926, in 1936 at 61,405 but a reasonably steady increase can be observed thereafter. The population trend from 1926 to 2011 in County Meath is displayed on **Figure 4.2**.

The population of County Westmeath represented approximately 1.9 % of the Irish population at the time of the 2011 Census at 86,164. This figure is a substantial increase of 8.6% on the 2006 figure of 79,346. The population was at its lowest in 1961 at 52,861, however, a significant increase can be observed thereafter. The population trend from 1926 to 2011 in County Westmeath is displayed on **Figure 4.3**.

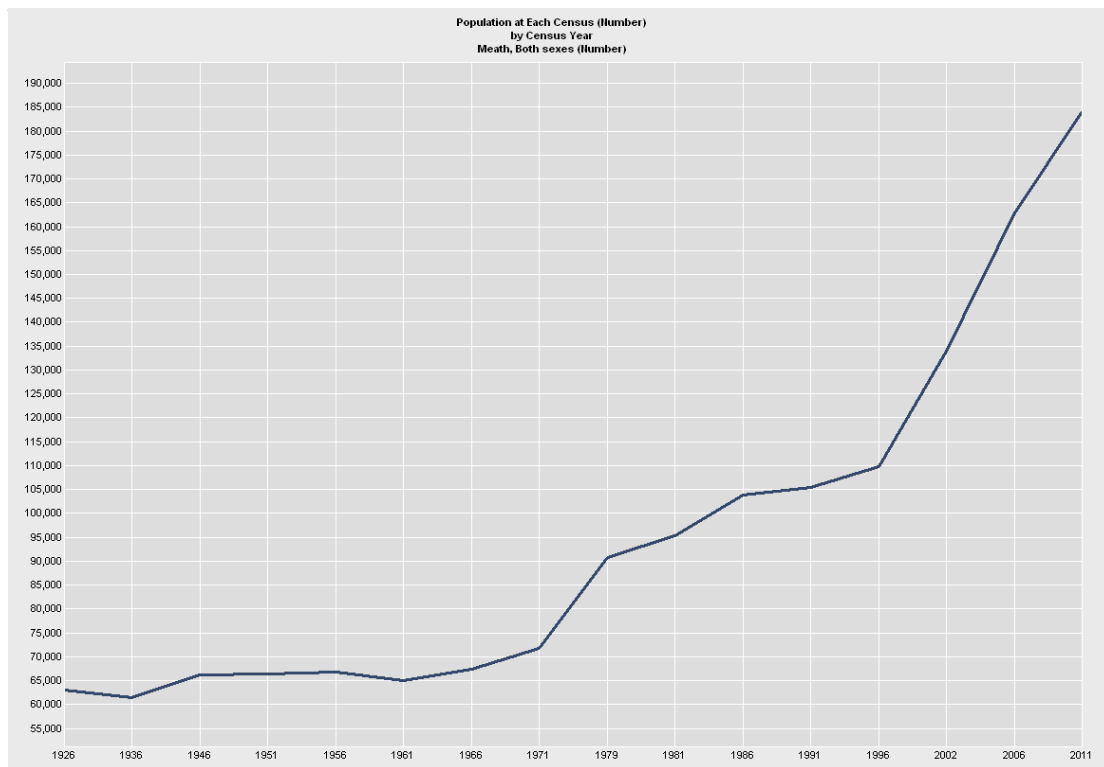


Figure 4.2 Population Trend in County Meath 1926 – 2011 (CSO, 2011)

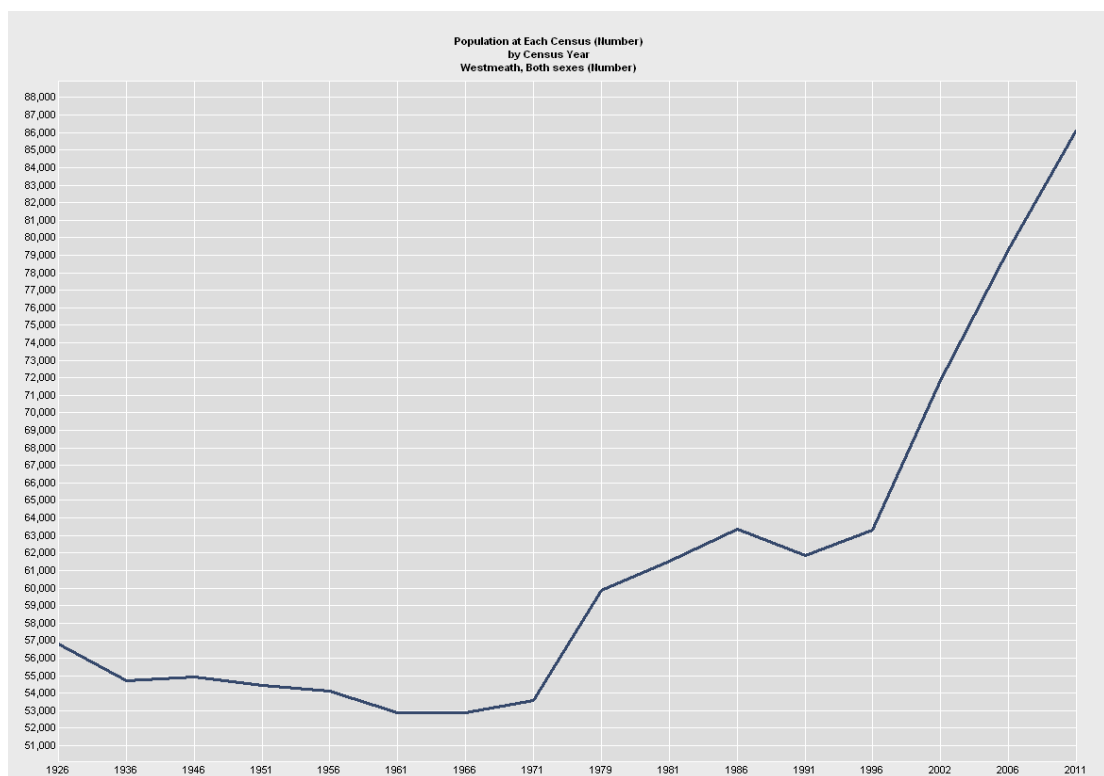


Figure 4.3 Population Trend in County Westmeath 1926 – 2011 (CSO, 2011)

4.2.2 *Regional Population*

Rhode is the closest population centre to the proposed Yellow River Wind Farm. The nearest turbine in the proposed Yellow River Wind Farm is located just north of the village of Rhode. The population of Rhode was 768 at the time of the 2011 census (CSO, 2011).

Edenderry is the closest legal town to the proposed development. The town grew in population size by approximately 10% to 6,490 (CSO, 2011) since the 2006 Census. Edenderry is located approximately 8.5km East of the proposed Yellow River Wind Farm.

Rochfortbridge is located approximately 4km North of the closest turbine. During the 2006- 2011 period, the population of Rochfortbridge experienced a small overall population increase from 1,473 to 1,494 individuals.

4.2.3 *Employment*

Employment figures for County Offaly categorised by industry were compiled by the Central Statistics Office (CSO) as part of the 2011 census. The total number of people employed in each industry is given in **Table 4.1**;

Persons at work by industry and sex		
Industry	Males	Females
Agriculture, forestry and fishing	1,991	276
Building and construction	1,438	103
Manufacturing industries	3,480	1,113
Commerce and trade	2,898	3,016
Transport and communications	1,014	311
Public administration	1,029	1,024
Professional services	1,414	4,464
Other	1,852	2,113
Total	15,116	12,420

Table 4.1 - Persons at Work by Industry in County Offaly (CSO, 2011)

Overall Professional Services and Commerce and Trade are responsible for most employment in Co. Offaly, with approximately 43% of the working population being employed in these sectors. Larger towns such as Tullamore, Birr and Edenderry host most of these professional services jobs. In the period between 2006 – 2011 census the total number of people receiving income from these occupations rose by 6.1%. This rise can be attributed to the creation of more jobs in this sector as well as a

general rise in unemployment throughout the county as a result of the economic recession. The largest drop in employment in one particular industry, between the 2006- 2011 period, was in Building and Construction where employment fell from 14.2% to 5.6%.

The total number of people employed in each industry in County Meath is given in **Table 4.2;**

Persons at work by industry and sex		
Industry	Males	Females
Agriculture, forestry and fishing	3,169	524
Building and construction	4,245	425
Manufacturing industries	6,449	2,333
Commerce and trade	9,655	9,689
Transport and communications	5,134	1,824
Public administration	2,623	2,365
Professional services	4,050	11,937
Other	4,777	5,143
Total	40,102	34,240

Table 4.2 - Persons at Work by Industry in County Meath (CSO, 2011)

Approximately 26% of the working population of county Meath are employed in the Commerce and Trade sector and this sector is the largest employment sector in the county. Although the numbers employed in Commerce and Trade have fallen, the percentage of the workforce working in this sector has remained static at 26%, over the 2006-2011 period. This can be put down to a smaller overall workforce as a result of the recession. Professional Services is another large employment sector in Meath. The percentage of the workforce working in this sector has risen from 14.5% to 21.5% over the 2006-2011 period.

The total number of people employed in each industry in County Westmeath is given in **Table 4.3;**

Persons at work by industry and sex		
Industry	Males	Females
Agriculture, forestry and fishing	1,651	203
Building and construction	1,576	120
Manufacturing industries	3,149	1,155
Commerce and trade	3,585	3,823
Transport and communications	1,610	457
Public administration	1,424	1,055
Professional services	1,851	5,722
Other	2,435	2,503
Total	17,281	15,038

Table 4.3 - Persons at Work by Industry in County Westmeath (CSO, 2011)

Professional Services make up approximately 23.4% of the working population and is the largest provider of employment in Westmeath. In the period between 2006 – 2011 census the total number of people receiving income from these occupations rose by approximately 6.4%. Overall this industry is responsible for most employment in Co. Westmeath. Commerce and Trade also accounts for approximately 23% of the Westmeath workforce. This figure has remained relatively static at 23% since 2006; however there has been a decrease in the actual numbers of people working in the industry.

4.2.4 Unemployment

Information on Live Register figures for Offaly, are available from the CSO⁹. These figures are presented in **Figure 4.4**. Unemployment remained relatively steady between 2002 and 2007. However, a significant increase in the numbers of people drawing social welfare payments is evident in the period from 2007 to present. Recent figures show a worrying trend of increasing unemployment in the Offaly region. At the time of the 2011 census approximately 14.2% of Offaly people over 15 years old were unemployed or looking for their first regular job. In February 2013, the Central Statistics Office (CSO) published figures, which showed a total of 9,270 people signing on in County Offaly an increase of 6,432 people since February 2006. This dramatic increase is as a result of the current economic downturn. The figure has reduced from its peak of 9,870 in July 2011.

⁹ <http://www.statcentral.ie/viewStat.asp?id=164>

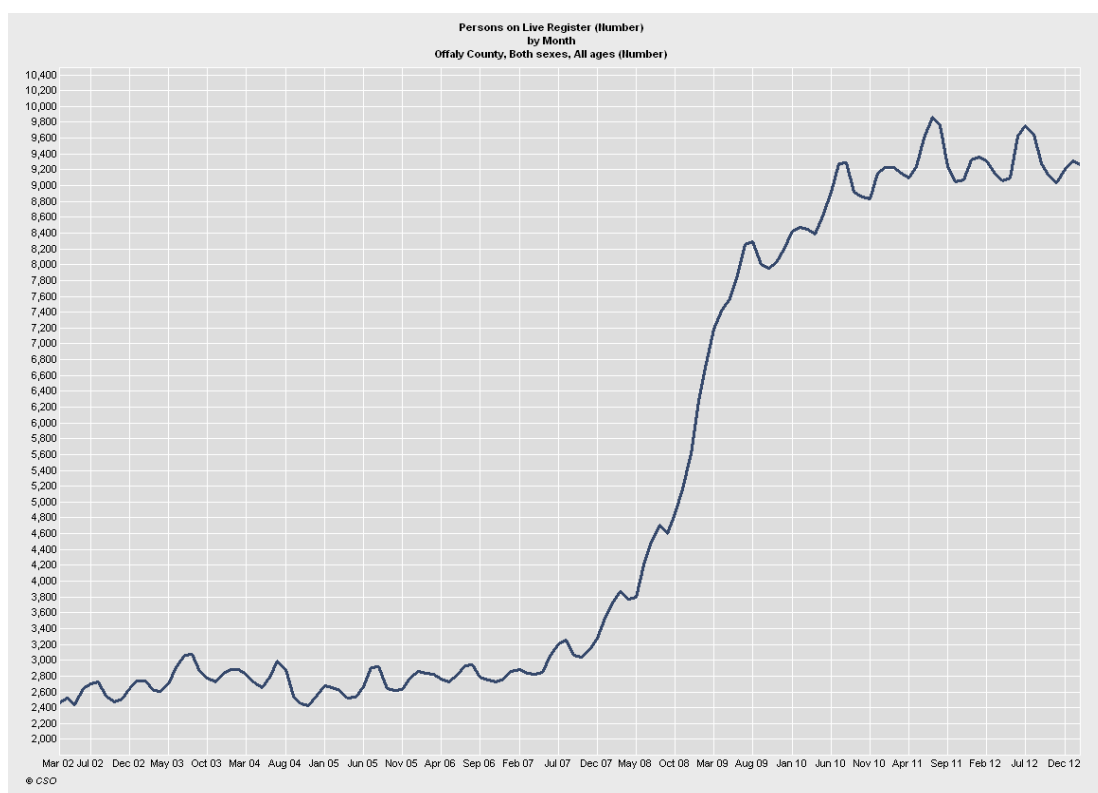


Figure 4.4 - Live Register trend in the Co. Offaly 2002 – 2012 (CSO, 2012)

Live register figures for County Meath are presented in **Figure 4.5**. The number of people qualifying for live register payments in Meath remained relatively steady until the end of 2007 and it was at this point that figures began to rise dramatically. At the time of the 2011 census, approximately 11.8% of Meath people over 15 years old were unemployed or looking for their first regular job. Live register figures peaked in July 2011 when there was 12,350 people receiving social welfare payments. Since then there has been a small decrease in live register figures. In February 2013, the live register figure was 10,830.

Live register figures for Westmeath are presented in **Figure 4.6**. Similarly to Meath, live register figures remained relatively steady until the end of 2007. After this there was a significant increase in people receiving live register payments. At the time of the 2011 census approximately 12.9% of Westmeath people over 15 years old were unemployed or looking for their first regular job. In February 2013 the CSO published statistics, which indicated that there were 10,302 signing on during this period. This figure is smaller than the peak figure of 11,043 in July 2007; however it is 7,415 more than the figure for the same period in 2006.

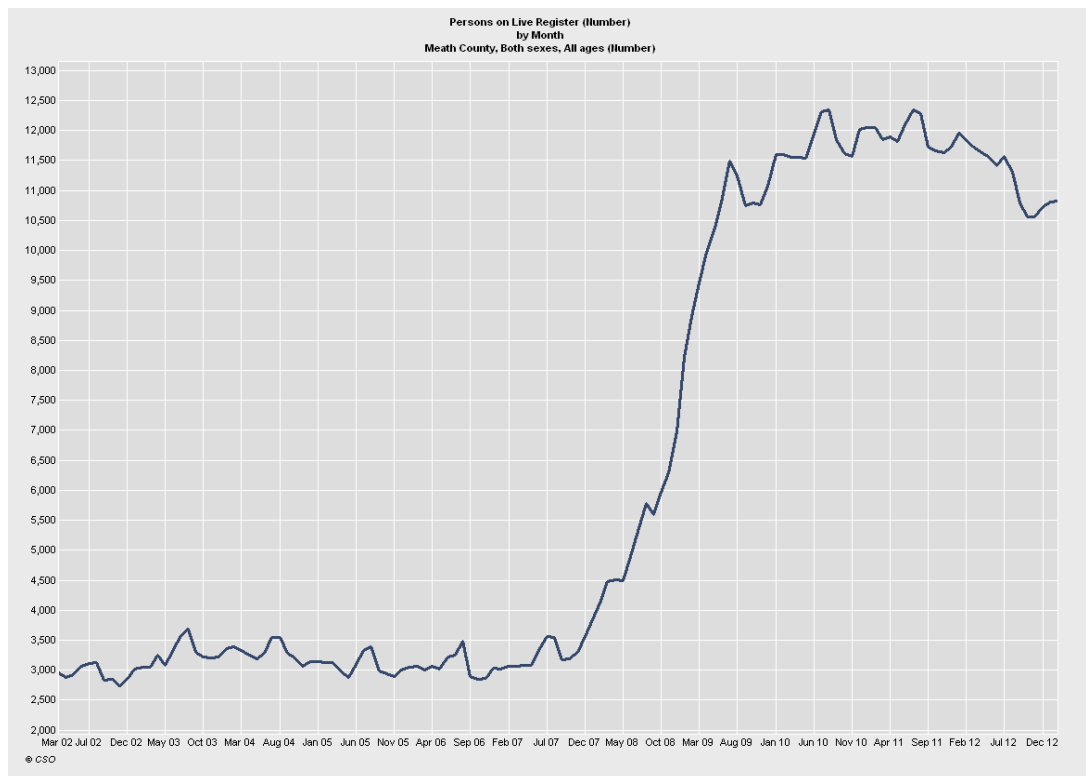


Figure 4.5 - Live Register trend in the Co. Meath 2002 – 2012 (CSO, 2012)

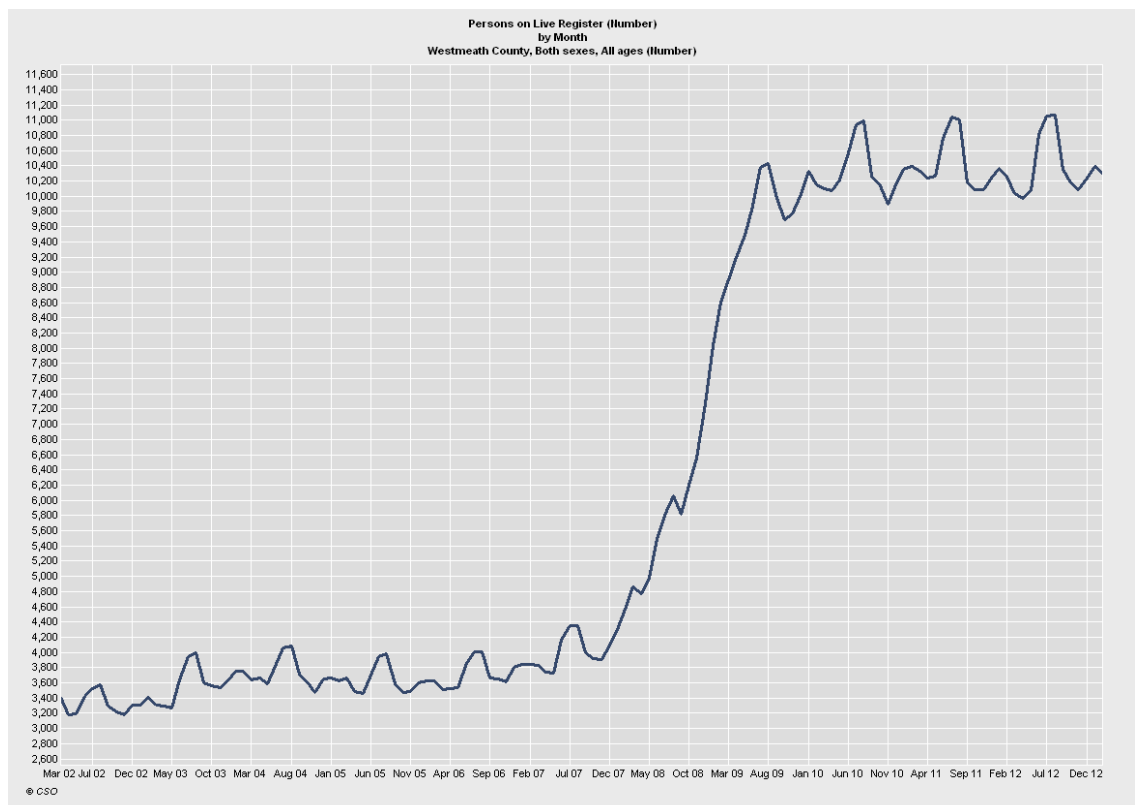


Figure 4.6 - Live Register trend in the Co. Westmeath 2002 – 2012 (CSO, 2012)

4.2.5 *Settlement Patterns*

Offaly has a mainly rural population, with only approximately 29% of the population living in “Legal Towns” within the county; i.e. Tullamore, Edenderry and Birr. Offaly also has a small urban base with Tullamore, the largest town, having a population of just 11,346. These factors make Offaly vulnerable to population decline, as major industries are reluctant to move to such areas.

The overall shift in population within the county is towards Tullamore. Tullamore town and Tullamore rural area account for nearly 49% of the population of Offaly. This significant population growth in the Tullamore region is due largely to the improved infrastructure and services in these areas.

	Persons 2006	Persons 2011	Percentage change 2006-2011
Birr Town	4,091	4,428	8.2
Tullamore Town	10,900	11,346	4.1
Birr rural area	15,975	16,560	3.7
Edenderry rural area	11,952	13,481	12.8
Roscrea rural area	4,673	4,837	3.5
Tullamore rural area	23,277	26,035	11.8
Offaly County	70,868	76,687	8.2

Table 4.4 Population of Towns and Rural Areas in Co. Offaly, 2006 and 2011 (CSO, 2011)

County Meath also has a mainly rural population. Navan is the largest town in the county with a population of 28,153 at the time of the 2011 census. Navan town and rural area accounted for approximately 24% of the population of Meath at the time of the 2011 census.

	Persons 2006	Persons 2011	Percentage change 2006-2011
Kells town	2,257	2,208	-2.2
Navan town	3,710	28,153	658.8
Trim town	1,375	1,441	4.8
Ardee rural area	3,017	3,105	2.9
Dunshaughlin rural area	41,909	48,351	15.4
Kells rural area	13,950	15,325	9.9
Meath rural area	27,939	32,720	17.1
Navan rural area	36,348	15,886	-56.3
Oldcastle rural area	4,279	4,633	8.3
Trim rural area	28,047	32,313	15.2
Meath County	162,831	184,135	13.1

Table 4.5 Population of Towns and Rural Areas in Co. Meath, 2006 and 2011 (CSO, 2011)

Westmeath has seen an overall 8.6% increase in population since the 2006 census. Athlone is the largest town with a population of 15,552 recorded at the time of the 2011 census. The majority of the Westmeath population live near the population centres of Athlone and Mullingar with approximately 85% of the population living within the Athlone town/ rural area and Mullingar rural area.

	Persons 2006	Persons 2011	Percentage change 2006-2011
Athlone town	14,347	15,552	8.4
Athlone rural area	10,152	11,162	9.9
Ballymore rural area	2,169	2,486	14.6
Coole rural area	1,901	1,897	-0.2
Delvin rural area	7,526	8,362	11.1
Mullingar rural area	43,251	46,705	8.0
Westmeath County	79,346	86,164	8.6

Table 4.6 Population of Towns and Rural Areas in Co. Westmeath, 2006 and 2011 (CSO, 2011)

4.2.6 Health and Safety

It is not possible to quantify the health and safety of the population of County Offaly or of the locality. Any development project, in its construction phase in particular, has the potential to affect health and safety of workers and the public. However, the construction practices and EIS processes outlined in this document will ensure that

impacts will be mitigated or eliminated. During its operational phase, the development will contribute to a reduced usage of fossil fuels and the resultant positive affect on climatic conditions will ultimately benefit human beings in the locality, the region and the country.

4.2.7 Land Use

The site is rural in nature with local people primarily engaged in agriculture. Land in the area is currently being used extensively for agricultural activity in grassland areas and there are also small areas of peat production. Two large quarries are in active production, one within the site boundary and the other immediately adjacent to the site boundary. There are also areas of forestry at a number of locations around the site.

The proposed thirty-two turbines and associated works will take up approximately 3% of the total area in control of the applicant.

4.2.8 Tourism

According to Failte Ireland Statistics, 760,000 overseas tourists visited the East and Midlands Region in 2011, with an overall of 2,128,000 tourists visiting the region (including Northern Ireland & domestic trips).¹⁰

County Offaly is a popular destination for foreign and Irish tourists alike. It is well known for its extensive boglands and unspoilt scenery. Tourism is an important component of Offaly's income sector. In 2011, a total of 49,000 overseas tourists visited Offaly; this generated approximately 17 million euro for the region, thus giving an average spend of €347¹¹. Offaly offers unspoilt scenery and a variety of outdoor activities. There are various amenities in the surrounding area, which would be of interest to tourists. It is famously home to a number of popular tourist destinations such as Clonmacnoise Monastic Settlement, Charleville Castle, Birr Castle and Lough Boora Parklands, which is set within the backdrop of the Sliabh Bloom Mountains. None of these tourist destinations will be impacted by the proposed development.

¹⁰

http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/3_General_SurveysReports/Tourism_Facts_2011_V3.pdf?ext=.pdf

¹¹

http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/2_Regional_SurveysReports/COUNTY_Numbers_Revenue_11P.pdf?ext=.pdf

Meath also attracts large numbers of tourists from Ireland and overseas. In 2011 an estimated 132,000 overseas tourists visited Meath, generating approximately 51 million euro for the county (an average spend of €386)⁴. Meath is known for the large number of historically important sites that located within the county. One of the most significant and most popular sites in the country is Newgrange, which is a passage tomb that was constructed over 5,000 years ago. It is part of a complex of monuments built along a bend of the River Boyne, known collectively as Bru na Boinne. Other popular tourist destinations in Meath include the Hill of Tara, Trim Castle, Slane Castle, Kells Monastic site and Loughcrew Megalithic Cairns. Two photomontages were taken from County Meath, one from the Hill of Tara, the other from Sliabh na Caillaghe (please refer to Chapter 11, Section 11.4.3 and the Visuals Booklet). The significance of the visual impact from both locations is deemed imperceptible. The proposed development will have no negative impact on tourism in County Meath.

County Westmeath attracted approximately 95,000 overseas visitors in 2011. This resulted in an additional 37 million euro being generated in the county, thus giving an average spend of €389⁴. Tourism is integral to the Westmeath economy and the county is known for its unspoilt countryside, which is dotted with sparkling lakes and rolling hills. As well as this there are a number of visitor sites and family friendly recreational areas within the county. Some of these include Belvedere House and Gardens, Fore Abbey and Locke's Distillery Museum. The proposed development will not impact on any of the sites above and will have no negative impact on tourism in general.

4.3 POTENTIAL IMPACT OF DEVELOPMENT

4.3.1 Population

This project will positively impact on the population in a number of ways. Employees who are not based in the region will temporarily relocate for the duration of the construction period. The project will improve the standard of living in the region by virtue of providing a sustainable power supply platform on which to develop industrial sectors. The quality of life will be improved in the hinterland of the project by means of financial inputs to the local economy; including employment opportunities, Local Authority Rates, Land Rents, increased demand for local support services (i.e. construction, operation & maintenance, legal & accounting), social contribution and increased local spending. This will result in the financial equivalent of 25 – 30 industrial jobs for the duration of the project, i.e. 30 years.

Green Wind Energy proposes to establish a Community Fund once the Yellow River Wind Farm is operational. The objective of the Community Fund will be to provide long-term financial support to local community groups, activities and projects.

4.3.2 *Employment*

The hinterland in which the proposed wind farm is to be located is rural in nature, however, this area has a strong industrial heritage of energy production since the 1950's. The strongest employment sectors in the area currently are agriculture, manufacturing industries, professional services and commerce/trade. With rising unemployment figures throughout the area, the investment in this wind farm project has the potential to generate a range of economic benefits for the hinterland, most notably employment opportunities, Local Authority Rates, Land Rents, increased demand for local support services (i.e. construction, operation & maintenance, legal & accounting), social contribution and increased local spending.

Opportunities for local contractors include construction works, the supply and delivery of construction materials, haulage/crane hire and mechanical/ electrical services. Specialist contract workers drafted in will reside in local accommodation during the construction period which will result in a temporary, positive benefit to the local economy by providing increased revenue for local accommodation providers and other local services.

The proactive and strategic development of wind energy has a clear role to play in Ireland's road to economic recovery and in stimulating employment growth. Approximately 75 temporary jobs are projected to be created during the construction phase of the project, providing employment at local level as well as at national and international level. Following construction, it is anticipated that four full time jobs will be created for the operation and maintenance phase of the wind farm over the lifetime of the project. This investment represents a long-term, positive commitment to the area and will be a major contribution to the local economy.

Employment will also be created and maintained on a regional, national and international level. A report entitled *Jobs and Investment in Irish Wind Energy* was commissioned by the IWEA and prepared by Deloitte in 2009¹². This report states at

12

http://www.iwea.com/contentFiles/Documents%20for%20Download/Publications/IWEA%20Policy%20Documents/2009_06_Deloitte_IWEA_Employment_in_Wind_Energy_Report.pdf?uid=1245768156894

least 25 per cent of capital investment in renewable energy is retained in the regional economy. The investment in this project has the potential to generate economic opportunities for businesses in the region, most notably employment opportunities and local spending. This report also estimates that each MW of wind energy installed results in 1.5 long term jobs in support and associated industries in Ireland, assuming that there is steady growth in the wind energy industry to 2020. Therefore, the investment of Yellow River wind farm, with an installed capacity of approximately 96MW, would result in the creation of 144 jobs.

The employment provided by this development in the construction and operational phases is likely therefore to be in the order of 75 to 150 jobs and is also likely to have a significant positive impact on the locality and a slight positive impact on the region. The developer is anxious that there would be the maximum use of local trades people / plant operatives during the construction phase of the project.

As an example of the economic impact of a recently constructed wind farm, the 28 MW wind farm at Slieve Kirk in Derry involved some 120,000 working hours in construction, equivalent to the creation of 42.6 full-time local construction jobs. At its construction peak, more than 150 people were employed on site, drawn from over 20 locally based suppliers in the engineering, construction and services sectors. As the power capacity of the proposed wind farm at Yellow River is a multiple of that at Slieve Kirk, it can be assumed that its local economic impact will be significantly higher.

4.3.3 Settlement Patterns

As this development contains no housing element, the predicted effect on the immediate settlement patterns is slight to non-existent. There is however the possible benefit which would accrue to the region in terms of the ability to provide electricity to industry and business in a high quality supply. This will lead to the region becoming more attractive to business and industry with the subsequent benefit of increased employment opportunities in the region. Offaly County Council will also benefit from business rates paid to them, which will contribute to the general upkeep of the region and fund local services.

While this is not likely to result in a marked increase in settlement in the area, it will, to a degree, reduce the population drain towards large urban areas such as Dublin.

This is dependent on national and global economic conditions as well as the types of industry, which may locate in the region.

Although there has been concern that wind farms can affect the value of neighbouring property, there is currently no statistical evidence of a drop in property prices nor do they support the case that proximity to wind farms results in a decline in property values (IWEA). A 2009 study commissioned by the US Office of Energy Efficiency and Renewable Energy¹³, and prepared by the Ernest Orlando Lawrence Berkeley National Laboratory, found no evidence of negative impact on property values in the communities near wind farms. The study recorded the sale price of 7,500 homes in nine states and then devised mathematical models to reveal how, all other things being equal, proximity to a wind farm affected their value. It found that homes less than 1.5 kilometres from a wind farm sold for no less, on average, than homes 8 kilometres away. Similarly, home values tended to remain stable long after wind farms sprung up.

4.3.4 Health and Safety

The development will contribute to a net national reduction in the emissions of greenhouse and other gases resulting from the combustion of fossil fuels. The approximate emissions savings that can be achieved each year through the use of a wind farm equivalent in size to the proposed 96 MW Yellow River Wind Farm, instead of the equivalent output from the current mix of generating fuel in Ireland are as follows:

- 144,000 tonnes of Carbon Dioxide (CO₂)
- 2,613 tonnes of Sulphur Dioxide (SO₂)
- 288 tonnes of Nitrous Oxide (NO_x)
- 2,180 tonnes of ash

The global warming potential of 1 tonne of NO_x is equivalent to 310 tonnes of CO₂. As such this proposed wind farm will achieve the removal of approximately 234,806 tonnes of CO₂ equivalent¹⁴. The relative reductions in greenhouse gas emissions in the energy sector will serve to reduce the effects of climate change on a national and global level, albeit at a small scale.

¹³ <http://eetd.lbl.gov/ea/ems/reports/lbnl-2829e.pdf>

¹⁴ http://www.sei.ie/Renewables/Wind_Energy/Wind_Farms_and_the_Environment

Physical health and safety concerns are twofold: -

- Construction workers and members of the public during construction
- Members of the public and employees of the developer during operation

There is the risk on all construction sites of accidents resulting in serious injury and death. Members of the public and employees of the contractors and developer on site may be exposed to potentially dangerous situations. With the establishment of a Health and Safety Plan for the construction phase, potential accidents can be avoided and mitigated against. Off site, construction related traffic might also pose a danger to the public on narrow roads in poor weather conditions. The adherence to the rules of the road and general good driving practice will reduce the severity of this impact. In general there are no specific safety considerations in relation to the operation of wind turbines. The area surrounding the turbine bases will still be available for use as normal.

4.3.5 Land Use

In terms of site area covered by the development, some 3% of the land will be available for a variety of uses during the operational phase. This future land use could include those practices currently being undertaken such as agriculture and peat harvesting.

The relevant landowners will benefit from an annual payment over the life of the project. This rental income will have a local benefit in sustaining local communities as it is reinvested in farm activity. In addition, the guaranteed income provided by this rental income can be used to support applications for loans from the bank, which can also be reinvested into the land. This will be a welcome addition to local family farm income which can vary from year to year and which is very much influenced by a number of factors. For instance, according to Teagasc, farm income for 2012 is estimated to be some 12 per cent lower than the 2011 level (27 per cent lower in the case of dairy farmers) brought about by the poor weather during the year and increased input costs¹⁵.

¹⁵ <http://www.teagasc.ie/news/2012/201212-10.asp>

4.3.6 *Tourism*

The proposed wind farm is not expected to impact significantly on tourism or landscape in the area. There are no major tourist attractions within the village of Rhode itself or the surrounding area. The Yellow River Wind Farm has the potential to boost tourism, all year round, by attracting visitors who are interested in seeing a wind farm in operation. The proposed wind farm development will provide an opportunity to attract visitors to the locality offering the opportunity to view a wind farm up close. This can benefit the local region itself through visitor spend on food, accommodation and gifts. The operation of the wind farm also represents an educational opportunity for schools, local community groups and the public. It would assist in raising awareness of wind energy generation, energy conservation issues and generational sustainability.

The surrounding countryside does not have any particular scenic quality and has been identified as a Low Sensitivity Landscape and an Area Suitable for Wind Energy Development according to the County Offaly Wind Strategy 2009-2015.

There are no designated scenic routes or protected views in the immediate vicinity of the wind farm. The closest designated view [V21] is approximately 4.5km North of the closest turbine within the proposed wind farm. View 21 [View to the South over Co. Offaly from Garrane Hill on the Regional Route R-446 between Tyrrellspass and Rochfortbridge.] is designated as a *View to be Preserved or Improved* by Westmeath County Development Plan 2008- 2014. Some turbines may be visible on a reduced scale at this location. A walking route known as the Grand Canal Way runs East/ West approximately 3.5km South of the proposed site. The proposed wind farm will be visible along sections of this route. This trail has not been marked as scenic according to Offaly County Development Plan.

Please refer to **Chapter 11** for further discussion on the visual impacts of the development.

The impact of the development on tourism in the area is related to public perception on wind energy development. A number of studies have been carried out which provide insight into the views and attitudes of the general public on wind energy development.

Failte Ireland and the Northern Ireland Tourist Board commissioned a study on *Visitor Attitudes on the Environment – Wind Farms*¹⁶. The survey was undertaken by Lansdowne Market Research and involved face-to-face interviews with 1,300 tourists, both domestic (25%) and overseas (75%) (1,000 in the Republic, 300 in Northern Ireland). Almost half the tourists interviewed in this survey had seen at least one wind farm during their holiday with most feeling that their presence did not negatively affect the quality of sightseeing. The largest proportion of those interviewed (45%) said that the presence of wind farms had a positive impact on sightseeing with only 15% saying they had a negative effect. According to this research, the landscape onto which a wind farm is to be sited can also have a significant impact on attitudes. Results showed a greater sensitivity to wind farms sited in perceived more beautiful landscapes, such as coastal landscapes. The Yellow River wind farm site is located on farmland/ bogland landscape, which is among the lesser valued landscapes and has been identified as a *Low Sensitivity Landscape* by Offaly County Development Plan 2009-2015. Approximately 27% of people expressed negativity about potential wind farms on farmland and 18% expressed negativity on wind farms on bogland.

Sustainable Energy Ireland produced a report in 2003, called “*Attitudes towards The development of Wind Farms in Ireland*”.¹⁷ This study was the first independent study of its kind and discovered that 80 % of people are favourable to having a wind farm built in their area, while just 1 in 4 felt that wind farms superimposed on highly scenic landscapes and impacted negatively upon the view presented. Overall the opinions of the perceived beauty of wind farms in bog land received high levels of endorsement for their scenic beauty.

Irish Wind Energy Association (IWEA) published a report in March 2013 entitled *Good Neighbour, IWEA Best Practice Principles in Community Engagement & Community Commitment*, which outlines the economic benefits, both locally and nationally, from the development of Wind Energy over the past 20 years. Effective Community Engagement is a key factor in achieving social acceptance over the lifetime of a wind energy project. The dialogue undertaken by stakeholders during the development of such projects should be inclusive, transparent, accessible and accountable.

¹⁶ http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/4_Visitor_Insights/Visitor-Attitudes-on-the-Environment.pdf?ext=.pdf

¹⁷ <http://www.seai.ie/uploadedfiles/RenewableEnergy/Attitudestowardswind.pdf>

A report for the Scottish Government in 2008 entitled “*The Economic Impacts of Wind Farms on Scottish Tourism*”¹⁸ found that three quarters of people felt that wind farms had a positive or neutral impact on the landscape. It also found that respondents who had seen a wind farm were less hostile than those who had not. As well as this overseas visitors were generally more positive about wind turbines than domestic tourists.

According to a poll carried out by MORI Scotland, (commissioned by the British Wind Energy Association (BWEA) and the Scottish Renewables Forum (SRF) 2002)¹⁹, the vast majority (91%) of tourists visiting Argyll in Scotland say the presence of wind farms made no difference to the enjoyment of their holiday, and only 8 per cent of the tourists who had seen a wind farm during their visit returned with a negative impression. Therefore based on this study there is no evidence that wind farms significantly detract from the tourist experience of an area.

These studies convey that most people are in favour of the generation of renewable energy from wind turbines and there is no evidence to suggest that wind farms have any detrimental effect on tourism in an area.

The proposed layout complies with the design goals for wind farms outlined in the *Wind Farm Planning Guidelines* published by the DoEHLG in 2006. Chapter 6 of the Guidelines lists a series of recommendations for sites that fit into the “Flat Peatland” designation. The Guidelines states that, “*the preferred approach here is one of large scale response*”. The Offaly Wind Energy Strategy 2009-2015 also states that site of the Yellow River Wind Farm is “*Suitable for Large Scale Wind Farms.*”

4.3.7 Cumulative Impacts

The consented Mount Lucas Wind Farm is located approximately 10km south of the proposed Yellow River Wind Farm. Mount Lucas will be operational during the construction and operation phase of the Yellow River wind farm. No cumulative impacts are predicted.

¹⁸ <http://www.scotland.gov.uk/Resource/Doc/214910/0057316.pdf>

¹⁹ <http://www.cne-siar.gov.uk/energy/2%20pg%20briefing.PDF>

4.4 MITIGATION MEASURES

Although no negative impact of significance has been established there are a number of measures, which may be implemented to protect the safety of workers and the public: -

- A code of construction practice will be established with the Local Authority and will have regard to Health and Safety on site and off site.
- Off site Health and Safety shall include adherence to the rules of the road at all times and proper signage when wide or long vehicles are in use. The use of a lead vehicle with warning lights at periods when large, wide or long vehicles are in use shall be established.
- Members of the public shall not be allowed onto the site during construction without the permission of the developer.

4.5 CONCLUSION

Ireland's current wind capacity of 1,763MW accounted for payment of approximately €11.5 million in Local Authority Rates in 2012 alone. With local economy benefits including employment opportunities, the certainty of land rents over the lifetime of wind farm projects for associated landowners and a more stable, indigenous energy source reducing Ireland's reliance on imported fossil fuels, the wind energy industry plays an important role in Ireland's economic renewal.

Overall, this development can be said to have a positive impact in terms of employment generation and benefits to the local economy, and a minor negative impact in terms of land take.

4.6 REFERENCES

1. Central Statistics Office (CSO) Census 2011 www.cso.ie
2. Central Statistics Office (CSO) 2013 Live Register www.cso.ie
3. Failte Ireland *Tourism Facts 2011*
4. Failte Ireland (2011) *Overseas Visitors to Counties in Ireland- Associated Revenue- Preliminary Estimates*

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5. IWEA (2009) *Jobs and Investment in Irish Wind Energy Study, 2009*
 6. US Office of Energy Efficiency and Renewable Energy (2009) *The Impact of Wind Power Projects on Residential Property Values in the United States*
 7. SEI *Wind Farms and the Environment*
 8. Teagasc 2012 www.teagasc.ie
 9. Failte Ireland 2008 *Visitor Attitudes on the Environment – Wind Farms*
 10. SEI 2003 *Attitudes Towards the Development of Wind Farms in Ireland*
 11. *The Economic Impacts of Wind Farms on Scottish Tourism 2008*
- British Wind Energy Association 2002 *Tourist Attitudes towards Wind Farms*

5.0 FLORA, FAUNA AND FISHERIES

5.1 FLORA & FAUNA - INTRODUCTION

5.1.1 Background

This study comprises the terrestrial ecological component of an Environmental Impact Assessment relating to a proposed wind farm development in the Rhode area of County Offaly. Emphasis is placed on identification and assessment of habitats of conservation value, as well as breeding and wintering bird species. The study included a specific survey for bats.

This report is based on work carried out in the period 2010 to 2013

The assessment is carried out in compliance with the European Communities (Environmental Impact Assessment) Regulations, 1989-2000, and follows the Environmental Protection Agency's *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002) and the European Communities (Environmental Impact Assessment)(Amendment) Regulations 2006.

5.1.2 Local and General Information

The proposed wind farm development is spread over a large area to the north of Rhode, Co. Offaly (roughly along an 11 km axis from E to W and a 7 km axis from north to south). Access to all areas is readily available from public roads and/or tracks.

The sector to the west of the R400 road, comprising 12 turbines, is on former raised bog in the Derryarkin area. The bog at Derryiron is currently being cut and the turbines here will be on largely bare peat (namely T8, T9, T10), while other areas of former bog are converted to intensive grassland or commercial forestry. One turbine (T11) is located within a stand of birch/willow dominated woodland on cutover bog. Commercial quarries, with large ponds, occur in the Derryarkin area.

The sector to the east of the R400 road is divided by the main channel of the Yellow River. Apart from three turbines (T25, T26, T27) within commercial forestry at Corbetstown, all the turbines here are on agricultural land used for both pastoral and arable practices. Hedgerows and treelines are a feature of the landscape, along with

scattered stands of mixed or deciduous woodland and remnant bogs (such as to the west of T14 and T15).

Overall, the general area in which the wind farm will be located is dominated by agricultural land. The presence of raised bogs is a feature of the landscape though most of these have been commercially exploited by Bord na Móna or by local cutting.

5.2 METHODOLOGY

5.2.1 *Habitats and Vegetation*

Site visits were made to the various development areas in June 2010, July 2012 and May 2013.

At the proposed turbine locations the dominant habitats/vegetation occurring within a 50 metre radius of the turbine centre were recorded.

Habitats occurring within the site are classified according to the scheme outlined in “A Guide to Habitats in Ireland” (Fossitt 2000). During the site survey particular attention was paid to the possible occurrence of plant species listed in either the 1999 Flora Protection Order or the Irish Red Data Book (Curtis and McGough 1988). Vascular plant species nomenclature in this report follows Stace (2010) whilst that of mosses follows Smith (2004).

5.2.2 *Birds*

Breeding birds

The site was surveyed for breeding birds in the following periods: April to June 2010, July 2012 and May 2013.

As the site comprises a multitude of land units over a large area, a focused walk-over survey at each turbine location was considered the most suitable method of survey. Some of the bog areas adjoining the site were assessed for breeding birds, while the main channel of the Yellow River (east of the R500) was surveyed for Kingfisher.

Winter birds

The site was surveyed for wintering birds in winter 2012/13. General walkover surveys to record all wintering birds in the development area were carried out by single visits in late-November, early-January and February. However, when it became obvious that the Derryarkin sector was being used by significant numbers of Whooper Swans, and also waders such as Golden Plover, weekly site visits were conducted between mid January and early April 2013. The methodology used for these surveys followed the Scottish Natural Heritage Guidance document (SNH 2005). The objective was to determine the locations of feeding and roost sites, so that potential disturbance and/or displacement by the wind turbines could be evaluated. Survey was carried out by a combination of vantage point watches over the Derryarkin sector of the development site and by road transects to search for feeding sites in the hinterland of the development. All areas within a distance of at least 500m of the development were checked for feeding birds on each survey visit. In addition, site walks were carried out within fields at Derryarkin where birds were not observed feeding during the watches to search for droppings which would indicate presence at other times (including during darkness). A total of 28 hrs and 40 minutes of systematic vantage point observations over the Derryarkin site was achieved during the winter.

Emphasis was placed on early morning and late evening sessions so as to monitor the movements of the swans between feeding and roost sites.

During the winter monitoring work, particular search was made for other species of conservation importance and notably Hen Harriers.

5.2.3 *Terrestrial Mammals, Amphibians and Reptiles*

Presence of mammals is indicated principally by their signs, such as dwellings, feeding signs or droppings - though direct observations are also occasionally made. The nature and type of habitats present are also indicative of the species likely to be present.

Mammal sightings and signs were recorded during the various habitat and bird surveys, with particular search for presence of badgers during the winter surveys.

Search was made for otter presence along the main Yellow River channel and at the proposed river and stream crossings.

Presence of the common frog and common lizard was recorded during the habitat and bird surveys.

5.2.4 *Bats*

A desk study into previous records of bat species in the area of the proposed development was carried out. This was based mainly on *Bat Conservation Ireland's* National Bat Distribution Database.

Site visits to the study area were made on 30th September and 1st October 2012 during which the on-site habitats (the nature of which are indicative of the bat species likely to be present) were assessed during daylight hours for their favourability for bats. A bat activity survey was carried out at dusk and through the night using heterodyne/frequency division detectors – Bat Box Duet and Pettersson D100. The assessment was undertaken by Mr Conor Kelleher.

Although the site surveys were undertaken in the autumn season, bats were still active due to mild weather with temperatures of 14°C in daylight hours and 12°C after dark. Winds were light and there was no rainfall at the time of survey.

5.2.5 *Survey Limitations*

No limitations are associated with the habitat or bird surveys as all were carried out during the optimum periods for the respective surveys and followed standard methodologies.

However, the detailed surveys for Whooper Swans were carried out only between January and early April. While the absence of survey in the early winter period (October-December) is a limitation, this is not considered a major constraint for the baseline assessment and is unlikely to significantly alter the overall evaluation of the importance of the site during the 2012/13 winter.

5.2.6 *Evaluation of Ecological Resources and Impact Assessment*

The evaluation of ecological interests and assessment of impacts is assisted by the relevant guidance documents, namely the NRA *Guidelines for Assessment of*

Ecological Impacts of National Road Schemes (NRA, 2009) and the *EPA Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002). Whilst the NRA guidelines were devised specifically for road schemes, they can be applied to general environmental impact assessment. Reference is also made to guidance in the *IEEM Guidelines for Ecological Impact Assessment in the United Kingdom* (IEEM 2006). The evaluation of ecological resources used in this report is in line with the NRA system, using the following five-point scale:

- International Importance
- National Importance
- County Importance
- Local Importance (higher value)
- Local Importance (lower value)

The importance of wintering wetland bird populations is evaluated according to the standard 1% thresholds for national (all-Ireland) and international importance (see Crowe 2006, Boland & Crowe 2012).

The prediction of impacts considers such factors as the magnitude, extent, duration and the timing and frequency of the predicted impact. The likelihood of the impact occurring is also considered where possible. From these criteria the significance of the impact is determined on the basis of the factors which characterise the ecological receptor (receptor being habitat and/or species) and take into account the effects on the conservation status or integrity of the receptor resulting from the proposed development. The integrity of a receptor can be regarded as the coherence of ecological structure and function, across the entirety of a receptor, which enables it to sustain all of the ecological resources for which it has been valued. The following impact significance criteria (EPA, 2002) are used where applicable:

Significance of Impact	Significance Criteria
Imperceptible impact	An impact capable of measurement but without noticeable consequences
Slight impact	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate impact	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
Significant impact	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Profound impact	An impact which obliterates sensitive characteristics

5.2.7 *Characteristics of the Development*

Full technical details of the project are given in Chapter 2, Project Description. The following is a summary of the characteristics of the development:

- Total site area **1,002.234 ha**
- Development footprint **20.58 ha**
- Peat Depth Range **0 – 3.6m**. Average peat depth **0.5 m** (Whitefords, Soils & Geology Report Chapter 6)
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands, including turning area, set down area & ancillary crane area
Total Area 1,995m²
- Temporary construction compound, approximately **50 m x 30 m**.
- Clear fell of plantation forestry area 1.5 ha per turbine (four turbines T1; T25; T26 and T27 = 6 ha) plus part of T2 area = 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor)
Overall Clear fell area Total 10.4 ha
- T11 scrub area to be felled = **1.5 ha**
- Construction of approximately **18,275 m** of new access tracks having a minimum finished width of 5 m with passing bays

- Upgrading of approximately **5,916 m** of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.
- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of an Substation Control Buildings and Compound on site area **1,850 m²**
- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings **9**
- Upgrade of existing bridges **1**
- The terrain is sloping with gradients between 1:25 and 1:100.

The development site does not require a borrow pit as required stone and gravel will be sourced from local quarries.

Sensitive design has ensured that the wind farm infrastructure is largely outside areas rated as of ecological importance, especially the area of raised bog at Derryiron. The project does not encroach on any site designated for nature conservation. Overall, the mitigation followed in this project has been a policy of avoidance, which is considered the best form of mitigation for projects in ecologically sensitive areas (details of measures are given in mitigation section).

5.3 DESCRIPTION OF THE EXISTING ENVIRONMENT

5.3.1 Sites Designated for Nature Conservation

No part of the proposed development site is within an area designated for nature conservation.

The following sites of nature conservation importance occur within a 15 km radius of the proposed wind farm (see Figure 5.2).

Lough Ennell SAC (code 000685) and SPA (code 004040)

Lough Ennell is a large, limestone lake. The lake is classified as a mesotrophic system by the EPA though it had been eutrophic in the past. The site is an SAC due to the presence of the Annex I habitat alkaline fen.

Lough Ennell is one of the most important midland lakes for wintering waterfowl, with nationally important populations of Mute Swan, Pochard, Tufted Duck and Coot. At times, the lake is utilised as a roost (with limited feeding) by the internationally important midland lakes population of Greenland White-fronted Goose (ca.400 strong) (this flock is now centred at Lough Iron and seldom uses Lough Ennell or the other large midland lakes, O. Crowe pers comm.). The site also attracts Golden Plover (200) and Lapwing (673) though these feed mainly outside of the SPA site.

Lough Ennell is located approximately 10 km to the north-west of the Derryarkin sector of the site.

River Boyne and River Blackwater SAC (code 002299) and SPA (code 004232)

This large site consists of the freshwater stretches of the River Boyne as far as the Boyne Aqueduct, the Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers.

Overall, this SAC site is of considerable conservation significance for the occurrence of good examples of a range of habitats and of populations of plant and animal species that are listed on Annexes I and II of the EU Habitats Directive respectively.

The site is a SPA as it is of special importance of Kingfisher. A survey in 2010 recorded 19 pairs of Kingfishers in the River Boyne and River Blackwater SPA

At the closest, the designated river is at a distance of approximately 14 km to the northeast of the development site.

Raheenmore Bog SAC (code 000582)

Raheenmore Bog is a classic example of a largely intact raised midland bog. It is located approximately 4 km southwest of the Derryarkin sector of the site.

Mount Hevey Bog SAC (code 002342)

Mount Heavy Bog SAC is located to the northeast of Kinnegad and approximately 9 km northeast of the northeastern sector of the proposed wind farm. The site is a good example of a mostly intact raised bog.

Split Hills and Long Hill Esker SAC (code 001831)

This esker ridge crosses the N5 Dublin to Galway road between Kilbeggan and Tyrellspass. The main habitat is semi-natural woodland, though there are several areas of species rich calcareous grassland. The SAC is located approximately 7 km west of the development site.

The Long Derries SAC (code 00925)

Located just over 3 km southeast of Edenderry, the Long Derries, Edenderry SAC is part of a low esker ridge running from Edenderry to Rathdangan. It primarily consists of glacial gravels interspersed with loam and peat soil. The dominant habitat is dry calcareous grassland, of which this is a particularly good example and includes a number of rare plant species. The SAC is located approximately 11 km southeast of the development site.

Woooddown Bog NHA (code 000694)

This NHA is a good example of a relatively intact raised bog. It is located about 4 km east of Mullingar and approximately 14 km to the north-northwest of the development area.

Nure Bog NHA (code 001725)

This NHA is a good example of a relatively intact raised bog. It is located to the southwest of Lough Ennel about 4 km east of Mullingar and approximately 12 km to the north-northwest of the development area.

Milltownpass Bog NHA (code 002323)

This NHA is located about 1 km north-east of Milltownpass and just over 8 km north-east of the Derryarkin sector of the site. The NHA is a fine example of a relatively intact raised bog.

Cloncrow Bog (New Forest) NHA (code 000677)

This NHA is located approximately 1 km west of Tyrellspass and just over 5 km west of the development site. The NHA is a fine example of a relatively intact raised bog.

Black Castle Bog NHA (code 000570)

This NHA is a good example of a relatively intact raised bog and is notable for its easterly location. It is located about 3 km northwest of Edenderry, and approximately 3 km to the west of the proposed wind farm.

Molerick Bog NHA (code 001582)

This NHA is a fine example of a relatively intact raised bog. It is located about 4 km west of Longwood and approximately 10 km northeast of the northeastern sector of the proposed wind farm.

Daingean Bog NHA (code 002033)

This NHA is a good example of a relatively intact raised bog. It is located about 2 km south west of Daingean village and approximately 10 km southwest of the development site.

Rahugh Ridge (Kiltober Esker) pNHA (code 0918)

The pNHA lies about 9 km northeast of Tullamore and runs for about 2.5 km in a northeast direction. Is a good example of an esker ridge with woodland and calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Ardan Wood pNHA (code 01711)

Ardan Wood is a crescent shaped woodland on a steep slope located about 5 km west of Kilbeggan. It is a good example of a semi-natural woodland. It is situated approximately 10 km west-southwest of the development site.

Murphy's Bridge Ridge Esker pNHA (code 01775)

The pNHA is a good example of an esker ridge with calcareous grassland and supports the rare and protected hemp nettle. It is situated approximately 7 km southwest of the Derryarkin sector of the site.

Royal Canal pNHA (code 02103)

The Royal Canal pNHA passes north of the proposed wind farm site (approximately 10 km from the nearest development area). The canal supports a wide range of ecological interests.

Grand Canal pNHA (code 02104)

The Grand Canal pNHA is situated to the south of Rhode and approximately 3 km south of the nearest part of the development site. The canal supports a wide range of ecological interests.

Site Name	Designation type	Distance from Landholding
Black Castle Bog	NHA	2.4km East
Grand Canal	pNHA	3km South
Raheenmore Bog	SAC, pNHA	4km South West
Cloncrow Bog	NHA	5km West
Rahugh Ridge (Kiltober Esker)	pNHA	7km Southwest
Murphy's Bridge Ridge Esker	pNHA	7km Southwest
Split Hills and Long Hill Esker	SAC	7km West
Milltown Pass Bog	NHA	8km North
Mount Hevey Bog	SAC/ pNHA	9km North West
Lough Ennell	SPA/ SAC/ pNHA	10km North West
Royal Canal	pNHA	10km North
Ardan Wood	PNHA	10km West Southwest
Daingean Bog	NHA	10km Southwest
Molerick Bog	NHA	10km Northeast
The Long Derries	SAC	11km Southeast
Nure Bog	NHA	12km North Northwest
Wooddown Bog	NHA	14km North Northwest
River Boyne & River Blackwater	SAC, SPA	14km Northeast

Table 5.1 - Designated Areas of Conservation within 15 km of the proposed site.

5.3.2 Habitats, Vegetation and Flora

A general description of the habitats and vegetation types within the entire Yellow River site is presented. This is followed by summary habitat descriptions for the turbine locations. Principal habitats are shown in Figure 5.1.

Description of habitats on site

Despite the large area over which the proposed wind farm extends, the area is characterised by a relatively low diversity of habitats. Of note is that apart from one area of raised bog none of the habitats correspond to any of the Annex I habitats of the EU Habitats Directive.

Depositing/lowland rivers (FW2)

The Yellow River is a main ecological feature of the area and is a fairly typical example of a depositing river. The river, however, has been heavily modified over time and has lost a lot of its naturalness. A full baseline assessment of the river is presented in an accompanying aquatic report.

Drainage ditches (FW4)

Drainage ditches are a frequent feature of the area, reflecting the general low-lying character of the landscape and the widespread reclamation of lands from bog. These vary in water depth and plant diversity according to the degree of recent maintenance. Widespread aquatic species present are watercress (*Nasturtium officinale*), fool's water cress (*Apium nodiflorum*), creeping bent (*Agrostis stolonifera*), starwort (*Callitriche spp.*) and common duckweed (*Lemna minor*). Yellow flag (*Iris pseudacorus*) occurs in places. Some of the channels are overgrown by marginal scrub vegetation, especially willows and brambles.

Drainage channels, especially when long established, can provide useful habitat for local wildlife and are rated as Local conservation interest (lower value).

Improved grassland (GA1)

Improved agricultural grassland is the dominant habitat within the site. This is mostly a well managed sward with regular fertiliser application and reseeded. The grassland is used for grazing (mostly cattle and sheep) or silage production (see Plate 1).

The dominant species of improved grassland are typically perennial rye grass (*Lolium perenne*), meadow grasses (*Poa spp.*), crested dog's tail (*Cynosurus cristatus*) and Yorkshire fog (*Holcus lanatus*). Frequent herbaceous species are clovers (*Trifolium repens*, *T. pratense*), plantains (*Plantago major*, *P. lanceolata*), creeping buttercup (*Ranunculus repens*), meadow buttercup (*Ranunculus acris*) and common mouse-ear (*Cerastium fontanum*). Coarse weeds occur scattered throughout, including thistles (*Cirsium spp.*), docks (*Rumex spp.*), ragwort (*Senecio jacobaea*) and nettles (*Urtica dioica*). Rushes, mostly soft rush (*Juncus effusus*) are present where drainage is poor but seldom dominate (less than 25% cover).

Improved grassland is a common habitat throughout Ireland and is not of any particular conservation value.

Wet grassland (GS4)

Wet grassland is a relatively scarce habitat along the route corridor, reflecting the intensity of agricultural practices. In most cases it occurs localised or scattered within larger fields of improved grassland though it is the dominant habitat at the location for T30.

The principal species associated with wet grassland are soft rush (*Juncus effusus*), creeping bent (*Agrostis stolonifera*), silverweed (*Potentilla anserina*) and creeping buttercup (*Ranunculus repens*). In wetter areas yellow flag (*Iris pseudacorus*) and meadowsweet (*Filipendula ulmaria*) may occur, along with the small rush species *Juncus articulatus* and *Juncus acutiflorus*.

While wet grassland is a widespread and common habitat in Ireland, it offers some habitat diversity in an intensively managed landscape such as within the study site. Rated as of Local importance (lower value).

Dry meadows and grassy verges (GS2)

This semi-natural grassland type is localised in the study area and is found along earthen banks and/or roadside margins. However, there are no extensive examples of the habitat. A range of grasses occur, including red fescue (*Festuca rubra*), cock's-foot (*Dactylis glomerata*), meadow foxtail (*Alopercurus pratensis*), and sweet vernal grass (*Anthoxanthum odoratum*). Herbaceous species recorded were common knapweed (*Centaurea nigra*), common centuary (*Centaureum erythraea*), bird's-foot trefoil (*Lotus corniculatus*), oxeye daisy (*Leucanthemum vulgare*), ladies bedstraw (*Galium verum*), yarrow (*Achillea millefolium*), cat's-ear (*Hypochoeris radicata*), self heal (*Prunella vulgaris*), ribwort plantain (*Plantago lanceolata*), white clover (*Trifolium repens*), and eyebright (*Euphrasia* sp).

The examples of this semi-natural grassland type within the study are small in size and generally remnants. However, they have some conservation value – rated as Local importance (lower value).

Raised bog (PB1)

A narrow strip of raised bog occurs at Derryiron to the south of turbines 8, 9 and 10 (see Plates 2 & 3). This extends from an active cut face to the Bord na Móna railway line to the south. Surface drains have been inserted into the western sector of the bog, while the eastern sector is more intact. The bog is dominated by ling heather (*Calluna vulgaris*), with cross-leaved heath (*Erica tetralix*), purple moor-grass (*Molinia caerulea*), common bog cotton (*Eriophorum angustifolium*), deer-grass (*Trichophorum cespitosum*) and bog asphodel (*Narthecium ossifragum*) also present. The moss layer varies though bog mosses (*Sphagnum spp.*) are locally common in the eastern sector.

While still uncut and retaining a typical surface vegetation, this strip of raised bog is hydrologically compromised due to the very active turbary along its northern margin and the surface drains across the western sector. Nevertheless, as raised bog is listed as an EU Habitats Directive Annex I habitat with priority status, this minor example is rated as Local importance (higher value).

Cutover bog (PB4)

T8, T9 and T10 are located on areas of recent bare peat within an area of active turbary (see Plates 3 & 4). The turbines are located close to the cut edge of the strip of raised bog already described.

While cutover bog can be of varying conservation value, the example at the turbine locations is not considered of any value as it is a recently cut surface that is still largely bare peat.

T7 is located along the margin of a small area of bog which occurs just south of the Yellow River (see Plates 5 & 6). This is an isolated bog remnant within a large field of improved grassland and it appears that the surface may have been turned/ploughed in the past (10+ years ago) as it is quite firm and very uneven (i.e. not an expected natural bog surface). The vegetation has recovered well but there is virtually no moss layer at all. While much of the surface is wet this appears more like waterlogging than natural bog wetness. Typical bog species such as ling heather, cross-leaved heath, bog cotton, deer sedge and bog asphodel are present.

The example of cutover bog at T7 is rated as Local importance (lower value).

Bog woodland (WN7)

A stand of woodland on cutover bog occurs at the location for T11 in the Derryiron area (see Plate 9). This is very much dominated by downy birch (*Betula pubescens*) and willows (most eared willow *Salix aurita*) and with gorse (*Ulex europaeus*) in varying amounts. The understorey and ground layer is usually of bramble (*Rubus fruticosus*) with a remnant bog flora of such species as ling heather (*Calluna vulgaris*). Bracken (*Pteridium aquilifolium*) also occurs in the woodland.

As this wood is on cutover bog it does not qualify as the Annex I habitat Bog woodland (which in Ireland is confined to a few relatively intact raised bogs with high water tables). Nevertheless it is a useful habitat for local wildlife and is rated at least as Local importance (lower value).

Conifer plantation (WD4)

Coniferous plantations occur in the north-western part of the Derryarkin sector and more extensively in the Carrick-Corbetstown area.

The stand at Derryarkin is Sitka spruce (*Picea sitchensis*) which is now in the closed canopy stage.

The plantations at Carrick-Corbetstown are mostly conifers, though there are some broadleaved stands (WD1) here as well.

Conifer or broadleaved plantation forest is not of conservation value from a habitat perspective

Hedgerows (WL1) and treelines (WL2)

Hedgerows or treelines occur throughout the study area and provide the principal field boundary type (other than on the reclaimed bog at Derryarkin) (see Plates 7 & 8).

The hedges are typically on earthen banks and are often accompanied by drainage ditches. The quality of hedgerows varies, from tall, well structured and diverse hedges that could often be described as treelines or even narrow strips of woodland (such as at Coolville) to very low (<1.5 m) hedges (such as within the intensively managed pasture and arable fields found on both sides of the Yellow River at Wood and Killowen).

Hawthorn (*Crataegus monogyna*) is the main hedge forming species, with ash *Fraxinus excelsior* the principal tall tree species. Blackthorn (*Prunus spinosa*), elder (*Sambucus nigra*), sycamore (*Acer pseudoplatanus*), willows (mostly grey willow *Salix atrocinerea*), and hazel (*Corylus avellana*) are fairly widespread, with holly (*Ilex aquifolium*), beech (*Fagus sylvatica*), oak (*Quercus* spp.) and elm (*Ulmus* spp.) scattered. Brambles (*Rubus fruticosus*) are frequent in the understorey layer throughout, with wild roses (*Rosa* spp.) also present and honeysuckle (*Lonicera periclymenum*) occasional. Ivy (*Hedera helix*) is common both in the trees and in the ground layers.

A fairly typical array of herbaceous species was recorded in the ground layer of the hedgerows. These include herb robert (*Geranium robertianum*), dog violet (*Viola riviniana*), lords and ladies (*Arum maculatum*), ground ivy (*Glechoma hederacea*), cleavers (*Galium aparine*), bush vetch (*Vicia sepium*), primrose (*Primula vulgaris*), and cow parsley (*Anthriscus sylvatica*). Ferns such as shield fern (*Polystichum setiferum*) and hart's tongue fern (*Phyllitis scolopendrium*) are fairly widespread. Coarse plants, such as nettles (*Urtica dioica*) and hogweed (*Heracleum sphondylium*) are often present along the hedge margins.

Hedgerows are an important feature of the study area and provide useful wildlife habitat in a largely agricultural landscape. Overall, hedgerows within the survey corridor are rated as having Local importance (Lower value).

Active quarries and mines (ED4)

Kilmurray quarry is an active sand and gravel facility. The complex includes some flooded quarry pits.

While not presently of conservation value from a habitats perspective, the flooded quarries provide useful habitat for aquatic birds while a colony of breeding sand martins occurs in the sand banks.

Arable land (BC1)

Arable land used intensively for cereal production is a feature of the eastern sector of the study area

Arable land is not of conservation value from a habitats perspective but can provide useful habitat for a range of farmland birds. .

Buildings and artificial surfaces BL3

The site includes a range of farm buildings and buildings associated with a commercial quarry complex at Kilmurray. Various roads and hard core tracks are scattered through the site.

Built land is not of conservation interest.

5.3.3 *Vegetation descriptions at turbine locations*

A summary of the principal habitat type at each turbine location is given in Table 1.

Turbine	Principal Habitat
1	Conifer plantation
2	Conifer plantation / Improved grassland
3	Improved grassland
4	Improved grassland
5	Improved grassland
6	Improved grassland
7	Improved grassland (adjoining remnant bog)
8	Cutover bog
9	Cutover bog
10	Cutover bog
11	Bog woodland
12	Improved grassland
13	Improved grassland
14	Improved grassland
15	Improved grassland
16	Improved grassland
17	Improved grassland
18	Improved grassland
19	Improved grassland
20	Improved grassland
21	Improved grassland
22	Arable
23	Arable
24	Improved grassland
25	Conifer plantation
26	Conifer plantation
27	Conifer plantation
28	Arable
29	Arable
30	Wet grassland / Improved grassland
31	Improved grassland
32	Improved grassland

Table 5.2. Principal habitats at location of each turbine.

Seventeen of the proposed turbine locations are located on improved grassland, much of which is intensively managed. One (T30) is within a field which is divided between wet grassland and improved grassland – this field merges with an area of remnant bog. A further turbine (T7) is on grassland that is along the margin of some remnant bog. Four of the turbines are in arable land (though landuse varies between arable and grassland between years). Four of the turbines are in forestry plantations, with another (T2) partly in forest. The plantations in the northern part of the site are coniferous but with broadleaved stands. Three turbines are on cutover bog, with one on bog woodland.

5.3.4 *Terrestrial mammals, amphibians and reptiles*

Otter (*Lutra lutra*) occurs on the Yellow River and is likely to be widespread along its tributaries. Signs were observed at the following locations in June 2010: N517 359 (main channel west of R400), N563 384 (main channel at Killowen).

Badgers (*Meles meles*) are widespread throughout the area, with signs such as feeding marks recorded in many of the grassland fields. A large sett occurs in the Derryarkin farm area.

The Irish Hare (*Lepus timidus hibernicus*) is widely distributed throughout the entire site. Foxes (*Vulpes vulpes*) are widespread within the site with several sightings and numerous signs.

Other ubiquitous mammal species such as **pygmy shrew** (*Sorex minutus*), **long-tailed field mouse** (*Apodemus sylvaticus*) and **hedgehog** (*Erinaceus europaeus*) would be certain to occur.

5.3.5 *Bats*

Desk study

Of the ten recorded bat species in Ireland, seven have been recorded within a 10 km radius of the study site including; common (*Pipistrellus pipistrellus*), soprano (*P. pygmaeus*) and Nathusius' (*P. nathusii*) pipistrelle, brown long-eared (*Plecotus auritus*), Leisler's (*Nyctalus leisleri*), Daubenton's (*Myotis daubentonii*) and Natterer's (*M. nattereri*) bats and other bat species may be expected to occur occasionally. Roosts of some of these species (soprano pipistrelle, brown long-eared and Daubenton's bats) are also known locally but these are outside of the study area as shown in Table 5.3.

Common name	Scientific name	No. of roosts	Distance from study area	Source
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	2	2km E and 10km NW	BCIreland
Brown long-eared bat	<i>Plecotus auritus</i>	2	3km NE and 10km NW	BCIreland
Daubenton's bat	<i>Myotis daubentonii</i>	1	10km NW	BCIreland

Table 5.3 Known bat roosts within 10 km of the study area.

Field survey

Sunset on the evening of the surveys was at 19:13 and 19:10 hrs respectively and, on both occasions within twenty minutes of sunset, the soprano pipistrelle was the first bat species observed on the wing. In total, six bat species were subsequently detected on-site with the most common being the soprano pipistrelle although the common pipistrelle was also widespread throughout the area. Both pipistrelle species foraged in the shelter of hedgerows, treelines, tree-lined minor roads, woodland and scrub areas, as well as vegetated areas of the Yellow River.

Leisler's bat was detected actively foraging over and commuting across the area on both nights. Several specimens of the species were present as more than one was visibly observed flying at height and at the same time over Derryarkin on the first night and over Killowen on the second night before full darkness prevented visual observation. During the hours of darkness each night, the species was frequently detected hunting throughout the area.

Brown long-eared and Natterer's bats, two species that are difficult to detect due to their quiet echolocation calls, were both encountered hunting along the woodland and well-treed lanes at Coolville/Ballyburly. Both species were also present along the well-vegetated lanes at Carrick at the north of the study area.

Daubenton's bat was detected hunting over the Yellow River at Garr Bridge and this species is expected to occur on all the larger watercourses in the area.

Although not recorded during the surveys, the whiskered bat *M. mystacinus* is certain to occur in wooded areas such as those at Coolville/Ballyburly, a preferred habitat of the species, as it is widespread in the Irish countryside. Brandt's bat *M. brandtii*, a sibling of the whiskered bat, may also occur on-site but it is a very rare animal that has only been recorded a few times to date in Ireland. Nathusius' pipistrelle, another rare species, has been detected locally and the species may occur on-site occasionally but it was not recorded on this occasion.

The lesser horseshoe bat *Rhinolophus hipposideros* is confined to the west of Ireland and is not known to occur in County Offaly.

No bat roosting sites were found on-site during the present surveys but bat roosts are certain to be present within such a large area. Roosts of three species are known nearby.

Table 5.4 outlines the adjudged local status of each bat species and its presence within the study site.

Common name	Scientific name	Occurrence on-site	Known roosts	Source
Common pipistrelle	<i>P. pipistrellus</i>	Present	No	BCIreland/ Pers. Obs.
Soprano pipistrelle	<i>P. pygmaeus</i>	Present	Yes	BCIreland/ Pers. Obs.
Nathusius' pipistrelle	<i>P. nathusii</i>	Potential – local records	No	BCIreland
Leisler's bat	<i>N. leisleri</i>	Present	No	BCIreland/ Pers. Obs.
Brown long-eared bat	<i>P. auritus</i>	Present	Yes	BCIreland/ Pers. Obs.
Lesser horseshoe bat	<i>R. hipposideros</i>	Absent	No	BCIreland
Daubenton's bat	<i>M. daubentonii</i>	Present	Yes	BCIreland/ Pers. Obs.
Natterer's bat	<i>M. nattereri</i>	Present	No	BCIreland/ Pers. Obs.
Whiskered bat	<i>M. mystacinus</i>	Certain	No	
Brandt's bat	<i>M. brandtii</i>	Potential – rare	No	

Table 5.4 Adjudged local status of Irish bat species.

5.3.6 *Amphibians and Reptiles*

The common frog (*Rana temporaria*) is widespread throughout much of the site, occurring in ponded areas, drains along tracks etc.

The common lizard (*Zootoca vivipara*), a species often found on peatlands and open areas, was not recorded and would not be expected in agricultural fields. However, it may occur on the strip of remnant bog at Derryiron.

5.4 BIRDS

5.4.1 *Breeding and summering birds*

A summary table of species recorded from the breeding surveys is presented in Table 5.5. The adjudged breeding status using the BTO Breeding Bird Atlas 2007-2011 criteria is given.

A total of 42 species was recorded within the site during the breeding surveys. Thirty-nine of these were considered to be in one of the three breeding categories (possible, probable, confirmed), with three species (grey heron, kestrel, black-headed gull) considered to be merely using the site but breeding elsewhere.

Breeding birds of bog and wetland habitats

The remnant area of raised bog at Derryiron and the adjoining cutover bog supports a relatively small number of breeding birds. Skylark and Meadow Pipit were by far the most widely distributed species in these habitats. Wren was the only other species recorded on the bog though Swallows fed over the surface of the bog. A pair of Stonechats bred in gorse scrub in the northern sector of the Derryiron bog area, with Linnet recorded (probably breeding nearby) in the cutover bog alongside the Yellow River channel.

A Wheatear was present on the recent cutover bog at Derryiron in May 2013 but was probably a migrant bird, while Cuckoo was heard locally. Sedge Warbler and Reed Bunting occur widely in the fringing vegetation along the Yellow River channel. Mallard and Moorhen breed at several locations along the Yellow River.

A pair of Lapwing attempted to breed in the area of recent cutover bog at Derryiron in 2010 but had abandoned the area by June undoubtedly due to the high level of disturbance from turbary activities. A single bird (possibly of a pair) was displaying here in May 2013 but again there was a high level of turbary activity nearby. Several pairs of Lapwing breed on the cutaway bog habitats to the north of the road leading to Derryarkin farm.

Sand Martins breed in a sand bank at Kilmurray quarry. In May 2013, a pair of Great Crested Grebes and a pair of Tufted Duck were on the quarry pond, along with four

Mute Swans, a pair of Moorhens and a Little Grebe. It is not known if the grebes or the Tufted Duck breed here.

A large colony of Black-headed Gulls nests on an island in a quarry lake at the Roadstone facility to the north of Derryarkin farm. An estimated 160 birds were present in 2010 and up to 400 birds in May 2013.

Breeding birds of pasture and arable habitats

Most of the grassland fields are managed intensively and support few breeding birds. Meadow Pipits were recorded in some of the less managed fields and were probably nesting locally. Starlings, Rooks and Jackdaws utilise the fields for feeding.

The arable fields, mostly cereals, provide suitable habitat for typical species of mixed agricultural lands, with Skylark, House Sparrow, Stock Dove (1 pair), Linnet and Yellowhammer (2 locations) recorded. The occurrence of Yellowhammer is of note as this is a Red List species.

Breeding birds of hedgerows, scrub and woodland

The majority of the passerine species found on site are associated with the hedgerow habitats. These are mainly ubiquitous species of the countryside, including Woodpigeon, Robin, Blackbird, Song Thrush, Willow Warbler, Goldcrest, Blue Tit, Chaffinch and Bullfinch. Several pairs of Blackcaps breed in the bog woodland north of Derryiron.

Lesser Redpoll was a widespread species, associated with scrub and conifer forest.

Breeding birds of buildings

Four species which occur on site breed in buildings within or around the site – these are Swallow, Pied Wagtail, House Sparrow and Starling.

Species	Breeding Status	Conservation Status
Little Grebe	Possible	Amber
Great Crested Grebe	Possible	Amber
Grey Heron	Non-breeder	Green
Mallard	Confirmed	Green
Tufted Duck	Possible	Amber
Kestrel	Non-breeder	Amber
Pheasant	Probable	Green
Moorhen	Confirmed	Green
Lapwing	Possible	Red
Black-headed Gull	Confirmed locally (offsite)	Amber
Woodpigeon	Confirmed	Green
Stock Dove	Probable	Amber
Cuckoo	Probable	Green
Skylark	Confirmed	Amber
Sand Martin	Confirmed	Amber
Swallow	Confirmed (nests in buildings)	Amber
Meadow Pipit	Probable	Green
Pied Wagtail	Probable	Green
Wren	Probable	Green
Robin	Probable	Green
Stonechat	Confirmed	Green
Wheatear	Possible	Amber
Blackbird	Probable	Green
Song Thrush	Probable	Green
Mistle Thrush	Possible	Green
Sedge Warbler	Probable	Green
Blackcap	Possible	Green
Willow Warbler	Confirmed	Green
Blue Tit	Confirmed	Green
Coal Tit	Confirmed	Green
Magpie	Probable	Green
Jackdaw	Confirmed	Green
Hooded Crow	Probable	Green
Starling	Confirmed	Amber
House Sparrow	Confirmed	Amber
Chaffinch	Confirmed	Green
Goldfinch	Possible	Green
Linnet	Probable	Amber
Lesser Redpoll	Probable	Green
Bullfinch	Possible	Green
Yellowhammer	Probable	Red
Reed Bunting	Confirmed	Green

Table 5.5. Breeding status of species recorded within Yellow River wind farm study area during surveys in 2010, 2012 and 2013. Red and Amber listed species (after Lynas *et al.* 2007) are highlighted.

5.4.2 *Wintering birds*

The wintering swans and wetland birds associated with Derryarkin Farm are discussed separately from the other birds which occur in the study area.

Wintering Whooper Swans, Golden Plover, Lapwing and Curlew

The improved grassland fields at Derryarkin farm provide suitable habitat for Whooper Swans and grassland feeding waders (Lapwing, Golden Plover, Curlew). Detailed observations of the usage of these fields through the winter are presented in **Appendix J**, with a summary in Table 5.6.

Whooper Swan

Whoopers Swans were recorded in the improved grassland fields of Derryarkin Farm in 10 of 15 winter visits between November 2012 and April 2013. Numbers ranged from 3 (plus 4 Mute Swans on same date) to 82 (though it is known that over 100 swans were present during December – S. Heery in conversation with B. Madden). The fields most often used were those adjoining the quarry complex, and especially fields no. 1 and 2 (see Figure 5.3). Swans were also recorded within fields no. 3, 4 and 5, and signs of recent usage were found in fields no. 6 and 7.

The Kilmurray quarry ponds were used by roosting swans occasionally.

These swans are part of a population that moved regularly between a cluster of feeding and roost sites in the immediate area, as follows (see Figure 5.4):

- Derryarkin farm – (within development site – fields no. 1- 4 (Figure 5.3) & site no. 1 in Figure 5.4) – used intensively for feeding, with occasional roosting on adjoining Kilmurray quarry ponds (R1 in Figure 5.4)
- Derryarkin cutaway bog – comprises the areas which adjoin Derryarkin farm to the north, northwest and northeast (site no. 3 in Figure 5.4). Provides feeding opportunities on wet bog and a safe roost site (Roadstone quarry pond – R2 in Figure 5.4)
- Grassland fields between Mongagh River and motorway (east side of R400) – general grid reference (N48 39 – site no. 4 in Figure 5.4)

- Grassland fields east side of R400 on Rochfortbridge side of motorway (grid ref. N480 407 – site no. 5 in Figure 5.4)

A further roost site is considered to exist within the Bord na Móna Drumman site (grid ref N510 400) where a series of quarry ponds occur (R3 in Figure 5.4).

The above sites are part of a larger complex of sites used by swans extending to Ballycon (south of Rhode). It appears that the swans were concentrated at the above listed sites in the Derryarkin area in the early part of the winter (to January) and then most moved to various locations near to Rhode in the later part of the winter. The reason for the shift may have been due to better feeding opportunities though high levels of disturbance from farming activities at Derryarkin may also have caused the swans to move.

During daylight, the swans fed almost continuously and generally flew only short distances within the fields in response to feeding patterns or local disturbance. All internal movements within the feeding fields were at low levels (10-15 m). Six flightlines were recorded of birds arriving or departing from the fields, with one of birds flying to the Kilmurray quarry ponds to roost (see Figure 5.5). Only one flightline was observed of birds arriving from outside of the area – this involved a group of 15 swans which arrived from the southeast at c.15.40 hrs on 24th January 2013. These birds, which were recorded from the entrance road, were descending towards fields at height of less than 30 m. A similar number was later seen roosting on the Roadstone quarry at darkness.

Of particular interest was that the swans were using nearby quarry ponds (Roadstone & Kilmurray) as night roosts. This enabled the birds to feed well after darkness and then to take a short flight to the night roost.

Up to four Mute Swans were often recorded with the Whooper Swan flock.

Golden Plover

A flock of Golden Plover was present in the Derryarkin Farm area through much of the winter. Numbers were generally in the low hundreds though a high count of 1,200 was made on 31st January 2013. The plover moved between all the fields within the site, with two records of birds in the fields at Derryiron.

Lapwing

As with Golden Plover, Lapwing was present in the Derryarkin Farm area through much of the winter. Numbers peaked at 400 on 8th January 2013.

Curlew

A regular flock of up to 45 Curlew was in the Derryarkin area throughout the winter. These birds were usually found roosting on the banks of the Kilmurray quarry pond though they also fed in the fields at times.

Date	Whooper Swan	Golden Plover	Lapwing	Curlew
22/11	19	0	0	28
29/11	11	60	0	14
21/12	16	0	0	22
08/01	45	80	400	15
21/01	82	280	240	36
24/01	0	350+	200+	42
31/01	0	1,200	140	40
04/02	0	200	180	35
12/02	0	60	160	45
20/02	3	30	30	0
01/03	0	160	55	32
07/03	18	40	85	22
13/03	38	0	0	0
26/03	26	0	0	0
02/04	13	0	0	0

Table 5.6. Numbers of Whooper Swans and grassland feeding waders at Derryarkin farm, winter 2012/13.

In addition to the swans and waders, a flock of up to 20 **Teal** was often found on a small pond within the site and sometimes on the Kilmurray quarry pond.

Large flocks of **Starlings** were regular in the fields, with an estimated 3,000 feeding on grassland on 21st January 2013.

Hen Harrier

A male Hen Harrier was recorded at Derryarkin on 26th March 2013 (see Figure 5.6). This bird flew low (<10 m) from the Derryarkin cutaway bog in a southeast direction towards Ballybeg. The bird appeared to be in foraging mode though was not observed striking any prey item.

Other wintering birds in study area

The majority of the study area comprises mixed agricultural lands, with hedgerows and treelines a feature. A list of the birds recorded on each of the three winter surveys is given in Table 5.7. Flocks of wintering finches, thrushes and larks were found throughout the area, with particularly good concentrations in areas with arable fields. Finch flocks comprised Chaffinches, Linnets, Greenfinches and Goldfinches. These often occurred in association with smaller numbers of Skylarks, Reed Buntings and Yellowhammers. Lesser Redpoll was fairly widespread throughout the area.

Redwings and Fieldfares, both wintering thrushes, occurred scattered in the fields and hedgerows and were often in the presence of Blackbirds and Song Thrushes. Flocks of Woodpigeons were widespread, along with the common crow species (Jackdaw, Rook and Hooded Crow).

Kestrel, Sparrowhawk and Buzzard were recorded throughout the area.

Snipe (usually single birds) were flushed regularly from pasture fields, especially the wetter fields. Mallard, Moorhen and Grey Heron occurred scattered in small numbers along the Yellow River channel.

Species	22-11-12	21-12-12	4-2-13	Comment
Grey Heron	2	4	2	
Mallard	8	3	10	Scattered along channels/wet fields
Buzzard	1	2	2	Coolville and Carrick
Sparrowhawk	1	1	2	
Kestrel	1	1	1	
Moorhen	2	1	3	
Snipe	4	7	3	Well scattered in wet fields
Skylark	14	22	8	Mostly in arable fields
Meadow Pipit	P	P	P	
Pied Wagtail	P	P	P	
Grey Wagtail	3	3	1	Associated with watercourses
Wren	4	P	P	
Robin	P	1	1	
Stonechat	1	1	2	
Blackbird	P	P	P	
Fieldfare	20	200+	150	
Song Thrush	P	P	P	
Redwing	60	120	400+	
Mistle Thrush	4	-	2	
Goldcrest	P	P	P	
Blue Tit	P	P	P	
Great Tit	P	P	P	
Coal Tit	P	P	P	
Long-tailed Tit	12	7	14	
Magpie	P	P	P	
Hooded Crow	P	P	P	
Raven	1	-	2	
Chaffinch	P	P	P	
Goldfinch	P	P	P	
Linnet	14	4	20+	
Lesser Redpoll	P	P	P	
Bullfinch	2		5	
Yellowhammer	7	11	6	Arable fields east of R400
Reed Bunting	8	12	6	

Table 5.7. Winter occurrences of species recorded within Yellow River wind farm study area during surveys in winter 2012/2013.

Numbers refer to the peak in each survey session. Widespread and common species are listed as present. Red and Amber listed species (after Lynas et al 2007) are highlighted. (Note that data on swans and grassland feeding waders are presented separately)

5.4.3 Evaluation of Conservation Importance of Study Area

Habitats and flora

None of the terrestrial habitats within the study area are rated as of more than Local Importance (higher value). The most important terrestrial habitat is the strip of raised

bog at Derryiron as this represents an EU Habitats Directive Annex I habitat with priority status. However, the bog is highly compromised due to intense turbary activity. Other habitats which are of some conservation value (Local Importance, local value) include the area of remnant bog adjoining the location for T7, the stand of bog woodland at T11, and the various hedgerows and treelines.

Fauna

The site supports a fairly typical mammalian fauna. The presence of otter on the Yellow River is of particular note as Otter is listed in Annex II and Annex IV of the EU Habitats Directive. Otter is also listed as 'Near threatened' in the Irish Red List. The Irish Hare is listed in Annex V of the Habitats Directive. The Common Frog, a widespread species throughout the site, is listed on Annex V of the Habitats Directive.

Common name	Scientific Name	Habitats Directive Annex No.	Wildlife Act 1976 and Amendment 2000	Irish Red List Status (after Marnell et al. 2009 or et al. 2012)
Badger	<i>Meles meles</i>	-	P	Least concern
Otter	<i>Lutra lutra</i>	II, IV	P	Near threatened
Hedgehog	<i>Erinaceus europaeus</i>	-	P	Least concern
Irish Hare	<i>Lepus timidus hibernicus</i>	V	P	Least concern
Pygmy Shrew	<i>Sorex minutus</i>	-	P	Least concern
Common pipistrelle	<i>Pipistrellus pipistrellus</i>	IV	P	Least concern
Soprano pipistrelle	<i>Pipistrellus pygmaeus</i>	IV	P	Least concern
Daubenton's bat	<i>Myotis daubentonii</i>	IV	P	Least concern
Leisler's bat	<i>Nyctalus leisleri</i>	IV	P	Near threatened
Natterer's bat	<i>Myotis nattereri</i>	IV	P	Least concern
Whiskered bat	<i>Myotis mystacinus</i>	IV	P	Least concern
Long-eared bat	<i>Plecotus auritus</i>	IV	P	Least concern
Common Frog	<i>Rana temporaria</i>	V	P	Least concern
Common Lizard	<i>Zootoca vivipara</i>	-	P	Least concern

P= Protected under Wildlife Act (1976) and Wildlife [Amendment] Act (2000)

Table 5.8 Legal status of protected fauna encountered or considered likely to occur within the study area.

The bat survey confirmed the presence of six bat species on-site and others may be expected to occur on occasion. All bat species are legally protected and are listed on Annex IV of the Habitats Directive. Leisler's bat is listed as 'Near threatened' in the Irish Red List.

The Common Frog, a widespread species throughout the site, is listed on Annex V of the Habitats Directive.

Birds

Species are classified as of conservation importance on the basis of the following criteria:

- EU Birds Directive, Annex I
- Birds of Conservation Concern Red List (High conservation concern) or Amber List (Medium conservation concern), after Lynas et al. (2007)

A summary of the species of conservation importance recorded on site is given in Table 5.9.

Species	EU Birds Directive Annex 1	Birds of Conservation Concern in Ireland: Red List	Birds of Conservation Concern in Ireland: Amber List
Little Grebe			X
Great Crested Grebe			X
Whooper Swan	X		X
Teal			X
Tufted Duck			X
Hen Harrier	X		X
Kestrel			X
Lapwing*		X	
Golden Plover	X		X
Snipe			X
Black-headed Gull**		X	
Stock Dove			X
Swift			X
Skylark			X
Sand Martin			X
Swallow			X
Wheatear			X
Starling			X
House Sparrow			X
Linnet			X
Yellowhammer		X	

- * only breeding Lapwing are Red listed
- ** colony of Black-headed Gulls is off-site

Table 5.9. Bird species of conservation importance recorded on site, 2010-2013

While a total of 21 species of conservation importance was recorded on site, the majority of these are in the Amber list category only (i.e. of medium conservation concern in Ireland).

Three of the species of conservation importance are listed as EU Birds Directive Annex I species. The presence of both Whooper Swan and Golden Plover is significant as these species occurred within the Derryarkin sector of the study site on a regular basis. While the numbers of birds involved are substantial, the recorded peaks of 82 Whooper Swans and 1,200 Golden Plover do not reach the respective national importance thresholds of 130 and 1,700 for these species (after Boland & Crowe 2012). The sighting of a Hen Harrier is not surprising as wintering Hen Harriers occur sparsely within this wider area. The late date (26th March) would suggest the bird was on its way to the breeding grounds (probably the Slieve Bloom Mountains). The site does not have significant potential to support winter roosting Hen Harriers.

Lapwing, a Red list species, attempts to breed on site annually (Derryiron bog area) but is unlikely to be successful due to a high level of turbary activity. A Black-headed Gull colony (Red list species) of national importance occurs on the large Roadstone quarry lake close to the Derryarkin sector of the site.

Yellowhammer, a further Red List species, breeds in the area of mixed agricultural land to the east of the R400. While scarce in many areas of Ireland, Offaly is within the main range for this species. Stock Dove and Skylark, both Amber list species, occur in similar habitats as the Yellowhammer, while House Sparrow and Starling are often found breeding in the vicinity of farmsteads. During winter, Starlings occur in large flocks on improved pasture at Derryarkin.

Linnet breeds on site and also occurs in winter. Swallow breeds in buildings and may also be seen feeding over the various fields throughout the area.

Three of the Amber listed species, Little Grebe, Great Crested Grebe and Tufted Duck, were found only on the Kilmurray quarry ponds, which is also the location that supports a breeding colony of Sand Martins.

The other Amber listed species, Kestrel, Swift and Wheatear, use the site for feeding and probably breed elsewhere.

5.5 POTENTIAL IMPACTS OF THE DEVELOPMENT

5.5.1 Construction Phase

Loss of Habitats

The entire development will result in a permanent loss of habitats (i.e. covered by hardcore) estimated at 20.58 ha total. As well as the actual loss of habitats, adjoining areas will be disturbed to some extent to accommodate the construction works. Also, there will be loss of existing habitats for temporary facilities, mainly the contractors construction lay down area and storage area.

The principal habitats affected by construction of the wind farm will be improved grassland and arable land in active agricultural use. Such habitats are not of conservation value.

Turbines T8, T9 and T10 are on bare peat in an area of recent and ongoing turbary and this habitat is not of conservation value (see Plate 4).

Turbine T7 is located along the western margin of an area of remnant bog (see Plate 6). The construction of the turbine and hardstand may impinge slightly onto the bog but this would be a very localised effect. Taking the relatively low ecological value of this bog remnant into account, the impact is not rated as of significance.

Five of the turbines will be in commercial forestry which is not of conservation value.

One turbine, T30, is in a field that is partly wet grassland. This is dominated by rushes and is of negligible conservation value.

One turbine, T11, is within an area of bog woodland at Derryiron (see Plate 9). Construction will require clearance of an area of 1.5 ha of woodland and scrub. This woodland is rated as of Local Importance (lower value) and the impact by the construction of the turbine will be significant.

The roads will largely be over agricultural land or along existing roads and tracks. Where the road runs perpendicular through a hedgerow, a section of approximately 8 m width will be cleared and if it is diagonally through it would need to be about 15m. In places, however, especially where existing roads need to be upgraded, longer strips of hedging will be removed. In total, it is estimated that the construction of the roads will require approximately 37 intersections with roads, along with the removal of hedging from along one side of a parallel track in at least two locations. This will result in the removal of 1,380 m of hedgerow and treeline (and associated drainage channels). The hedgerows, treelines and drainage channels are considered of importance in a local context and the estimated loss is rated as a significant impact.

Other Impacts on Habitats

In addition to habitat loss there will be disturbance to adjoining areas of habitats around the construction work areas, though this can be minimised with care. While there are no additional sensitive habitats which would be disturbed, care is required at the following:

- T7 construction site to minimise disturbance to the adjoining area of remnant bog
- T11 construction site to minimise disturbance to remainder of bog woodland

The excavations for T7 may affect the hydrology of the adjoining remnant bog though, as already noted, this bog has been disturbed in the past by cutting and/or heavy burning and grazing and there is presently no Sphagnum layer. If localised drying was to occur as a result of the works, robust species such as ling heather (*Calluna vulgaris*) and deer sedge (*Trichophorum cespitosum*) would probably increase in frequency.

As the soil throughout the site is peat, it is expected that areas of bare peat along the access tracks and around the turbine bases and other infrastructure will quickly become colonised by a range of rushes and grasses, with soft rush (*Juncus effusus*), bulbous rush (*Juncus bulbosus*) and bent grasses (*Agrostis* spp.) typically prominent. Alternatively, some of the disturbed areas may be replanted with agricultural grass.

Potential Impacts on Birds of Conservation Importance

Impacts on Annex I and Red Listed bird species

Whooper Swan (Annex I species)

The winter surveys showed that Whooper Swans visit the Derryarkin sector of the site on a regular basis through the winter and at times in significant numbers (though not at national importance level)..

All apart from one flightline recorded were movements within the site or to local roost and/or feeding sites (see Figure 5.5).

The swans using the site could be affected in a number of ways, as follow:

Disturbance during construction

Construction works on Turbines 1 to 7 would almost certainly deter swans from using the feeding fields at Derryarkin. This would be a significant impact for the local swan population which was heavily dependent on these fields in December 2012 and January 2013.

This impact can be avoided completely by restricting works in this sector of the site to the April to October period inclusive.

Permanent loss of habitat

The footprint of turbines T3 to T6, which are the ones on improved pasture used by swans, is 0.924 ha. This is a very small area of the grassland available to the swans in the immediate area and would not have a measureable negative impact.

Displacement from feeding areas and roost sites

Birds' avoidance responses to wind farms vary within and between species, but swans and geese are considered sensitive to these developments because they frequent open landscapes (Hotker et al. 2006). In a major review of the impacts of wind farms on swans and geese, Rees (2012) recorded displacement distances of 200-560 m for

swans. She notes, however, that long-term post-construction studies, and thus information on whether birds adapt to the change in landscape, are rare. Reference is made to one such study by Fijn et al. (2012) which specifically analysed the proportion of swans wintering in the vicinity of a wind farm before and after construction. This study found a significant drop, post-construction, in the proportion of wintering Bewick's Swans using the area where wind turbines had been installed in Polder Wieringermeer, the Netherlands (from 1,099 to 530 birds). The study found evidence of habitation, with swans feeding closer to the turbines later in the study, but with fewer birds overall present in the study area. A further long-term post-construction study on whether birds adapt to the change in landscape found that Pink-footed Geese at sites in Denmark grazed closer to wind turbines c.20 years after construction than 10 years previously (Madsen & Boertmann 2008). The study also found that the geese remained at a greater distance from the larger turbines.

Based on the international literature and the large size of the proposed turbines, it would seem probable that swans will avoid feeding within an area of at least 200 m (but possibly up to 500 m) of each turbine at least in the early operational phase. The relevant turbines are as follows:

- T2 – while turbine is on edge of conifer plantation, suitable grassland for feeding also occurs within a 200-500 m radius of the turbine
- T3 – turbine is within suitable grassland for feeding, with wet cutaway bog within 500 m radius to north
- T4 – turbine is within suitable grassland for feeding
- T5 – turbine is within suitable grassland, with wet cutaway bog within 500 m radius to north and west
- T6 – turbine is within suitable grassland, with scrub dominated cutaway bog (not suitable for feeding) within 500 m radius to north

Two of the turbines (T1 & T7) at Derryarkin are not in areas likely to be used by swans, as follows:

- T1 is within a conifer plantation and the swans would be unlikely to graze on grassland close to the forest edge
- T7 is located alongside remnant bog in the extreme eastern sector of a group of large fields which are used by swans. The remnant bog would not provide suitable feeding. While grassland occurs to the south and west, this is close to an access road and no swans were recorded here during the winter surveys.

It is probable that the wintering swans will no longer use the Kilmurray quarry ponds for roosting due to the proximity of two of the turbines (T4 & T6) but the larger Roadstone quarry to the north is unlikely to be affected as the nearest turbines (T5 + T6) are more than 500 m from it.

Overall, it is expected that feeding swans will be displaced from suitable grassland and wet bog feeding habitats around five of the turbines and that the Kilmurray quarry ponds may no longer be used as a roost site. It is not known whether, or in what space of time, the swans may habituate to the presence of the turbines and, indeed, Rees (2012) highlighted the need for post-construction studies in this respect.

While the impact of potential displacement from feeding habitat and a roost site is significant for the local swan population, the following points are noted:

1. The Derryarkin area is not a natural or traditional wintering site for swans and it can be assumed that they are only present in this area because of the presence of intensive agricultural land for feeding and man-made quarry ponds for roosting.
2. There is already a significant level of disturbance in these fields due to regular farming and quarrying activities and the swans seem to have no problem resorting to other feeding sites in the wider area when disturbed.
3. Even without allowing for a degree of habituation to the presence of the turbines, there will still be substantial areas of improved grassland available to provide feeding in the immediate area. It is the intention of the local landowners to continue the current farming practices at all grasslands in the vicinity of T2 to T6 (excluding those used as part of the wind farm and those lands required to facilitate continuation of the commercial quarry activity),

and therefore the lands will continue to be agricultural grassland, basically a well-managed, low sward (see mitigation section).

Barrier effect

Rees (2012) cites eight published studies of flight behaviour which reported changes in flightlines for swans or geese initially seen heading towards turbines, at distances ranging from a few hundred metres to 5 km (the larger distances were by birds on migration); 50-100% of individuals/groups avoided entering the area between turbines, but in some cases the sample sizes were small. One of the studies, from the Hellrigg wind farm in the UK (cluster of four 80 m turbines), involved Whooper Swans with an estimated avoidance distance of >200 m. Commenting on studies to assess the barrier effect, Rees writes “*Avoidance of turbines should be related to whether or not flights were initially in line with the wind farm, rather than in relation to all bird movements in the area, as including the latter artificially boosts sample sizes used for calculating avoidance rates.*”

As Derryarkin is not within a regular flight line by Whooper Swans, such as a route used by migrating birds or by birds commuting from a roost to a feeding site (or vice versa), it is considered that a potential ‘barrier effect’ impact is not relevant in this case. It is also noted that the layout for the proposed turbines is not on a linear plan or involves small clusters and that the turbines will be in the region of 500 m apart, which would encourage flying birds to pass between them.

Collisions with turbines

Jenkins et al. (2010) notes that theoretically, relatively large, heavy and socially interactive birds (e.g. swans and geese) are more susceptible to collision than small, light and relatively large-winged birds with acute vision. In a review of impacts of wind farms on swans and geese, Rees (2012) found that 72 swans or geese were reported as collision victims at 46 wind farms, but most (39 birds) were reported at 23 German wind farms where such data are collated, and even there only usually for c. 1 year post-construction. Two of the casualties were Whooper Swans, 25 were Mute Swans and four were unidentified swan species. While the review by Rees demonstrates that collisions do occur, she points out that swans and geese have good eyesight and that the review indicates that high levels of avoidance do occur.

During the short days of the mid-winter period, and especially during cold weather, Whooper Swans attempt to maximise available time spent feeding – this was well demonstrated during the present study when the swans continued to feed in virtual darkness and sometimes their departure from the fields only detected by their calls. For Whooper Swans, Brazil (2003) notes that during their typical very low-altitude flights between roosting and foraging sites they are, particularly in poor light, very much at risk from objects such as telephone and power lines and trees. Collisions are a particularly significant cause of swan mortality, accounting for 33-44% of casualties (Brazil 2003). It is noted, however, that most of the recorded collisions were with power lines or cables which the birds just cannot see. Although swans have a wide field of monocular vision to each side, suitable for detecting disturbance in any direction, they have only a narrow zone of binocular vision to the front and rear, and it appears they are rather poor at detecting thin horizontal objects ahead of them.

At Derryarkin, it is considered that swans feeding in local fields would be highly aware of the presence of the turbines in daylight and during normal weather conditions. Also, local flights within the feeding fields and to or from the night roost sites would normally be at low levels (less than 30 m) and well below the rotor sweep of the turbines (51.5 m distance from ground to blade sweep). Indeed, Larsen and Clausen (2002) found that on the basis of recorded heights of flocks in flight, wind parks with medium-sized turbines posed a greater risk than those with large rotors. From the available evidence, it is concluded that at Derryarkin there is some risk of collision with the turbines mainly when swans are commuting between feeding and roost sites in poor light or perhaps inclement weather. However, the risk is rated as being low because of the typical low altitude of the flight lines compared to the height of the rotor sweep. Mitigation to minimise the risk is suggested by the use of hazard warning lights on turbines 1 to 7 to make them more visible to the swans.

There will be no overhead power lines associated with the turbines and hence no risk of colliding with lines.

Golden Plover (Annex I species)

The winter surveys showed that Golden Plover visit the fields in the Derryarkin and, to a lesser extent, the Derryiron sectors of the site on a regular basis through the

winter and at times in significant numbers (peak of c.1,200). The birds use the fields for feeding purposes.

As with the Whooper Swans, construction work during the winter period is likely to cause disturbance to the Golden Plover. This can be easily mitigated by restricting works in this sector of the site to the April to October period inclusive (restrictions at Derryiron are not considered necessary as plover were recorded in these fields on only 3 occasions during the winter and in relatively small numbers).

Loss of potential feeding habitat is not considered a significant issue as the loss is very small in relation to the size of the fields.

While the issue of potential displacement from a zone around turbines has been raised in locations where Golden Plover breed, it seems that displacement has not been identified in the international literature as an issue with wintering birds. It would seem unlikely that flocks of wintering birds would avoid areas with turbines and, indeed, flocks of Golden Plover regularly utilise fields with large pylons carrying electric lines.

Similarly, the issue of collision appears not to have been identified in the literature as an issue for wintering Golden Plover using grassland fields. As Golden Plover are small, light-weight birds with excellent manoeuvrability, it is considered that the risk of collision is negligible or at most low, and unlikely to be significant at the population level.

Hen Harrier (Annex I species)

The winter surveys recorded a single male Hen Harrier foraging close to the proposed T7 location but did not detect the presence of any winter roosts on site or in surrounding areas. Hen Harrier is likely to be an occasional visitor to the wider area and will forage across farmland as well as semi-natural habitats such as cutover bog, wet grassland, scrub and woodland. Most foraging in winter is at low altitudes (invariably less than 20 m) and well below the rotor sweep of the turbines (51.5 m above ground level).

On the basis that Hen Harrier is at most a scarce and occasional winter visitor to the site, and taking into account the typical low height of foraging birds, it is not expected

that the presence of the turbines would have a deterring effect on the movement of Hen Harriers in the area or would pose any significant risk of collision.

Lapwing (Red List species)

The baseline surveys showed that Lapwing (1 pair) attempts to nest on the cutaway bog at Derryiron on an annual basis. However, success is extremely unlikely due to the high degree of disturbance from turbary activities in recent years.

Construction works for T8, T9 and T10 would cause disturbance to prospecting or nesting birds from March through to possibly July (should nesting be successful). Mitigation is required to ensure that the works do not interfere with a nesting attempt.

Black-headed Gull (Red List species)

A Black-headed Gull colony of national importance occurs on an island in the Roadstone quarry lake to the north of the Derryarkin sector of the site. Occasional sightings of Black-headed Gulls were made on the proposed wind farm site, especially at the Kilmurray quarries.

T5 (the nearest turbine) is at an approximate distance of 600 m from the breeding colony and it is possible that disturbance from noise and/or the visual presence of workers etc could be caused to the birds during construction works at this turbine in the period April to July. However, disturbance from construction activities at such a distance is unlikely to be significant, especially as there will be no access by workers or machinery anywhere near the nesting area. Further, there is already substantial background noise from quarry activities, Bord na Móna rail traffic and nearby motorway traffic.

As a group, gulls are not considered to be in the high risk collision category as they normally have a relatively slow, buoyant flight with good manoeuvrability.

Yellowhammer (Red List species)

Generally, wind farm developments can be expected to have fewer effects on passerine species than on waterfowl or birds of prey (Devereux *et al.* 2008). While Yellowhammers will experience some loss of habitat (arable land, hedgerows), the

amount involved is hardly significant in the context of the wider area and is not expected to affect the local Yellowhammer population. The presence of the operational turbines is unlikely to deter Yellowhammers from using the local fields.

Impacts on Amber Listed bird species

Four of the amber listed birds (Little Grebe, Great Crested Grebe, Teal & Tufted Duck) are aquatic species associated with the Kilmurray quarry ponds. Impacts on these species by the proposed development (either during construction or operation) are considered unlikely.

Snipe occurs widely through the site area during winter and is not expected to be affected by the proposed development.

Potential Impacts on Terrestrial Mammals

Otter

The assessment for Otters showed that they occur along the main channel of the Yellow River though may also use tributary streams.

As the development includes a 50 m buffer from all main river channels, and requires strict measures to maintain water quality, it is considered that Otters will not in any way be affected by the proposed wind farm and will continue to utilise the site during and after construction.

Where crossing points over rivers and streams are required, bridges or open bottom culverts will be used which will not impede the movement of otters.

Badger

Badgers are considered to be widespread in the area. Principal impacts by the proposed development are loss of feeding habitat and possible disturbance to setts.

The loss of relatively small amounts of pasture and arable habitats, which provide feeding habitat for badgers, is not considered a significant impact as such habitats occur abundantly throughout the study area.

While the present surveys did not indicate the presence of badger setts at the turbine locations within fields, further assessment is required at turbines located in woodland and also along sections of the road which need to be upgraded (see mitigation). Any disturbance to a badger sett would require appropriate mitigation.

Other mammal species

Apart from temporary disturbance in immediate work areas, the proposed development would not be expected to have any significant adverse impacts on the other mammal species which inhabit the site and surrounding areas.

All the species recorded, or considered likely to occur, would be expected to continue to be found in the area after construction of the wind farm is complete.

Potential Impacts on Bats

The most favourable bat habitats on-site are the deciduous woodlands, larger watercourses and their riparian vegetation, scrub areas and tree-lined minor roads, all of which offer shelter for swarming insects on which bats feed. The areas of bog (intact, degraded and recolonising) are windswept, open landscapes that are poor for these animals although sheltered areas of scrub within the bogs may be reached by bats by following drainage channels or nearby hedgerows. The present survey of bat activity within the study area has confirmed the presence of six bat species on-site and others may be expected to occur on occasion. Apart from one, each of the bat species confirmed or expected on-site are normally low fliers, e.g. <10m above ground level, and as such are considered to be at a low risk from turbine impacts. The exception is Leisler's bat which is a high-flying species and as such is of most concern.

Leisler's bat is classified as a *high risk* species in relation to wind turbines as it is a high flier (Carlin and Mitchell-Jones 2009), which travels considerable distances (up to 13.4km has been recorded in Ireland, Shiel *et al.* 1999) between roosts and foraging areas. The species has evolved for fast flight in excess of 40km/h (Dietz *et al.* 2007) and is less manoeuvrable as a consequence. It therefore avoids cluttered environments by keeping above the tree canopy normally flying between 10m and 70m above the ground (Russ 1999) but which has been known to reach heights of

500m (Bruderer and Popa-Lisseanu 2005). Flying at such heights potentially brings it into conflict with wind turbines.

In mainland Europe and North America, evidence of bat collisions has led to growing concern about the siting and operation of wind turbines. The most serious incidents have involved bat species that fly very high and for long journeys, particularly species on long distance migrations. Many of these overseas turbine / bat mortality studies are at wind farms with significantly large numbers of turbines, sited along known bat migration routes where many hundreds or even thousands of bats commute seasonally resulting in numerous deaths and injuries. There is currently no evidence that mortality of bats on the same scale occurs in Ireland and indeed such mortality would not be expected as Ireland does not support comparable bat migrations.

Additionally, there is some international evidence that barotrauma, which involves tissue damage to air containing structures caused by rapid or excessive pressure change, rather than collision may be a contributory factor where bat mortalities have been recorded.

Wind turbines are a known risk to bats (for example see Arnett *et al.* 2008 & Baerwald *et al.* 2008, Johnson *et al.* 2003) and the *EUROBATS Secretariat* has recently published guidelines on bats and wind farm projects (Rodrigues *et al.* 2008) to ensure bats are considered as part of development proposals. Currently, these are the only applicable guidelines for bats and wind farms/turbines for Irish wind farm and turbine developments as the Irish Government has yet to produce national guidelines. However, *Bat Conservation Ireland* published wind turbine/wind farm development bat survey guidelines in December 2012 (Version 2.8).

Adjudged likely impact of the proposed development on bats

The planned wind farm development is to be sited within an area of bog and agricultural grasslands currently over-flown by Leisler's bat and whose woodland, scrub, hedgerow, treeline and watercourse habitats are currently in use by at least six bat species. Although there are no published results of a study of bat mortality from Irish wind turbines, considering recent research from mainland Europe and North America, there is an increasing amount of detailed published evidence that wind turbines cause bat fatalities. However, many of these turbine/bat mortality studies are

at wind farms with significantly large numbers of turbines and often sited along known bat migration routes where many hundreds or even thousands of bats commute seasonally resulting in numerous deaths and injuries. There is currently no evidence that mortality of bats on the same scale occurs here. Also, although it is known that Nathusius' pipistrelle migrates from Scandinavia to Scotland and to the north of Ireland and back again (Russ et al. 2001), apart from this species, there is currently no evidence that internal or external bat migration routes of other bat species exist elsewhere in Ireland. Nevertheless, risks to bats from wind turbines have to be acknowledged and it is possible that some bat mortality may occur due to the planned development. Mitigation measures are therefore recommended to reduce the likelihood of adverse impacts on local bat populations.

Potential Impacts on Amphibians and Reptiles

The Common Frog is widespread throughout the site where suitable standing water occurs. The construction and operation of the wind farm is not expected to have any adverse impacts on the local frog population.

The Common Lizard is likely to be found on areas of bog throughout the study area. The construction and operation of the wind farm is not expected to have any adverse impacts on the local lizard population as none of the bog areas within the site will be affected.

Potential Impacts on Designated Sites

As no part of the development site is within, or adjoins, a designated area, and as the nearest designated site (Black Castle Bog NHA) is a distance of just over 2 km away, it is concluded with certainty that the proposed development will not have adverse impacts on any Natural Heritage Area or proposed Natural Heritage Area.

Possible impacts on all Natura 2000 sites within a distance of 15 km of the development site are considered in the accompanying Appropriate Assessment Screening report.

Cumulative Impacts with Other Wind Farms

Mount Lucas wind farm is located approximately 10 km south of the proposed Yellow River development. Mount Lucas is currently under construction and comprises 28 turbines with an output of 79.2 MW.

Apart from Mount Lucas, there are no other wind farms in the wider area (next wind farms are Carrig and Skehanagh in Co Tipperary, approximately 65 km to the southwest).

As there is a substantial distance between the development site and Mount Lucas, and considering the generally low terrestrial ecological interests of the area, it is concluded that there would be no significant cumulative impact on terrestrial ecological interests as a result of the proposed development.

5.6 MITIGATION MEASURES

5.6.1 Construction Phase Mitigation

Mitigation by Avoidance

Habitat Avoidance

Mitigation by avoidance, which is the most effective method of mitigation, has been followed in this project as far as was feasible. The following specific measures to preserve habitats of conservation importance influenced the final layout of the scheme:

- Exclusion of turbines from the strip of intact (but partly drained) raised bog at Derryiron.
- Relocation of T7 to the margin of the bog remnant (away from the central area).

Measures to Maintain Habitat Integrity

The following measures will be taken to ensure that habitat integrity is maintained as far as is feasible.

T11 location

As this turbine is within an area of bog woodland, care is needed to minimise the construction footprint. At the start of construction, the required work area will be marked out and fenced so as to prevent accidental incursions into the adjoining woods. An ecologist will inspect the site in the company of the project engineer.

T7 location

As this turbine is along the margin of a bog remnant, care is needed to minimise the construction footprint. At the start of construction, the required work area will be marked out and fenced so as to prevent accidental incursions into the bog. An ecologist will inspect the site in the company of the project engineer.

Hedgerow and tree removal

Care will be taken to minimise the removal of hedge sections and trees and also to prevent disturbance to root systems.

Hedgerow and tree replacement

The permanent removal of hedgerows and trees (mostly for road construction) will be compensated for by a replanting scheme using similar species (though native species will be used instead of exotics such as sycamore). Suggested species include ash (*Fraxinus excelsior*), hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*), native holly (*Ilex aquifolium*), and oak (*Quercus robur*).

It is proposed that an area of land equivalent to that being lost by hedgerow removal will be added to the total area of land to be acquired for commercial forestry replanting. With an estimated length of 1,360 m of hedgerow removal, and taking an average hedge width of 6 m, it is calculated that 8,160 m² will be required to compensate for hedgerow loss.

Compliance with the Wildlife Acts

Section 40 of the Wildlife Act 1976, as amended by Section 46 of the Wildlife (Amendment) Act 2000, restricts the cutting, grubbing, burning or destruction by

other means of vegetation growing on uncultivated land or in hedges or ditches during the nesting and breeding season for birds and wildlife, from 1 March to 31 August.

The above restrictions will apply to the removal of all trees, hedging and areas of woodland or scrub.

Should clearance be required within the closed season, advice will be sought from the National Parks & Wildlife Service.

Measures for breeding Lapwing

Should works be commenced on the cutaway bog at locations for T8, T9 & T10 during the period March to July, a survey for nesting Lapwing will be carried out. Should a breeding territory be found, works will be delayed in an area of up to 500 m from the nest location until the nesting attempt is complete (as determined by further survey).

Measures for Whooper Swans

Seasonal restrictions on construction

Construction of turbines 1 to 7 will be outside of the period November to March (inclusive) so as to avoid disturbance to wintering swans.

Use of warning lights on turbines

Hazard warning lights (similar to aircraft warning lights) will be placed on the hubs of turbines 1 to 7 so as to minimise risk of collision during poor light conditions or inclement weather (fog etc.). These lights will be in use from November to March inclusive. It is recommended that the lights should be programmed to come on for 90 minutes before and after sunset and for 90 minutes before and after sunrise.

Maintenance of grassland for feeding swans

As discussed, it is considered likely that the Whooper Swans will avoid feeding in areas close to the turbines. The avoidance distances may be from 200 m (or even less)

to possibly up to 500 m, though these distances are likely to diminish as the birds become accustomed to the presence of the turbines.

As the fields presently provide optimum feeding for the swans, it is the intention of the local landowners to continue the current farming practices at all grasslands in the vicinity of T2 to T6 (excluding those used as part of the wind farm and those lands required to facilitate continuation of the commercial quarry activity), and therefore the lands will continue to be agricultural grassland, basically a well-managed, low sward, which will provide feeding for Whooper Swans.

Monitoring of swans

The usage of the Derryarkin fields by wintering swans, including the benefits of the mitigation measures outlined above, will be monitored in the winter prior to construction and then for a period of up to 5 years post construction. Particular attention will be given to the distances feeding swans approach to the turbines. Flight lines to and from the site will be recorded. The population will be monitored in the context of the wider population (similar to the surveys as carried out for the present project). These monitoring reports will be submitted to NPWS on an annual basis.

During the surveys, other wetland birds on site, and particularly Golden Plover, will be recorded.

Measures for Otters

As adverse impacts on otters are not anticipated, specific mitigation measures are not considered necessary.

The measures being taken by the project to maintain local water quality and to provide unhindered access for fish along watercourses, will suffice for the needs of otters.

Measures for Badgers

Badger presence on site was established during the baseline surveys, including the presence of one large sett at Derryarkin farm. However, dense vegetation precluded

search in the bog woodland at the T11 location and in the conifer plantations. Also, the hedgerows to be impacted for road construction were not assessed.

As required under the Wildlife Acts, mitigation is required to ensure that active setts are not disturbed. The following approach is recommended:

Prior to hedge or tree clearance, a survey for presence of badgers will be carried out in the vicinity of the impact locations by an ecologist with experience of badger survey. This will be done during the period November to April when vegetation cover is low. This survey will identify signs of badger presence and will aim to establish the general locations of setts (if any).

Depending on the results of the survey, the ecologist will recommend mitigation as considered necessary (within the context of the Wildlife Acts). If a sett(s) is found, mitigation may include application to NPWS for a licence to close active setts that could be disturbed by the works. Note that since closure of active setts is prohibited during the breeding season (December to June inclusive), scheduling of the survey is important to avoid delays.

If the results of the survey are inconclusive due to difficulty of access through woodland, the ecologist may be required to be on site to monitor for setts during the actual tree clearance works. Should an active sett be found then, all works will cease and the ecologist will recommend a procedure to be followed. If sett closure is considered necessary, the approach of obtaining a licence will be followed (and again it is noted that closure of active setts is not permitted during the December to June period).

Measures for Bats

The following specific measures will be followed to protect bats on-site.

Retention of trees

Any trees and treelines along approach roads and planned site access tracks should be retained where possible. Retained trees shall be protected from root damage by machinery by an exclusion zone of at least 7 metres or equivalent to canopy height.

Such protected trees shall be fenced off by adequate temporary fencing prior to other works commencing.

Removal of trees

Trees may be impacted due to construction and upgrading of roads to accommodate the project. Mature deciduous trees, which are to be removed, shall first be inspected for potential bat roosts. Trees shall ideally be felled in the period late August to late October, or early November, in order to avoid disturbance of any roosting bats as per *National Roads Authority* guidelines (NRA 2006a and 2006b). Tree felling shall be completed by mid-November at the latest as bats roosting in trees are very vulnerable to disturbance during their hibernation period (November – April). Trees with ivy (*Hedera helix*) cover, once felled, shall be left intact on-site for 24 hours prior to disposal to allow any bats beneath the foliage to escape overnight.

Lighting restrictions

In general, artificial light creates a barrier to bats so lighting shall be avoided where possible. Where lighting is required, directional lighting (i.e. lighting which only shines on work areas and not nearby countryside) shall be used to prevent overspill. This shall be achieved by the design of the luminaire and by using accessories such as hoods, cowls, louvers and shields to direct the light to the intended area only.

Bridges

Any local bridge proposed for strengthening works prior to use for haulage of construction materials for this development, shall be surveyed for bat presence prior to any upgrading or maintenance works. Bats, especially Daubenton's, regularly use bridges for roosting and are vulnerable within such structures due to infilling of crevices during which they may be entombed. If bats are found within a bridge then some crevices beneath it shall be retained for their continued use according to best practice bat mitigation measures for bridge works (see *Billington and Norman 1997, Highways Agency 2001, Joint Nature Conservation Committee 2004, National Roads Authority 2006a/2006b* and *Shiel 1999*). Any re-pointing or pressure grouting of bridges shall only proceed after an inspection of the structure for bats and, should bats be found, an application for a derogation licence to legally allow works on or near a bat roost shall be made to the *National Parks and Wildlife Service*.

Vegetation-free buffer zone

Bats commuting and foraging along on-site linear features such as hedgerows, treelines and woodland edge boundaries shall be safeguarded by providing a 50 m *minimum* buffer zone between the rotors of planned turbines and the nearest vegetation to reduce the risk of collision and/or barotrauma.

Note that this 50 m buffer distance should be measured from the vegetation to *the tip of the rotor blades*, **not** to the base of the turbine. The following is noted (from Carlin and Mitchell-Jones 2012): *It is incorrect to measure 50m from the turbine base to habitat feature at ground level as this would bring the blade tips very close to the canopy of a tall hedgerow tree and potentially put bat populations at risk. Instead, it is necessary to calculate the distance between the edge of the feature and the centre of the tower (b) using the formula:*

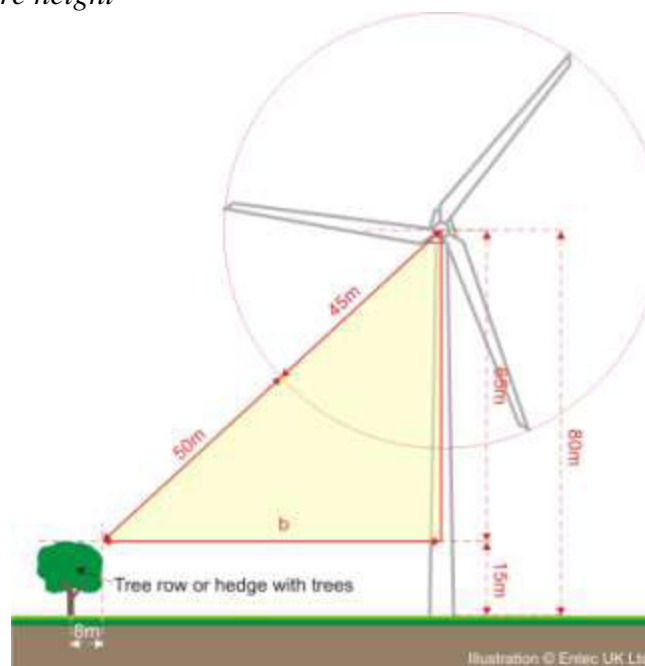
$$b = \sqrt{(50 + bl)^2 - (hh - fh)^2}$$

where, (in metres):

bl = blade length

hh = hub height

fh = feature height



For the example above, $b = 69.3m$

This is in line with current UK (Carlin and Mitchell-Jones 2012) and Northern Ireland guidelines on vegetation-free buffer zones on wind development sites and should prevent impacts to bats that mainly fly low along linear features e.g. the pipistrelles. It should be noted, however, that the EUROBATS guidelines for wind development projects specify that this vegetation-free buffer zone should be a minimum of *200m*. Buffer zones can be provided by either siting a turbine so that its rotors are a minimum of 50 m away from existing vegetation or, if this is not possible, by felling any tree within 50 m of rotors (but any such tree loss should be offset by compensatory planting elsewhere). Such cleared vegetation should be managed and maintained during the operational life of the development.

The proposed locations of turbines 13 and 14 at Coolville are immediately adjacent to the most favourable bat habitat on-site therefore these two turbines especially should be sited as far away as possible (50 m upwards) from the nearest treelines/woodland. Likewise, Turbine 11, at Derryiron, which is proposed to be sited in bog woodland should be positioned as close to the woodland edge as practicable and a 50 m vegetation-free buffer zone should be cleared and maintained around it.

5.7 CONCLUSION

The proposed development site has relatively low ecological interests, with the presence of wintering Whooper Swans and Golden Plover, Otters and various bat species considered the most important features of the area.

It is considered that the careful planning and design of the wind farm layout, along with appropriate mitigation as required, will minimise ecological impacts and all species of conservation importance will continue to have a presence in the area after the works are complete. In particular, it can be objectively shown that none of the designated sites within the wider area of the site will be affected in any way.

It is concluded that the proposed project will not result in any residual significant impacts on the terrestrial ecology of the area.

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www.npws.ie

5.9 AQUATIC ECOLOGY - INTRODUCTION

5.9.1 *Background*

Biosphere Environmental Services has commissioned Conservation Services - Ecological & Environmental Consultants to carry out a freshwater ecological assessment for the proposed wind farm at Rhode, County Offaly.

The aims of the assessment are:

- To assess the present fishery value, invertebrate fauna, aquatic flora, water quality, habitat value and general ecological condition of streams and rivers in the vicinity of the proposed development and provide baseline data against which any future changes can be assessed
- To assess the general status of the streams from an ecological and fisheries perspective in the context of their wider catchment based on survey data, published sources, EPA data, and on consultation with Inland Fisheries Ireland, NPWS and Marine Institute
- To assess the potential impact of the proposed development on water quality and aquatic flora and fauna
- To recommend mitigation measures where potential negative impacts are predicted

Assessment of potential impact on aquatic mammals, amphibians and birds is included in the terrestrial ecology report.

5.9.2 *Relevant Legislation*

The main legal constraints on the proposed development in relation to aquatic flora, fauna, habitats and fisheries are:

The Local Government (Water Pollution) Act, 1977 (and associated regulations)	Prohibits the entry of unlicensed polluting matter into waters
European Communities Environmental Objectives (Surface Waters) Regulations 2009	The Regulations give legal status to the criteria and standards to be used for classifying surface waters in accordance with the ecological objectives approach

	of the Water Framework Directive. The classification of waters is a key step in the river basin management planning process and is central to the setting of objectives and the development of programmes of measures. Waters classified as 'high' or 'good' must not be allowed deteriorate. Waters classified as less than good must be restored to at least good status within a prescribed timeframe. The environmental targets or goals and the programmes of measures to be included in river basin management plans must therefore reflect these requirements.
The Fisheries (Consolidation) Act, 1959 as amended by the Fisheries (Amendment) Act, 1962	Prohibits: 1. The entry of deleterious matter into waters. (Deleterious matter is defined as any substance that is liable to injure fish, their spawning grounds or their food, or to injure fish in their value as human food.) 2. Obstructing the passage of salmon, trout or eels or their smolts and fry 3. Injury or disturbance of the spawn or fry of salmon, trout or eels or to their spawning or nursery areas
Fisheries (Amendment) Act 1999	Requires the regional fisheries board to have regard for the need for the conservation of fish and other species of fauna & flora habitat and biodiversity of inland fisheries and ecosystems. Under this Act the Regional Fisheries Board has the responsibility to protect and conserve all freshwater fisheries within its area of jurisdiction. It is the stated policy of the Regional Fisheries Boards that <i>"every river, stream, canal, lake, pond and reservoir must be regarded as constituting and/or supporting a Fishery under the meaning of the Fisheries Acts unless otherwise regarded by the Boards."</i>
The Freshwater Fish Directive 78/659/EEC as transposed into Irish law under E.C. (Quality of Salmonid Waters) Regulations 1988 (S.I. No. 293 of 1988)	Lays down standards for the quality of designated waters and requirements for monitoring.
The Wildlife Act 1976	Prohibits damage to protected species which includes certain freshwater aquatic species.
The Habitats Directive (92/43/EEC) as transposed into Irish law under the E.C. (Natural Habitats Regulations 1997 (S.I. No. 94 of 1997)	Lists certain species (Annex II) and habitats (Annex I) which require to be protected within SACs. Annex II species include crayfish, salmon, and all three Irish species of Lamprey.
Water Framework Directive (2000/60/EC)	The Water Framework Directive requires the achievement of at least good ecological status and the maintenance of existing status in all surface waters, which in the Irish context is generally taken

	to mean achieving salmonid water quality standards regardless of whether the watercourse is designated under the Salmonid Regulations.
Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage	The Environmental Liability Directive specifies that Member States should, inter alia, establish a civil liability regime whereby operators of specified activities which cause environmental damage are financially liable for remedying this damage. The Directive also aims to hold those responsible for certain activities which have caused an imminent threat of environmental damage liable for taking preventive actions.

Table 5.10 Relevant legislation

5.10 METHODOLOGY

5.10.1 *Selection Of Waterbodies And Sites For Assessment*

All watercourses were assessed which are marked on the EPA mapping of streams (<http://maps.epa.ie/internetmapviewer/mapviewer.aspx>) and which are within 1km down gradient from any part of the proposed wind farm site where works will be carried out. As EPA mapped streams commonly includes streams/drains which are too small to be useful salmonid habitat, and as general guidelines are presented for procedures at any watercourse crossing, the survey is adequate to ensure that all measures necessary to prevent significant impacts are identified. Potentially affected watercourses are shown on Figure 5.7.

5.10.2 *Habitat Assessment*

Habitat assessment was carried out between 25th and 29th of October 2012 and on 13 May 2013.

Stream habitat assessment was carried out on c.23km of stream/river habitat i.e. adjacent to and for at least 1km downstream of all elements of the proposed development which could potentially impact on watercourses. Each watercourse section assessed was examined by boat or by walking and/or wading the channel.

Each section was assessed in terms of:

1. Stream width and depth
2. Substrate type

3. Flow type
4. Dominant bank-side vegetation
5. In-stream vegetation
6. Estimated degree of shade

Salmonid, lamprey and crayfish habitat quality was assessed, taking into account the environmental features 1-6 listed above. Based on these observations and more detailed criteria outlined in Sections 5.2.3 – 5.2.5 below, the value of each river section for the different life stages of salmonids and lamprey and Crayfish was estimated. Locations for identification of habitat assessment locations were recorded as Irish Grid References using a GPS. Photographs were taken to illustrate the habitat quality in each section.

5.10.3 Assessment of Salmonid Habitat Quality

Habitat quality for in-stream invertebrate and plant communities, and for fish, and riparian birds and mammals, is primarily a function of 'naturalness' and diversity. The more diverse the stream habitat in terms of substrate, flow rate, depth, riparian vegetation, light conditions etc., the richer the biological community is likely to be, and the more suitable it is likely to be for salmonid fish (trout and salmon).

Assessment of the quality of salmonid spawning habitat, nursery habitat and adult habitat is based on personal expertise developed over a period of 16 years of electrofishing and on published information such as the following:

1. Favourable locations for salmon spawning are likely to occur where the gradient of a river is 3% or less (Mills 1989).
2. Preferred current velocity for spawning is within the range $25\text{--}90\text{ cm s}^{-1}$, with a water depth in the range $17\text{--}76\text{ cm}$ (Hendry & Cragg-Hine 1997).
3. Typical spawning sites are the transitional areas between pool and riffle where flow is accelerating and depth decreasing, where gravel of suitable coarseness is present and interstices are kept clean by up-welling flow (Peterson 1978, Bjorn & Reiser 1991).

4. Salmon fry and parr occupy shallow, fast-flowing water with a moderately coarse substrate with cover (Symons & Heland 1978, Baglinière & Champigneulle 1986).
5. Deep or slow-moving water, particularly when associated with a sand or silt substrate, does not support resident juvenile salmonids (Wankowski & Thorpe 1979, Baglinière & Champigneulle 1986).
6. Suitable cover for juveniles includes areas of deep water, surface turbulence, loose substrate, large rocks and other submerged obstructions, undercut banks, overhanging vegetation, woody debris lodged in the channel, and aquatic vegetation (Heggenes 1990; Bjorn & Reiser 1991; Haury *et al.* 1995).
7. The juxtaposition of habitat types is also important. The proximity of juvenile habitat to spawning gravels may be significant to their utilisation. In addition, adults require holding pools immediately downstream of spawning gravels in which they can congregate prior to spawning. Cover for adult salmon waiting to migrate or spawn can be provided by overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water and surface turbulence (Bjorn & Reiser 1991).
8. Bjorn & Reiser (1991) suggest that proximity of cover to spawning areas may be a factor in the selection of spawning sites by some salmonid species.

5.10.4 Assessment of Lamprey Habitat Quality

Lamprey habitat preferences change with the stages of their life cycle. They show a preference for gravel-dominated substratum for spawning. After hatching the larvae swim or are washed downstream by the current to areas of sandy silt in still or slow flowing water where they burrow and spend the next few years in tunnels. Lampreys therefore require mainly silt and sand dominated substratum for nursery habitat. Other important environmental characteristics for optimal ammocoete habitat are shallow waters with low water velocity, and the presence of organic detritus and/or plant material. Sub-optimal habitat supporting only a few individuals may consist of a few square centimetres of suitable silt in an open, comparatively high-velocity, boulder-strewn streambed. Spate rivers, with high flow velocities, tend to support fewer ammocoetes because they contain smaller areas of stable sediment (Maitland 2003).

5.10.5 Assessment of Crayfish Habitat Quality

White-clawed crayfish are typically found in watercourses of 0.75 m to 1.25 m deep, but the species may occur in very shallow streams (about 5 cm of water) and in deeper, slow-flowing rivers (2.5 m). The white-clawed crayfish typically occupies cryptic habitats under rocks and submerged logs, among tree roots, algae and macrophytes, although it usually emerges to forage for food. Juveniles in particular may also be found among cobbles and detritus such as leaf litter. Adults may burrow into suitable substrates, particularly in the winter months. In habitats with flowing water the white-clawed crayfish may be found associated with:

1. Undermined, overhanging banks.
2. Sections exhibiting heterogeneous flow patterns with refuges.
3. Under cobbles (juveniles) and rocks in riffles, and under larger rocks in pools.
4. Among roots of woody vegetation, accumulations of fallen leaves and boulder weirs.
5. Under water-saturated logs. (Holdich 2003)
6. Peay (2000) lists the following habitat features as favoured by crayfish:
7. Slow-flowing glides and pools (provided there are refuges), localised velocity of 0.1m/s or less
8. Loose boulders (>25cm) or other similarly sized material
9. Boulders or large cobbles in groups with crevices between them
10. Deep crevices in bedrock
11. Underlying substrate of fine gravel/sand with some pebbles
12. Submerged refuges in stable banks (e.g. natural crevices, stone block reinforcement or stable, slightly undercut banks with overhanging vegetation, large tree roots, etc).
13. Un-mortared stone revetting which protects banks from erosion

14. Stands of submerged and emergent aquatic plants.

5.10.6 Biological Water Quality Assessment

Stream Invertebrate Sampling

The following sampling sites were established for biological water quality assessment (see Figure 5.8).

Sampling Site No.	Grid Reference
A	N 52261 39968
B	N 55371 40800
C	N 51880 35966
D	N 54977 37829
E	N 58130 38620
F	N 55254 38239

A five-minute kick and stone wash sample was taken at each of the water quality assessment sites (ISO 7828:1985). Each sample was retained in a large plastic bag at the sampling site. Sample processing and preservation was carried out under laboratory conditions within 24 hours of sampling. Mud was removed from each sample by sieving under running water through a 500µ sieve. Sieved samples were then live sorted for 30 minutes in a white plastic sorting tray under a bench lamp (ISO 5667-3:1994) and if necessary using a magnifying lens. Macroinvertebrates were stored in 70% alcohol. Preserved invertebrates were identified to the level required for the EPA Q-rating method (Clabby *et al*, 2006) using high-power and low-power binocular microscopes when necessary. The preserved samples were archived for future examination or verification. Based on the relative abundance of indicator species, a biotic index (Q-rating) was determined for each site in accordance with the biological assessment procedure used by the Environmental Protection Agency (Clabby *et al* 2006) and more detailed unpublished methodology (McGarrigle, Clabby and Lucey pers. comm.)

Biotic Index	Water Framework Directive Ecological Status	Quality Status	Condition*
Q5	High	Unpolluted Waters	Satisfactory
Q4-5	High		Satisfactory
Q4	Good		Satisfactory
Q3-4	Moderate	Slightly Polluted Waters	Unsatisfactory
Q3	Poor	Moderately Polluted Waters	Unsatisfactory
Q2-3	Poor		Unsatisfactory
Q2	Bad	Seriously Polluted Waters	Unsatisfactory
Q1-2	Bad		Unsatisfactory
Q1	Bad		Unsatisfactory

*"Condition" refers to the likelihood of interference with beneficial or potential beneficial uses

Table 5.11 Biological Assessment biotic index (Q-rating)

Sampling for water quality assessment was carried out 25th – 27th October 2012 except for Site F which was sampled on 13th May 2013.

5.10.7 Significance Of Potential Impacts

Impacts are defined on the basis of severity of impact on aquatic species and/or habitats. Species protected under national and European legislation are given special consideration. Because of their amenity, commercial and legal status, salmonid fish (trout and salmon) are given special consideration. Assessment of the importance of a potential impact takes into account not only the ecological considerations in the immediate vicinity of the potential impact, but also geographical and wider catchment considerations. If spawning and nursery habitat of a species are limiting factors in short supply in a particular river system, then impacts on them will have an importance out of proportion with their apparent 'face value'.

If an aspect of a proposed development is judged likely to have a measurable negative effect on salmonid fish populations or any rare or protected species, it would be classified as a significant potential impact. The criteria for assessing the significance

of impacts on flora, fauna and fisheries are as follows. (For details of water-body categories see section 5.2.8.)

A Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	SEVERE	SEVERE	SEVERE
Localised	MAJOR	MAJOR	SEVERE	SEVERE

B Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MAJOR	MAJOR	SEVERE	SEVERE
Localised	MODERATE	MODERATE	MAJOR	MAJOR

C Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MODERATE	MODERATE	MAJOR	MAJOR
Localised	MINOR	MODERATE	MODERATE	MODERATE

D Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	MINOR	MINOR	MODERATE	MODERATE
Localised	NOT SIGNIFICANT	MINOR	MINOR	MINOR

E Sites

	Temporary	Short-term	Medium-term	Long-term
Extensive	NOT SIGNIFICANT	NOT SIGNIFICANT	MINOR	MINOR
Localised	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT

Table 5.12 The criteria for assessing the significance of impacts on flora, fauna and fisheries, NRA (2006)

In line with the EPA guidelines (EPA 2002) the following terms are defined when quantifying duration:

- Temporary: Up to 1 year
- Short-term: From 1 to 7 years
- Medium-term: 7 to 15 years

- Long-term: 15 – 60 years
- Permanent: over 60 years

For the purposes of this report 'localised' impacts on rivers are loosely defined as impacts measurable no more than 250 metres from the impact source. 'Extensive' impacts on rivers are defined as impacts measurable more than 250m from the impact source. Any impact on salmonid spawning habitat or nursery habitat where it is in short supply, would be regarded as an extensive impact as it is likely to have an impact on the salmonid population beyond the immediate vicinity of the impact source.

5.10.8 Classification Of Importance Of Freshwaters

Rating

A Internationally Important

Habitats designated as SACs for Annex II species under the EU Habitats Directive. Major Salmon river fisheries. Major salmonid lake fisheries.

B Nationally or Regionally Important

Other major salmonid waters and waters with major amenity fishery value. Commercially important coarse fisheries. Waters with important populations of species protected under the Wildlife Act and/or important populations of Annex II species under the EU

C High Value, locally important

Small water bodies with known salmonid populations or with good potential salmonid habitat, or any population of species protected under the Wildlife Act and/or listed Annex II species under the EU Habitats Directive. Large water bodies with some fisheries value.

D Moderate value, locally important

Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any stream with an unpolluted Q-value rating.

E Low value

Water bodies with no current fisheries value and no significant potential fisheries value. Habitat diversity low and degraded.

NRA (2006)

5.10.9 Limitations Encountered

It was intended to carry out an electrofishing survey as part of the present EIS and a Section 14 permit was obtained to electrofish the potentially affected sections of the Yellow River and Mongagh/Castlejordan River. It was however found that the potentially affected main channels of the Yellow River and Mongagh/Castlejordan River (arterially drained channels) are too deep for the backpack electrofishing method. Inland Fisheries Ireland were consulted in this regard and responded: “*IFI have no requirement for electrofishing as we will assume that In the absence of electrofishing the precautionary principle would be applied and mitigation measures put in place on the assumption that salmonid fish are present.*” (N. McGloin e-mail of 17/5/13).

5.10.10 Characteristics of the Development

The proposed development will include the following key elements, any/all of which could cause negative impacts on the aquatic environment in the absence of adequate mitigation:

- Total site area 1,002.234 ha
- Development footprint 20.58 ha
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands, including turning area, set down area & ancillary crane area
Total Area 1,997m²
- Temporary construction compound, approximately 50 m x 30 m.
- Clear fell of forestry area 1.5 ha per turbine (five turbines T1; T25; T26 and T27 = 6 ha) + T2 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor)
- T11 clear felling 1.5 ha of scrub
- Construction of approximately 18,275 m of new access tracks having a minimum finished width of 5 m with passing bays.
- Upgrading of approximately 5,916 m of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.

- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of an Substation Control Buildings and Compound on site area 1,850 m²
- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings 9
- Upgrade of existing bridges 1

5.11 RECEIVING ENVIRONMENT

5.11.1 *General Catchment Information*

The site of the proposed Yellow River wind farm is located entirely within the south western section of the catchment of the Boyne River, one of Ireland's largest river catchments, draining an area of about 2,500km² in the central and eastern part of Ireland. The potentially affected watercourses are the Mongagh/Castlejordan River and its tributary the Yellow River (See Figure 5.7). The Mongagh/Castlejordan River rises near Tyrrellspass and Rochfortbridge and it flows for 19 km through Co. Westmeath in an easterly direction before joining with the Yellow River just upstream of Clongall Bridge, near Castlejordan. The Yellow River rises north of Daingean Co. Offaly and flows in an easterly direction for approximately 13 miles before entering the Boyne 3 miles above Ballyboggan Bridge. The area of the proposed wind farm in the Yellow River catchment is c. 5km upstream of the River Boyne confluence. The area of the proposed wind farm which drains directly to the Castlejordan River is c. 9km upstream of the River Boyne confluence. The confluence with the River Boyne is c.14km upstream of the section of the River Boyne designated as a Special Area of Conservation.

Fishery Value

The River Boyne is a designated salmonid water under the European Communities (Quality of Salmonid Waters) Regulations of 1988 (S.I. No. 293, 1988). The Boyne

system is listed as a salmon, grilse and brown trout fishery by Whelan (1989). O'Reilly (2002) states: *"(The Boyne) is one of the country's premier game fisheries and both the Boyne and its tributaries offer a wide range of fishing for spring salmon and grilse; sea-trout and brown trout The prime salmon angling water is now found between Navan and Drogheda and on a stretch of the Kells Blackwater immediately upstream of Navan. Nowadays, the river gets very few of big three-sea-winter fish from 20 to 30 lb. These fish generally arrive early in February and March. Smaller spring fish, averaging about 10 lb., arrive in April and early May. Water permitting, the grilse come into the river in July. The river gets a further run of fish in late August and September and this run would appear to last long after the season closes. The river usually gets an excellent run of sea-trout. ... The fishing extends up as far as Slane bridge. Sea-trout have been found as far as Navan and even Trim, but not in sufficient quantities to warrant fishing specifically for them. The River Boyne and its tributaries hold superb stocks of wild brown trout. There is probably more trout fishing now on the main river than before drainage schemes were implemented, but some sections of good fishing were lost on the tributaries. Some rehabilitation works have been carried out."*

O'Grady (1991) states that *"The salmonid populations use this (the Boyne/Blackwater) catchment as a single integrated system. ...Spawning sites for salmon and trout are confined almost exclusively to the tributary catchments - there are very limited gravel deposits in the main channel. The tributaries function as nursery areas for the two salmonid species and the larger of these channels also support substantial populations of resident brown trout."*

O'Grady (1998) states that *"There is a sea trout population in the Boyne. Returning adults are caught by anglers in significant numbers in the lower reaches of the main channel downstream of Navan."*

Inland Fisheries Ireland states: *"The Yellow River has good stocks of Brown Trout. With regard to the Castlejordan or Mongagh River, ... as well as having stocks of Brown Trout, its Rochfortbridge tributary contain good stocks of Salmon"*. (e-mail 1/8/12 from Noel McGloin Inland Fisheries Ireland). The Rochfortbridge Stream was also identified as a salmon spawning area in Mott McDonald Pettit (2009) which states: *"Following consultation with the Eastern Regional Fisheries Board (ERFB), it was confirmed that the Rochfortbridge Stream, which joins the Mongagh River ..., has salmonid spawning potential and adult salmon and salmon redds have been*

observed in the Rochfortbridge Stream.” The Rochfortbridge Stream joins the Mongagh River about 2.5km upstream of the proposed Yellow River wind farm site. Whereas the proposed Yellow River wind farm could not directly impact on this stream, salmon must annually run up the Mongagh river adjacent to the proposed wind farm site to access the stream.

A recent study of trout genetics in the Boyne catchment has found that: “The Mongagh (River) and Kinnegad (River) stocks are ..very different genetically in nature to the populations in tributaries in the middle reaches of the catchment. ...Three tributaries in the upper catchment (Mongagh, Kinnegad and Deel) make no contribution the mixed stock in the main stem angling zone.”

www.fisheriesireland.ie/EREP/brown-trout-genetics-in-the-boyne-catchment.html

Water Quality

EPA biological water quality monitoring data 1971 – 2012 for the Yellow River, Castlejordan/Mongagh River and the main channel of the River Boyne are presented in **Appendix J**.

After the most recent published round of monitoring of the Yellow (Castlejordan) river (2012) EPA concluded: *“Assessment: The Yellow (Castlejordan) River was in a satisfactory ecological condition in the upper (0070) and lower reaches (0300) in September 2012, however the dominance of pollution tolerant macroinvertebrate species indicated continuing unsatisfactory ecological conditions at Garr Bridge (0100).”*

After the most recent published round of monitoring of the Castlejordan River (2012) EPA concluded: *“The complete lack of sensitive macroinvertebrate fauna, dominance of pollution tolerant species, abundant instream macrophyte growth and excessive siltation indicated unsatisfactory poor ecological conditions in the upper reaches (0040) of the Castlejordan river in September 2012. The dominance of pollution tolerant macroinvertebrate species and abundant macrophyte growth continues to indicate moderate ecological conditions at Baltinoran Bridge (0100). Good ecological conditions persist in the lower reaches (0190) however calcification and compaction of the substratum was noted”.*

Ecological Importance

The River Boyne is part of the River Boyne and River Blackwater Special Area of Conservation (SAC No. 2299 see site synopsis in **Appendix J**). The Conservation Objective of the SAC is: “*To maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the SAC has been selected: Lampetra fluviatilis (River Lamprey), Salmo salar (Salmon), Lutra lutra (Otter), Alkaline fens, Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicetum albae)*” (www.npws.ie)

Salmon

The River Boyne and River Blackwater SAC site synopsis states that “*Atlantic Salmon (Salmo salar) use the tributaries and headwaters as spawning grounds. ... Atlantic Salmon run the Boyne almost every month of the year. The Boyne is most important as it represents an eastern river which holds large three-sea-winter fish from 20 –30 lb. These fish generally arrive in February with smaller spring fish (10 lb) arriving in April/May. The grilse come in July, water permitting. The river gets a further run of fish in late August and this run would appear to last well after the fishing season.*”

Lamprey

A survey of Lamprey in the Boyne system (O'Connor 2006) found that “*significant populations of river/brook lampreys occur throughout the River Boyne catchment. It is likely that populations in the lower reaches of the river include Lampetra fluviatilis populations while Lampetra planeri is likely to be the dominant species in more up-river areas. Sea lampreys were not confirmed during the current survey.*” Regarding the Yellow River/ Mongagh River part of the Boyne catchment, O'Connor (2006) states: “*River/brook lamprey (probably Lampetra planeri) were confirmed from this catchment. Lampreys are present at an overall favourable conservation status level.*” Whereas *Lampetra planeri* (Brook Lamprey) are listed in Annex II of the Habitats Directive, the species is not a qualifying interest the River Boyne and River Blackwater SAC which is located c.20km downstream of the proposed wind farm development.

Crayfish

Crayfish (*Austropotamobius pallipes*) were previously widespread in the Boyne system; however Demers & Reynolds (2002) stated that: “no crayfish were found in most of the catchment. They were only present in the Kells Blackwater subcatchment. This may be due to an earlier outbreak of the fungal plague caused by *Aphanomyces astaci*.” Demers & Reynolds (2002) also indicated that whereas crayfish were found in the Castlejordan/ Mongagh River in 1977-1986, none were found in 2000. The re-establishment of the crayfish in the Mongagh/Yellow rivers catchment is indicated by Reynolds (2007) who reported them in the Castlejordan, and is also indicated in current records for the species in both the Castlejordan/Mongagh River and in the Yellow River downstream of the confluence with the Castlejordan (www.biodiversityireland.ie). Crayfish are protected under the Wildlife Act and are listed in Annex II of the Habitats Directive; however they are not a qualifying interest in the River Boyne and River Blackwater SAC which is located c.20km downstream of the proposed wind farm development.

On the basis of its designation as a SAC and on the basis of its status as a major salmon fishery, the Boyne system as a whole is classified as of international importance.

5.11.2 Potentially Affected Waters

HABITAT ASSESSMENT

Location of habitat sections and habitat ratings for each section are presented in Figures 9-20.

Yellow River Main Channel

Section Y1 – Yellow River Main Channel

Location	N49398 26291 to N49650 36450				
Length	c.400m				
Description	Stream 3-5m wide and 20-50 cm deep. Straight channel consisting mostly of fast glide with short sections of riffle over substrates of slightly compacted gravel, sand and mud. Bankside vegetation consists of Reed Canary Grass, Gorse and grasses.				
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Fair		
Salmonid Nursery Habitat	Fair - Good	Lamprey Nursery Habitat	None		
Salmonid Spawning Habitat	Fair - Good	Lamprey Spawning Habitat	Fair - Good		



Riffle and glide flow over gravel & sand



Straight channel with marginal Phalaris

Section Y2 – Yellow River Main Channel**Location** N49650 36450 to 51701 35970**Length** c.2km**Description** Uniform canalised channel with steep sides and variable bankside cover with willow, *Phalaris* and gorse. Heavy shade by hawthorn and willow towards downstream end of section. Moderately dense in-stream *Potamogeton* in places. Flow mostly uniform glide.**Salmonid Adult Habitat** Fair - Good**Crayfish Habitat** Poor**Salmonid Nursery Habitat** Poor - Fair**Lamprey Nursery Habitat** Fair (tentative rating)**Salmonid Spawning Habitat** Poor - Fair**Lamprey Spawning Habitat** Poor - Fair

Slow uniform glide

Section with moderately dense
PotamogetonUniform glide
Dense bankside cover of *Phalaris*River bank poached by cattle
Heavier bankside cover of hawthorn and willow at
downstream end of section

Section Y3 – Yellow River Main Channel

Location	N51701 35970 to N51950 35960				
Length	c.200m				
Description	River c.8m wide with depths of 20-40 cm. Flow consisting of fast run and riffle. Substrate predominated by sand and mud with some cobble and gravel. Shade by bankside hawthorn and willow (c.65%).				
Salmonid Adult Habitat	Fair - Good		Crayfish Habitat	Poor	
Salmonid Nursery Habitat	Fair		Lamprey Habitat	Nursery	None
Salmonid Spawning Habitat	Poor - Fair		Lamprey Spawning Habitat	Poor - Fair	



Fast run and riffle

Section Y4 – Yellow River Main Channel**Location** N51950 35960 to N52783 36212**Length** c.1km**Description** Uniform straight channel, mostly deep glide with a few sections of run/riffle. Moderate cover by bankside hawthorn, and gorse. Much of substrate not visible; where visible consists of sand and mud with some cobble and gravel.**Salmonid Adult Habitat** Fair - Good**Crayfish Habitat** Poor**Salmonid Nursery Habitat** Fair**Lamprey Nursery** Poor**Habitat****Salmonid Spawning** Fair**Lamprey Spawning** Fair**Habitat****Habitat**

Deep glide



Riffle & run

Section Y5 – Yellow River Main Channel

Location	N54726 37701 to N58171 38646				
Length	c.4km				
Description	Mostly uniform glide (width c. 15m) with a few sections of more rapid run. Canalised river with high steep banks. Scattered bankside willow. Marginal <i>Phalaris</i> well developed. Deeper substrates poorly visible, shallower substrates consist of muddy sand and gravel with limited cobble.				
Salmonid Adult Habitat	Fair - Good	Crayfish Habitat	Fair		
Salmonid Nursery Habitat	Poor - Fair	Lamprey Habitat	Nursery	Fair (estimated)	
Salmonid Spawning Habitat	Poor - Fair	Lamprey Spawning Habitat	Poor - Fair		



Scattered bankside willows



Steep sided canalised river



Slow uniform glide



Short section of more rapid run flow

Yellow River Tributaries**Section YT1 – Derryiron Stream West (Yellow River Tributary)**

Location	N50756 36065 to N50858 36306				
Length	c.300m				
Description	Bog drain				
Salmonid Adult Habitat	None	Crayfish Habitat	None - Poor		
Salmonid Nursery Habitat	None	Lamprey Habitat	Nursery	None - Poor	
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None		



Shallow drain with dense vegetation



Deeper ponded drain

Section YT2 – Derryiron Stream East (Yellow River Tributary)**Location**

N51146 35820 to N51737 35733

Length

c.1km

Description

Steep sided bog drain mostly with imperceptible flow. Substrate of peat with very small occurrence of gravel on peat. Width 1.5 to 3m.

Salmonid Adult Habitat

None

Crayfish Habitat

None

Salmonid Nursery Habitat

None - Poor

Lamprey**Nursery**

None - Poor

Habitat**Salmonid
Habitat****Spawning**

None - Poor

**Lamprey
Habitat****Spawning**

None - Poor



Slow flowing bog drain



Limited area of gravel on peat



Uniform slow flowing drain

Section YT3 – Derryiron Stream East (Yellow River Tributary)**Location**

N51737 35733 to N51831 35954

Length

c.250m

DescriptionStraight channel 6-8m wide consisting of glide over silty peaty sand. Dense in-stream *Rorripa* and *Apium*. Moderate bankside shade of birch, willow and hawthorn.**Salmonid Adult Habitat**

Fair

Crayfish Habitat

Poor

Salmonid Nursery Habitat Poor – Fair

Lamprey Nursery Poor

Salmonid Spawning Habitat Poor - Fair

Lamprey Spawning Poor - Fair



Dense in-stream growth of Apium & Rorippa



Glide over silty, peaty sand.

Section YT4 – Coolcor Stream (Yellow River Tributary)

Location N52691 34570 to N52089 34705

Length c.1km

Description Short section of muddy glide with very limited muddy gravel at upstream end of section. Mostly steep sided drain with deep mud and dense growths of aquatic plants. Very slow flow.

Salmonid Adult Habitat Potential

None

Crayfish Habitat Fair

Salmonid Nursery Habitat Potential

None

Lamprey Nursery Fair

Salmonid Spawning Habitat Potential

None

Lamprey Spawning None



Short section with gravel on mud



Muddy drain



Drain with dense vegetation



Drain with dense vegetation

Section YT5 – Coolcor Stream (Yellow River Tributary)**Location** N52089 34705 to N52270 35250**Length** c.700m**Description** Canalised muddy glide c.8m wide. Instream vegetation (*Rorippa*, *Apium* and *Sparganium erectum*) well developed in parts.**Salmonid Adult Habitat** Fair**Crayfish Habitat** Poor - Fair**Salmonid Nursery Habitat** None**Lamprey Nursery** Fair**Habitat****Salmonid Spawning** None**Lamprey Spawning** None**Habitat**

Glide with well-developed in stream vegetation



Slow uniform glide

Section YT6 - Coolcor Stream (Yellow River Tributary)**Location** N52270 35250 to N52355 35507**Length** c.300m**Description** Rapid glide on muddy substrate. Moderate bankside shade of willow and gorse**Salmonid Adult Habitat** Fair - Good**Salmonid Nursery Habitat** Poor**Crayfish Habitat**

Poor

Lamprey Nursery

Poor - Fair

Habitat**Salmonid Spawning** None - Poor**Lamprey Spawning**

None - Poor

Habitat**Habitat**

Fast glide

Section YT7 - Srah Stream (Yellow River Tributary)

Location		N54076 35512 to N54191 36027			
Length		c.500m			
Description		Muddy drain heavily shaded by birch and willow.			
Salmonid Adult Habitat		None	Crayfish Habitat	None - Poor	
Salmonid Nursery Habitat		None	Lamprey Nursery Habitat	None	
Salmonid Spawning Habitat		None	Lamprey Spawning Habitat	None	



Muddy drain

Section YT8 - Srah Stream (Yellow River Tributary)

Location	N54191 36027 to N54326 36636				
Length	c.650m				
Description	Stream 1 – 2m wide consisting mostly of muddy sandy glide with a few short poor riffles. Heavily shaded by hawthorn, birch and ash.				
Salmonid Adult Habitat	None - Poor	Crayfish Habitat		Poor	
Salmonid Nursery Habitat	Poor	Lamprey Habitat	Nursery	Poor	
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	None - Poor		



Short section of poor riffle



Muddy glide with dense in-stream vegetation

Section YT9 - Srah Stream (Yellow River Tributary)

Section 119 - Brain Stream (Fallow River tributary)					
Location		N54326 36636 to N64014 37089			
Length		c.500m			
Description		Muddy sandy glide c.2m wide with very little muddy riffle on cobble. Heavy shade by willow, birch, hazel, hawthorn & blackthorn. Dense in-stream <i>Apium</i> in less shaded sections.			
Salmonid Adult Habitat		None - Poor	Crayfish Habitat		Poor
Salmonid Nursery Habitat		Poor - Fair	Lamprey Habitat	Nursery	Fair - Good
Salmonid Habitat	Spawning	Poor	Lamprey Habitat	Spawning	Poor



Muddy sandy glide



Short section of muddy riffle on cobble

Section YT10 - Wood Stream West (Yellow River Tributary)

Location	N55017 37576 to N54977 37829				
Length	c.250m				
Description	Steep sided, slow flowing field drain. Depth 2-5cm and width c.1m. Heavily shaded by hazel, hawthorn, ash and oak. Dense <i>Rorippa</i> and <i>Apium</i> in less shaded sections. Muddy substrate with some heavily silted gravel and cobble in the lowest c.50m.				
Salmonid Adult Habitat	None	Crayfish Habitat	Poor		
Salmonid Nursery Habitat	Poor	Lamprey Habitat	Nursery	Poor	
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	Spawning	Poor	



Dense aquatic vegetation



Slow flowing field drain

Section YT11 - Wood Stream East (Yellow River Tributary)

Location	N55461 37787 to N55400 37930				
Length	c.150m				
Description	Muddy drain heavily shaded in parts by willow, oak, ash & beech. Dense growths of <i>Apium</i> and <i>Rorippa</i> in less shaded sections.				
Salmonid Adult Habitat	None	Crayfish Habitat	Poor		
Salmonid Nursery Habitat	None	Lamprey Habitat	Nursery	None	
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	Spawning	None	

Drain with dense *Apium* & *Rorippa*

Section YT12 - Corbetstown Bridge Stream (Yellow River Tributary)**Location** N53432 38819 to N54120 38759**Length** c.750m**Description** Mostly uniform muddy glide with dense in-stream growths of *Apium* in sections. Moderate to heavy shade by hawthorn, willow and bramble. Short section of riffle on muddy gravel and cobble at the downstream end of the section.**Salmonid Adult Habitat** None - Poor**Crayfish Habitat** Poor**Salmonid Nursery Habitat** Poor – Fair**Lamprey Nursery Habitat** Poor – Fair**Salmonid Spawning Habitat** Poor – Fair**Lamprey Spawning Habitat** Poor - Fair

Glide heavily shaded by bramble, willow and hawthorn



Dense instream growth of Apium



Glide on mud



Short section of riffle on muddy cobble & gravel

Section YT13 - Corbetstown Bridge Stream (Yellow River Tributary)

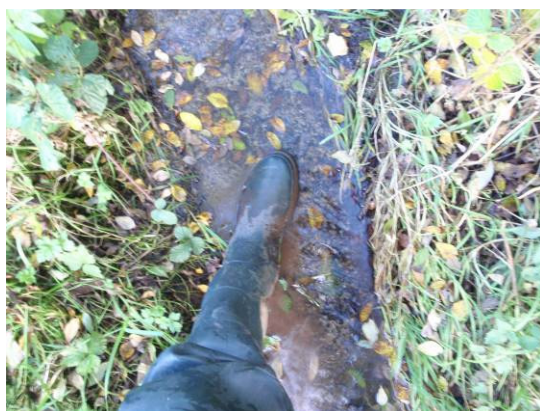
Location		N54120 38759 to N54150 38879			
Length		c.100m			
Description		Uniform glide on mud, sand and gravel. Low level of shade by bankside grass, hawthorn and gorse.			
Salmonid Adult Habitat		None - Poor	Crayfish Habitat	Poor - Fair	
Salmonid Nursery Habitat		Poor	Lamprey Nursery Habitat	Fair	
Salmonid Habitat	Spawning	Poor	Lamprey Spawning Habitat	Poor	



Glide on substrate of mud with some sand and gravel

Section TY14 – Corbetstown Bridge Stream (Yellow River Tributary)

Location		N53937 39576 to N53592 39410			
Length		c.350m			
Description		Very small stream width c.30cm and depth c. 4cm on sand & mud substrate. Moderate shade by willow. Dense <i>Apium</i> towards downstream end of section.			
Salmonid Adult Habitat		None	Crayfish Habitat	None	
Salmonid Nursery Habitat		None	Lamprey Nursery Habitat	None	
Salmonid Habitat	Spawning	None	Lamprey Spawning Habitat	None	



Very small stream on mud and sand substrate



Dense growths of *Apium*

Section YT15 - Corbetstown Bridge Stream (Yellow River Tributary)

Location		N53592 39410 to N53550 39403			
Length		c.100m			
Description		Small stream c.1m wide and 3cm deep on substrate of cobble, gravel and mud.			
Salmonid Adult Habitat		None	Crayfish Habitat	None	
Salmonid Nursery Habitat		Poor	Lamprey Nursery Habitat	None	
Salmonid Habitat	Spawning	Poor	Lamprey Spawning Habitat	None	



Riffle on muddy cobble

N.B Section of stream between Section YT15 and YT16 was inaccessible.

Section YT16 - Corbetstown Bridge Stream (Yellow River Tributary)**Location** N53809 39134 to N54341 38869**Length** c.700m**Description** Slow flowing, steep sided muddy drain 2m wide with dense growths of *Apium nodiflorum*. Moderate shade by willow and hawthorn. Substrate of mud with some surface sand and fine gravel**Salmonid Adult Habitat** None**Crayfish Habitat** Poor**Salmonid Nursery Habitat** None - Poor**Lamprey Nursery** Fair**Habitat****Salmonid Spawning** None**Lamprey Spawning** None**Habitat****Habitat**Dense growth of *Apium*

Slow flowing watercourse



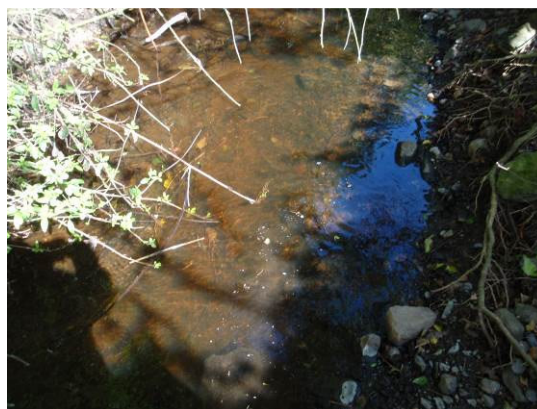
Substrate of mud with some surface sand & fine gravel

Section YT17 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N54373 38852 to N55264 38242				
Length	1.5km				
Description	Stream c.3m wide and 5 -15cm deep. Mostly glide over sand & mud with some poor sections of riffle on muddy sand, gravel and cobble. Heavy shade by hawthorn, willow, ash and brambles.				
Salmonid Adult Habitat	Poor	Crayfish Habitat	Poor - Fair		
Salmonid Nursery Habitat	Fair	Lamprey Habitat	Nursery	Fair	
Salmonid Spawning Habitat	Poor	Lamprey Spawning Habitat	Poor		



Glide over sand and mud substrate



Poor riffle on muddy sand, gravel & cobble

Section YT18 – Corbetstown Bridge Stream (Yellow River Tributary)

Location	N55264 38242 to N55548 38162				
Length	c.350m				
Description	Stream c.3m wide and 10 – 25cm deep consisting mostly of glide on sand, gravel and cobble. Heavy shade by ash, hawthorn, beech and willow.				
Salmonid Adult Habitat	Poor – Fair		Crayfish Habitat	Poor – Fair	
Salmonid Nursery Habitat	Fair		Lamprey Nursery Habitat	None	
Salmonid Spawning Habitat	Fair		Lamprey Spawning Habitat	Fair	



Section YT19 - Corbetstown Bridge Stream (Yellow River Tributary)

Location	N55548 38162 to N55619 38125				
Length	c.150m				
Description	Small stream with mixture of glide and riffle on substrates of cobble, sand and gravel. Heavily shaded by ash and hawthorn in upper section, un-shaded in lowest section				
Salmonid Adult Habitat	Fair	Crayfish Habitat	Fair - Good		
Salmonid Nursery Habitat	Fair - Good	Lamprey Nursery Habitat	Poor		
Salmonid Spawning Habitat	Fair	Lamprey Spawning Habitat	Fair		



Riffle & glide on cobble, sand & gravel



Glide on sandy substrate



Less shaded lower section



Riffle area just upstream of confluence with Yellow River

Section YT20 – Killowen Stream (Yellow River Tributary)

Location	N56458 38224 to N56737 38435				
Length	c.400m				
Description	Stream 2-3m wide. Mostly glide with some riffle on sand, gravel and cobble. Moderate shade by hawthorn and holly.				
Salmonid Adult Habitat	Fair		Crayfish Habitat	Fair	
Salmonid Nursery Habitat	Fair - Good		Lamprey Nursery Habitat	Poor	
Salmonid Spawning Habitat	Fair		Lamprey Spawning Habitat	Fair	



Shallow glide and riffle on sand, gravel & some cobble



Glide on sandy substrate



Riffle on sandy cobble



Section of riffle just upstream of confluence with Yellow River

Mongagh/Castlejordan River Main Channel and Tributaries

Section M1 – Mongagh/Castlejordan River Main Channel

Location	N52255 39931 to N52300 41125				
Length	c.1.3 km				
Description	Mostly slow deep glide with dense <i>Rorippa</i> , <i>Potamogeton</i> , <i>Sparganium erectum</i> & <i>Callitriche</i> sp.				
Salmonid Adult Habitat	Poor	Crayfish Habitat	Fair		
Salmonid Nursery Habitat	None	Lamprey Nursery Habitat	Fair (estimated)		
Salmonid Spawning Habitat	None	Lamprey Spawning Habitat	None		



Deep glide with dense *Potamogeton*



Dense marginal *Rorippa*

Section M2 - Mongagh/Castlejordan River Main Channel

Location	N52300 41125 to N55371 40800				
Length	c.3.75km				
Description	Slow to medium glide 15-20m wide and c.1.5m deep. Substrate mostly muddy sand (where visible). <i>Potamogeton</i> sp. With 25-60% cover in much of the channel and dense <i>Phalaris</i> and <i>Rorippa</i> in margins				
Salmonid Adult Habitat	Fair	Crayfish Habitat	Poor – Fair		
Salmonid Nursery Habitat	None – Poor	Lamprey Habitat	Nursery	Fair	
Salmonid Spawning Habitat	None - Poor	Lamprey Spawning Habitat	Spawning	None - Poor	

Slow deep glide with dense in-stream *Potamogeton*Slow glide with dense *Phalaris* in margins

Section MT1 – Major Bog Drain – (Mongagh River Tributary)

Location		N52414 39582 to N52255 39931			
Length		c.400m			
Description		Ponded bog drain c.30m wide.			
Salmonid Adult Habitat		None	Crayfish Habitat	None	
Salmonid Nursery Habitat		None	Lamprey Nursery Habitat	None	
Salmonid Habitat	Spawning	None	Lamprey Spawning Habitat	None	



Large ponded bog drain



Culvert discharge to Mongagh River

5.11.3 Water Quality

Biological water quality at all sites is shown on Figure 21 (See Figure 5.8 for site names).

SITE A

The invertebrate community at this site merits a Q-rating of Q2-3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	Limnephilidae	2
	<i>Phryganea sp.</i>	11
	<i>Sericostoma sp.</i>	1
Group C - Moderately Pollution Tolerant	<i>Potamopyrgus antipodarum</i>	1
	<i>Hydropsyche sp.</i>	5
	Haliplidae	1
	Chironomidae	4
Group D - Very Pollution Tolerant	Sphaeriidae	c.170
	<i>Asellus aquaticus</i>	88
	<i>Sialis sp.</i>	3
Group E - Most Pollution Tolerant	None Recorded	

Table 5.13 Biological water quality at SITE A

SITE B

The invertebrate community at this site merits a Q-rating of Q2-3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	<i>Athripsodes sp.</i>	1
	<i>Goera sp.</i>	3
Group C - Moderately Pollution Tolerant	<i>Potamopyrgus antipodarum</i>	1
	<i>Baetis rhodani</i>	4
	<i>Hydropsyche sp.</i>	13
	Chironomidae	1
	Simuliidae	4
Group D - Very Pollution Tolerant	<i>Asellus aquaticus</i>	c.120
Group E - Most Pollution Tolerant	None Recorded	
Not assigned to an indicator group	Lumbricidae	3
	Lumbriculidae	2

Table 5.14 Biological water quality at SITE B

SITE C

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	<i>Protonemura sp.</i>	2
Group B - Moderately Pollution Sensitive	<i>Lepidostoma sp.</i>	1
Group C - Moderately Pollution Tolerant	<i>Gammarus duebeni</i>	7
	<i>Baetis rhodani</i>	4
	<i>Hydropsyche sp.</i>	15
	<i>Rhyacophila sp.</i>	3
	Elmidae	20
	Chironomidae	3
	Tipulidae (Pediciidae)	12
Group D - Very Pollution Tolerant	<i>Asellus aquaticus</i>	10
	<i>Glossiphonia sp.</i>	1
Group E - Most Pollution Tolerant	None Recorded	
Not assigned to an indicator group	Lumbricidae	6
	Lumbriculidae	4

Table 5.15 Biological water quality at SITE C

SITE D

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	<i>Heptagenia sp.</i>	7
Group B - Moderately Pollution Sensitive	Limnephilidae	1
	<i>Sericostoma sp.</i>	6
Group C - Moderately Pollution Tolerant	<i>Gammarus duebeni</i>	70
	<i>Hydropsyche sp.</i>	22
	<i>Rhyacophila sp.</i>	1
	Elmidae	4
	Chironomidae	1
	Simuliidae	1
	Tipulidae (Pediciidae)	9
Group D - Very Pollution Tolerant	<i>Asellus aquaticus</i>	1
Group E - Most Pollution Tolerant	Tubificidae	2
Not assigned to an indicator group	Lumbriculidae	2

Table 5.16 Biological water quality at SITE D

SITE E

The invertebrate community at this site merits a Q-rating of Q3-4 indicating slightly polluted conditions and moderate ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	<i>Heptagenia sp.</i>	1
Group B - Moderately Pollution Sensitive	<i>Agapetus sp.</i>	1
	Limnephilidae	1
	<i>Sericostoma sp.</i>	3
	<i>Silo sp.</i>	1
Group C - Moderately Pollution Tolerant	<i>Ancylus fluviatilis</i>	2
	<i>Potamopyrgus antipodarum</i>	5
	<i>Gammarus duebeni</i>	38
	<i>Baetis rhodani</i>	5
	<i>Hydropsyche sp.</i>	11
	Elmidae	87
	Simuliidae	4
	Tipulidae (Pedicidae)	18
Group D - Very Pollution Tolerant	<i>Erpobdella sp</i>	2
	<i>Glossiphonia sp.</i>	1
	<i>Asellus aquaticus</i>	8
Group E - Most Pollution Tolerant	None recorded	
Not assigned to an indicator group	Lumbricidae	1
	Lumbriculidae	29

Table 5.17 Biological water quality at SITE E

SITE F

The invertebrate community at this site merits a Q-rating of Q3 indicating moderately polluted conditions and poor ecological status.

INDICATOR GROUP	TAXON	2012
Group A - Very Pollution Sensitive	None recorded	
Group B - Moderately Pollution Sensitive	<i>Baetis muticus</i>	8
	<i>Agapetus sp.</i>	4
	Limnephilidae	26
	<i>Sericostoma sp.</i>	3
Group C - Moderately Pollution Tolerant	Tricladida	1
	<i>Piscicola geometra</i>	1
	<i>Gammarus duebeni</i>	35
	Hydracarina	1
	<i>Baetis rhodani</i>	11
	<i>Hydropsyche sp.</i>	6
	<i>Plectrocnemia sp.</i>	3
	Dytiscidae	2
	Elmidae	6
	Gyrinidae	2
	Chironomidae	4
	Tipulidae (Pedicidae)	2
Group D - Very Pollution Tolerant	<i>Haemopsis sanguisuga</i>	1
	<i>Asellus aquaticus</i>	51
Group E - Most Pollution Tolerant	Tubificidae	7
Not assigned to an indicator group	Lumbriculidae	4
	Ceratopogonidae	2

Table 5.18 Biological water quality at SITE F

Fishery Value

Recent genetic studies of trout in the Boyne catchment have found that there are five different families of trout in the catchment one of which is located in the Kinnegad/Mongagh/Yellow River part of the catchment. The study also concluded that the contribution of fish from individual tributaries to the main stem stock is very variable and bears no relationship to the size of the individual sub catchment. It was concluded that the trout from the Mongagh/Kinnegad population “*make little or no contribution to the main stem population. These fish are staying at home!!*”. Whereas the genetic diversity of the trout from the Mongagh/Kinnegad population adds ecological value to the trout populations in this section of the catchment, it appears that this population does not make a significant contribution to the angling value of the main channel of the Boyne.

www.fisheriesireland.ie/Press-releases/a-pioneering-study-of-the-genetic-makeup-of-brown-trout-stocks-in-the-boyne-catchment.html)

Yellow River Main Channel: IFI states that the Yellow River has good stocks of Brown Trout. The most upstream section of the Yellow River assessed was c.400m long Section Y1 which flows adjacent to proposed Turbine 7. This section had the best salmonid spawning and nursery habitat recorded in the surveyed section of the Yellow River with Fair – Good quality being recorded for all salmonid life stages. All the other potentially affected sections of the Yellow River consist of a uniform canalised channel with steep sides and variable bankside cover. The flow is mostly glide with a few limited sections of run and riffle. Most of this channel constitutes adult salmonid habitat of fair – good quality and mediocre salmonid nursery and spawning habitat. Applying the precautionary principle, it is assumed that section Y1 has a significant population of juvenile brown trout. Salmon are known to run up the Castlejordan river to spawn in Rochfortbridge Stream; the precautionary principle is therefore applied and for the purposes of mitigation it should be assumed that salmon may also run up the Yellow River in small numbers, and that juvenile salmon are present in Habitat Section Y1, where Fair – Good spawning habitat was recorded. Based on the habitat and water quality recorded in this survey, it is concluded that the remaining main Yellow River sections are likely to have a fair population of adult trout and low densities of juvenile salmonids.

Castlejordan/Mongagh River Main Channel: The c.5km of channel assessed for the present report consists of uniform glide with substrate mostly muddy sand (where visible). This section of channel has no significant salmonid spawning or nursery habitat and constitutes adult salmonid habitat of mediocre quality. IFI states that as well as having stocks of Brown Trout, this river has good stocks of salmon in its Rochfortbridge tributary. As the Rochfortbridge tributary is upstream of the proposed wind farm, it is certain that adult salmon annually migrate upstream past the proposed wind farm site to the spawning areas in the Rochfortbridge tributary, and salmon smolts migrate downstream past the site en route to the sea.

Tributaries: The fish habitat value of the potentially affected tributaries was found to be generally low; however a few short sections of channel were found to have significant salmonid habitat.

Derryiron Stream	West	No significant salmonid habitat value
Derryiron Stream	East	No significant salmonid habitat value
Coolcor Stream		No significant salmonid spawning or nursery habitat value. Adult trout habitat value fair in Section YT5 (700m) and fair-good in Section YT6 (300m).
Srah Stream		No significant salmonid habitat value
Wood West Stream		No significant salmonid habitat value
Wood East Stream		No significant salmonid habitat value
Corbetstown Stream	Bridge	Significant salmonid habitat value only in lowest 500m where nursery and spawning habitat value was fair in Section YT18 (350m) and in Section YT19 salmonid nursery habitat value was fair – good and spawning habitat value was fair. Trout were observed in this section of stream and applying the precautionary principle it should be assumed that juvenile salmon may be present in the lowest section of the stream.
Killowen Stream		The potentially affected section (YT20 (400m) has fair adult trout habitat quality, fair - good salmonid nursery habitat and fair salmonid spawning habitat quality. On the basis of the habitat quality and applying the precautionary principle it is assumed that this section of stream has a significant population of brown trout and may also have juvenile salmon.

Ecological Value

Yellow River and Mongagh/Castlejordan Main Channel: Three Habitats Directive Annex II species are known to occur in in the main channels of the Yellow and Castlejordan Rivers: these are River/Brook Lamprey (*Lampetra* Sp.), Crayfish (*Austropotamobius pallipes*) and Atlantic Salmon (*Salmo salar*). Regarding the

Yellow River/ Mongagh River part of the Boyne catchment O'Connor (2006) states: "*River/brook lamprey (probably *Lampetra planeri*) were confirmed from this catchment. Lampreys are present at an overall favourable conservation status level.*" Whereas *Lampetra planeri* (Brook Lamprey) are listed in Annex II of the Habitats Directive, the species is not a qualifying interest of the River Boyne and River Blackwater SAC which is located c.20km downstream of the proposed wind farm development. The re-establishment of the crayfish in the Mongagh/Yellow rivers catchment is indicated by Reynolds (2007) who reported them in the Castlejordan, and is also indicated in current records for the species in both the Castlejordan/Mongagh River and in the Yellow River downstream of the confluence with the Castlejordan (www.biodiversityireland.ie). Crayfish are protected under the Wildlife Act and are listed in Annex II of the Habitats Directive, however they are not a qualifying interest in the River Boyne and River Blackwater SAC. Salmon are reported in the Castlejordan River by IFI (see Fisheries Value Section) and are a qualifying interest in the River Boyne and River Blackwater SAC.

No crayfish were recorded at any of the sites assessed for invertebrate fauna in the present survey. On the basis of the habitat assessment carried out for this report, it is concluded that crayfish habitat in the potentially affected sections of the Yellow and Castlejordan rivers is generally of relatively poor quality, and crayfish are therefore likely to be present at relatively low density. Fair lamprey nursery habitat was widespread in the main channels assessed; however habitat suitable for lamprey spawning was found to be scarce. O'Connor (2006) found "good numbers" of juvenile lamprey at Sheep Bridge but low density (1 per 5m²) at Garr Bridge on the Yellow River. Given the poor lamprey spawning habitat in the main channel, it is likely that the good juvenile lamprey density at Sheep bridge consists of lamprey spawned in the Corbetstown Bridge and/or the Killowen tributaries which are upstream of Sheep Bridge.

This section of the Boyne catchment is known to have a population of salmon, thereby making it a significant part of the Boyne fishery and relevant to maintaining/attaining favourable conservation status of salmon in the River Blackwater & River Boyne SAC, in which salmon is a qualifying Annex II interest. These channels are therefore classified as of regional importance.

Tributaries:

Stream	Description	Ecological Value
Derryiron West Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Derryiron East Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Coolcor Stream	Section YT4 & YT5 (1.7km) fair crayfish and fair lamprey nursery habitat. Based on habitat quality and applying precautionary principle, crayfish and brook lamprey assumed to be present.	High Local Value
Srah Stream	Section YT9 (500m) fair – good lamprey nursery. Based on habitat quality and applying precautionary brook lamprey assumed to be present.	Moderate Local Value
Wood West Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Wood East Stream	No significant lamprey or crayfish habitat. Crayfish and lamprey unlikely to be present.	Low Value
Corbetstown Bridge Stream	Approx. 2km of fair lamprey nursery habitat. Crayfish habitat quality generally of mediocre quality but with c150m of fair – good crayfish habitat in the lowest section (YT19). Based on habitat quality and applying precautionary principle, crayfish and brook lamprey assumed to be present.	High Local Value
Killowen Stream	Habitat Section YT20 c.400m of fair crayfish habitat and fair lamprey nursery habitat. Based on habitat quality and applying	High Local Value

precautionary principle, crayfish and brook lamprey assumed to be present.

5.12 DO NOTHING IMPACT

If the proposed development does not proceed, the “Do nothing Scenario” is that the ecological and fishery value of the potentially affected rivers and streams is likely to remain as described in Section 5.3, apart from some improvement in water quality to good ecological status, as would be required under the European Communities Environmental Objectives (Surface Waters) Regulations 2009.

5.13 POTENTIAL IMPACTS OF THE DEVELOPMENT

The potential significant impacts of the proposed development on aquatic ecology could be:

1. Pollution of watercourses with suspended solids due to runoff of silt from construction areas.
2. Pollution of watercourses with nutrients due to ground disturbance during construction and during clear felling of 10.4 ha of forestry plantation
3. Pollution of watercourses with nutrients due to decomposition of brash after forest clear felling
4. Pollution of watercourses during construction phase with other substances such as fuels, lubricants, waste concrete, waste water from site toilet and wash facilities, etc.
5. Pollution of watercourses with surface drainage water from paved areas and road surfaces.
6. Hydrological impact due to changes in the flow rates of streams/rivers.
7. Permanent loss of habitat due to culverting or bank/stream alteration.
8. Obstruction to upstream movement of aquatic fauna due to culverting
9. Obstruction of upstream fish movement during construction of river/stream crossings.

Potential impacts are described under two headings:

1. An assessment of the potential environmental impact of the proposed wind farm during the period of construction.
2. An assessment of potential long-term effects of the operational phase of the proposed wind farm on freshwater invertebrate fauna, flora, fish and habitats.

5.13.1 Construction Phase

Pollution of streams with suspended solids

In the absence of adequate mitigation any element of the wind farm construction which involves excavation or soil placement has potential for suspended solids contamination of surface waters. The main elements of the proposed development that pose a risk of suspended solids pollution are the turbine foundation bases, the c.17.7 km of new site roads, the upgrading of 7.1km of existing site roads, the laying of electrical and communications cabling, the construction of the grid control building and the temporary construction compound. (The location of turbines and roads in relation to watercourses is shown on Figure 5.8). Any works proposed in areas with significant depths of peat may also pose risks of serious environmental impact due to peat failure or slippage resulting in contamination and possible scouring of watercourses.

Suspended sediment due to runoff of soil from construction areas, forestry clearance operations or due to disturbance of fine sub-surface sediments in the course of instream construction and excavation, can have significant negative impacts on invertebrate and plant life and on all life stages of salmonid fish. Peat soils have high erodability (Forest Service 2008) and may be less amenable to removal by conventional settlement ponds unless properly sized to allow for peat particles.

- Suspended sediment can settle on spawning areas, infill the intragravel voids and smother the eggs and alevins (newly hatched fish) in the gravel.
- Bed Load (coarse material transported along the bottom of the stream) and settled sediments can infill pools and riffles, reducing the availability and quality of rearing habitat for fish.

- Suspended sediment can reduce water clarity and visibility in the stream, impairing the ability of fish to find food items.
- Settled sediments can smother and displace aquatic organisms such as macroinvertebrates (including crayfish), reducing the amount of food items available to fish.
- Increased levels of sediment can displace fish out of prime habitat into less suitable areas. (Chilibeck *et al* 1992)
- Suspended solids can abrade or clog the gills of salmonid fish. It takes a high concentration of solid wastes to clog a fish gill and cause asphyxiation, but only a little to cause abrasions and thus permit the possibility of infections. (Solbe 1988)

In the absence of adequate mitigation measures, contamination of water courses with suspended solids, with the resultant potential impact on salmonid spawning and nursery areas, is one of the most significant potential aquatic ecological impacts of the proposed development, and would be classified as a moderate potential impact on all potentially affected streams.

A peat stability assessment has been carried out and it has been concluded that no significant risk of peat failure will be caused by the proposed development. (Whiteford GeoServices Peat Slide Risk Assessment Report)

Pollution Of Watercourses With Nutrients Due To Ground Disturbance During Construction And During Clearfelling Of Conifers

The main potential sources of nutrient inputs to freshwater due to ground disturbance are:

1. Nutrients adsorbed or chemically bound to eroded suspended solids
2. Leaching of fertilisers used during the forestry operation

Nutrients adsorbed or chemically bound to eroded suspended solids

Several studies in the United States have found increases in both nitrogen and phosphorus export into streams following ground disturbance, particularly in association with organic particles (Golladay & Webster 1988; Likens *et al* 1970). Giller *et al* (2002) concluded that phosphates released into streams after forestry clear-felling are mainly attached to small soil particles and are carried into watercourses if there is sediment input and increased erosion following clear-felling. Busman *et al* (2002) found that “*phosphorus in soils is almost entirely associated with soil particles. When soil particles are carried to a river or lake, phosphorus will be contained in this sediment.. ... Phosphate in soils is associated more with fine particles than coarse particles. When soil erosion occurs, more fine particles are removed than coarse particles, causing sediment leaving a soil through erosion to be enriched in phosphorus*”. It is therefore concluded that in the context of the Yellow River Wind Farm site the main potential source of nutrient enrichment of surface waters due to soil disturbance will be nutrients associated with eroded soil particles.

Leaching of fertilisers used during the forestry operation

A range of studies in Ireland and abroad have indicated that peat cannot ‘store’ significant amounts of phosphorus, therefore phosphorus applied to these soils are not retained for long but leach to surface and ground waters. The potential for loss of added phosphorus from peatland soils with low levels of iron and aluminium has been recognised for at least three decades. (Cummins & Farrell 2003). In the Irish context Daly *et al* (2001) and Styles (2004) concluded that peat soils have limited capacity to chemically bind phosphorus and create any phosphorus reserves. Daly & Styles (2005) found that “*peat soils and high organic matter soils did not chemically adsorb P in the same way that mineral soils do. ... The concept of P “build-up” cannot be applied to peat soils in the agronomic sense. ... These soils are vulnerable to P loss through a lack of sorption capacity and binding energy rather than high rates of desorption to solution.*”

A substantial proportion of the area of forestry to be felled i.e. in Derryarkin and Corbetstown (Sites 1 & 2) are unlikely to have received any fertiliser application and definitely not in the last 10 years. The third site at Corbettstown is situated 50:50 on the boundary of an old field and rough pasture area. It is possible that the rough pasture area received an application of fertiliser when the site was planted 8 years

ago. The maximum rate permitted under the Forest Service Scheme for such a site type is Ground Rock Phosphate (14% P) at 250Kgs/Ha. The old field part of the plot is precluded from any application of fertilizer.

As the peat soils in the areas to be felled that have not been fertilised within the last 8- 10 years (if at all) it is likely that most of the phosphorus applied to the plantations have by now leached from the system or been assimilated into biomass. (Jennings O'Donovan Pers. Comm).

Pollution of watercourses with nutrients due to decompositon of brash after forestry clearfelling

“Any organic matter (particularly recently dead material such as brash or roots) that is left on site to rot will release phosphorus and nitrogen. The breakdown of brash, roots and other organic matter takes a number of years. Potentially, therefore, a clearfell site may continue to release phosphorus to the aquatic zone for at least three years after clearfelling. The rate of decomposition is influenced by temperature, moisture and humidity. Consequently, phosphorus loss tends to be greatest during the warmer months and may be particularly problematic during a flood event following a prolonged hot and dry period.” (Forest Service 2008).

In Ireland it is now recognised that a significant potential source of nutrient leaching to receiving waters from forestry on peat comes via decaying organic matter, including the foliage and branches, unwanted stems, stumps and dead roots, left on site after crop thinning or felling which are added to the soil at the same time that nutrient uptake is reduced. (Hutton et al 2008; Kennedy 2005; Campbell & Foy 2008; Rogers et al 2008). Dr Martin McGarrigle of EPA indicates that standing crop of 20 kg/ha phosphorus in brash may have loss rates “similar to intensive farmland with just 10% loss per annum” (McGarrigle 2008).

In a study of a peat soil forest catchment in the Burrishoole river system Rodgers et al (2008) stated that: Significant increases in P concentrations and loads were observed at the downstream station after clearfelling and harvesting compared with the P concentrations and loads at the upstream station. Phosphorus load release rates were 2,243.9 g TRP/ha per year in the harvested catchment and 20 g TRP/ha per year in the undisturbed forest catchment.” Whereas the study did not quantify the contribution that different aspects of the forestry operation made to the elevated

phosphorus figures, it is clear that decomposition of brash was regarded as a significant contributor in the Burrishoole study. Rodgers et al (2008) state that “Yanai (1998) hypothesised that the elevated P concentration in the study stream caused by the clearfelling and harvesting could last years because of the slow decay process rates. In this study, about 19 months after the clearfelling and harvesting operations were complete, 100 µg TRP/l were found in the water at the downstream station.”

Pollution of streams/rivers with other substances associated with the construction process

The potential exists for a range of serious pollutants to enter watercourses during construction. For example any of the following will have deleterious effects on fish, plants and invertebrates (including crayfish) if allowed to enter watercourses.

- Raw or uncured concrete and grouts
- Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks
- Fuels, lubricants and hydraulic fluids for equipment used on the development site
- Waste from on site toilet and wash facilities

Obstruction to fish movement during construction

As all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works there will be no obstruction to upstream fish movement during construction.

5.13.2 Operational Phase

Pollution Of The Streams With Surface Runoff From Completed Development

The operation of a turbine development produces no discharges and, other than lubricants, uses no chemicals; the risk of significant pollution from paved areas after the construction is completed would appear to be minimal. Nevertheless due care and

best practice will be required to prevent any contamination of surface waters with hydrocarbons.

EIFAC (Svobodova *et al* 1993) states that “*a sensory assessment is preferred to toxicological analysis in determining the highest admissible amounts of oil and oil products that can be present in water; on this basis the highest admissible concentrations are in the range of 0.002 to 0.025 mg per litre*”.

Harmful effects include:

- The prevention of gaseous exchange at the water surface, leading to reduced dissolved oxygen in the underlying water (Solbe 1988)
- In the case of turbulent waters the oil becomes dispersed as droplets into the water. In such cases, the gills of fish can become mechanically contaminated and their respiratory capacity reduced (Svobodova *et al* 1993).
- Oil products may contain various highly toxic substances, such as benzene, toluene, naphthenic acids and xylene which are to some extent soluble in water; these penetrate into the fish and can have a direct toxic effect. It is generally agreed that the lighter oil fractions (including kerosene, petrol, benzene, toluene and xylene) are much more toxic to fish than the heavy fractions (heavy paraffins and tars) reduced (Svobodova *et al* 1993).

The wind farm will have the potential for ongoing pollution of watercourses with suspended solids (for impact see Section 5.5.1 above) due to eroding of road surfaces and drains.

Hydrological Impacts

Following completion of the wind farm, unless adequately mitigated, the rate and amount of surface water runoff from the site may be greater than at present due to removal of peat, felling of areas of forestry, excavation of drains and more rapid runoff from surfaced areas. There is the possibility of significant changes in the flow regimes of drains on site and streams to which these drains flow.

Should they occur, major changes in hydrology reflected in significant changes in peak and minimum flows would have significant effects on instream flora and fauna, both directly and through the effects of increased erosion.

Permanent Loss Of Habitat Due To Culverting, Road Construction & Road Upgrading

Stream/River Crossings

The proposed wind farm road network crosses streams/ivers shown on EPA stream mapping (www.epa.ie) at ten locations (see Figure 5.22).

Crossing No.	Stream/River	Grid Ref.	Salmonid Spawning Habitat	Salmonid Nursery Habitat	Salmonid Adult Habitat
C1	Yellow River	250444, 236339	Poor - Fair	Poor - Fair	Fair - Good
C2	Derryiron Stream West	250839, 236275	None	None	None
C3	Derryiron Stream East	251775, 235747	Poor - Fair	Poor -Fair	Fair
C4	Corbetstown Bridge Stream	253800, 239124	None	None- Poor	None
C5*	Corbetstown Bridge Stream*	254354, 238857	Poor	Fair	Poor
C6	Wood Stream West	255006, 237548	None	Poor	Poor
C7	Yellow River	255054, 237857	Fair - Good	Poor - Fair	Poor - Fair
C8	Wood Stream East	255456, 237778	None	None	None
C9	Yellow River	255982, 238270	Fair - Good	Poor - Fair	Poor - Fair
C10	Killowen Stream	256552, 238276	Fair	Fair - Good	Fair

***Existing road crossing to be upgraded**

Table 5.19 Salmonid Habitat Quality At Proposed Stream/River Crossings

All stream/river crossings will be by way of clear span bridging with no in-stream works; there will therefore be no significant impact on in-stream habit.

Loss of riparian (bank-side) habitat due to construction

All proposed new site tracks/roads will be constructed no less than 50m from all EPA mapped watercourses except in the immediate vicinity of proposed watercourse crossings. As bankside habitat on the proposed wind farm site is generally of low or moderate quality, the resulting loss on streamside habitat will not be significant.

Obstruction to upstream movement of aquatic fauna due to culverting

The proposed wind farm road network intersects streams shown on EPA stream mapping (www.epa.ie) at ten locations (see Figure 22). All crossing will be by means of single span bridging with support structures set back from the river bank. There will therefore be no potential post construction impact on upstream movement of aquatic fauna.

5.14 MITIGATION MEASURES

5.14.1 Construction Phase Mitigation

Reduction and prevention of suspended solids pollution

General Recommendations

Release of suspended solids to all watercourses should be kept to a minimum. Total suspended solids in discharges should not exceed 30 mg/l in the case of all EPA mapped watercourses (i.e. streams shown on Figure 5.7). This limit should apply to direct discharges to these waters. Non-salmonid drains receiving runoff should not exceed 30 mg/l suspended solids at the point where they join the salmonid watercourses.

The following additional recommendations are made from the Aquatic Ecological perspective and it is recognised that the specific means by which suspended solids in discharges to streams will be prevented from exceeding 30 mg/l is a matter of detailed engineering design.

The key factors in erosion and sediment control are to intercept and manage off- and on-site runoff, and maximise the distance between construction areas and sensitive watercourses. This limits the potential for soils to be eroded and enter streams in runoff. Runoff and surface erosion control is more effective and less expensive than sediment control with sediment control ponds only.

The following general guidelines for erosion and sediment control, which are largely based on Goldman *et al* (1986), should be followed:

1. Schedule development close to watercourses to minimise risk of potential erosion by, where possible, planning construction activities during drier months, halting construction during periods of heavy precipitation and runoff to minimise soil disturbance, and restrict vehicular and equipment access or provide working surfaces/pads.
2. Retain existing vegetation where possible and physically mark clearing boundaries on the construction site.
3. Revegetate denuded areas, particularly cut and fill slopes and disturbed slopes as soon as possible. Use mulches or other organic stabilisers to minimise erosion until vegetation is established on sensitive soils. However it should be noted that re-sodding is essential on upland and lowland peatlands, as reseeding is likely to be unsuccessful and exposed peat is liable to erode. Non-development site vegetation should not be introduced on semi-natural sites such as peatlands. (DOEHLG 2006)
4. Divert runoff away from denuded areas.
5. Minimise the length and steepness of slopes where possible.
6. Minimise runoff velocities and erosive energy by maximising the lengths of flow paths for precipitation runoff, constructing interceptor ditches and channels with low gradients to minimise secondary erosion and transport, and lining unavoidably steep interceptors or conveyance ditches with filter fabric, rock or polyethylene lining to prevent channel erosion.

7. Retain eroded sediments on site with erosion and sediment control structures such as sediment traps (mobile or constructed), silt fences and sediment control ponds.
8. Access roads should be constructed or topped with a suitable coarse granular material and if possible organic topsoil should be stripped prior to access road construction.
9. No stream diversions are proposed; however, in the case of temporary watercourse diversions (such as to facilitate culvert installation), the diversion should be excavated in isolation of stream flow, starting from the bottom end of the diversion channel and working upstream to minimise sediment production. The temporary channel should be constructed in such a way as to minimise suspended solids released when the river is re-routed. Upon completion the bank should be stabilised around the temporary diversion.
10. Prior to construction consultation should take place with IFI regarding the details of bridge and/or open arch stream/river construction. Other than single span temporary bridges with no instream structures, no temporary stream crossings or temporary culverting should take place without the prior agreement of Inland Fisheries Ireland.
11. Machinery should never cross a watercourse by entering it .
12. Construction likely to generate suspended solids upstream of significant sections of salmonid nursery habitat should not take place between the beginning of October and the end of April. Specifically this would refer to works in the vicinity of Section Y1 of the Yellow River main channel, the Corbetstown Bridge stream downstream of Corbetstown Bridge and in the vicinity of Killowen Stream
13. A monitoring programme should be established which will include visual inspection of silt traps and settlement ponds. A visual inspection programme of the site should be carried out daily during construction to monitor integrity and general performance of silt traps, settlement ponds and erosion control

measures. A log of visual inspections will be maintained and any identified issues will be brought to the contractors attention for immediate action.

Recommendations for construction of turbine pads, laying of site cables and upgrade of roads/tracks

1. The drainage system with settlement ponds, soak-aways, and interceptor drains should be installed prior to any excavation work along access roads to be constructed.
2. Settlement ponds/ silt traps should be installed towards the end of drainage channels, however, where practicable these should not be closer than 100m to the receiving watercourse.
3. Machinery and vehicles used in track construction should be operated from the track as it is constructed. Excavation machinery should be operated from access roads and trench digging machinery should be operated from bog mats where appropriate.
4. Surface vegetation turves should be laid out, stored and watered for restoration use after construction, in suitably designated areas. The stored turves should be used to reinstate turbine foundations etc following construction.
5. If, during excavation, spoil is to be stored or is likely to fall onto the adjacent bog surface, the bog surface should be protected with shuttering boards or geotextile.
6. At locations where excavated materials are stored, french drains should surround and intercept surface runoff from materials mounds and distribute this water to the controlled drainage system in place.
7. The excavated material should be laid alongside the trench for use in reinstatement following the laying of the cables. Silt runoff from excavated material to surface waters should be prevented using methods outlined above, and any water pumped from trenches should be passed through a suitable silt removal facility before discharge to surface waters.

Recommendations for Forestry Clearfelling

The following recommendations should be applied to all watercourses including drains:

1. Vegetated riparian buffer zones where they exist should be maintained and where possible left undisturbed to prevent or reduce the input of nutrients.
2. Drainage channels should never form a direct connection between the clearfell area and the stream (i.e. bypassing of buffer strips should not occur in any way). If it is not possible to get machines on to a clearfell site to block all drainage channels which empty directly into a stream, straw bales placed in these drains to act as filters may be an option to reduce the input of sediment. However, care must be taken to prevent the release of trapped sediment when the bales are removed.
3. Care should be taken to prevent bank collapses and slippages. Any risk of bank collapse and slippage should be identified and eliminated prior to commencement of clearfelling operations.
4. Silt traps should be installed at locations that will intercept run-off to streams.
5. Machinery roads/tracks should be kept away from watercourses to avoid them becoming a direct route of sediment input. Where tracks have been created on slopes, small offlets should be dug at intervals to prevent water running directly down the slope.
6. If erosion and soil inputs to streams/rivers occur, be prepared to modify operating procedures immediately (including cessation of the operation if necessary) and install silt traps as appropriate. However, it is strongly recommended that installation of silt traps always occurs prior to commencement of clearfelling operations.

Mitigation of Pollution of watercourses with nutrients due to ground disturbance

As much of the potential nutrient input to streams during ground disturbance due to construction of forestry clear-felling is associated with suspended soil particles, the measures outlined in the '*Reduction and prevention of suspended solids pollution*' section apply equally to prevention of nutrient inputs to streams.

Mitigation Of Pollution Of Watercourses With Nutrients Due To Decaying Brash

If left on site brash should be moved at least 20m from all watercourses including drains.

Stacking and loading of timber should not be carried out in proximity to a watercourse, and ideally should be located on dry ground.

Reduction or elimination of pollution of the streams with other substances associated with the construction process

The following guidelines should be followed:

1. Turbines footprints will be located a minimum of 50m from EPA mapped streams & rivers.
2. Raw or uncured waste concrete should be disposed of by removal from the site.
3. Only ready-mixed concrete should be used during the construction phase, with all ready-mixed concrete being delivered from batching plants in sealed concrete delivery trucks.
4. Only the chute of the concrete delivery truck should be cleaned on site, using the smallest volume of water necessary. Concrete trucks should be directed back to their batching plant for washout.

5. So as to avoid spillage concrete should not be transported around the site in open trailers or dumpers. All concrete used in the construction of turbine bases should be pumped directly into the shuttered formwork from the delivery truck.
6. The arrangements for concrete deliveries to the site should be discussed with suppliers before commencement of work, agreeing routes, prohibiting on-site washout and discussing emergency procedures.
7. Clearly visible signs should be placed in prominent locations close to concrete pour areas, stating that washout of concrete lorries is not permitted on the site.
8. Large concrete pours should be avoided where prolonged periods of heavy rain are forecast and covers should be available for freshly placed concrete to avoid the surface washing away in heavy rain.
9. Wash down water from exposed aggregate surfaces and cast-in-place concrete should be trapped on-site to allow sediment to settle out and reach neutral pH before clarified water is released to the stream or drain system or allowed to percolate into the ground.
10. Fuels, lubricants and hydraulic fluids for equipment used on the construction site should be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to best codes of practice.
11. Fuelling and lubrication of equipment should be carried out in a specially bunded area.
12. Any spillage of fuels, lubricants or hydraulic oils should be immediately contained and the contaminated soil removed from the site and properly disposed of.
13. Waste oils and hydraulic fluids should be collected in leak-proof containers and removed from the site for disposal or re-cycling.

14. Hardstandings or crane platforms will be required in the vicinity of each turbine position to allow two cranes to work in the vicinity of a turbine. During turbine foundation construction, the crane platform also serves as a storage area for material (e.g. reinforced steel) and machinery. Runoff from the platforms should be to a drainage system which includes silt removal.
15. Prior to any work close to water courses ensure that all construction equipment is mechanically sound to avoid leaks of oil, fuel, hydraulic fluids and grease.
16. All pumps using fuel or containing oil should be locally and securely banded when situated within 25m of waters or when sited such that taking account of gradient and ground conditions there is the possibility of discharge to waters.
17. Where site works involve the discharge of drainage water to receiving surface waters, temporary oil interceptor facilities should be installed and maintained.
18. Appropriate spill control equipment, such as oil soakage pads, should be kept within the construction site to deal with any accidental spillage and emergency response procedures should be put in place.
19. Foul drainage from site offices etc. should be removed to a suitable treatment facility.

Location of sites for use as storage areas, machinery depots, site offices, temporary access roads or the disposal of spoil

In general such sites should be located as far as is practicable from watercourses. In general any site which is at least 50m from the nearest watercourse may be chosen. Disposal of spoil should not be carried out in any location where runoff can occur into watercourses.

Prevention of Obstruction to fish movement during construction

As all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works there will be no significant obstruction to upstream fish movement during construction.

Procedure for Contractors

Following on consultation which has taken place during the design and pre-development phase of the project, contractors should establish contact with Inland Fisheries Ireland before works commence, and there should be ongoing liaison with IFI throughout the construction process. Contractors should be in possession of, and familiar with the contents of "*Control of water pollution from construction sites - Guidance for consultants and contractors*" published by the Construction Industry Research and Information Association (CIRIA 2001) (e-mail enquiries@ciria.org.uk).

Contractors should be provided with the IFI guidance document "*Requirement for the Protection of Fisheries Habitat during Construction and Development Works*" and be familiar with its contents. Contractors will also be provided with any updated guidance when published.

5.14.2 Operational Phase Mitigation

Mitigation Of Pollution Of Watercourses With Contaminated Water Draining From The Proposed Development

1. Kerbs should be incorporated into the design of the bridges/crossings to prevent roadway run-off directly into streams.
2. A sustainable drainage system should be installed on the new road, which will prevent significant pollution to surface receiving waters.
3. As virtually all treatment options require proper maintenance in order to function properly, and as some can become a source of pollution if not properly maintained, a program of regular cleaning, maintenance and inspection of the road runoff treatment system should be adopted to ensure it functions correctly.

Mitigation Of Hydrological Impacts

1. Flow attenuation should be included in the wind farm design if necessary to ensure that no significant increase in peak stream/river flows is caused by the proposed development.

2. Natural drainage patterns should be restored after the completion of road construction by allowing surface drainage to pass under or over the proposed new road at intervals, corresponding with existing natural drainage lines.
3. Where necessary to avoid bank erosion and significant changes to watercourse flow patterns, energy breaks should be installed to reduce the velocity of the outfalls from drains to receiving waters.
4. Water abstraction from watercourses for any purpose should only take place at locations, in a manner and during a time period agreed with Inland Fisheries Ireland.

Mitigation Of Habitat Loss

One of the most effective methods of minimising loss of stream and riparian habitat during developments such as forestry clearance for construction, new road construction etc. is the establishment of riparian buffer zones: areas of land and vegetation adjacent to watercourses that are to remain in an undisturbed state, throughout and after the development process (Chilibeck *et al* 1992). Riparian buffer zones are valuable not only because riparian vegetation is a vital component of a healthy stream ecosystem, but because this vegetation acts as an effective screen/barrier between the stream and the development area, intercepting runoff and acting as an effective filter for sediment and pollutants from the development area. Where development is to take place close to rivers/streams, a riparian buffer zone should be clearly marked and its significance explained to machinery operators.

Loss or degradation of in-stream habitat will be avoided as all EPA mapped streams and rivers will be crossed by single span structures requiring no in-stream works.

Mitigation Of Obstruction To Upstream Movement Of Aquatic Fauna Due To Construction Of Culverts/ Culvert Replacement

1. All crossings of EPA mapped streams will be by way of clear span bridges.
2. Culversion of any other watercourses or drains to facilitate road/track crossings should in the case of box culverts be at least 30 cm below the streamgrade and in the case of pipe culverts should be at least 1.2 times the

bankfull width of the watercourse + 0.5m and should be embedded to a depth of at least 25% of the pipe diameter.

3. Culverts should be installed at the stream gradient otherwise they may result in a change in water velocities which may create a drop below the culvert or may create a hydraulic jump at the end of the culvert.
4. Culverts should not be aligned so that culvert outflows are directed into a watercourse bank.
5. The culvert should be installed so that it has a constant slope through its length except for the appropriate camber allowance where settlement is anticipated.

5.15 MONITORING

Biological monitoring should be carried out at Sites A – F (See Section 5.2.6 & Figure 5.8) immediately prior to commencement of construction, and repeated on completion of the construction.

5.16 CONCLUSION

If all recommended mitigation measures are implemented in full, there will be no significant impact on fish or other surface water flora and fauna.

5.17 MATRIX OF IMPACTS / MITIGATION / RESIDUAL IMPACTS

	IMPACTS DURING CONSTRUCTION				LONG-TERM IMPACTS		
Potentially Impacted Watercourse	Suspended Solids Pollution	Other Pollutants	Nutrient inputs	Obstruction to fish movement during construction	Potential Loss of Habitat	Potential Obstruction to Movement of Aquatic Fauna	Pollution in Run-Off
Yellow River Main Channel	Moderate	Moderate	Moderate	Not Significant	Not Significant	Not Significant	Minor
Mongagh/Castlejordan Main Channel	Moderate	Moderate	Moderate	None	None	None	Minor
Derryiron Stream West	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Derryiron Stream East	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Coolcor Stream	Moderate	Moderate	Moderate	None	None	None	Minor
Shrah Stream	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Wood Stream West	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Wood Stream East	Minor	Minor	Minor	Not Significant	Not Significant	Not Significant	Minor
Corbetstown Bridge Stream	Moderate	Moderate	Moderate	Not Significant	Not Significant	Not Significant	Minor
Killowen Stream	Moderate	Moderate	Moderate	No Significant	Not Significant	Not Significant	Minor
Mongagh Major Bog Drain	Not Significant	Not Significant	Not Significant	None	None	None	Not Significant

Table 5.20 Summary Of Potential Impacts In The Absence Of Mitigation Measures

Potentially Impacted Watercourse	Minimise pollution generated during construction process (see note 1)	Max. suspended solids in discharges to surface water 30 mg/l	Construction time constraints	Single span bridge with no in-stream structures	All crossings should maintain habitat continuity (see note 3)	Minimise pollution generated during and after forestry felling (see note 4)	Minimise pollution from runoff from access roads and other paved areas (see note 5)	Avoid significant hydrological changes to existing streams (see note 6 below)	Leave strips of >10m from river bank where works are planned close to streams (see note 7)
Yellow River Main Channel	✓	✓	✓ (see note 2)	✓		✓	✓	✓	✓
Mongagh/Castlejordan Main Channel	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	No works proposed within 50m
Derryiron Stream West	✓	✓		✓			✓	✓	✓
Derryiron Stream East	✓	✓		✓			✓	✓	✓
Coolcor Stream	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	✓
Srah Stream	✓	✓		No Crossings Proposed	No Crossings Proposed		✓	✓	No works proposed within 50m
Wood Stream West	✓	✓		✓			✓	✓	✓
Wood Stream East	✓	✓		✓			✓	✓	✓
Corbetstown Bridge Stream	✓	✓	✓ (see note 2)	✓		✓	✓	✓	✓

Potentially Impacted Watercourse	Minimise pollution generated during construction process (see note 1)	Max. suspended solids in discharges to surface water 30 mg/l	Construction time constraints	Single span bridge with no in-stream structures	All crossings should maintain habitat continuity (see note 3)	Minimise pollution generated during and after forestry felling (see note 4)	Minimise pollution from runoff from access roads and other paved areas (see note 5)	Avoid significant hydrological changes to existing streams (see note 6 below)	Leave strips of >10m from river bank where works are planned close to streams (see note 7)
Killowen Stream	✓	✓	✓ (see note 2)	✓			✓	✓	✓
Mongagh Major Bog Drain	✓			No Crossings Proposed	No Crossings Proposed		✓		
All other watercourses and drains	✓				✓		✓		

Table 5.21 Summary Of Mitigation Measures

Note 1: See report Sections 5.6.1

Note 2: Construction likely to generate suspended solids in the vicinity of Section Y1 of the Yellow River main channel, the Corbetstown Bridge stream downstream of Corbetstown Bridge and in the vicinity of Killowen Stream should not take place between the beginning of October and the end of April unless otherwise agreed with Inland Fisheries Ireland.

Note 3: Pipe culverts should have diameter at least 1.2 times the bankfull width of the watercourse + 0.5m and be embedded to a depth of at least 25% of the pipe diameter. Box culverts should be embedded at least 30cm below the existing watercourse bed.

Note 4: Follow guidelines in Section 5.6.1.

Note 5: Follow guidelines in Section 5.6.2 above.

Note 6: Follow guidelines in Section 5.6.2 above.

Note 7: To apply except at actual stream crossing points. Turbines and new roads/tracks will not be located within 50m of EPA mapped watercourses and a buffer zone of 10m will be established around all man made drains

	IMPACTS DURING CONSTRUCTION				LONG-TERM IMPACTS		
Potentially Impacted Watercourse	Suspended Solids Pollution	Other Pollutants	Nutrient inputs	Obstruction to fish movement during construction*	Potential Loss of Habitat	Potential Obstruction to Movement of Aquatic Fauna	Pollution in Run-Off
Yellow River Main Channel	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Mongagh/ Castlejordan Main Channel	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Derryiron Stream West	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Derryiron Stream East	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Coolcor Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Shrah Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Wood Stream West	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Wood Stream East	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Corbetstown Bridge Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Killowen Stream	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
Mongagh Major Bog Drain	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Table 5.22 Residual Impacts if all mitigation measures are fully implemented

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6.0 SOILS AND GEOLOGY

6.1 INTRODUCTION

6.1.1 Background

At the request of Jennings O'Donovan & Partners Consulting Engineers (JOD), Whiteford Geoservices Ltd (WGS) undertook a hydrogeological and geotechnical study of the proposed Yellow River Wind Farm near Rhode, County Offaly.

The purpose of this work is to:

- Undertake a study of soils, water and general ground stability conditions at the proposed site.
- Identify likely impacts of the proposed development upon these aspects of the environment including a peat slip risk assessment.
- Identify mitigation measures to avoid, remediate or reduce the impacts identified.
- Identify residual impacts of the development after implementation of mitigation measures recommended.

6.1.2 Relevant Legislation

This study was undertaken in accordance with The Planning (Environmental Impact Assessment) (Amendment) Regulations (Ireland) 2002, as well as Statutory Instrument 2007 No. 684, known as The Waste Water Discharge (Authorisation) Regulations 2007. This complies with the European Directive 85/33/EEC, as amended by 97/11/EC, which require Environmental Impact Assessment for certain types of major development before development consent is granted.

The following report is based upon the documentation contained in the Scottish Executive's "*Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments*", published as a final version in December 2006. Unless otherwise stated, all assessments and conclusions contained within this report are made with reference to this publication. These guidelines are

commonly in use in Ireland and have been accepted as authoritative, by the relevant Public Bodies.

In addition to this planning legislation, other environmental legislation that is relevant to the hydrological aspects of this study is as follows:

Quality of Water Intended for Human Consumption (80/778/EEC) and Quality of Water Intended for Human Consumption Directives (98/83/EC).

The Groundwater Directive (80/68/EEC) and The Groundwater Regulations (Ireland) 2003.

Dangerous Substances Directive (2006/11/EC) and The Surface Waters (Dangerous Substances) (Classifications) Regulations 2003.

Water Act and Water (Ireland) Order 2003.

Integrated Pollution Prevention Control (IPPC) Directive (Ireland) 2007.

The Water Framework Directive (2000/60/EC) and The Water (Water Framework Directive) Regulations (Ireland) 2006.

The Water Framework Directive (WFD) which was passed by the European Union (EU) in 2000 but will not come into legal effect until 2015, is a wide-reaching legislation that will eventually replace a number of the previous water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive.

6.1.3 Schedule of Works

Whiteford Geoservices Ltd (WGS) personnel visited the site from October 4th to 9th 2012 and on May 20th and 21st 2013 to undertake assessments of topography, geology, drainage and ground stability conditions at the site.

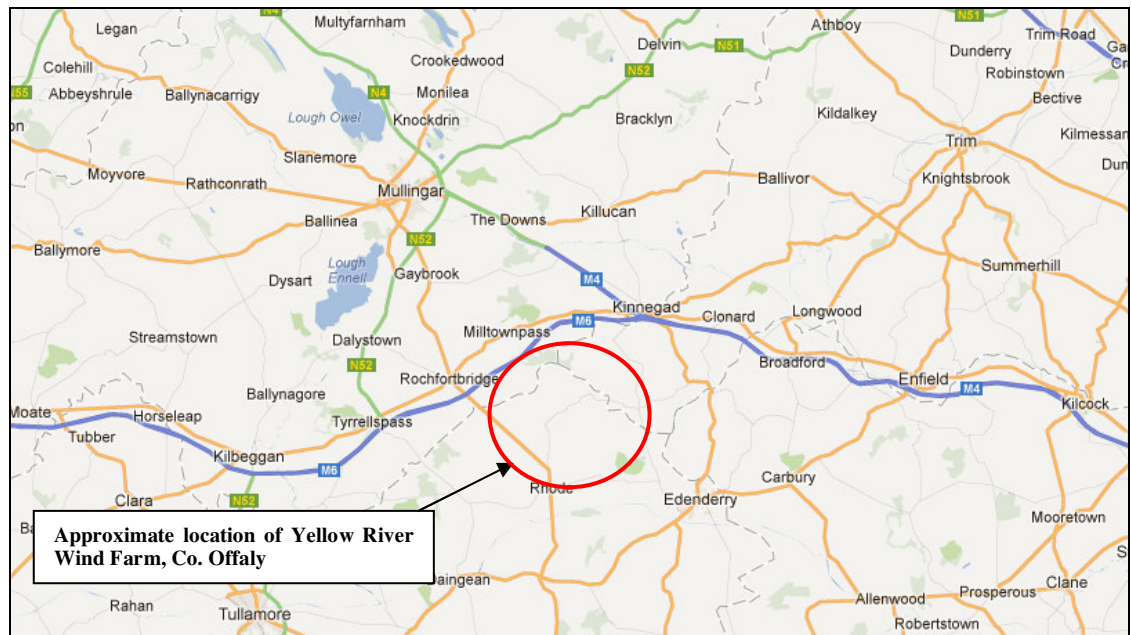


Figure 6.1 - Site Location Plan

Reproduced from GSI Online Mapping (Copyright Ordnance Survey Ireland – License No.EN 0047212)

6.2 METHODOLOGY

6.2.1 Desk Study

WGS undertook a desk study assessment of the soils, geology, hydrology and slope aspects of the proposed development site in October 2012. This involved the following components:

Acquire and compile all maps of the proposed wind farm development.

Study geotechnical reporting available within the public domain for the locality. Particular use was made of the following report, issued in June 2000, for the proposed N6 dual carriageway:-

- *“N6 Kinnegad to Athlone Dual Carriageway, Geotechnical Constraints” report, produced by Riada Consult on behalf of Westmeath County Council*

Study and assess the proposed locations of turbines and access roads with regard to available data on site topography and slope gradients.

Study and assess the proposed locations of turbines and access roads with regard to available data on site soils, subsoils and bedrock geology.

Study and assess the proposed locations of turbines and access roads relative to aerial photographs.

Overlay Geological Survey of Ireland (GSI) online data to determine site bedrock geology and the presence of any major faults or other anomalies.

Use of Geological Survey of Ireland (GSI) Quaternary mapping to determine soil classification on the site.

Consultation with the Geological Survey of Ireland (GSI) in relation to other publications in the fields of geology and hydrogeology resources of Co. Offaly.

Consultation with the Met Eireann Office for meteorological records pertaining to the site.

Consultation with the Water Service of Ireland to identify water supply sources in the vicinity of the proposed wind farm.

Conduct peat slip risk assessment to identify any potential hazards at turbine positions and along access roads.

The equipment and materials used during this desk study consisted of:

- AutoCAD (Graphics)
- Microsoft Excel (Database)
- Microsoft Word (Report)
- PDF (Report)
- Thales DGPS System
- Peat probing rods

6.2.2 *Site Investigations*

WGS carried out preliminary site investigations at the site of the proposed development in October 2012 and May 2013.

These works consisted of:

- Bedrock and subsoils outcrop logging and characterisation at turbines, other structures and access roads.
- Two machine excavated trial pits to a maximum depth of 3.25m below existing ground level.
- Peat depth probing. Peat probing was undertaken manually by pushing a series of rods into the ground at a selection of proposed turbine positions until a significant change in resistance was registered within the sub-soil. The depth to this increase in resistance was then measured and recorded.
- Shear strength of the peat was measured using a hand held shear vane.
- The purpose of these investigation methods was to assess the impact of external factors (such as local hydrology, vegetation etc) on the tensional forces binding the peat and hence its tendency towards failure, by shear, during construction works.
- Recording of GPS co-ordinates for all investigation points in the study.

6.2.1 Impact Assessment Methodology

From the desk and field data acquired, the following calculations and assessments were undertaken in order to evaluate the stability and type of soils, geology, contamination of water and slope aspects of the environment at the proposed development site for Yellow River Wind Farm:

- Characterisation of the sites topographical, geological, hydrological and geomorphological regime from the data acquired
- Consideration of ground stability issues as a result of the proposed development, its design and methodology of construction
- Assess the combined data acquired and evaluate any likely impacts on the soils, geology and water aspects of the environment

- If impacts are identified, consider measures that would mitigate or reduce the identified impact
- Present and report these findings in a clear and logical format that complies with EIS reporting requirements²⁰

6.2.2 Characteristics of the Development

The proposed site is composed of approximately 1,002.234 hectares, with the development footprint measuring 20.58 hectares. The proposed site for Yellow River Wind Farm is located to the north and south of the Yellow River and its tributaries. Two proposed turbine locations are situated to the south of the Mongagh River, which forms part of the County Offaly border.

Within Kilmurray's quarry settlement lagoons have formed due to current quarrying operations. Turbines 1 – 7 are bordered to the north by Roadstone quarry and a Bord Na Mona peat bog, where a number of large drains are in place within this site.

The majority of the proposed development site consists of improved grassland, currently in use as agricultural pastureland. Turbines 8 - 12 consist of peat bog and heath grassland, the maximum depth of which was found to be 3.60m, with an average depth of around 0.50m.

Analysis of preliminary trial hole investigations indicate that peaty, clayey topsoil overlies a natural sequence of glacial sands and gravels at the proposed site.

Loose to medium dense sand, with varying gravel content, was found to be present within both excavations and continued at the terminal depths of 2.80m and 3.25m below existing ground level. Due to the somewhat unconsolidated and granular nature of the soils, excavations were unstable and wall collapses were observed during site works.

Groundwater, generally in a state of moderately weak to moderately strong flow, was encountered during excavation works at depths ranging from 2.20m to 3.10m b.g.l.

²⁰ Statutory Rule 1999 No. 73 "The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 1999".

Slope ranges are negligible over the survey area and the site of the development is generally flat.

Primarily, the scope of the proposed development can be characterised as follows:

- Total site area **1,002.234 ha**
- Development footprint **20.58 ha**
- Peat Depth Range **0 – 3.6m**. Average peat depth **0.5 m**.
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands area (**1,250m²**) and associated splays (**745 m²**) **Total Area 1,995m²**
- Temporary construction compound, approximately **50 m x 30 m**.
- Clear fell of plantation forestry area 1.5 ha per turbine (four turbines T1; T25; T26 and T27 = 6 ha) plus part of T2 area = 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor)
Overall Clear fell area Total 10.4 ha
- T11 scrub area to be felled = **1.5 ha**
- Construction of approximately **18,275 m** of new access tracks having a minimum finished width of 5 m with passing bays
- Upgrading of approximately **5,916 m** of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.
- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of Substation Control Buildings and Compound on site area **1,850 m²**

- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings 9
- Upgrade of existing bridges 1
- The terrain is sloping with gradients between 1:40 and 1:100.

6.3 RECEIVING ENVIRONMENT

6.3.1 Geology

Land in the vicinity of the proposed Yellow River Wind Farm site is predominantly underlain by Visean Basinal Limestone and Shale, Waulsortian Mudbanks, Marine Shelf Facies, and Carboniferous Volcs and minor intrusions. The Dominant rock in the central portion of the site is Walsortian Mudbank, with Marine Shelf Facies prevelant in the eastern portion and Visean Basal Limestone prevelant in the western part. Carboniferous Volcs intrude on the north western part of the site.

Consultation with the GSI online database indicates that there are no solution cavities or abandoned mines on or near the proposed site.

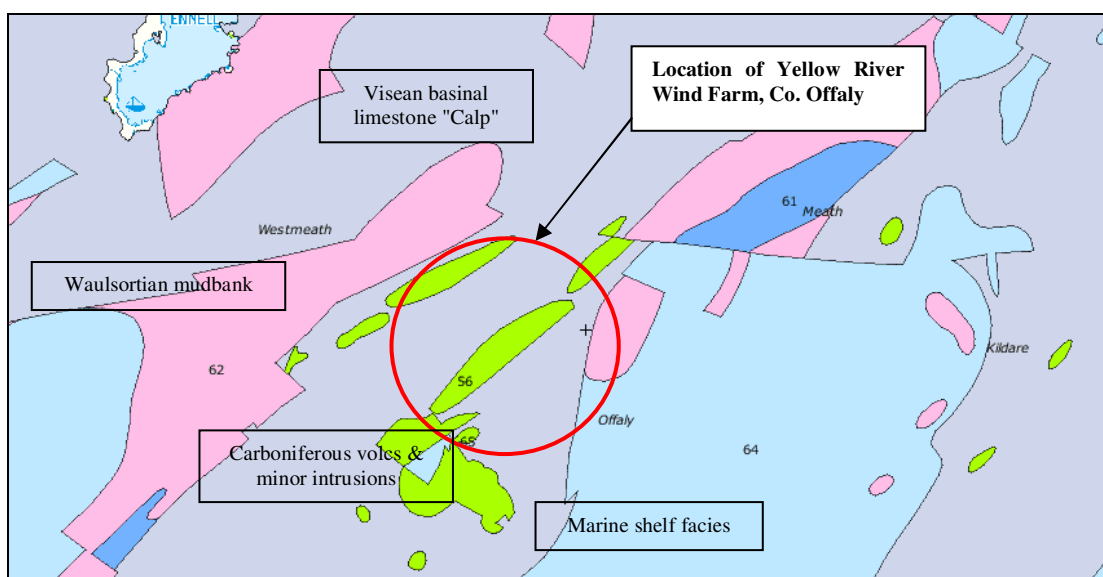


Figure 6.2 - Site Geology

Reproduced from GSI Online Mapping (Copyright Ordnance Survey Ireland – License No.EN 0047212)

Consultation with the Geological Survey of Ireland indicates that there are 3 Nr. active quarries within a 15km radius of the proposed site of Yellow River Wind Farm.

Two further quarries are present closer to the site; one being situated within the proposed boundary of Yellow River Wind Farm. Kilmurray Sand and Gravel quarry, located approximately 3km north-west of Rhode village on the R400, is currently operational. A Roadstone Quarry, also in operation, is located immediately north of Kilmurray's quarry.

No shafts or adits were recorded within 10km of the proposed site.

Please refer to Figure 6.3 below for a schematic representation of active quarries near the Yellow River Wind Farm site.

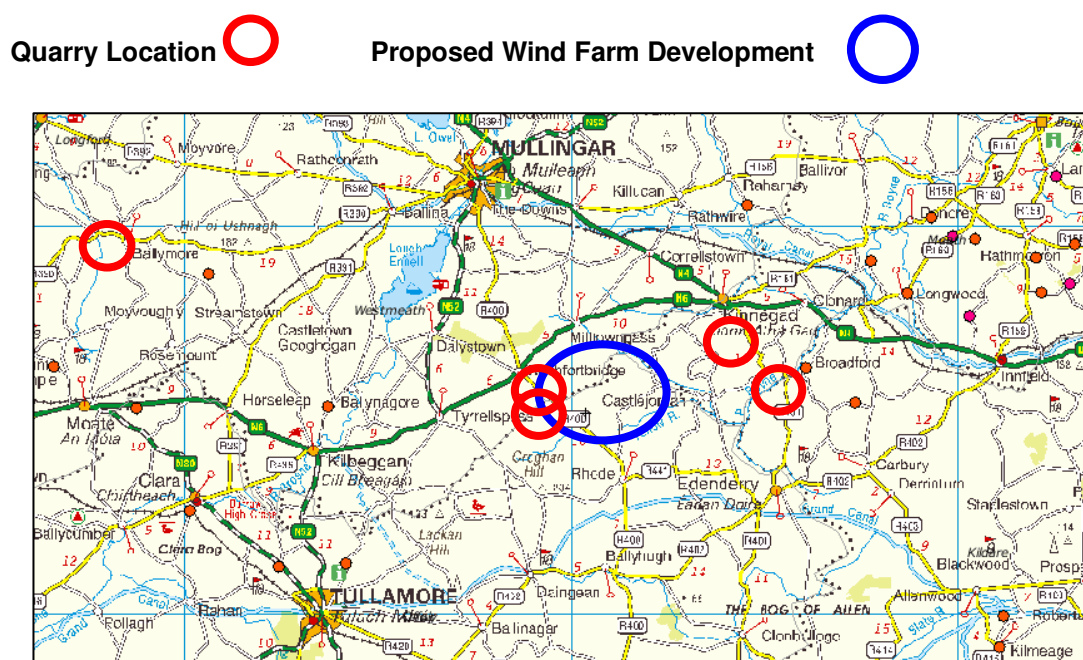


Figure 6.3 Location of active quarry sites within 15km radius of proposed Yellow River Wind Farm

6.3.2 Regional Hydrogeology

Aquifer Classification

Consultation was made with the Geological survey of Ireland's National Draft Bedrock Aquifer map.

The geology of the site comprises superficial drift deposits overlying Carboniferous Limestone. The drift deposits are likely to vary from impermeable clay to very permeable, clean sands and gravels. Layers of permeable and impermeable material can alternate in the vertical and horizontal planes producing complex bodies. The groundwater in the drift deposits can be in contact with the Limestone or exist as distinct bodies perched above the solid geology. Some permeable lenses of gravel may be small and distinct which may produce high initial flows but quickly decline because they are not replenished. However, where such a layer of clean gravel is in contact with a water body, high flows can continue for some considerable time. The complexity of drift hydrogeology is such that two permeable layers may have a water table at the same elevation but not be connected.

Essentially, surface water is anticipated to enter the sub-surface where it is permeable and will continue vertically downwards until it comes into contact with either an impermeable stratum or the water table. At this point the surface water will migrate in the same direction as the groundwater or according to the gradient of the impermeable stratum.

The Carboniferous Limestone yields groundwater via the fissures and not the matrix. Experience has shown that only a few and not all the fissures may control the movement through the rock material. Where the fissures are clean and wider than 5mm, and there is an adequate source, flow can be considerable. When assessing the presence of groundwater in a fissured Limestone the concept of a water table can be misleading. For example, a borehole drilled into the rock mass may be dry while another sunk a short distance away may intersect a water bearing fissure. Lowering of the water table in the Limestone due to construction processes such as cutting may result in the consolidation of the overlying glacial deposits.

The National Draft Bedrock Aquifer map indicates that the site is underlain by locally important aquifers, which are generally moderately productive.

Groundwater Vulnerability

The groundwater vulnerability varies within the boundaries of the proposed development. The majority of the site is located within areas of low to moderate

vulnerability. Regions of the site within landholdings containing turbines T15, T16, T17, T18, T19, T20 and T21 present areas of increased groundwater vulnerability.

Wind farm drainage has been designed to adequately cope with the groundwater conditions identified at the most vulnerable turbine locations. Please refer to sections 2.7.12 and 3.2.4 for further details.

Well Database

Consultation with the Geological Survey of Ireland's database indicates that there have been a high number of exploratory wells undertaken within the land surrounding the proposed development area.

6.3.3 Local Hydrology

Site Drainage

Across the proposed site development there are a number of drains in place. The majority of these occur along the boundaries between individual fields on agricultural land. Most are approximately 2.00m wide and 1.00m deep. Within the peat bog areas drains are present more frequently, although it was not possible to determine the full extent of the site drainage system.

Please refer to the site walk-over and reconnaissance section for details of existing site drainage features identified within the vicinity of each proposed turbine location.

Local Watercourses

The proposed development site for Yellow River Wind Farm is located to the north and south of the Yellow River and its tributaries. Two proposed turbine locations are situated to the south of the Mongagh River, which forms part of the County Offaly border.

Within Kilmurray's quarry settlement lagoons have formed due to the quarry currently in operation. Turbines 1 - 7 are bordered to the north by Roadstone quarry and a Bord Na Mona peat bog, where a number of large drains are in place within this site.

Palaeo-Karst Features

Karst topography is defined as “An assemblage of topographic forms resulting from dissolution of the bedrock and consisting primarily of closely spaced sinkholes.”²¹ Karst topography can form in regions of exceptionally soluble rocks, including Limestone. Large areas of the proposed site development are underlain by Visian Basinal Limestone.

During completion of the walkover survey the proposed site development area has been visually assessed to determine if any karstic features are present. The presence of such features has, in some cases, resulted in structural instability.

6.3.4 Soils and Sub-soils

The Quaternary Geological Map of Ireland, published by the Geological Survey of Ireland (GSI), shows that the study site is mainly mantled by peat which is underlain by glacial subsoils.

WGS observed that the proposed Wind Farm site consists generally of cutaway raised bog and improved agricultural grassland.

The table 6.1 lists the findings of the peat probing and illustrates the presumed peat thickness.

²¹ (Skinner and Porter, 1987: p259)

Turbine	Deepest peat depth in Turbine Vicinity (m)
T1	0.25
T2	0.05
T3	0.10
T4	0.50
T5	0.00
T6	0.48
T7	3.00
T8	0.52
T9	1.50
T10	0.05
T11	0.50
T12	0.03
T13	0.48
T14	1.00
T15	1.00
T16	0.50
T17	0.50
T18	0.50
T19	0.21
T20	0.50
T21	0.50
T22	0.50
T23	0.50
T24	0.50
T25	0.50
T26	0.50
T27	0.22
T28	0.18
T29	0.14
T30	1.46
T31	0.64
T32	0.95

Table 6.1 – Generalised Peat Depth Distribution

Although the results of probing indicate a presumed peat depth range of 0 to 3.60m at the location of proposed structures, it should be noted that it is assumed that the depth of peat corresponds to an increase in resistance on the probes

Obstructions within the peat would cause an increase in resistance or refusal, resulting in an inaccurate interpretation. Results of probing should therefore be considered to be indicative only.

All proposed turbine locations are situated on relatively flat ground, where slopes have been confirmed to be < 5 degrees to the horizontal.

6.3.5 Potential For Bog Failure

Based on topography and collected peat depth thickness at each turbine an assessment was made of the potential for peat movement. From this information Table 6.2 of potential risks was produced. The Peat Slide Risk Assessment Report can be found in **Appendix K**.

Reference is made, in this section, to “*Peat Slide Hazard and Risk Assessment Best Practice Guide for Proposed Electricity General Developments*”, produced by The Scottish Executive & Halcrow Group Ltd (Dec 2006).

Stability Issue	New Access Routes	Turbine Base Location
<i>Existing Slopes</i>	The slopes encountered at the proposed site are generally low and vary between approximately 0 – 5 degrees to the horizontal.	Slopes encountered at the proposed turbine locations are generally low and display magnitudes of 0 – 5 degrees to the horizontal.
<i>Landslip / Bog Slide</i>	<u>Excavations</u> The favoured method of construction for new access roads is to found, where possible, directly on top of the natural soils present immediately underlying the peat. Where this is carried out and slopes are of low to moderate magnitude (0 – 5 degrees) the potential for bog slide, at a time post-dating the completion of the site works, is classified to be at INSIGNIFICANT RISK . <u>“Floated” Road Construction</u> Where the peat thickness is in excess of 1.50m, “floated road” construction is considered to be more effective than excavation. Current information suggests that this method of construction will be applicable to short stretches of access road in the vicinity of turbines T7, T8, T9, T10 and T23.	From topography and peat depth data the following assessment is made at each proposed turbine location. Walkover assessment confirms that only 7 out of the 32 proposed turbine locations are within areas where peat could be considered the prevailing superficial soil type. The turbines affected are T7, T8, T9, T10, T23, T30 and T31. <u>Excavations</u> At turbine locations T8, T10, T23, T30 and T32 the peat cover present is not significant and the proposed locations of the turbine bases are situated on slopes of negligible magnitude. Consequently, these proposed turbine locations can be classified - INSIGNIFICANT RISK. At turbine locations T7 and T9 peat thicknesses in excess of 2.5m and potentially in excess of 4m are present. However, given the negligible ground slopes and relative distance from sensitive receptors peat slide risk is determined to be - INSIGNIFICANT RISK The designation INSIGNIFICANT RISK does not however mean that the risks of constructing within PEAT can be ignored. This designation makes the assumption that correct procedures will be adopted and implemented fully during the construction period. If SIGNIFICANT RISK were to be encountered specific procedures would be appropriate to mitigate the risk and reduce it to an acceptable level.

Table 6.2 – Summary of Peat Slide Analysis for Yellow River Wind Farm

These potential risks have been used to calculate a risk ranking, based on the following:-

- **HAZARD:** the likelihood of the peat slide event occurring

(This relates to the potential for a peat slide to be triggered. Factors considered include the topographic slope, peat thickness, strength of peat, type of peat present and method of construction proposed.)

Table 6.3 gives a general view of some of the factors used to establish HAZARD RISK:-

(The actual calculation of HAZARD is a complex procedure based on a detailed numerical analysis of key indicators.)

<i>Scale of Risk</i>	<i>Hazard</i>
0	<i>Peat not present and average slopes < 5 degrees to the horizontal</i>
1	<i>Peat less than 2.50m thick and slopes < 5 degrees to the horizontal</i>
2	<i>Peat less than 2.50m thick and slopes 5 – 10 degrees to the horizontal Peat 2.50m to 4.00m and slope < 5 degrees to the horizontal Where peat cover is greater than 1.50m, the construction of “floated” roads is recommended</i>
3	<i>Peat 2.50m to 4.00m thick and slopes > 5 and < 10 degrees to the horizontal</i>
4	<i>Peat 2.50m to 4.00m thick and slopes > 10 and < 22.5 degrees to the horizontal Peat > 4.00m thick and slopes > 5 and < 10 degrees to the horizontal</i>

Table 6.3 Qualitative assessment of Peat Slide Hazard

- **EXPOSURE:** the impact that such an event might have at this particular location

(This relates to the receptor in the event of a peat slide. This can range from adjacent areas of blanket bog, to farmland, watercourses, water abstraction sites, roads, un-occupied structures and occupied structures.)

Table 6.4 gives a general view of some of the factors used to establish EXPOSURE RISK:-

<i>Scale of Exposure</i>	<i>Determining Factors</i>	<i>Impact upon total project</i>
1	<i>Flat agricultural land or blanket bog within 100m of structure or 50m for roads</i>	<i>Very low Impact (< 1%)</i>
2	<i>Structure <100m from minor water course or <50m for roads</i>	<i>Low Impact (1% - 4%)</i>
3	<i>Structure or roads <100m from major water course, or uninhabited building</i>	<i>High Impact (4% - 10%)</i>
4	<i>Structure <100m from major public road</i>	<i>Very High Impact (10% - 100%)</i>
5	<i>Structure <100m proximity to inhabited buildings</i>	<i>Extremely High Impact (> 100%)</i>

Table 6.4 Qualitative assessment of Peat Slide Exposure

By assessing each peat slide event against the scales given above, it is possible to assess the hazard ranking by multiplying the hazard and exposure of each event.

This results in a Hazard Ranking value between 0 and 25. (i.e. **HAZARD RANKING = HAZARD x EXPOSURE**). Table 6.5 outlines the suggested action for the different levels of hazard ranking.

<i>Hazard Ranking</i>	<i>Hazard Ranking Level</i>	<i>Action Suggested</i>
17 - 25	Serious	Avoid project development at these locations
11 - 16	Substantial	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less.
5 - 10	Significant	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
0 - 4	Insignificant	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

Table 6.5 Hazard Ranking and Suggested Actions (in accordance with “Peat Slide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments”, December 2006)

Table 6.6 summarises the relative Hazard Ranking of each Turbine to be constructed at Yellow River Wind Farm

ID	Co-ordinates		Peat Slide Hazard Ranking
	Easting	Northing	
T7	249352	236407	4 ²²
T8	250187	236156	2
T9	250565	236006	4
T10	251119	235699	4
T23	254931	238582	2
T30	235594	240494	1
T32	254120	241523	2

Table 6.6 Hazard Ranking for each Turbine Location at Yellow River Wind Farm

A similar Hazard Ranking is anticipated for short stretches of the site access roads in the vicinity of these turbines.

6.4 DO NOTHING IMPACT

In the absence of the proposed development the following summarises the affect on the lands:-

There will be no positive impact to Soils and Geology, which would remain relatively unchanged, where site drainage remains effective.

Thus should the wind farm not be constructed, there would be a minor positive impact on the soils and environment with respect to peat stability when compared to the situation where the wind farm is constructed.

However, it should also be recognised that the improvements proposed to site drainage will increase peat stability (where peat is present) through a reduction in hydrostatic pressure. Conversely, the maintenance of effective site drainage cannot be guaranteed.

²² A selection of 7 proposed turbine locations were visited to estimate peat depth, peat decomposition, ground slopes, presence of relic landforms and proximity to sensitive receptors.

Consequently, following construction there would be a minor improvement in slope stability and this would also have a corresponding minor positive impact in respect to soils and geology.

6.5 POTENTIAL IMPACTS OF THE DEVELOPMENT

6.5.1 Construction Phase

Earthworks Activities

Implementation of the proposed development will result in the removal of peat in parts of the site to facilitate excavation for the construction of access roads and platforms for the wind turbines to a competent stratum or bedrock suitable for placement of foundations.

Ground conditions vary across the site with a fluctuating peat cover. At the turbine bases, excavation is required to around 3.0m dependent on local ground conditions for a suitable foundation for the turbine.

Potential for Bog Failure

Consideration has been given to the potential for bog failures at the Yellow River Wind Farm site. These mass movements of peat can take the form of either bog burst or bog slide. Historical evidence suggests that raised bogs are more prone to bog bursts while bog slides are more common on blanket bogs, however it is noted that there is no historical or visually identifiable evidence of peat slides or ground instability at the development site. (*The site at Yellow River would be considered to be “raised bog” where bogland has been identified.*)

These peat failures generally occur either during or immediately after periods of heavy rainfall. Failures are especially likely to occur where there is a break of slope at the edge of an upland plateau of peat. Records indicate that bog bursts can naturally occur on shallow slope angles of less than 6 degrees while bog slides appear to occur on slopes that are steeper than 6 degrees.

Following recent, well documented bogslides on the slopes of Dooncarton and Barnachuille mountains, Co. Mayo in September 2003 and more significantly at Derrybrien, Co. Galway in October 2003, the potential for bog failure has come to the

fore in consideration of planning for wind farm development. The following potential causal factors for bog failure are identified following research and assessment of recent slides and from historical evidence over the last 200 years in Ireland.

1. Research into the history of bogslide occurrence indicates that the majority of bogslides have occurred on the blanket bogs in the west where rainfall is highest. Here, bogslides tend to be more frequent during the autumn and winter months.
2. The following criteria are considered to be the causal or contributory factors to bogslide occurrence:
 - (a) Slope is the single most important factor for blanket bogs. Bog slides are especially likely to occur where there is a break in slope at the edge of an upland plateau of blanket peat, providing a line of weakness. While initial failure is likely to be slippage (translational or rotational faults) semi-fluid to fully fluid behaviour is the main movement mechanism downslope. Slope gradient imparts kinetic energy to the sliding material.
 - (b) The depth of peat and its relationship to humification (the degree to which the fibre structure of the peat has decayed), pore water pressure, shear vane strength and other parameters generally indicates that the deeper the peat profile the more unstable it is, if external controls such as slope, drainage, removal of adjoining earth materials are changed. Exact depth thresholds for stability are not applicable due to the variability of peat environments (raised bog, blanket bog or fen habitats) and their site specific conditions. However, as a rule of thumb peat of depths greater than >1.5m is significantly more vulnerable to instability than shallower peat at <1.5m depth, and in particular the top-layer of acrotelm (living) peat at <0.3m.
 - (c) The pattern of recent precipitation at the site over the last c. 30 years such as intense localised rainfall (or melting snow) is an important trigger mechanism.
 - (d) Antecedent weather conditions such as drought conditions are identified as a contributing factor. In the case of the recent landslides at Dooncarton and Barnachuille in September 2003 and at Derrybrien October 2003, short

intense periods of heavy rainfall followed an exceptionally dry late summer. Historically, the Owenmore bogslide in Erris, Co. Mayo (1819) was also preceded by two months of drought. Sustained dry conditions leads to high soil moisture deficit (SMD). This dries the blanket peat, causing shrinkage and desiccation cracks.

- (e) Some bogslides are caused by excessive interference – e.g. opening of turf banks, opening deep drains on blanket bog. All drains should be perpendicular to slope contour not parallel to it.

Finally, the following items are noted:

1. Geological structural features generally play no part in bogslide occurrence.
2. Bogslides are prone in certain upland locations due to their peculiar topography, ground composition and hydrology. When a slide occurs, it acts as a safety valve to restore equilibrium.
3. The most destructive bogslides involve the combination of slide materials with floodwaters, diluting the peat and mud in waterways and accelerating the velocity of the debris flow.

Water Quality

The following impacts both likely and potential are identified:

Suspended solids release during excavations

In a wind farm development, it is the construction phase that poses the highest risk to the site's hydrology, in particular to the quality of surface water due to generally poor aquifer conditions on high elevation terrain. The Yellow River site does not have this high terrain but does have a low lying terrain. Nevertheless, it is likely that during excavation works, storage and re-use of materials, suspended solids will be entrained by sustained rainfall and surface water runoff.

The most vulnerable areas to surface water quality deterioration are (a) access road crossings of man made drains and (b) turbine hardstand and infrastructure

development at moderate gradient slopes proximal to existing waterways, which this site should not be threatened by as it has relatively low gradients and no natural waterways within 50m of turbine locations.

Some of the man made drains have steep gradients cut out, which should be taken into account if constructing new access tracks. This is considered to be short-term and temporary but could have significant negative impact. With appropriate environmental engineering controls and measures, this impact can be negated and mitigated against.

Risk of pollution from hydrocarbons

The second pollutant of concern during the construction phase of the project is the potential spillage and release of hydrocarbons from plant equipment and associated transfer stations during the construction phase. An accidental hydrocarbon spillage would have a significant negative impact on both vegetation and water quality at the site.

Temporary sanitation

A temporary site office, service area and sanitation will be required for the construction stage of the development. Associated with this facility is the potential risk of water and soil contamination by wastewater release or chemical contamination of water and soil from temporary sanitation facilities. The level of risk posed is dependent on the type and location of facilities that are put in place.

The Water Framework Directive (WFD) highlights that all groundwater has a value irrespective of whether it occurs in a major or minor aquifer. Groundwater also contributes and maintains the surface water network and as a result its contamination should be mitigated.

6.5.2 Operational Phase

Change to Hydrological Regime

The rate and amount of surface water runoff from the site will increase as a function of the replacement of vegetation, peat and subsoils cover (which absorb rainfall) in

parts of the site with a concrete/aggregate hardstand at turbine locations, and aggregate mix for proposed access tracks.

Water Quality

A potential impact on water aspects of the environment may arise during the operational phase of the development if regular maintenance, monitoring and auditing of mitigation structures and procedures are not undertaken during the lifetime of the project.

6.6 MITIGATION MEASURES

6.5.3 Construction Phase Mitigation

Earthworks Activities

The removal of bedrock may be unavoidable in places but every effort should be made to ensure that the amount of subsoils to be removed is kept to a minimum in order to limit the impact on the geotechnical and hydrological balance of the site.

It is noted that the “natural hydrology” of parts of the site may have been significantly altered by land drainage, however measures will be emplaced to minimise any additional changes to the existing site hydrology resulting from the construction of the wind farm.

During the construction works, the excavation, storage and re-use of excavated materials have the potential to directly or indirectly negatively impact on water quality. Appropriate engineering controls, such as the installation of a drainage system with settlement / stilling ponds, silt traps, check dams and interceptor drains, will be carried out in tandem with, and where possible, prior to, any excavation work to mitigate potential impacts. In relation to construction works, the most important aspects of these recommendations involve:

1. Deep excavations at turbine base locations in order to construct turbine foundations and hardstandings to support crane loadings.
2. Construction of new site roads and the upgrade of existing site roads.

3. Construction of new sections of “floated road” where excess peat depth is present.
4. Removal of waste peat and glacial spoil and disposal within designated zones.

These recommendations should be included in the Contractor’s contract of works for the site. In addition, a construction phase management plan will be in operation to check equipment, materials storage and transfer areas, drainage structures and their attenuation ability on a regular basis. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations.

Potential for Bog Failure

Site investigations and assessment of the Yellow River Wind Farm site indicate that the site is a low risk for slope failure or mass movements. Areas of moderate risks would be deep peat >2.5m and the presence of very sensitive, very weak peat (<15kPa). It is considered that no proposed turbine is located within such an area.

Applying the precautionary principle however, the following procedures are recommended as best-practise mitigation measures to avoid slope instability at wind farm sites.

These are:

The contractor’s methodology statement should be reviewed and approved by a suitably qualified geotechnical engineer prior to site operations.

- Any excavations that may tend to undermine the up-slope component of a peat and or unstable subsoils slope should be sufficiently supported by buttress, frame or rampart to resist lateral slippage.
- Drainage management measures will be installed to effectively drain grounds in tandem with access track construction. Such drains should be positioned at an oblique angle to slope contours to ensure ground stability. Drains on areas of the site with minimal risk of bog failure as identified by site investigations

can be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage.

- Due to peat's fluid-like properties, all peat excavated should be immediately removed from sloping sites. If peat is required for reinstatement, then acrotelm peat (<0.3m shallow, living layer) should be moved to a lower elevation part of the site that is characterised by near-horizontal slopes, is >100m away from any significant break of slope and is >50m away from drains and streams.
- If additional materials are required for the construction process, after exhausting excavated materials during road and infrastructure construction, additional materials may be acquired from local quarries. Wherever possible any imported aggregates should consist of a similar geo-chemistry to the local geology of the site. It should be noted that this is dependent on the quality and variety of aggregate supplied by the local quarries.
- From recent evidence (landslides in Mayo and Galway). Excessively wet periods should be avoided in terms of scheduling significant excavations in peat substrates.

Water Quality

During the construction phase, surface water drainage is generally found to be more at risk to water quality change than groundwater, where the majority of documented pollution events tend to involve suspended solids from sediment flows. The following mitigation measures are recommended to protect surface water and, to a lesser degree, groundwater quality.

Groundwater Dewatering

Any water ingress that may be encountered in the upper weathered zone of the bedrock during the construction phase should be intercepted by a toe drain and diverted to an existing artificial drainage channel and attenuation before release.

The design of the drainage takes into account factors of slope stability and where possible should be sealed at the base. However there should be minimal slope stability issues at the site.

6.5.4 Operational Phase Mitigation

Change to Hydrological Regime

Stilling ponds and interceptors will be removed following the completion of construction works. The proposed Jennings O'Donovan drainage design will be capable of dealing with any additional surface runoff arising from the proposed development.

The proposed drainage design prevents both *(a) hydraulic loading* of the existing surface water network and *(b) provides sufficient attenuation of suspended solids* prior to outfall to the natural drainage network, in order to maintain the existing environments baseline chemistry. Surface water flows in all existing waterways and drainage should not be impeded in any way by the proposed development. Access tracks that intercept existing waterways will be designed so that the culverts installed to maintain baseline flows are large enough to accommodate peak flow within a 100-year return period.

Water Quality

WGS recommends the following measures to mitigate pollution to surface waters and groundwaters during the lifetime of the project.

A regular programme of environmental site maintenance for the drainage network and drainage culverts to ensure their performance to standards at the site. Some changes in the drainage network may be required as a result of unanticipated changes in the hydrological regime at the site during the operation phase of the project.

Although no onsite refuelling is proposed at the site, on completion of the construction phase, if fuelling has occurred on site, the fuel tanks and oil interceptor used at the fuel transfer area should be removed by a suitably qualified contractor. An audit of ground and water conditions immediately under and around the transfer area is recommended to investigate whether any leakage has occurred to the hydrological system and whether some clean-up measures are required. Aside from the use of

lubricant oils at the substation (low volume), fuels should not be stored on site for the operation phase of the project.

The substation compound is likely to require substation transformer cooling oil or gas. This should be stored in containers within a safe part of the substation compound, minimising accidental leakage and / or fire hazards. Consideration should also be given to a bunded area for the oil. Similarly, any other potentially harmful substances used to service the substation should be stored in an environmentally safe manner to mitigate impact to the soils and water.

6.6 RESIDUAL IMPACTS OF THE DEVELOPMENT

Residual impacts that are most likely to occur at the Yellow River Wind Farm site during the construction phase would be as follows:

There will be a change in ground conditions at the site with the replacement of natural materials such as peat, subsoils and possibly bedrock by concrete, subgrade and surfacing materials. This is a direct permanent change to the materials composition at the site.

Limited temporary decrease in water quality on a local level is likely to arise from the release of suspended solids and sediments during the excavation and construction process, particularly following rainfall events after a sustained dry period. This local deterioration in water quality will subsequently be reduced naturally by dilution and by managed mitigation prior to exiting from the site boundary to main catchments.

Residual impacts that are most likely to occur at the Yellow River wind farm site during the operational phase would be as follows:

Changes in ground surfacing including areas of new hardstands will impact on the hydrology of the site and may result in increased runoff of rainwater and increased drainage discharge. It is assumed this should not have a significant impact on the hydrology of the site.

The drainage infrastructure that will be emplaced as part of the roads and turbines development will also change the subsurface hydrology by replacing a natural diffuse drainage system with line interceptors and point discharges to buffered outfalls.

Careful design of this drainage to mimic natural conditions will help to mitigate negative impacts of artificial drainage.

6.8 MONITORING

All drainage systems should be properly maintained at regular intervals.

Slopes, disposal sites and roads should be inspected regularly.

Regular analysis of watercourses should be undertaken.

All activity on site and at boundaries should be monitored and a register kept.

Only authorised and suitably qualified persons on site – strictly restricted access at all times.

The site should be inspected regularly for fire hazards.

6.7 CONCLUSION

Successful adherence to the mitigation measures contained within this report allows the optimal level of risk to be attained at each proposed turbine and access roads at the proposed development site of Yellow River Wind Farm.

Appraisal of the Hazard Rankings for each proposed turbine location indicates that the site (encompassing the “worst case scenario” turbines T7, T8, T9, T10, T23, T30 and T32) carry **INSIGNIFICANT** Hazard Rankings as determined in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in “*Peat Slide Hazard and Risk Assessment - Best Practice Guide for Proposed Electricity Generation Developments*”, December 2006.

Excavation of peat so that road bases can be founded directly onto the underlying glacial soils remains the optimal approach. There is normally a higher degree of risk associated with this method in areas where peat is greater than 1.50m depth and in such cases “floating” road construction is the preferred method of access road emplacement.

In the case of Yellow River Wind Farm the thickness of sensitive peat appears to be generally <1.5m, although thicker sequences of peat are present in the vicinity of T7, T9 and T23. However the presence of deep peat cannot be ruled out at the locations

of T8, T10, T30 or T32, where with obstructions, such as buried tree branches, trunks and stumps may be present within the bogland soils.

Regardless of the above the Hazard Ranking attributable to the access roads and turbine locations remains **INSIGNIFICANT**, according the Scottish Executive guidance

The Yellow River Wind Farm site is suitable for development as proposed. Peat slide risk has indicated an INSIGNIFICANT risk of instability in relation to all aspects of the proposed development.

6.8 REFERENCES

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7.0 WATER

7.1 INTRODUCTION

7.1.1 Background

Hydro-Environmental Services (HES) was engaged by Jennings O'Donovan & Partners Ltd to undertake an assessment of the potential impacts of the proposed wind farm at Yellow River, Co. Offaly on water aspects (hydrology and hydrogeology) of the receiving environment.

The primary objectives of the assessment include:

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the proposed wind farm development;
- Identify likely positive and negative impacts of the proposed development on surface and groundwater during construction and operational phases of the development; and,
- Identify mitigation measures to avoid, remediate or reduce significant negative impacts.

7.1.2 Relevant Legislation

The EIS is carried out in accordance with the follow legislation:

- S.I. No. 349 of 1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84 of 1995, S.I. No. 352 of 1998, S.I. No. 93 of 1999, S.I. No. 450 of 2000 and S.I. No. 538 of 2001), S.I. No. 30 of 2000, the Planning and Development Act, and S.I. 600 of 2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/373/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 600 of 2001 Planning and Development Regulations, 2001;

- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988 Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it will fully replace a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;
- S.I. No. 41 of 1999 Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 2007);

- S.I. No. 439 of 2000 Quality of Water intended for Human Consumption Regulations and S.I. No. 278 of 2007 European Communities (Drinking Water No. 2) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations;
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010: and,
- European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

7.1.3 Relevant Guidance

The water assessment of the EIS is carried out in accordance with guidance contained in the following:

- Environmental Protection Agency (2003): Advise Notes on Current Practice (in the preparation on Environmental Impact Statements);
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements;
- Institute of Geologists Ireland (2002): Geology in Environmental Impact Statements – A Guide;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Offaly County Council - County Development Plan 2009 – 2015;
- Wind Farm Development Guidelines for Planning Authorities (September, 1996);

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh; and,
- Coillte (2009): Forest Operations & Water Protection Guidelines.

7.2 METHODOLOGY

7.2.1 Desk Study

A desk study of the site and the surrounding area was completed in advance of undertaking the walkover survey. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - National Draft Bedrock Aquifer map;
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- The Department of Communications Marine and Natural Resources - Exploration and Mining Division website (www.minex.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive “WaterMaps” Map Viewer (www.wfdireland.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Galway - Offaly). Geological Survey of Ireland (GSI, 1996);
- Geological Survey of Ireland – Athboy & Trim Groundwater Bodies - Initial Characterisation Reports - Draft (2004);
- OPW Indicative Flood Maps (www.flooding.ie); and,

- CFRAM – Catchment Flood Risk Assessment and Management – Preliminary Flood Risk Assessment maps (www.cfram.ie).

7.2.2 Consultation

A number of public and private bodies were consulted in relation to the proposed development and the EIA process. Water (hydrology & hydrogeology) related responses are summarised in Table 7.1.

Body Name	Key Water Related Points in Response
Department, Agriculture, Food & Fisheries	The potential impacts of tree felling operations and mitigation to prevent impact on surface waters.
Geological Survey of Ireland	Potential impacts on the warm spring at Toberdaly (E251700, N231700) arising from the proposed development are to be assessed.
Inland Fisheries Ireland	Fish stocks would be protected from the negative effects of in-stream works associated with this project (turbines, buildings, cabling, roads, etc) and that adequate buffer zones are set around watercourses. IFI Guidance Document “Guidelines Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites” must be adhered to.

Table 7.1: Summary of Water Related Consultation Responses.

7.2.3 Site Investigations & Surveys

Hydrological baseline monitoring and sampling was undertaken by HES on 11th and 12th October 2012 and on 9th May 2013. Investigations to address the Water Section of the EIS included the following:

- Walkover surveys and hydrological mapping of the site and the surrounding area were undertaken by HES whereby water flow directions and drainage patterns were recorded;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken at a number of locations to determine the origin of surface water flows;
- Field hydrochemistry measurements to determine potential groundwater and surface water interactions; and,

- 4 no. surface water samples were taken by HES to determine the baseline water quality of the primary surface waters downstream of the site.

7.2.4 *Impact Assessment Methodology*

Please refer to Chapter 1 of the EIS for details on the impact assessment methodology (EPA, 2002 & 2003). In addition to the above methodology the sensitivity of the water environment receptors were assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 7.2 are then used to assess the potential effect that the proposed development may have on them.

Sensitivity of Receptor:

- **Not sensitive:** Receptor is of low environmental importance (*e.g.* surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability “Low” – “Medium” classification and “Poor” aquifer importance.
- **Sensitive:** Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability “High” classification and “Locally” important aquifer.
- **Very sensitive:** Receptor is of high environmental importance or of national or international value *i.e.* NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability “Extreme” classification and “Regionally” important aquifer.

Table 7.2: Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk).

7.3 RECEIVING ENVIRONMENT

7.3.1 *General Site description*

The proposed wind farm development, which comprises 32 no. turbines (and related ancillary infrastructure) over multiple landholdings, is located on lands to the northwest, north and northeast of Rhode, Co. Offaly. The dispersed sections of the site are described below. Refer to Figure 7.1 for their locations.

Proposed turbines T1 to T7 are located on an area of extensively drained and improved grassland approximately 4km to the northwest of Rhode. The proposed

development area, which has an elevation range of between 83 and 93mOD, is predominately flat with the exception of some small hills on the south of the landholding. An unnamed tributary stream of the Yellow River flows in an easterly direction through the centre of the landholding. An area of intact bog exists on the eastern side of the landholding in the vicinity of proposed turbine T7.

Proposed turbines T8 to T12 are located in an area of cutaway raised bog which exists approximately 2.5km to the northwest of Rhode village. A small section of intact raised bog still exists on the south of the landholding. The topography of the landholding is relatively flat (with the exception of the transition from the cutaway bog into the raised bog i.e. bank face) and has an elevation range of between 80 and 83mOD. The Yellow River flows in an easterly direction through the northern section of the landholding.

Proposed turbines T13 to T15 are located on area of grassland comprising poorly draining soils which is situated approximately 1km to the northeast of Rhode village. The landholding, with an elevation of between 80 and 90mOD, slopes gently to the northwest in the direction of the Yellow River which runs approximately 1km to the north of the landholding boundary.

Proposed turbines T16 to T23 are located on poorly draining grassland to the north and south of the Yellow River, approximately 2.5km to the west of Castlejordan. The land on either side of the Yellow River has an elevation range of between 70 and 80m OD with a gentle slope towards the Yellow River channel.

Proposed turbines T24 – T32 are located in an area grassland and forestry which mainly slopes in a northerly and westerly direction towards the Castlejordan River. The southern section of the landholding slopes south towards the Yellow River. The western side of the landholding borders on an area of cutaway peat. The central section of the landholding is covered by dense deciduous and conifer plantations while the northern section of the landholding is open grassland.

7.3.2 *Water Balance*

Long term rainfall and evaporation data was sourced from Met Éireann. The 30 year annual average rainfall (AAR) recorded at Rhode immediately to the south of the

proposed wind farm development and at Derrygreenagh (i.e. Bord na Mona site), 4km to the west of the proposed development, are presented in Table 7.3.

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Rhode		253600		233600		94		1944		1985		
<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>July</i>	<i>Aug</i>	<i>Sept</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>	
87	62	66	56	64	63	59	78	78	87	80	88	868
Derrygreenagh		249300		238200		90		1955		N/A		
<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>July</i>	<i>Aug</i>	<i>Sept</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>	
88	62	67	57	65	62	58	79	80	86	82	89	875
										Average		872

Table 7.3m: Local Average Long Term Rainfall Data (mm).

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Mullingar, approximately 50km north of the proposed development. The long term average PE for this station is 448mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the site is estimated as 425mm/yr (which is $0.95 \times PE$).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

$$\text{Effective rainfall (ER)} = \text{AAR} - \text{AE}$$

$$= 872\text{mm/yr} - 425\text{mm/yr}$$

$$\text{ER} = 447\text{mm/yr}$$

Based on recharge coefficient estimates from the GSI (*Appendix L* (7.1)), an overall estimate of 20% recharge is taken for each of the landholding as an overall average. This value is for “Moderate permeability subsoil overlain by poorly drained (gley) soil” with a “Moderate” vulnerability rating. The lowest value in the available range was chosen to reflect the relatively high drainage density in the region which reflects poor recharge. Therefore, annual recharge and runoff rates for the sites are estimated to be 89mm/yr and 358mm/yr respectively.

7.3.3 Local & Regional Hydrology

Regionally the proposed development is located in the Yellow River and the Casltejordan River surface water catchments which are sub-catchments of the River

Boyne surface water catchment within Hydrometric Area (HA) 07 of the Eastern River Basin District. The River Boyne flows in a northerly direction approximately 2km downstream of the confluence of the Yellow River and the Castlejordan River (i.e. approximately 5km downstream of the eastern extremity of the proposed development). Proposed turbines T1 to T25 are located in the Yellow River surface water catchment while proposed turbines T26 to T32 are located in the Castlejordan River surface water catchment. A regional hydrology map is shown as Figure 7.1.

7.3.4 Site Drainage

As presented in Section 7.3.1 above the proposed development is clustered in into five main separate landholding areas. The drainage associated with each of these areas is discussed below.

Turbine Location T1 to T7

T1 to T7 are to be located in an area that is characterised by heavily drained improved grassland. Drains DA-1, DA-2 and DA-3, which are the primary collector drains in the vicinity of the proposed turbine locations, drain towards a tributary of the Yellow River which flows in a north-easterly direction to the southeast of the turbine locations. Drains DA-1 to DA-3 are deep drains which have intercepted the sand and gravel deposits (and the groundwater table) which underlie the peat in this area. Site observations indicate that much of the surface runoff which enters the drains percolates into the underlying saturated sand and gravel deposits as it was noted in May 2012 that drainage water contained within DA-1 had disappeared beneath the base of the drain prior to its outfall at the tributary of the Yellow River. A site drainage map for this area is shown as Figure 7.2.

Turbine Location T8 to T12

Proposed turbine locations T8 to T12 are located in an area of cutaway peat / improved grassland which lies adjacent to the Yellow River. The primary drainage feature (with the exception of the Yellow River) is a peat face bank drain DB-1 which flows in a south-easterly direction close to the cutaway peat bank face. Drain DB-1 enters the Yellow River approximately 200m to the south of proposed turbine T11. The south-eastern end of the peat bank face (i.e. in the vicinity of T10) drains predominately by concentrated overland flow towards drain DB-2 which enters the

Yellow River on the south-eastern corner of the landholding. The Yellow River flood plain extends onto areas of this landholding. Flooding and flood zones are dealt with in Section 7.3.5 below. A site drainage map for this area is shown as Figure 7.3.

Turbine Location T13 to T15

The predominant drainage features in the vicinity of proposed turbines T13 to T15 are streams SC-1 and SC-2 which are tributaries of the Yellow River. The Yellow River flows approximately 1.2km to the north of the landholding. Localised land drains in the vicinity of the proposed turbine locations drain into SC-1 and SC-2 prior to two streams converging to the north of the landholding. A site drainage map for this area is shown as Figure 7.4.

Turbine Location T16 to T23

Proposed turbines T16 to T23 are located on grassland to the north (T20-T24) and south (T16-T19) of the main Yellow River channel. The area is drained by three unnamed streams (i.e. SD-1, SD-2 & SD-3) which are tributaries of the Yellow River. The landholding area, which has a large network of deep land drains (i.e. field boundary drains), drain towards the Yellow River channel from the north and south. The land drains are generally associated with field boundaries. A site drainage map for this area is shown as Figure 7.5.

Turbine Location T24 to T32

Turbines T27 and T30 to T32 drain via a network of drains to the Castlejordan River which flows in an easterly direction to the north of the landholding. The major drains draining the northern section of the landholding include drains DE-1 and DE-2. Turbines T26, T28 and T29 drain (i.e. DE-3 & DE-4) in a southerly direction towards an unnamed tributary stream of the Castlejordan River. Turbines T24 and T25 drain in a southerly direction via a network of forestry and land drains (i.e. DE-5) towards the Yellow River. A site drainage map for this area is shown as Figure 7.6.

7.3.5 Flood Risk Identification & Assessment

CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie) and the OPW's indicative river and coastal flood mapping (www.flooding.ie) were consulted to identify potential areas of the proposed development that maybe at risk of flooding.

The PFRA mapping shows the extents of the indicative 100-year flood zone which relates to fluvial (i.e. river) and pluvial (i.e. rainfall) flood events. As part of the wind farm layout design all proposed turbine locations were cited outside of the fluvial indicative 100-year flood zone as shown in Figures 7.7 to 7.9. However, there is a potential for flooding near some of the proposed access roads as some sections are located within the 100-year flood zone (i.e. between T8 – T11, T9 – T12, met mast and T18-T19). Access roads and the met mast would be considered Less Vulnerable developments as referred to in The Planning System and Flood risk Management – Guidelines for Planning Authorities (DEHLG, 2009). Also, these structures themselves will not enhance downstream flooding as they will not occupy floodplain space/flood storage volume.

In addition the OPW's indicative flood mapping was also consulted and shows no recorded flooding in the vicinity of the proposed development; however these maps are more generalised and would not have the same flood zone details as the PFRA mapping which were the main source used in terms of flood risk assessment.

7.3.6 Surface Water Quality

EPA Q-rating data is available for the Yellow River immediately downstream of proposed turbine landholding area T1 to T9 and immediately upstream of the confluence with the Castlejordan River. A Q-rating of Good and Moderate has been assigned for these locations respectively.

EPA Q-rating data is available for the Castlejordan River upstream of the proposed development at Rochfortbridge and upstream of the confluence with the Yellow River (i.e. downstream of the development). A Q-rating of Poor and Good has been assigned for these locations respectively. The Boyne River downstream of the proposed development has been assigned a Q-Rating of Good.

Field hydrochemistry measurements of unstable parameters, electrical conductivity ($\mu\text{S}/\text{cm}$), pH (pH units) and temperature ($^{\circ}\text{C}$) were taken at various locations in surface watercourses at the proposed development area on 11th and 12th October 2012 and 9th May 2013. The hydrochemical field measurements and the locations are listed in Table 7.5.

Electrical conductivity values for the site surface waters ranged between 250 μ S/cm and 700 μ S/cm with the higher value representative of drains that intercept the saturated gravel deposits. pH values which were all slightly basic ranged from 7.6 to 8.3. This is consistent with the fact that all catchments are dominated by mineral subsoils which is underlain by limestone bedrock. Temperature readings were normal for the time of year visited (October 2012 & May 2013).

Location ID	Easting	Northing	Conductivity (μ S/cm)	pH	Temp °C
FP1	247336	237073	567	8.3	9.2
FP2	246996	236181	638	8	8.9
FP3	247275	236356	663	8	8.9
FP4	248006	236493	647	8	9.1
FP5	254100	235310	250	7.8	9.3
FP6	253740	235350	230	7.8	9.2
FP7	251844	235956	360	7.9	8.9
FP8	256760	238470	563	7.7	8.8
FP9	254833	282480	700	7.6	9.1
FP10	254690	241070	400	8	8.9

Table 7.5: Summary of Surface Water Chemistry Measurements.

Water samples were taken from surface waters downstream of the proposed development on 12th October 2012 at locations SW1, SW2, SW3 and SW4. The sampling points are shown on Figures 7.2 to 7.6. Samples were stored in a cool environment and transported to City Analysts Ltd (Dublin: 01-6136003) where they were analysed for a list of parameters as shown in Tables 7.6 & 7.7 below. Results of analysis are shown alongside relevant surface water regulations. For comparison Environmental Objectives Surface Water Regulations (S.I. 272 of 2009) are shown in Table 7.8. Certificates of analysis are shown in **Appendix L (7.2)**.

PARAMETER	UNIT S	EC DIRECTIVES				SAMPLE ID	
		75/440/EEC	78/659/EEC		98/83/EC	SW1	SW2
			Salmonid	Cyprinid			
Total Suspended Solids		50 (A1)	≤ 25 (O)	≤ 25 (O)		13	88
Ammonia N						0.08	0.05
Total Nitrogen						<10	<10
Nitrite (NO ₂)		0.05	≤ 0.01	≤ 0.03	0.5	0.16	0.1
Ortho Phosphate (P)		0.03				<0.025	0.049
Nitrate (NO ₃)		25 (A1) 50 (A2 & A3)			50	9.57	<8.9
Phosphorus (unfiltered)		400 (A1) 700 (A2)				0.13	0.36
Chloride		250			250	13.28	<10
BOD		5 (A1)	≤ 3	≤ 6		2	5

Table 7.6: Analytical Results of Surface Water Samples.

PARAMETER	UNITS	EC DIRECTIVES				SAMPLE ID	
		75/440/EEC	78/659/EEC		98/83/EC	SW3	SW4
			Salmonid	Cyprinid			
Total Suspended Solids		50 (A1)	≤ 25 (O)	≤ 25 (O)		32	10
Ammonia N						0.22	0.37
Total Nitrogen						<10	<10
Nitrite (NO ₂)		0.05	≤ 0.01	≤ 0.03	0.5	0.1	0.13
Ortho Phosphate (P)		0.03				0.04	0.047
Nitrate (NO ₃)		25 (A1) 50 (A2 & A3)			50	14.62	12.8
Phosphorus (unfiltered)		400 (A1) 700 (A2)				0.25	0.16
Chloride		250			250	11.02	
BOD		5 (A1)	≤ 3	≤ 6		3	3

Table 7.7: Analytical Results of Surface Water Samples.

BOD	High status ≤ 1.3 (mean) Good status ≤ 1.5 mean
Ammonia-N	High status ≤ 0.04 (mean) Good status ≤ 0.065 (mean)
Ortho-phosphate	High status ≤ 0.025 (mean) Good status ≤ 0.035 (mean)

* Environmental Objectives Surface Water Regulations (S.I. 272 of 2009).

Table 7.8: Chemical Conditions Supporting Biological Elements*.

In comparison to the Environmental Objectives Surface Water Regulations (S.I. 272 of 2009), all results for ammonia-N exceeded the “Good Status” threshold with the exception of SW2.

For ortho-phosphate all results exceed the “Good Status” threshold with the exception of SW1 which was in the “High Status” threshold. For BOD all results exceeded the “Good Status” threshold.

Suspended solids results were between 10 and 88mg/l. All samples with the exception of SW2 (88mg/l) were below the surface water regulation (75/440/EEC) values of 50mg/l. The heavy rainfall at the time of sampling may have attributed to the exceedence in SW2.

7.3.7 Hydrogeology

The GSI bedrock map of the area (www.gsi.ie) shows that the majority of the western landholding areas are underlain by the Dinantian Upper Impure Limestone, while the eastern landholding areas are predominately underlain by the Dinantian Pure bedded Limestone. Intrusions of basalt and other volcanic rocks are also mapped in the area. A bedrock aquifer map is shown as Figure 7.10.

Based on the GSI mapping (www.gsi.ie) the Dinantian upper impure limestone are classified as a Locally Important Aquifer LI (bedrock which is moderately productive only in locals zones) while the Dinantian Pure bedded Limestone are classified as a Locally Important Aquifer Lm (bedrock which is moderately productive).

The bedrock in both aquifer types is described as been highly heterogeneous and the depth to which major groundwater flows are encountered varies even over short distances. In general in a locally important aquifer such as this the majority of groundwater flow is expected to occur in an upper broken and weathered zone, which is considered to be about 3m thick. Additional flows are commonly found in the upper 10m where groundwater flows along fracture networks. Occasionally deeper isolated groundwater flows are found in cavities which may have been layers or pure limestone solutionally enlarged by karstification.

Deposits of poorly sorted sand and gavels were noted to underlie the peat in landholding areas T1 to T7 and T8 to T12. The land drains in both landholding areas

were noted to intercept the sand and gravel deposits and a groundwater level of 1.5m below ground was noted on the day of the survey (Refer to Plate A). The sand and gravels are fully exposed in an existing open sand and gravel pit to the southeast of turbine location T6. The sand and gravel deposits are estimated to have a moderate to high permeability which may have implications for construction dewatering in terms of turbine base construction (This is discussed further in the Impact and Mitigation Section below).

The remainder of the proposed turbine locations are located in poorly draining agricultural land and high water tables (<1m) are expected in many areas.



Plate A: Existing exposed sand and gravel deposits beneath peat

7.3.8 *Groundwater Vulnerability*

The vulnerability of the aquifers underlying the study area is rated between “Low” and “Extreme” by the GSI (www.gsi.ie). The groundwater vulnerability rating in the area of the western landholdings (i.e. turbines T1 – T12) is generally mapped as “Low” and this is due to the coverage of peat in this area. The remainder of the landholdings are located in areas mapped as “Moderate” vulnerability with the more elevated areas having an “Extreme” vulnerability rating.

Trial pits TP1 and TP2 were undertaken by Whitefords Ltd in landholding A and D respectively. Both trial pits encountered sand deposits exceeding 3m in depth. Based

on GSI groundwater vulnerability mapping criteria these locations would be rated as “High” vulnerability. The total depth to bedrock is unknown.

However, due to the nature of wind farm developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. Also, the fact that there are no proposed on-site borrow pits is positive in terms of potential impacts on groundwater, as borrow pits generally pose a greater risk to groundwater and adjacent water supplies due to their general greater depth of excavation.

7.3.9 Groundwater Hydrochemistry

Sampling of groundwater was not undertaken at the site as part of the assessment. Such sampling would not normally be completed as surface water is the main receptor for wind farm developments. Based on groundwater quality data from elsewhere in the country, the expected groundwater type within the Dinantian Limestone would be Calcium Bicarbonate (Ca-HCO₃) type. EPA water quality data for Toberdaly spring which is used as a public supply source is shown in Table 7.9 below (Refer to Section 7.3.14 below for details of source).

Parameter	Unit	29/11/2012
Total Coliforms	cfu	<1
Faecal Coliforms	cfu	<1
pH_Laboratory	pH units	7
Conductivity	µS/cm	614
Alkalinity	mg/l	280
Total Hardness	mg/l	320
Colour	Hazen	5
Turbidity	NTU	<0.5
Ammonium	mg/l	<0.026
Nitrite as NO ₂	mg/l	<0.002
Nitrate as NO ₃	mg/l	15.54
Nitrate as N	mg/l	3.51
Total Phosphorus	mg/l	0.021
Ortho-phosphate	mg/l	0.020
Total Organic Carbon	mg/l	1.5
Chloride	mg/l	15
Fluoride	mg/l	0.17
Sulphate	mg/l	16
Sodium	mg/l	8.1
Potassium	mg/l	1.7
Magnesium	mg/l	15.9
Calcium	mg/l	98
Iron	µg/l	<10
Manganese	µg/l	1

Table 7.9: Water Quality Data for Toberdaly Spring

7.3.10 Water Framework Directive Water Body Status & Objectives

The Eastern River Basin District (ERBD) Management Plan was adopted by all local authorities in the ERBD prior to 30th of April 2010, as stipulated in the European Communities (Water Policy) Regulations 2003 (S.I. 722 of 2003 as amended). The ERBD Management Plan (2009 – 2015) objectives, which will be integrated into the design of the proposed wind farm development, include the following:

- Prevent deterioration and maintain a high status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2015;
- Ensure waters in protected areas meet requirements; and,
- Progressively reduce chemical pollution.

Section 4.2.3 of the ERBD Management Plan States:

“Alternative objectives can also be set in cases where certain developments may cause a failure to achieve good status or to maintain high status. This is subject to the developments being of overriding public interest and/or there being overriding benefits to human health and safety. Alternative options for delivering these benefits must be considered and all practicable steps must be taken to mitigate adverse impact on the water body”

Our understanding of these objectives is that surface waters, regardless of whether they have ‘Poor’ or ‘High’ status, should be treated the same in terms of the level of protection and mitigation measures employed, *i.e.* there should be no negative change in status at all.

Strict mitigation measures in relation to maintaining a high quality of surface water runoff from the development and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the site will be at least maintained (see below for WFD water body status and objectives) regardless of their existing status.

7.3.11 Groundwater Body Status

Local Groundwater Body and Surface water Body status reports are available for download from www.wfdireland.ie.

The Athboy (GWB: IE_EA_G_001) and Trim Groundwater Bodies (GWB: IE_EA_G_002) which underlie the proposed wind farm site are assigned ‘Good

Status²³ (www.wfdireland.ie), this applies to both quantitative status and chemical status. The overall risk rating for both groundwater bodies is 2a – Not at Risk. The western landholding areas (*i.e.* turbines T1 – T12 and T25 – T32) are within the Athboy GWB while the eastern landholding areas are within the Trim GWB.

7.3.12 Surface Water Body Status

Based on WFD mapping, the proposed development lies within the Castlejordan (IE_EA_07_1025), the Yellow River Upper (IE_EA_07_332) and the Yellow River Lower (IE_EA_07_1026) surface water bodies. The downstream water body to the development is the Boyne (IE_EA_07_235). Refer to Figure 7.1.

A summary of the water body status, risk result and protection objective for the surface water body is shown in Table 7.10 below.

Water Body	Macro-invertebrate Status	Overall Ecological Status	Overall Status	Overall Risk Result	Overall Objective
Castlejordan	Poor	Poor	Poor	At Risk (1a)	Restore_2027
Yellow Upper	Good	Good	Good	At Risk (1a)	Protect
Yellow Lower	Moderate	Moderate	Moderate	At Risk (1a)	Restore_2015
Boyne Upper	Good	Good	Good	At Risk (1a)	Protect

Table 7.10: Summary WFD Information for Surface Water Bodies.

7.3.13 Designated Sites

Designated sites include proposed National Heritage Areas (pNHAs), National Heritage Areas (NHA), candidate Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs).

The proposed development site is not located within or adjacent to any designated site. The closest downstream (*i.e.* approximately 17km) designated site is the River Boyne and Blackwater SAC.

7.3.14 Water Resources

Toberdaly spring which is used as a public supply source is located approximately 2km to the southwest of Rhode town. The GSI Groundwater Protection Zone (ZOC)

²³ 'Status' means the condition of the water in the waterbody. It is defined by its chemical status and its ecological status, whichever is worse. Waters are ranked in one of 5 classes: High, Good, Moderate, Poor and Bad (WFD, 2010).

for this spring is shown on Figure 7.10. None of the proposed development or any of its ancillary activities lie within the ZOC to the spring. There can be no impact on this water source as a result of the proposed wind farm development.

A search of the Geological Survey of Ireland (GSI) well database (www.gsi.ie) only indicated 2 no. private wells within the vicinity of the site (refer to Figure 7.10). These wells are located more than 1km from the landholding boundary and are situated outside the groundwater catchment to the site. As the GSI well database is not exhaustive in terms of the locations of all wells in the area (as the database relies on the submission of data by drillers and the public etc) to be conservative it is assumed that every private dwelling in the vicinity of the proposed development has a groundwater supply well/spring associated with it (this is very unlikely to be the case). Shown on Figures 7.2 to 7.6 are the locations of private dwellings within close proximity to the landholding areas. A private well impact assessment is undertaken for each of the dwellings as shown below.

The assessment assumes that the groundwater flow direction in the aquifer underlying the site mimics topography whereby flow paths will be from topographic high points to lower elevated discharge areas at the streams and rivers. Therefore, if no dwellings are located in the groundwater flow path between the proposed development areas (*i.e.* turbine location) and the discharge zone (*i.e.* stream/river) there can be no impact on any potential wells associated with dwellings.

Turbine Location T1 to T7

Six private dwellings are located to the southeast of proposed turbines T1 to T7 (LH-A). The inferred groundwater flow direction in the vicinity of the turbine locations is southeast towards the tributary stream of the Yellow River which acts as the discharge zone (Refer to Figure 7.2). Likewise the inferred groundwater flow direction in the vicinity of the dwellings is northwest towards the stream. Therefore, no dwellings are located in the groundwater flow path between the proposed turbine locations and the discharge zone stream and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Locations T8 to T12

Three private dwellings are located to the northeast of Landholding B (T8 to T12). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north and south towards the Yellow River channel (Refer to Figure 7.3). The houses to the northeast of the landholding are not within the groundwater flow path of any of the proposed turbine locations and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Locations T13 to T15

There are a large number of private dwellings located to the east and west of proposed turbine locations T13 to T15 (Refer to Figure 7.4). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north towards the main Yellow River channel. Shallow groundwater flow may discharge into streams SC1 and SC2 which flows to the west of the proposed turbine locations. The houses to the east and west of the proposed turbine locations are not within the groundwater flow path and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Location T16 to T23

There are a large number of private dwellings located to the north and south of proposed turbine locations T16 to T23 (Refer to Figure 7.5). The inferred groundwater flow direction in the vicinity of the proposed turbine locations is north and south towards the main Yellow River channel. There are no private dwellings located in the groundwater flow path between the proposed turbine locations and the Yellow River channel and therefore there can be no impact on any potential wells associated with houses in this area.

Turbine Location T24 to T32

The inferred groundwater flow direction in the vicinity of the proposed turbine locations T27, T30 to T32 is in a northerly direction towards the main Castlejordan River channel (Refer to Figure 7.6). There are no private dwellings located in the groundwater flow path between the proposed turbine locations and the Castlejordan River channel and therefore there can be no impact on any potential wells. The

inferred groundwater flow direction in the vicinity of the proposed turbine locations T24 to T26, T28 and T29 is in a southerly direction towards a tributary stream of the Yellow River. There are no private dwellings located in the flow path between the proposed turbine locations and this stream and therefore there can be no impact on any potential wells associated with houses in this area.

7.3.15 Receptor Sensitivity

Due to the nature of wind farm developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the site would be from hydrocarbon spillage, leakages at storage areas, and from domestic wastewater discharge. These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the site during the construction and operational phases of the development and mitigation measures are proposed within the EIS to deal with these potential minor impacts. Also, the fact that there are no proposed on-site borrow pits is a positive thing in terms of potential impacts on groundwater as borrow pits generally pose the greatest risk to groundwater and adjacent water supplies if not managed properly.

Groundwater at the site can be classed as sensitive (refer to Table 7.2 for sensitivity criteria) because most of the underlying aquifers are classified as being Locally Important. The low permeability peat and poorly draining soils which overlying much of the site will provide some protection, however, where excavations occur the underlying sand and gravels (*i.e.* T1 to T12) will be made increasingly vulnerable to contamination.

The moderate runoff coefficient at the site makes surface water bodies such as streams and rivers more vulnerable to pollution than groundwater bodies at this site. Runoff from development sites drains into the headwaters of the Yellow River and the Castlejordan River. However, due to the flat topography of the landholdings, control and attenuation of runoff will be easily achieved. All natural water bodies draining the site can be classified as very sensitive.

Mitigation measures will ensure that surface runoff from the developed areas of the site will be of high quality and therefore there will be no impact on the quality of

downstream surface water bodies. Any introduced drainage works at the site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the site.

Hydrological constraints mapping for the development areas is shown on Figures 7.2 – 7.6 and Figures 7.7 and 7.9 (*i.e.* flood zone mapping). The map shows that all proposed development areas are generally away from areas on the site that have been determined to be hydrologically sensitive (*i.e.* Yellow River, Castlejordan River and their tributaries). The large setback distance from sensitive hydrological features means they will not be impacted on by excavations/drains etc. It also allows adequate room for the proposed drainage mitigation measures (discussed below) to be properly installed up-gradient of primary drainage features. This will allow attenuation of surface runoff to be more effective.

7.4 POTENTIAL IMPACTS OF THE DEVELOPMENT

7.4.1 *Development Description*

The proposed development comprises 32 no. turbines (excavation diameter 18m, depth 2m), temporary construction compound, substation/control building, 18,275m of new access track, 5,916m of existing track upgrade, 1 no. meteorological mast and 9 no. stream/river crossings. The development will also require the felling of 10.4ha of forestry.

7.4.2 *Do Nothing Scenario*

If the wind farm development does not proceed, the proposed development sites will remain solely as poorly draining agricultural land. In areas where conifer forestry plantations are present, deforestation and reforestation will continue to occur into the future.

7.4.3 *Worst Case Scenario*

Contamination of surface water streams during the construction and operational phases, which in turn could affect the ecology and quality of the downstream water bodies such as the Yellow River and Castlejordan River. Also, potentially localised groundwater contamination may occur. However, measures will be put in place to prevent this from happening.

7.5 LIKELY IMPACTS AND MITIGATION MEASURES

The likely impacts of the proposed development and mitigation measures that will be put in place to eliminate or reduce them are shown in Table 7.10.

7.5.1 *Background on Proposed Runoff Control and Drainage Design*

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the proposed development. The first method involves 'keeping clean water clean' by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations and construction areas. The second method involves collecting any drainage waters from works areas within the site that might carry silt or sediment, and nutrients, to route them towards attenuation/settlement ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface water. During the construction phase all runoff will be attenuated and treated to a high quality prior to being released. The flat topography of the site means runoff can be easily managed and treated prior to being released.

CONSTRUCTION PHASE IMPACTS & MITIGATION MEASURES

1. CLEAR FELLING OF CONIFEROUS PLANTATION & WATER QUALITY IMPACTS

Approximately 10.4ha of existing plantation forestry will be felled to allow for development of the proposed wind farm infrastructure. Provision of the construction area at each turbine location will require approximately 1.5 hectares for turbines T1, T25, T26 & T27 and part of T2 (6.77ha in total for turbine hardstanding & assembly areas). The estimated loss of forestry due to access roads is approximately 3.63ha based on the requirement for approximately 2,425 metres of new access road. This gives a total area for tree felling as a result of the development of approximately 10.4ha, with 2.77ha being located in Landholding A and 7.63ha being located in Landholding E.

The total area of tree felling required for the proposed development represents approximately only 3.7% of the total forested area which is 275ha. The locations of

the areas to be felled are shown in Figures 7.2 and 7.6.

Potential impacts during tree felling occurs mainly from:

- Exposure of soil and subsoils due to vehicle tracking, and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

In their consultation response the Department of Agriculture highlighted the potential impacts of the proposed tree felling on the aquatic environment and stated that mitigation measures and monitoring need to be addressed adequately in the EIS;

Pathways - *Drainage and surface water discharge routes.*

Receptors - Surface waters and associated dependent ecosystems.

Potential

Impacts - Direct, negative, moderate, short term, high probability impact on water quality.

Proposed Mitigation Measures:

Best practise methods related to water incorporated into the forestry management and mitigation measures have been derived from:

- Forestry Commission (2004) Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009) Forest Operations & Water Protection Guidelines; and,
- Coillte (2009) Methodology for Clear Felling Harvesting Operations.

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practise as set out as

follows:

- Machine combinations will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soils disturbance;
- Use of buffer zones for aquatic zones (see Table 7.11 below);
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Mound drains which drain from the areas to be felled towards main drains (*i.e.* DA-2, DA-3, DE-2, DE-4 & DE-5) will be blocked, and temporary silt traps will be constructed. Drains and sediment traps should be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains must be provided with water drops and rock armour where there are steep gradients, and should avoid being placed at right angles to the contour;
- Sediment traps will be sited outside of buffer zones and have no direct outflow into the aquatic zone. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of away from all aquatic zones. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion, it may be necessary to install double or triple sediment traps.
- All drainage channels will taper out before entering the aquatic buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils silt traps will be installed at the end of the drainage channels to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimised and controlled;
- Brash mats will be used (with further advice from the ecologist) to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding

the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction should be suspended during periods of high rainfall;

- Timber should be stacked in dry areas, and outside a local 50m stream buffer zone. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works should be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Do not refuel or maintain machinery within 50m of an aquatic zone. Dedicated refuelling areas will be used during the felling works;
- Do not allow branches, logs or debris to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but avoid removing natural debris deflectors.

Mitigation Measures as recommended in (Coillte, 2009):

Buffer zones:

There is a requirement in the Forest Service Best Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths are shown in Table 7.11

Table 7.11: Forest Service Best Code of Practice Buffer Zone Widths

Average slope leading to the aquatic zone	Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodable soils
Moderate (0 – 8.50)	10 m	15 m
Steep (8.5 – 16.70)	15 m	20 m
Very steep (>16.70)	20 m	25 m

All proposed tree felling areas are located significantly more than 25m from a

primary water course (Refer to Figures 7.2 & 7.6). 10m is the minimum distance recommended by Forest Service Best Code of Practice for moderate sloped ground, which would apply in this area. There are no natural streams in the vicinity of the proposed felling areas. All watercourses present in the area are manmade drainage channels associated with forestry plantations. Nevertheless mitigation measures to prevent impact on more ecologically sensitive downstream water bodies are discussed below.

Silt Traps:

Silt traps will be strategically placed down-gradient within mound drains or collector drains as required. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner. This also allows nutrient bearing water to have more contact with mineral soil and thus more nutrients are retained and do not runoff. Silt traps are particularly effective in the removal of mineral silt and less so in the case of organic (from peat or decayed vegetation) or colloidal silt (gleys, clays) where it can take a lot longer for sedimentation to occur. Mineral silt poses the largest threat to watercourses in its potential to settle on a streambed and damage fish spawning areas.

In cases where mineral subsoils are present beneath the peat subsoil additional mitigation by way of use of specialist treatment systems such as Siltbuster systems with two-stage chemical dosing to aid settlement can be employed.

Drain Inspection and Maintenance:

The following items shall be carried out during inspection pre-felling and after:

1. Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;
2. Inspection of all areas reported as having unusual conditions;
3. Inspection of main drainage ditches and outfalls. During pre-felling inspection the main drainage ditches shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall;
4. Following tree felling all main drains shall be inspected to ensure that they are functioning;
5. Extraction tracks nears drains need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining

ground;

6. Culverts on drains exiting the site must be unblocked; and,
7. All silt removed from drains, culverts and silt traps must be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring

Water Sampling:

1. Sampling will be done before, during (if the operation is conducted over a protracted time) & after the felling activity. The 'before' sampling should be conducted within 4 weeks of the felling activity, preferably in medium to high water flow conditions;
2. The 'after' sampling should comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (*i.e.* where an impact has been shown).

Criteria for the selection of water sampling points include the following:

- Avoid man-made drains & watercourses without all-year flow;
- Select sampling points upstream and downstream of the forest activity;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry; and,
- Where possible, three downstream locations should be selected: one immediately below the forest activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other land-uses where impact increases at third downstream location relative to second downstream location).
- At a minimum sampling should be undertaken at the surface water sampling locations used in this EIS investigation (*i.e.* SW1, SW2, SW3 & SW4). Additional sampling points in main drains upstream and downstream of felling areas will be added where required (*i.e.* DA-2, DA-3, DE-2, DE-4 & DE-5).

Residual Impact - Direct, negative, slight, short term, low probability impact.

- 2. EARTHWORKS (REMOVAL OF VEGETATION COVER, EXCAVATIONS AND STOCK PILING) RESULTING IN SUSPENDED**

SOLIDS ENTRAINMENT IN SURFACE WATERS.

Construction phase activities including access road, turbine base construction, drainage installation and cable trenching will require earthworks resulting in removal of vegetation cover and excavation of peat and mineral subsoil where present. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from road and turbine base excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of access road culverts resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks in the downstream Yellow River and Castlejordan River.

Pathways - Drainage and surface water discharge routes.

Receptors - Down-gradient rivers and dependant ecosystems

Potential

Impacts - Direct, negative, significant, short term, high probability impact.

Proposed Mitigation Measures:

Mitigation by avoidance:

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas. A 50m wide watercourse buffer zone will be in place during the construction phase where possible. From Figures 7.2 to 7.6 it can be seen that all of the proposed development areas are generally away from the primary water bodies in the area which include the Yellow River and the Castlejordan River. The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively.

Exceptions to this self imposed 50m buffer include stream/river crossings or where existing roads adjacent to streams require upgrade. Stream/river crossings and near stream construction work in dealt with in Impact Section 9 below.

The proposed buffer zone will:

- Avoid physical damage to watercourses, and associated release of sediment;
- Avoid the entry of suspended sediment from earthworks into watercourses; and,
- Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone;

Excavations have the potential to release sediment into surface waters, however excavations may encounter mineral subsoils (where present) and therefore there is a higher risk from this activity. It is proposed that the following design mitigation measures will be installed prior to excavations taking place.

Mitigation by Design:

- Interceptor drains will be installed up-gradient of works areas to collect surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground as overland flow;
- Swales will be used to intercept and collect runoff from works areas of the site, likely to have entrained suspended sediment, and channel it to stilling ponds for sediment settling;
- Check dams will be installed at regular intervals along interceptor drains and swales in order to reduce flow velocities and therefore minimise erosion within the system during storm rainfall events;
- Stilling ponds, emplaced as pairs in series, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses. Stilling ponds will be designed to retain the volume associated with a 1 in 100 year 6 hour return period. Stilling ponds are designed to reduce the flow velocity of discharge water; and,
- Vegetation filters, that is areas of existing vegetation, accepting drainage water issuing from level spreaders as overland flow, will remove any suspended sediment from water channelled via interceptor drains.

Cable Trenching:

The design of the cable trench alignment will avoid the creation of preferential flow

paths. The following shall apply to the construction of the cable trenches at the site:

- To minimise impacts from disturbance, cables will be laid in small trenches alongside the access roads as far as possible;
- Where feasible trenches will be excavated during dry periods and any spoil will be immediately removed and stored in the repository;
- Excavation of cable trenching will be carried out over short distances, with frequent backfilling of trenches in order to minimise opportunity for the ingress of water;
- Temporary silt traps will be placed in longer trench runs and on steeper ground;
- Swale slopes are to be correctly reinstated post infilling of the cable trench; and,
- There will be no cable trenching laid under natural streams.

Water Treatment Train:

If the discharge water from construction areas fails to be of a high quality then a filtration treatment system (such as a 'siltbuster' unit (<http://www.siltbuster.com/sheets/RCW.pdf>) or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

All concrete wash down at the site should be completed in a dedicated RCW concrete wash unit. This unit catches the solid concrete and filters and holds wash liquid for pH adjustment and further solids separation. The residual liquids and solids can be disposed of off-site at an appropriate waste facility.

Silt fences:

Silt fences will be emplaced within forestry drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Pre-emptive Site Drainage Management:

The works programme for the initial construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of peat/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:

General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;

MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;

3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,

Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works should be suspended if forecasting suggests either of the following is likely to occur:

>10 mm/hr (*i.e.* high intensity local rainfall events);

>25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or,

>half monthly average rainfall in any 7 days.

Prior to works being suspended the following control measures should be completed:

- Secure all open excavations;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Timing of site construction works:

Construction of the site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

Residual Impact - Negative, imperceptible, short term, medium probability impact.

Monitoring:

An inspection and maintenance plan for the on-site drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended. Inspections will also be undertaken after tree felling.

Any excess build up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each watercourse (*i.e.* at SW1, SW2, SW3 & SW4 sample locations), and specifically following heavy rainfall events (*i.e.* weekly, monthly and event based). The will be done in consultation with the Fisheries Board.

3. IMPACTS ON THE RIVER BOYNE & BLACKWATER SAC

The River Boyne and Blackwater SAC exist approximately 17km downstream of the

proposed wind farm development. Significant hydrological or water quality impacts on the Yellow River and the Castlejordan River (which are both tributaries) could potentially have an impact on the water quality flowing towards the SAC.

Pathway - Surface water drainage network.

Receptor – The River Boyne / Blackwater SAC and related habitats.

Potential

Impact - Indirect, negative, moderate, short term, low probability impact on the SAC.

Impact Assessment:

The proposed mitigation measures which will include buffer zones and drainage control measures (*i.e.* interceptor drains, swales, temporary stilling ponds) will ensure that the quality of runoff from proposed development areas will be very high. As stated in Impact Section 2 above, there could potentially be an “*imperceptible, short term, low probability impact*” on local streams and rivers but this would be very localised and over a very short time period (*i.e.* hours). Therefore, direct, or indirect impacts on the River Boyne / Blackwater SAC, which exists 17km downstream of the proposed development will not occur.

Residual Impact – No impact

4. POTENTIAL RELEASE OF HYDROCARBONS DURING CONSTRUCTION AND STORAGE

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway – Groundwater flow paths and site drainage network.

Receptor – Groundwater, surface water & water supplies (if present).

Potential

Impact - Direct, negative, significant, temporary, medium probability impact to surface water quality.

Direct, negative, significant, temporary, medium probability impact to local

groundwater quality.
<u>Proposed Mitigation Measures:</u> Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows: 1. Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Off-site refuelling should occur at a controlled fuelling station. 2. On site re-fuelling will take place at a specific designated re-fuelling area. This re-fuelling area will be bunded appropriately for the fuel usage volume for the time period of the construction and fitted with an appropriate oil interceptor. 3. Fuels stored on site should be minimised. This storage area will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor. 4. The electrical control building should be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor. 5. The plant used should be regularly inspected for leaks and fitness for purpose; and, 6. An emergency plan for the construction phase to deal with accidental spillages will be contained within Environmental Management Plan. Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.
Residual Impact - Direct, negative, imperceptible, short term, low probability impact.
5. GROUNDWATER & SURFACE WATER CONTAMINATION FROM WASTEWATER DISPOSAL Release of effluent from domestic wastewater treatment systems have the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.
Pathway – Groundwater flow paths and site drainage network. Receptor – Down-gradient well supplies and surface water. Potential Impact - Direct, negative, significant, temporary, low probability impact to surface water quality. Direct, negative, slight, temporary, low probability impact to local groundwater.
<u>Proposed Mitigation Measures:</u>

1. A self contained port-a-loo with an integrated waste holding tank will be used, maintained by the providing contractor, and removed from site on completion of the construction works.
2. Water supply for the site office and other sanitation will be brought to site and removed after use from the site to be discharged at a suitable off-site treatment location; and,
3. No water will be sourced on the site, or discharged from the site.

Residual Impact – No impact

6. RELEASE OF CEMENT BASED PRODUCTS

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to introduction of high pH alkaline waters into the system. Batching of wet concrete on site and wash out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution.

Pathway – site drainage network.

Receptor – Surface water and peat water hydrochemistry and water dependant ecosystems (*i.e.* the on-site wetland).

Potential

Impact - Direct, negative, moderate, short term, medium probability impact to surface water.

Proposed Mitigation Measures:

The following mitigation measures are proposed:

- 1) No batching of wet-cement products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place.
- 2) Where possible pre-cast elements for culverts and concrete works will be used.
- 3) No washing out of any plant used in concrete transport or concreting

operations will be allowed on-site.

- 4) Where concrete is delivered on site, only the chute need be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be tanked and removed from the site to a suitable, non-polluting, discharge location.
- 5) Use weather forecasting to plan dry days for pouring concrete.
- 6) Ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.
- 7) The 50m wide river buffer zone which will be emplace for the duration of the construction phase. No construction activity will occur within the buffer zone with the exception of river crossings and road upgrade works.

The buffer zone will:

- Prevent any cement based products accidentally entrained in the construction phase drainage system entering directly into watercourses, achieved in part by ending drain discharge outside the 50m buffer zone and allowing percolation across the vegetation of the buffer zone;
- Provide a buffer against accidental direct pollution of surface waters by any pollutants, or by pollutants entrained in surface water runoff.

Residual Impact - Negative, direct, imperceptible, short term, moderate probability impact.

7 IMPACTS ON PEATLAND HYDROLOGY

Proposed turbines T9 are located in an area of cutaway raised bog. The bog is undesignated, however potential impacts on the local peat hydrology could occur as result of the following:

- Construction and operational phase lowering of peat water levels in the vicinity of roads, turbines and other development infrastructure due to emplaced artificial drainage and excavations;
- Road emplacements, depending on design, can act as drains or barriers to flow, resulting in lowered water levels;
- Changes to peat water flow directions due to emplacement of roads, drains and other infrastructure;
- Construction and operational phase re-distribution of natural and additional surface water run-off, resulting in changes to the natural distribution of drainage; and,
- Change in hydrochemistry due to materials used to construct roads and turbine

bases and hardstands,
Pathway – Drainage and excavations Receptor – Peatland hydrology; Potential Impact - Direct, adverse, moderate, high probability impact on peatland hydrology.
Impact Assessment: Proposed turbine T9 is located in an area of cutaway raised bog (<i>i.e.</i> close to the peat cutting face) and therefore the potential to further impact on the peatland hydrology (which has already been impacted on to some extent) of the section of bog in question is low. There are a number of existing significant drains in the area and therefore the proposed wind farm infrastructure will only have a very subdued impact on the peat hydrology (<i>i.e.</i> water levels) immediately adjacent to the proposed turbines and access roads.
Residual Impact: Direct, adverse, negligible, high probability impact on peatland hydrology.
8 PHYSICAL CHANGES TO SURFACE WATERCOURSES AND DRAINAGE PATTERNS. Diversion, culverting and bridge crossing of surface watercourses can result in changes to drainage patterns and alteration of aquatic habitats. Construction of structures over watercourses has the potential to significantly interfere with water quality and flows during the construction phase. A total of nine bridge crossings will be required over the Yellow River (including its tributaries) to allow for the proposed wind farm access road infrastructure. The remainder of the crossings are over local field drains with generally little or no flow. The locations of all crossings are shown in Figures 7.2 to 7.6.
Pathway: Surface water discharge routes. Receptor: River morphology and associated dependant ecosystems. Potential Impact: Direct, negative, slight, short term to permanent, high probability impact.
<u>Impact Assessment & Mitigation</u> The proposed stream crossings over the Yellow River will be clear spanning and the existing banks will remain undisturbed. No in-stream works are proposed and therefore there will be no impact on the Yellow River at the proposed crossing

locations.

Any guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland will be incorporated into the design of the proposed crossings.

As a further precaution near stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "*Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites*", that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses.

During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase. There will be no batching or storage of cement allowed in the vicinity of the crossing construction areas.

All river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

Residual Impact: Direct, negligible, short term, low probability impact.

9 EXCAVATION DEWATERING & IMPACTS ON SURFACE WATER QUALITY & GROUND WATER LEVELS

Excavation seepage will likely occur in turbine base excavations and can potentially result in a localised flow of groundwater into the excavation. This can create additional volumes of water to be treated by the runoff management system. The proposed turbine base excavations will be dug to approximately 2 metres below ground level (mbgl) and therefore may intercept the saturated gravels (estimated to be moderate/high permeability from field observations) that underlie the peat deposits in places. Groundwater inflows may require management and treatment to reduce suspended sediments.

Excavation dewatering has also the potential to impact on water levels in the vicinity of the excavation and adjacent well supplies.

Pathway: Surface water discharge routes.

Receptor: Drainage routes and overland flow.

Potential Impact: Direct, negative, moderate, short term, high probability impact on surface water quality

Direct, negative, slight, short term, high probability impact on local groundwater levels.

Impact assessment

The presence of saturated gravels with a high water table (<1.5m) beneath the peat deposits in the western areas (*i.e.* turbines T1 to T12) will mean that dewatering of turbine base excavation will likely be required. In addition, the remainder of the proposed turbine locations are generally located on poorly draining land where the water table is likely to be shallow (*i.e.* <1m). Management of groundwater inflows and subsequent treatment prior to discharge into the drainage network will be required as follows:

Design and Control Measures to deal with excavation seepages include:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation seepage will prevent build up of seepage water in the excavation;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems if required;
- Attenuation/Stilling ponds will be located on the inlet and outlet sides of the open drain. These ponds will be robust enough to allow for frequent cleaning.
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination; and,
- Daily monitoring of excavations by a suitably qualified person should occur during the construction phase. If high levels of seepage inflow occur, excavation work should immediately be stopped and a geotechnical assessment undertaken.

A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a

rugged unit. The mobile units are specifically designed for use on construction-sites.

In terms of impacts on local groundwater levels, a slight lowering (<0.3m) of groundwater levels in close proximity (<20m) of the excavation may occur. The proposed turbine base excavation depth is 2m in total and on average 0.5m of this will comprise low permeability peat. Therefore, the excavation depth into the saturated gravels will only be in the order of 1.5m. Dewatering an excavation of such shallow depth in saturated gravels will have minimal surrounding impacts on groundwater levels. Also, the dewatering will only be a temporary requirement (*i.e.* days) while the base is being constructed.

The potential impact on local well supplies is addressed in Section 7.3.14 and Potential Impact no. 11 below.

Residual Impact: Direct, negligible, short term, low probability impact on local surface water bodies.

10 IMPACTS ON LOCAL/PUBLIC GROUNDWATER (WELL) SUPPLIES

Excavation dewatering, storage and handling of fuels etc have the potential to impact on groundwater supplies down-gradient of development areas.

Toberdaly spring which is used as a public supply source is located approximately 2km to the southwest of Rhode town. The GSI Groundwater Protection Zone (ZOC) for this spring is shown on Figure 7.10. None of the proposed development or any of its ancillary activities lie within the ZOC to the spring. There can be no impact on this water source as a result of the proposed wind farm development.

In terms of local well supplies the assessment undertaken in Section 7.3.14 assumes that the groundwater flow direction in the aquifer underlying the site mimics topography whereby flow paths will be from topographic high points to lower elevated discharge areas at the streams and rivers. Therefore, if no dwellings are located in the groundwater flow path between the proposed development areas (*i.e.* turbine location) and the discharge zone (*i.e.* stream/river) there can be no impact on any potential wells associated with the dwellings. The assessment identified no dwellings in the groundwater flow path down-gradient of the main development areas (*i.e.* proposed turbine locations) and therefore impacts on groundwater supplies is not expected.

Residual Impact: No impact

Table 7.11: Potential Impacts and Proposed Mitigation Measures

7.6 REFERENCES

Environmental Protection Agency (2003): *Advice Notes on Current Practice (in the preparation on Environmental Impact Statements)*.

Environmental Protection Agency (2002): *Guidelines on the Information to be Contained in Environmental Impact Statements*.

Forest Services (2004): *Forestry Schemes Manual*.

Institute of Geologists Ireland (2002): *Geology in Environmental Impact Statements – A Guide*.

National Roads Authority (2005): *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

Wind Farm Development Guidelines for Planning Authorities (September, 1996).

8.0 AIR QUALITY

8.1 INTRODUCTION

8.1.1 Background

Despite the ongoing deterioration in air quality on a national level due to the reliance on fossil fuel generated energy, Ireland as a whole is relatively free of air pollution when compared with other more industrialised countries. The combustion of fossil fuels for energy results in the release of several gases which contribute to climate change and acid rain, including carbon dioxide (CO₂), sulphur dioxide (SO₂) and nitrogen oxides (NO_x).

Climate change has begun to manifest itself in Ireland, as it has globally, in recent years with increased air temperatures and changes in precipitation patterns. In 2005, the emissions data estimated that Ireland was 25.4 % above the level for 1990. The most recent emissions data shows that in 2008 we were 23.04 % above the level for 1990 (the base year for Kyoto targets). Ireland's target is to limit the growth of emissions to 13 %, therefore Ireland is still a considerable way off the target, (EPA, Annual Highlights, 2008).

The EU Commission has also imposed targets on Ireland's emissions. These require Ireland to reduce its greenhouse gas emissions by 20 % by 2020, using 2005 figures as a base.

8.1.2 Relevant Legislation

There are various regulatory measures in force for the prevention or control of air pollution, adopted both nationally and by the EC. The Air Quality Framework Directive (96/62/EC) sets out the principles of ambient air quality monitoring, assessment and management and was followed by four daughter directives:

- Air quality 1st Daughter Directive (99/30/EC) deals with sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead.
- Air quality 2nd Daughter Directive (2000/69/EC) deals with carbon monoxide and benzene.
- Air quality 3rd Daughter Directive (2002/3/EC) deals with monitoring of ozone levels.

- Air quality 4th Daughter Directive (2004/107/EC) covers polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air.

The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives. The fourth Daughter Directive (2004/107/EC) will be included in CAFE at a later stage.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and S.I. No. 33 of 1999.

The fourth Daughter Directive was transposed into Irish legislation by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009).

8.2 EXISTING ENVIRONMENT

Air quality in Ireland is generally regarded as good, particularly in rural areas such as the site of the proposed development. Air quality is monitored by EPA stations nationwide. The closest air monitoring station to the proposed wind farm is in Mullingar town; however there is currently no validated data available for air quality at this monitoring station. The closest monitoring station with validated air quality data is located in Ferbane approximately 37km West of the proposed site. Ferbane is in Zone D, one of the four air quality zones in Ireland. Zone D consists of small towns and rural areas of the country.

Air quality in Ferbane was assessed between 11th October 2006 and the 28th March 2007. Monitoring was done by a mobile unit containing monitors for sulphur dioxide, nitrogen oxides, carbon monoxide and PM₁₀. Metals in air were also measured.

The Air Quality Framework Directive states that modelling or objective estimation techniques may be used to assess ambient air quality if levels of the pollutant in question in that zone are below the lower assessment threshold. Continuous monitoring is required if levels exceed the upper assessment threshold. No limit values were exceeded at the Ferbane monitoring station during the assessment period. Concentrations of carbon monoxide, sulphur dioxide, nitrogen dioxide and lead were

below their respective lower assessment thresholds. Levels of PM_{10} exceeded the upper assessment threshold for this parameter. Therefore levels of PM_{10} need to be monitored continuously while levels of CO , SO_2 , NO_2 and lead can be assessed using modelling or objective estimation techniques.

Particulate Matter (PM) less than ten micrometres in size (PM_{10}) can penetrate deep into the respiratory system increasing the risk of respiratory and cardiovascular disorders. PM_{10} arises from direct emissions of primary particulate such as black smoke and formation of secondary PM in the atmosphere by reactions of gases such as sulphur dioxide and ammonia. The main sources of primary PM_{10} are incomplete burning of fossil fuels such as coal, oil and peat and emissions from road traffic, in particular diesel engines. Other sources of particulates include re-suspended dust from roads. Natural PM includes sea-salt and organic materials such as pollens. The diverse sources and impacts of PM make it one of the most challenging issues to address.

The CAFE Directive (2008/50/EC) outlines the limit values for PM_{10} mass concentration levels. The PM_{10} daily mean limit of $50 \mu g/m^3$ should not be exceeded more than 35 times per calendar year and the annual mean PM_{10} limit value is $40 \mu g/m^3$. Particulate matter (PM_{10}) concentrations in Ireland in 2010 were all compliant with the standards introduced. All stations were compliant with the limits which permits no more than 35 daily values greater than the limit value of $50 \mu g/m^3$. Levels were highest in traffic influenced sites in the cities and large urban areas.

Nitrogen oxides (NO_x), includes the two pollutants, nitric oxide (NO) and nitrogen dioxide (NO_2). Power-generation plants and motor vehicles are the principal sources of NO_x , through high temperature combustion. NO_x contributes to the formation of acid rain and is also a recognised ozone precursor. Short-term exposure to NO_2 is associated with reduced lung function and airway responsiveness, and increased reactivity to natural allergens. Long-term exposure is associated with increased risk of respiratory infection in children.

Nitrogen Dioxide (NO_2) concentrations measured in Ireland in 2010 were compliant with all Directive (CAFE) Directive (2008/50/EC) limit values. The highest annual mean value of $35 \mu g/m^3$ recorded at Winetavern Street in Dublin was below the limit value of $40 \mu g/m^3$. There were no exceedances of the hourly limit value which will

permit no more than 18 exceedances greater than $200 \mu\text{g}/\text{m}^3$ in a calendar year (EPA, 2011).

Annual rainfall totals were mostly average for 2012. They ranged from 837.1 mm at Carlow Oakpark to 1530.9 mm at Newport. The closest synoptic station to the proposed Yellow River site is Mullingar which recorded 1024.2 mm of rain in 2012. This level is higher than the latest 30-year annual average (1981-2010) which is 970.9mm. The prevailing wind directions are from the southwest and west.

The energy industry is responsible for over 23 % of all greenhouse gas emissions in Ireland. This is an improvement from the position in the late 1990's when it contributed over 30 % to the emission load. This improvement is largely as a result of switching to cleaner and emission free fuels such as natural gas and renewables (EPA, 2011).

8.3 POTENTIAL IMPACTS OF THE DEVELOPMENT

The proposed Yellow River Wind Farm does not contain any element, which will produce greenhouse gaseous emissions or odorous emissions. Indeed the development will contribute to a net national reduction in the emissions of greenhouse and other gases resulting from the combustion of fossil fuels. The Energy sector as a whole in Ireland contributed over 23 % of total greenhouse gas emissions in 2005 (National Climate Change Strategy, 2007-2012).

The gases of main concern are those that contribute to an increase of the Greenhouse Effect (Carbon dioxide, Methane, Nitrous oxide and other Nitrogen oxides) and those that contribute to Acid Rain (principally Sulphur dioxide). The degree to which wind energy reduces levels of emissions depends on the method of electricity generation which it is replacing. The proposed Yellow River Wind Farm will consist of thirty two turbines, each with an overall height of up to 166m.

The hub height of the proposed turbine type will be up to 110m and the rotor diameter up to 112m, which gives an overall blade tip height of up to 166m. The potential output of a turbine in this dimension range is 3MW.

The proposed project aims to generate approximately 252,000 MWhr of electricity per year operating at 30% average capacity. This would be enough to supply up to

50,400 households. This is the equivalent energy production from 53,760 tonnes of oil or 797 tonnes of coal each year. The approximate emissions savings that can be achieved each year through the use of a wind farm equivalent in size to the proposed 96 MW Yellow River Wind Farm, instead of the equivalent output from the current mix of generating fuel in Ireland are as follows:

- 144,000 tonnes of Carbon Dioxide (CO₂)
- 4,704 tonnes of Sulphur Dioxide (SO₂)
- 528 tonnes of Nitrous Oxide (NO_x)
- 16,800 tonnes of ash

The global warming potential of 1 tonne of NO_x is equivalent to 310 tonnes of CO₂. As such this proposed wind farm will achieve the removal of approximately 307,680 tonnes of CO₂ equivalent.

No appreciable effect on the air quality in the immediate environs of the site is expected from the construction and operation of the proposed development. However, the relative reductions in greenhouse gas emissions in the energy sector will serve to reduce the effects of climate change on a national and global level, albeit at a small scale.

There are other potential impacts associated with the construction phase of the project including dust generation from excavation. These impacts are short term and of a low intensity and are not considered significant.

8.4 MITIGATION MEASURES

Sporadic wetting of access tracks and loose stone surface will be carried out during the construction phase to minimise movement of dust particles to the air. Should the production of dust be such that it might be capable of causing nuisance or may be injurious to health and safety of persons on site or nearby residents, the Contractor will be ordered to arrange implementation of appropriate dust control measures which will be agreed with Offaly County Council. Wheel wash facilities will be put in place to reduce the movement of dirt particles out of the site.

It is not envisaged that there will be much construction dirt generated during the construction of the turbine hardstands and foundations. No negative impacts of significance have been identified in this analysis.

A net benefit in terms of the reduction of greenhouse gas emissions in the energy sector can be noted.

8.5 CONCLUSION

It is concluded that the proposed development will contribute to a long-term positive impact in terms of air quality and climate.

8.6 REFERENCES

1. Environmental Protection Agency *Air Quality in Ireland 2007 - Key Indicators of Ambient Air Quality* www.epa.ie
2. National Climate Change Strategy 2007-2012 www.environ.ie
3. Met Eireann - www.met.ie
4. EPA, Environmental Monitoring, Air Quality Data, Offaly
5. SEI, *Wind Farms and the Environment*

9.0 NOISE

9.1 INTRODUCTION

A wind farm development (Yellow River Wind Farm), consisting of thirty two turbines is proposed for an area in Co. Offaly located between Rochfortbridge and Rhode. Each turbine can have a hub height up to 110m, a rotor diameter up to 113m and an overall height up to 166m.

Noise and Vibration Consultants Ltd. were commissioned to undertake a noise assessment to consider the impact of the proposed development on the surrounding area and in particular on the nearest residential properties.

9.1.1 Statement of Authority

This Section has been prepared by Mr Brendan O'Reilly of Noise and Vibration Consultants Ltd. Mr. O'Reilly has a Masters degree on noise and vibration from Liverpool University and has over 35 years experience in noise and vibration control (and many years experience in preparation of noise impact statements) and is a member of a number of professional organisations. Mr. O'Reilly was an author and project partner (as a senior noise consultant) in '*ENVIRONMENTAL QUALITY OBJECTIVES Noise in Quiet Areas*' administered by the Environmental Protection Agency on behalf of the Department of the Environment, Heritage and Local Government (as a first step towards implementation of the EC Directive relating to the Assessment and Management of Environmental Noise (EU, 2002).

Noise & Vibration Consultants have considerable experience in the assessment of noise impact and have compiled studies for in excess of 60 planned wind farm developments throughout Ireland ranging in size from 1 to 40 turbines.

9.1.2 Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment and is normally localised. Environmental noise is normally assessed in terms of A-weighted decibels, dB (A), when the 'A weighted' filter in the measuring device elicits a response which provides a good correlation with the human ear. The

criteria for environmental noise control are of annoyance or nuisance rather than damage. In general a noise level is liable to provoke a complaint whenever its level exceeds by a certain margin the pre-existing noise level or when it attains an absolute level. A change in noise level of 3 dB (A) is the minimum perceptible under normal circumstances while an increase in noise level of 10 dB (A) is perceived as a twofold increase in loudness. A noise level in excess of 83 dB (A) gives a significant risk of hearing damage.

Construction and industrial noise sources are normally assessed and expressed using equivalent continuous levels, L_{Aeq} ²⁴. Road traffic noise is normally assessed using L_{10} dB (A) or L_{Aeq} . L_{90} is the background noise and is the level equalled or exceeded for 90% of the measurement interval. Table 9.1 gives a comparison of noise levels in our environment.

Source/Activity	Indicative noise level dBA
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5km	35-45
Car at 65km/hr at 100m	55
Busy general office	60
Conversation	60
Truck at 50km/hr at 100m	65
Inside a typical shopping centre	70-75
Inside a modern car at around 90km/hr	75-80
Passenger cabin of jet aircraft	85
City Traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

Source: Fact sheet published by the Australian Greenhouse Office and the Australian Wind Energy Association

Table 9.1 Comparison of noise levels in our environment

9.2 EVALUATING CRITERIA

The noise limits suggested by the *Wind Energy Development Guidelines* have been derived with reference to the following, and other, points:

- Existing standards and guidance relating to noise emissions

²⁴ L_{Aeq} is defined as being the A-weighted equivalent continuous steady sound level during the sample period and effectively represents a type of average value.

- Society's need for renewable energy sources to reduce harmful greenhouse gas emissions in pursuance of government energy policy
- The ability of manufacturers and developers to meet these noise limits
- The research of Noise Working Groups in the UK, Denmark, Holland and Germany.

The following are a number of key extracts from the *Wind Energy Development Guidelines* in relation to noise impact:

General Noise Impact

"Noise impact should be assessed by reference to the nature and character of noise sensitive locations."

"Separate noise limits should apply for day-time and for night-time"

"Noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed."

"In general, noise is unlikely to be a significant problem where the distance from the nearest turbine to any noise sensitive property is more than 500metres."

Measurement Units

"The descriptor [$L_{A90\ 10min}$] which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources, should be used for assessing both wind energy development noise and background noise."

Specific Noise Limits

"Noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed."

"In general, a lower fixed limit of 45dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However in very quiet areas, the use of the margin of 5dB(A) above the background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments. Instead in low noise environments where background noise is less than 30 dB(A), it is recommended that the day time level of $L_{A90,10min}$ of the wind energy development noise should be limited to an absolute level within the range 35-40dB(A)".

“Separate noise limits should apply for day-time and for night-time. During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB (A) $L_{A90,10min}$ is deemed to protect sleep inside properties during the night”

The proposed limits for this development are:

- A fixed lower limit of 45dB (A) $L_{A90,10min}$ or 5dBA above background, whichever is the greater, at all residents.
- A fixed lower limit for night-time 43dB (A) $L_{A90,10min}$ or 5dBA above background, whichever is the greater.

The derived background noise levels were above 30dBA at all monitoring locations during day time.

9.2.1 Existing Environment

Noise Sensitive Locations (NSL's)

The locations of NSL's within 1km of the proposal were identified through map searches, visits to the site and are shown in the Figures 9.25 to 9.29 inclusive (see **Appendix M** for locations). Table 9.2 inclusive give the co-ordinates and distances from each of these houses to the nearest turbine.

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearsest Turbine (m)	Distance (m)
1	248567	235952	87	7	1013
2	253125	234854	90	13	769
3	252847	235075	88	13	961
4	252814	235059	88	13	996
5	253151	234776	87	13	789
6	253312	234330	86	13	1024
7	253317	234312	86	13	1037
8	253320	234292	86	13	1054
9	253351	234320	86	13	1015
10	253352	234300	86	13	1032
11	253375	234293	86	13	1029
12	253399	234292	86	13	1020
13	253412	234315	86	13	994
14	253443	234315	86	13	983
15	253446	234304	86	13	992
16	248662	235946	86	13	964
17	247686	235439	88	2	1038
18	253533	234720	91	13	576
19	254679	235250	92	14	549
20	257540	239043	73	19	1108
21	257278	239056	74	19	957
22	251645	237031	87	11	1065
23	254330	242124	81	32	697
25	255208	235063	92	14	1109
26	255206	236003	89	15	854
29	255168	236052	87	15	825
30	255056	235079	98	14	963
32	253325	234255	88	13	1085
33	253325	234232	88	13	1105
36	255179	236937	77	16	778
37	255061	236912	76	16	738
41	247997	236211	89	4	662
42	253233	236099	77	13	1032
43	253451	234289	86	13	1004
44	253462	234280	86	13	1009
45	253470	234276	86	13	1010
46	253484	234274	87	13	1008
47	253493	234279	86	13	1000
48	253504	234288	86	13	988
49	253505	234299	86	13	977
50	253508	234312	86	13	964
51	253506	234321	86	13	956
52	253537	234323	87	13	945
53	253540	234316	87	13	951
54	253536	234301	87	13	967
55	253539	234294	87	13	973
56	253535	234280	87	13	987

Table 9.2: Noise Sensitive Location / Nearest Turbine Separation.

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearrest Turbine (m)	Distance (m)
57	253538	234274	87	13	992
58	253239	234858	89	13	670
59	256033	237147	75	18	809
60	252914	235036	90	13	902
61	252938	235015	91	13	884
62	253240	235150	91	13	561
63	253230	234878	90	13	667
64	253206	234827	88	13	715
65	254072	234708	91	13	593
66	253659	241041	81	30	622
67	247805	235869	87	2	772
68	251228	237472	106	11	1098
69	253243	234926	91	13	631
74	257892	238120	88	19	1127
75	257889	238079	89	19	1130
77	254061	238638	79	24	533
79	255853	237190	76	18	679
80	254136	234300	87	13	993
81	254085	234740	91	13	571
82	253241	235118	91	13	565
83	253107	235469	82	13	727
85	251205	237399	100	11	1023
86	250527	237235	84	11	764
87	251976	235986	79	12	852
88	255053	235825	96	15	696
89	255277	236775	76	16	967
90	255188	236882	76	16	829
91	255992	236980	76	18	930
92	256000	237349	74	18	633
93	256150	237164	74	18	871
94	256553	237273	73	19	995
95	256613	237376	73	19	882
98	255304	235274	86	15	1126
99	255275	235286	87	15	1095
100	254979	235261	91	14	828
102	255190	235126	94	14	1069
103	255140	235061	96	14	1047
104	254117	238648	78	24	547
105	254035	238637	78	24	525
106	255252	239287	79	20	593
107	255119	239662	81	20	943
108	255299	239972	79	20	1110
110	255240	240390	78	31	1041
111	254501	240623	85	31	509
112	254300	240602	84	31	569
113	255670	239696	79	20	745
114	256175	239631	81	20	803

Table 9.2: Noise Sensitive Location / Nearest Turbine Separation (continued)

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearest Turbine (m)	Distance (m)
115	256157	239657	81	20	815
119	257812	237829	87	19	1120
120	257738	237877	85	19	1034
121	257427	237822	76	19	780
122	257348	237814	74	19	719
123	257388	237816	75	19	750
124	257308	237806	74	19	692
125	256922	237544	75	19	716
126	253134	235422	84	13	687
127	253014	234962	92	13	826
129	251194	237368	98	11	990
130	252967	234994	91	13	861
131	252992	234975	92	13	843
132	255432	235683	89	15	1092
133	254782	235295	92	14	629
134	254751	235282	91	14	604
135	255271	236950	77	16	825
136	256580	237359	73	19	905
137	256764	237362	74	19	882
138	254349	238723	76	23	538
139	254521	238947	76	23	521
140	254550	238960	76	23	513
141	254905	239054	77	23	506
142	254929	239108	79	23	532
143	253136	235891	77	13	931
144	253157	235988	77	13	988
145	255399	236884	76	17	930
146	253043	234909	92	13	818
147	250459	237281	85	11	828
150	247773	235882	87	2	739
151	253250	234967	91	13	606
152	255344	236871	75	17	927
153	255467	237058	75	18	749
154	255198	235218	91	14	1050
155	255096	235307	90	14	931
156	255078	239295	78	23	747
157	255440	239556	80	20	673
158	257511	237922	77	19	807
162	255219	240255	79	31	1128
163	255322	239896	79	20	1031
164	255524	239623	80	20	703
165	255485	239615	80	20	709
166	255217	239886	78	20	1070
167	255254	239573	80	20	788

Table 9.2: Noise Sensitive Location / Nearest Turbine Separation (continued)

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearrest Turbine (m)	Distance (m)
168	255200	239475	80	20	752
169	255210	239184	80	20	580
170	255025	239163	79	23	635
171	254949	239125	79	23	582
172	254551	239015	77	23	557
173	254312	238769	76	24	577
175	255714	239696	79	20	742
176	255247	240361	78	31	1067
177	255291	239603	80	20	790
178	255096	239603	80	20	916
179	254989	239163	78	23	626
181	257086	237641	78	19	680
182	257093	237687	77	19	643
185	256204	239568	80	20	767
186	255785	239548	81	20	595
187	255615	239684	79	20	741
188	255448	239926	79	20	1015
190	256750	239334	76	20	1076
191	256307	239403	78	20	720
192	256185	239484	79	20	690
193	254620	240381	83	31	759
194	254652	240610	86	31	541
195	254095	238602	80	24	579
196	254092	238643	78	24	540
197	253684	238390	82	24	765
198	253409	238094	82	25	992
199	254170	238194	76	22	713
200	251779	235993	79	12	656
203	251043	237236	89	11	805
204	251006	237187	88	11	746
205	250489	237255	84	11	794
207	253953	239994	83	28	501
208	254079	240060	84	28	638
209	254261	240143	83	28	836
210	253804	241176	82	32	452
211	254181	240585	83	31	637
212	254232	234223	89	13	1100
213	251956	235813	79	10	844
214	247785	235857	87	2	765
216	255108	240498	79	31	872
217	255281	240592	79	31	942
218	255460	240830	75	31	997
219	255285	241036	78	31	781
220	255608	240886	77	31	1126
221	255523	241106	80	31	1014
222	255330	241212	82	31	824
223	255322	241490	82	31	888

Table 9.2: Noise Sensitive Location / Nearest Turbine Separation (continued)

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearsest Turbine (m)	Distance (m)
224	255299	241806	80	31	1038
226	256380	237956	73	19	485
227	255224	235079	92	14	1118
228	251226	237475	106	11	1100
229	252058	235989	80	12	933
230	255275	236764	76	16	975
231	253711	238425	82	24	725
234	253140	237956	80	13	771
236	255319	241508	82	31	893

Table 9.2: Noise Sensitive Location / Nearest Turbine Separation (continued)

Baseline Noise Methodology

In order to represent the prevailing background noise in the area continuous noise monitoring was set up at 10 locations for an extended period of 3 weeks from 12th to 30th May 2013 (see Figure 9.30 Monitoring locations).

The following conditions and methods were adhered to in undertaking the survey:

Measurement of background and ambient noise levels using 10-minute intervals was undertaken during varied wind speeds / directions using instruments which comply to Type 1 standard in IEC 651-1: 1979¹.

All microphones were fitted with double skin windscreens based on that specified in W/31/00386/REP 'Noise Measurements in Windy Conditions'.

Concurrent measurements of average wind speed / direction and noise levels were recorded at 10-minute intervals with the times synchronised.

The noise monitors were set up to record a number of statistical noise indices, including Leq, L90, maximum and minimum levels on *fast response*. The results were automatically logged at 10 minute intervals.

Wind speed data was recorded from a mast on site with anemometer's sited at 80.8m and 44.8m. The hub height wind speed was derived using the calculated wind shear on site and then standardised to 10m height using a roughness length of 0.05m (methodology to derive the 10m height was according to that described in the

'Acoustic Bulletin' by the 'Institute of Acoustics professional journal dated March/April 2009' (see **Appendix M**). The derived 10m wind speed was plotted against the background noise levels

The baseline noise survey was carried out according to *ISO 1996 Part 1 (Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures taking cognisance of Department of Environment, Heritage and Local Government 'Wind Energy Development Guidelines 2006'*.

Wind speed data was taken from anemometers on the wind mast on site (co-ordinates 252422E, 234669N). An electronic rain gauge was installed on site at location H226.

Instrumentation Used

The following instrumentation was used in the baseline survey measurements:

- Eight Larson Davis 812 Precision Integrating Sound Level Analyser/Data logger with 828 Pre-amplifier set on 'fast response' and 1/2" Pre-polarised Microphone.
- Two Larson Davis 831 Precision Integrating Sound Level Analyser/Data logger with 828 Pre-amplifier set on 'fast response' and 1/2" Pre-polarised Microphone.
- Wind Shields Type: Double Skinned Windscreen.
- Fixed Wind Mast on site .
- Calibration Type: Larson Davis Precision Acoustic Calibrator Model CA250.
- One electronic rain gauge to log rainfall

All noise monitoring systems were calibrated before and after the survey and the drift of calibration were less than 0.2dB for all systems. All noise instruments (812's and 831'S have a noise floor below 20dB.

Table 9.3 gives the summary calibration certificate details of the instruments used in the baseline noise survey.

Instrument/Model	Date of Calibration	Serial Number	Calibration By
Larson Davis 812	12 th April 2013	0590	MTS Calibration Ltd
Larson Davis 812	8 th Feb'2012	0712	MTS Calibration Ltd
Larson Davis 812	4 th Oct 2012	0713	MTS Calibration Ltd
Larson Davis 812	19 th Oct 2012	0775	MTS Calibration Ltd
Larson Davis 812	11 th Oct 2012	0726	MTS Calibration Ltd
Larson Davis 812	14 th Oct 2011	0583	MTS Calibration Ltd
Larson Davis 812	15 th Dec'2011	0606	MTS Calibration Ltd
Larson Davis 812	19 th Dec'2011	0783	MTS Calibration Ltd
Larson Davis 831	11 th July 2012	0002920	PCB Piezotronics
Larson Davis 831	27 th June 2012	0002920	PCB Piezotronics
Larson Davis Calibrator CA250	26 th Sept 2012	3034	MTS Calibration Ltd

NB: All instruments have been calibrated with pre-amp and microphone, with certificates available on request

Table 9.3: Summary Details on Calibration Certificate

Measurement Procedure

Continuous noise monitoring was carried out at 10 locations representing houses within 1km over a 20-day period using environmental noise analysers with data logging facilities set on real time. All Instruments were synchronised to standard time.

All microphones were positioned more than 10m from any reflecting façade at 1.5m above ground level. The logged data was later downloaded to a personal computer. All acoustic instrumentation was calibrated before and after each survey and the drift of calibration observed was less than 0.2dB so no adjustments were made to the recorded levels.

The baseline survey locations were selected on the basis of their location relative to wind turbines and the nearer residential properties as given in Table 9.4 (see photos of locations in **Appendix M**). Where the noise levels in a locality or cluster of houses are similar, then that single monitoring location can represent a group of houses in that locality.

Monitoring Locations	Description
H210	Microphone at 1.2m height in back garden as in photo
H138	Microphone at 1.2m height, approx. 40 from house in field
H192	Microphone at 1.2m height, approx. 200m from house in field
H226	Microphone at 1.2m height in front garden of farmhouse
H145	Microphone at 1.2m height in back garden
H88	Microphone at 1.2m height in garden in front of house
H18	Microphone at 1.2m height in front garden of 2 storey house
H87	Microphone at 1.2m height in back garden of bungalow
H41	Microphone at 1.2m height in garden at side of farmhouse
H220	Microphone at 1.2m height in back of bungalow

Table 9.4: Noise monitoring details

The time subsets are according to UK guidelines as given in ETSU-R-97 and are as follows:

Quiet waking hours or quiet day-time periods defined as;

All evenings from 18.00 to 23.00hrs

Plus Saturday afternoon from 13.00 to 18.00hrs plus all day Sunday 07.00 to 18.00hrs

Night-time is defined as 23.00 to 07.00hrs

Noise Survey Results and Analysis of Data

The lands in the proposal area is a flat rural farming landscape. The local environment is predominately controlled by wind influence on vegetation, agricultural activity and road traffic on the local road network. The higher background levels were recorded from monitoring locations which were closer to the higher traffic flow roads (Regional roads) and Motorway. Background noise levels from a motorway at up to 5km can be increased by anything up to 7 dBA depending on wind direction and traffic flow.

The prevailing background noise level has been calculated based on the methodology contained in the UK document ETSU-R-97 and referenced in the Guidelines for Planning Authorities issued by the Department of Environment, Heritage and Local Government. The general methodology uses a polynomial regression line calculated

through the background noise data for each 10 minute period to give the prevailing background noise data. A 2nd or 3rd order polynomial regression line is then plotted through the background noise data. The choice of order of polynomial regression line is based upon whichever order of curve gives the *best-fit* to the measured data.

Prior to analysis, the acoustic data is filtered and noise due to heavy rainfall or activity that gave unusually elevated levels (including dawn chorus) was removed from the data set. Table 9.5 gives the background noise levels at varying wind speed derived from polynomial regression analysis with best-fit curve /line for day time and night time.

The derived background with wind speed takes account of wind shear.

Monitoring Location	Period	Average Wind Speed						
		4	5	6	7	8	9	10
		Background noise L ₉₀ dBA						
H210	Day	32.9	33.9	35.1	36.6	38.3	40.3	42.5
	Night	28.3	29.7	31.1	32.3	33.5	34.5	35.5
H138	Day	30.7	31.6	33.0	35.1	37.7	41.0	44.8
	Night	29.0	30.3	31.8	33.6	35.6	38.0	40.7
H192	Day	33.1	34.3	35.9	37.8	40.1	42.7	45.7
	Night	29.0	30.4	32.3	34.8	37.9	41.5	45.8
H226	Day	33.9	34.6	35.8	37.4	39.5	42.1	45.2
	Night	26.5	28.2	30.3	32.8	35.7	38.9	42.4
H145	Day	34.5	35.3	36.3	37.4	38.6	40.0	41.5
	Night	32.8	33.9	35.0	36.2	37.5	38.8	40.2
H88	Day	30.2	31.8	34.0	36.9	40.1	43.8	48.0
	Night	23.9	26.2	29.1	32.3	35.9	39.6	43.3
H18	Day	37.0	37.9	39.3	41.3	43.9	47.1	50.8
	Night	27.5	28.4	29.8	31.6	33.9	36.6	39.8
H87	Day	33.6	34.5	36.0	38.1	40.7	43.9	47.7
	Night	23.9	25.6	28.3	32.0	36.6	42.3	48.9
H41	Day	34.6	36.3	38.8	41.8	45.5	49.9	49.9
	Night	28.8	30.7	32.9	35.3	37.7	40.4	43.2
H220	Day	31.7	32.6	33.9	35.7	38.0	40.8	44.1
	Night	28.3	29.1	30.3	31.8	33.7	36.0	38.6

Table 9.5: Background noise levels with varying wind speed derived from regression analysis with best-fit plotted line for day and night

Table 9.6 gives the noise limit derived from the baseline noise survey at varying wind speeds for day and night.

Monitoring Location	Period	Average Wind Speed						
		4	5	6	7	8	9	10
		Background noise L ₉₀ dBA						
H210	Day	40	40	40.1	41.6	43.3	45.3	47.5
	Night	40	40	40	40	40	40	40.5
H138	Day	40	40	40	40.1	37.7	46.0	49.8
	Night	40	40	40	40	40.6	43.0	45.7
H192	Day	40	40	40.9	42.8	45.1	47.7	50.7
	Night	40	40	40	40	42.9	46.5	50.8
H226	Day	40	40	40.8	42.4	44.5	47.1	50.2
	Night	40	40	40	40	40.7	43.9	47.4
H145	Day	40	40.3	41.3	43.4	42.6	45.0	46.5
	Night	40	40	40	41.2	42.5	43.8	45.2
H88	Day	40	40	40	41.9	45.1	48.8	53.0
	Night	40	40	40	40	40.9	44.6	48.3
H18	Day	42.0	42.9	44.3	46.3	48.9	52.1	55.8
	Night	40	40	40	40	40	41.6	44.8
H87	Day	40	40	41.0	42.1	45.7	48.9	52.7
	Night	40	40	40	40	41.6	47.3	53.9
H41	Day	40	41.3	42.8	46.8	50.5	54.9	54.9
	Night	28.8	30.7	32.9	35.3	37.7	40.4	43.2
H220	Day	40	40	40	40.7	42.0	45.8	49.1
	Night	40	40	40	40	40	41.0	42.6

Table 9.6: Derived noise limit from baseline noise survey for day and night

9.3 NOISE IMPACT

9.3.1 *Characteristics of Proposal*

There are two quite distinct types of noise sources within a turbine. The mechanical noise produced by the gearbox, generator and other parts of the drive train; and the aerodynamic noise produced by the passage of the rotor blades through the air. Over the last number of years there has been a significant reduction in the mechanical noise generated by wind turbines, and it is now generally less than the aerodynamic noise.

Aerodynamic noise is a low level noise generated as a result of the turbine rotor blades moving through the air. Turbine noise is generally classed as broadband in nature, not unlike wind blowing through vegetation but modulated with a regular swishing sound. With distance from a turbine this blade swish normally decreases as the sound decays into the background. Because of the low level of noise generated from a turbine it is very difficult to measure at distance as the sound generated masks into the background noise. In very low wind speeds turbines do not operate. As the

wind speed increases so too does the sound generated by the turbine along with the sound generated by the action of wind on vegetation and objects.

With continuing improvements in design, lower rotational speeds produce higher rated outputs. Low rotational speeds reduce the probability of any audible tonal or impulsive components.

The audibility of noise from wind turbines will generally be greatest at lower wind speeds, less than 6 m/s. At receptor ground level and at average wind speeds of around 7-8 m/s and above, it generally becomes quite an abstruse issue to discuss sound emissions from modern wind turbines since background noise (wind on vegetation / objects) will generally mask any turbine noise.

The proposal for the site is for 32 no. wind turbines. The final turbine selection for the site will be made during the design and procurement phase. The candidate turbine used in this assessment is a Siemens SWT-3.0-113, however, there are other turbines in the market place (Enercon E82 E3 and Vestas V112-3) which have hub heights up to 110m and can operate within the same sound power level of emission.

Noise levels were calculated using the data supplied by the turbine manufacturer Siemens for the SWT-3.0-113, 3MW turbine. The data was obtained from a Standard Acoustic Emission document id: E WEN OEN DES TLS 7-10-000-0763-00 GBI / 2012.12.18. The sound power level of a Siemens SWT 3.0-113 turbine at varying wind speeds at 10m height wind speeds for a turbine hub height of 122.5m was used as it gave a marginally higher sound power level output than a lower turbine hub height. This data is given in Table 9.7 below. The sound power levels of the SWT turbine does not increase with wind speed above 7m/s. The turbine has a cut-in speed of 3 m/s and a cut-out speed of 25 m/s. The 1/1 octave band analysis from the test measurement is given in Table 9.8 for a wind speed of 8m/s.

10m Height Wind Speed, $V_{10}/\text{m/s}$	Sound Power Level L_{WA} [dB(A)]
4	98.6
5	101.6
6	104.6
7	105.5
8	105.5
9	105.5
10	105.5

Table 9.7: Sound power levels for the Siemens-3.0-113, turbine, (hub height of candidate turbine not to exceed 110m)

Assessment Methodology

The assessment was carried out according to the guidance given in ETSU-R-97 taking into account The Wind Energy Development Guidelines, '*Guidelines for Planning Authorities*', June, 2006 and recommendations in '*The Prediction and Assessment of Wind Turbine Noise*', published in the Institute of Acoustics '*Acoustics Bulletin*.' and '*A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise*,' May 2013. .

Continuous measurements of noise and wind speed were made at 10 minute intervals and the data was analysed to produce a best-fit line. The line was then used to derive a limit upon which the assessment was made. Figures 9.1 to 9.24 shows the fixed and derived line corresponding to the limits set for the ten baseline monitoring locations around the site.

Based on the noise specification for the Siemens turbine the following details have been assumed:

- a maximum hub height of 110m
- a maximum rotor diameter of 113m
- a sound power level, measured of L_{WA} of 105.5 dBA, for a 10m height wind speed (v_{10}) of 8m/s

- an 1/1 octave band spectrum, in reference conditions, as given in Table 9.8
- tonal emission characteristics such that no clearly audible tones are present at any wind speed
- each turbine is modelled as a point source at hub-height
- the turbines are identical
- an estimated gradient of 3dBA/m/s between a wind speed of 4 to 6m/s
- All turbines will be run at full power except for T23, T24 and T28 which will be run at a noise control setting of -1dB.

In the software model for prediction, 1 dBA is added for uncertainty to the values given Table 9.8 over the range of octaves between 63 and 8000Hz (Standard setting equals a SPL value of 106.5dBA as input to model while the -1dB setting equals 105.5dBA).

SWT-3.0-113-3.0MW	122.5m hub height									
			1/1 Octave at 8m/s							
Standard Setting										SPL
Frequency (Hz)	63	125	250	500	1000	2000	4000	8000		dba
Sound Power Level (L _{WA}) 8m/s	92.2	94.2	97.2	97.9	99.5	98.6	95.2	86.3	105.5	

Table 9.8: 1/1 Octave band analysis for the Siemens-SWT-3.0-113, turbine

9.3.2 Predicted Wind Turbine Noise

There are numerous models for predicting noise from a point source and some of these models are specifically used for the prediction of noise from wind farms. In this instance a version of WindFarm by Resoft wind energy development software package was used to determine the noise levels at the prediction locations. Noise predictions have been carried out using International Standard ISO 9613, Acoustics – Attenuation of Sound during Propagation Outdoors. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short term down wind (ie. worst-case) conditions or long term

overall averages. Only the worst-case down wind condition has been considered in this assessment; that is for wind blowing from each turbine directly to each house.

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

$$\text{Predicted Octave Band Noise level} = LW + D - (A_{\text{geo}} + A_{\text{atm}} + A_{\text{gr}} + A_{\text{br}} + A_{\text{mis}})$$

These factors are discussed in detail below. The predicted octave band levels from each of the turbines are summed to give the overall 'A' weighted predicted noise level from all the turbines operating together.

No allowance has been made for the character of noise emitted by the turbines, however the emissions from wind turbines are assumed to be broad band in nature.

A_{geo} – Geometric Spreading

Geometric (spherical) spreading from a simple free-field point source results in attenuation over distance according to:

$$L_p = L_w - (20 \log R + 11), \text{ where:}$$

L_p = sound pressure level

L_w = sound power level

R = distance from the turbine to receiver

D – Directivity Factor

The directivity factor allows for adjustment where the sound radiated in the direction of the receptor is higher than that for which the sound power level is specified. In this case the sound power levels are predicted as worst case propagation conditions, i.e. in downwind conditions, so no additional adjustments are necessary.

A_{gr} - Ground Effects

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

Ground conditions are described according to a variable defined as G, which varies between 0 for hard ground and 1 for soft ground. Although in reality the ground is predominately porous / soft, it has been modelled as corresponding to a ground absorption coefficient of 0.5. The predictions were carried out corresponding to the proposed height of the turbine nacelle and a receiver height of 4m. The Prediction and Assessment of Wind Turbine Noise agreement, published by the '*Institute of Acoustics*', May 2013, suggests that the use of G =0.5, a receptor height of 4m will generally result in realistic estimates of noise emission levels at receptor locations downwind of wind turbines where predictions are based on manufacturers noise data.

A_{bar}-Barrier Attenuation

The effect of a barrier (including a natural barrier) between a noise source and receptor is that noise will be reduced according to the path difference (difference between the direct distance between source to receptor and distance between source and receptor over the barrier). The reduction is relative to the frequency spectrum of the sound and may be predicted according to the method given in ISO 9613. In the prediction model zero attenuation is given for barrier effects, which is a worst case scenario setting.

A_{atm} - Atmospheric Absorption

Sound energy through the atmosphere is attenuated by conversion of sound energy to heat. This energy is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent. The attenuation by atmospheric absorption depends on distance according to:

$$A_{atm} = \alpha$$

Where, d = distance from the turbine

α = atmospheric absorption coefficient in dBm^{-1}

The values used in the model are according to ISO 9613 and assumes atmospheric conditions of 10°C and 70% relative humidity. The octave band attenuation coefficient at the various frequencies are given in Table 9.9 below.

1/1 Octave Band Attenuation Coefficients (dB/m)								
Octave Band (Hz)	63	125	250	500	1k	2k	4k	8k
dB/m	0.0001	0.0004	0.001	0.0019	0.0037	0.0097	0.0328	0.117

Table 9.9: 1/1 Octave band coefficient (dB/m)

A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here and any such effects are unlikely to significantly reduce noise levels below those predicted.

The ISO 9613-2 standard calculates under downwind propagation conditions and therefore predicts the average downwind sound pressure level at each dwelling. Downwind propagation conditions are wind direction within $\pm 45^{\circ}$ of the direction connecting the dominant noise source and the receiver dwelling.

The prediction model is calculated as a worst-case scenario. As such, it has been shown by measurement-based studies that this model like others, tend to over-estimate the noise levels at nearby dwellings.

The predicted turbine noise has been adjusted by subtracting 2 dBA to give the equivalent L_{90} dBA level as suggested in ETSU-R-97.

Table 9.10 gives the predicted noise levels at varying wind speed at the nearest noise sensitive residences. The following conservatism has been employed in the propagation modelling;

- down-wind propagation is modelled in all directions so predicted values are over-estimated, upwind and cross wind. In practice dwellings cannot be down-wind of all turbines simultaneously.

- although in reality the ground is predominately porous it has been modelled as mixed corresponding to a ground absorption coefficient of 0.5
- trees and other topography features have not been considered
- all dwellings were modelled at a receptor height of 4m. Using a 4m receptor height results in a more conservative result than using a 1.5 receptor height with the difference being more than 1dBA.
- the effects of wind shear has been taken into account in deriving the background noise levels with respect to wind speed

House No	Distance to nearest turbine (m)	Predicted Noise Levels L90, dBA at various Wind Speeds (m/s)						
		4	5	6	7	8	9	10
1	1013	32.1	35.1	38.1	38.7	38.7	38.7	38.7
2	769	30.4	33.4	36.4	37.0	37.0	37.0	37.0
3	961	29.4	32.4	35.4	36.0	36.0	36.0	36.0
4	996	29.2	32.2	35.2	35.8	35.8	35.8	35.8
5	789	30.2	33.2	36.2	36.8	36.8	36.8	36.8
6	1024	28.1	31.1	34.1	34.7	34.7	34.7	34.7
7	1037	28.0	31.0	34.0	34.6	34.6	34.6	34.6
8	1054	27.9	30.9	33.9	34.5	34.5	34.5	34.5
9	1015	28.2	31.2	34.2	34.8	34.8	34.8	34.8
10	1032	28.1	31.1	34.1	34.7	34.7	34.7	34.7
11	1029	28.1	31.1	34.1	34.7	34.7	34.7	34.7
12	1020	28.1	31.1	34.1	34.7	34.7	34.7	34.7
13	994	28.3	31.3	34.3	34.9	34.9	34.9	34.9
14	983	28.4	31.4	34.4	35.0	35.0	35.0	35.0
15	992	28.3	31.3	34.3	34.9	34.9	34.9	34.9
16	964	32.3	35.3	38.3	38.9	38.9	38.9	38.9
17	1038	30.1	33.1	36.1	36.7	36.7	36.7	36.7
18	576	32.6	35.6	38.6	39.2	39.2	39.2	39.2
19	549	34.3	37.3	40.3	40.9	40.9	40.9	40.9
20	1108	27.6	30.6	33.6	34.2	34.2	34.2	34.2
21	957	29.0	32.0	35.0	35.6	35.6	35.6	35.6
22	1065	30.6	33.6	36.6	37.2	37.2	37.2	37.2
23	697	31.1	34.1	37.1	37.7	37.7	37.7	37.7
25	1109	28.8	31.8	34.8	35.4	35.4	35.4	35.4
26	854	30.8	33.8	36.8	37.4	37.4	37.4	37.4
29	825	31.1	34.1	37.1	37.7	37.7	37.7	37.7
30	963	29.9	32.9	35.9	36.5	36.5	36.5	36.5
32	1085	27.7	30.7	33.7	34.3	34.3	34.3	34.3
33	1105	27.6	30.6	33.6	34.2	34.2	34.2	34.2
36	778	33.4	36.4	39.4	40.0	40.0	40.0	40.0
37	738	33.4	36.4	39.4	40.0	40.0	40.0	40.0
41	662	34.4	37.4	40.4	41.0	41.0	41.0	41.0
42	1032	30.6	33.6	36.6	37.2	37.2	37.2	37.2
43	1004	28.3	31.3	34.3	34.9	34.9	34.9	34.9
44	1009	28.2	31.2	34.2	34.8	34.8	34.8	34.8
45	1010	28.2	31.2	34.2	34.8	34.8	34.8	34.8
46	1008	28.2	31.2	34.2	34.8	34.8	34.8	34.8
47	1000	28.3	31.3	34.3	34.9	34.9	34.9	34.9
48	988	28.4	31.4	34.4	35.0	35.0	35.0	35.0
49	977	28.5	31.5	34.5	35.1	35.1	35.1	35.1
50	964	28.6	31.6	34.6	35.2	35.2	35.2	35.2
51	956	28.6	31.6	34.6	35.2	35.2	35.2	35.2
52	945	28.7	31.7	34.7	35.3	35.3	35.3	35.3
53	951	28.7	31.7	34.7	35.3	35.3	35.3	35.3
54	967	28.5	31.5	34.5	35.1	35.1	35.1	35.1
55	973	28.5	31.5	34.5	35.1	35.1	35.1	35.1
56	987	28.4	31.4	34.4	35.0	35.0	35.0	35.0

Table 9.10: Predicted noise levels at nearest houses expressed as $L_{eq, 10min}$ dBA

House No	Distance to nearest turbine (m)	Predicted Noise Levels L90, dBA at various Wind Speeds (m/s)						
		4	5	6	7	8	9	10
57	992	28.3	31.3	34.3	34.9	34.9	34.9	34.9
58	670	31.4	34.4	37.4	38.0	38.0	38.0	38.0
59	809	31.9	34.9	37.9	38.5	38.5	38.5	38.5
60	902	29.7	32.7	35.7	36.3	36.3	36.3	36.3
61	884	29.8	32.8	35.8	36.4	36.4	36.4	36.4
62	561	33.0	36.0	39.0	39.6	39.6	39.6	39.6
63	667	31.5	34.5	37.5	38.1	38.1	38.1	38.1
64	715	30.9	33.9	36.9	37.5	37.5	37.5	37.5
65	593	33.1	36.1	39.1	39.7	39.7	39.7	39.7
66	622	34.8	37.8	40.8	41.4	41.4	41.4	41.4
67	772	32.8	35.8	38.8	39.4	39.4	39.4	39.4
68	1098	29.7	32.7	35.7	36.3	36.3	36.3	36.3
69	631	31.9	34.9	37.9	38.5	38.5	38.5	38.5
74	1127	26.8	29.8	32.8	33.4	33.4	33.4	33.4
75	1130	26.8	29.8	32.8	33.4	33.4	33.4	33.4
77	533	35.6	38.6	41.6	42.2	42.2	42.2	42.2
79	679	33.2	36.2	39.2	39.8	39.8	39.8	39.8
80	993	28.8	31.8	34.8	35.4	35.4	35.4	35.4
81	571	33.4	36.4	39.4	40.0	40.0	40.0	40.0
82	565	32.9	35.9	38.9	39.5	39.5	39.5	39.5
83	727	31.5	34.5	37.5	38.1	38.1	38.1	38.1
85	1023	30.1	33.1	36.1	36.7	36.7	36.7	36.7
86	764	32.0	35.0	38.0	38.6	38.6	38.6	38.6
87	852	31.7	34.7	37.7	38.3	38.3	38.3	38.3
88	696	32.1	35.1	38.1	38.7	38.7	38.7	38.7
89	967	32.1	35.1	38.1	38.7	38.7	38.7	38.7
90	829	33.0	36.0	39.0	39.6	39.6	39.6	39.6
91	930	31.1	34.1	37.1	37.7	37.7	37.7	37.7
92	633	33.5	36.5	39.5	40.1	40.1	40.1	40.1
93	871	31.5	34.5	37.5	38.1	38.1	38.1	38.1
94	995	30.4	33.4	36.4	37.0	37.0	37.0	37.0
95	882	30.8	33.8	36.8	37.4	37.4	37.4	37.4
98	1126	28.9	31.9	34.9	35.5	35.5	35.5	35.5
99	1095	29.1	32.1	35.1	35.7	35.7	35.7	35.7
100	828	31.3	34.3	37.3	37.9	37.9	37.9	37.9
102	1069	29.2	32.2	35.2	35.8	35.8	35.8	35.8
103	1047	29.2	32.2	35.2	35.8	35.8	35.8	35.8
104	547	35.6	38.6	41.6	42.2	42.2	42.2	42.2
105	525	35.6	38.6	41.6	42.2	42.2	42.2	42.2
106	593	34.6	37.6	40.6	41.2	41.2	41.2	41.2
107	943	32.1	35.1	38.1	38.7	38.7	38.7	38.7
108	1110	30.8	33.8	36.8	37.4	37.4	37.4	37.4
110	1041	30.3	33.3	36.3	36.9	36.9	36.9	36.9
111	509	34.7	37.7	40.7	41.3	41.3	41.3	41.3
112	569	34.6	37.6	40.6	41.2	41.2	41.2	41.2
113	745	32.1	35.1	38.1	38.7	38.7	38.7	38.7
114	803	31.4	34.4	37.4	38.0	38.0	38.0	38.0

Table 9.10: Predicted noise levels at nearest houses expressed as $L_{eq, 10min}$ dBA (continued)

House No	Distance to nearest turbine (m)	Predicted Noise Levels L90, dBA at various Wind Speeds (m/s)						
		4	5	6	7	8	9	10
115	815	31.3	34.3	37.3	37.9	37.9	37.9	37.9
119	1120	26.9	29.9	32.9	33.5	33.5	33.5	33.5
120	1034	27.5	30.5	33.5	34.1	34.1	34.1	34.1
121	780	29.7	32.7	35.7	36.3	36.3	36.3	36.3
122	719	30.4	33.4	36.4	37.0	37.0	37.0	37.0
123	750	30.0	33.0	36.0	36.6	36.6	36.6	36.6
124	692	30.7	33.7	36.7	37.3	37.3	37.3	37.3
125	716	31.1	34.1	37.1	37.7	37.7	37.7	37.7
126	687	31.8	34.8	37.8	38.4	38.4	38.4	38.4
127	826	30.1	33.1	36.1	36.7	36.7	36.7	36.7
129	990	30.3	33.3	36.3	36.9	36.9	36.9	36.9
130	861	29.9	32.9	35.9	36.5	36.5	36.5	36.5
131	843	30.0	33.0	36.0	36.6	36.6	36.6	36.6
132	1092	29.1	32.1	35.1	35.7	35.7	35.7	35.7
133	629	33.4	36.4	39.4	40.0	40.0	40.0	40.0
134	604	33.6	36.6	39.6	40.2	40.2	40.2	40.2
135	825	33.3	36.3	39.3	39.9	39.9	39.9	39.9
136	905	30.8	33.8	36.8	37.4	37.4	37.4	37.4
137	882	30.3	33.3	36.3	36.9	36.9	36.9	36.9
138	538	36.0	39.0	42.0	42.6	42.6	42.6	42.6
139	521	35.8	38.8	41.8	42.4	42.4	42.4	42.4
140	513	35.8	38.8	41.8	42.4	42.4	42.4	42.4
141	506	35.6	38.6	41.6	42.2	42.2	42.2	42.2
142	532	35.1	38.1	41.1	41.7	41.7	41.7	41.7
143	931	30.7	33.7	36.7	37.3	37.3	37.3	37.3
144	988	30.5	33.5	36.5	37.1	37.1	37.1	37.1
145	930	32.5	35.5	38.5	39.1	39.1	39.1	39.1
146	818	30.1	33.1	36.1	36.7	36.7	36.7	36.7
147	828	31.6	34.6	37.6	38.2	38.2	38.2	38.2
150	739	33.1	36.1	39.1	39.7	39.7	39.7	39.7
151	606	32.2	35.2	38.2	38.8	38.8	38.8	38.8
152	927	32.5	35.5	38.5	39.1	39.1	39.1	39.1
153	749	33.7	36.7	39.7	40.3	40.3	40.3	40.3
154	1050	29.4	32.4	35.4	36.0	36.0	36.0	36.0
155	931	30.5	33.5	36.5	37.1	37.1	37.1	37.1
156	747	34.0	37.0	40.0	40.6	40.6	40.6	40.6
157	673	33.1	36.1	39.1	39.7	39.7	39.7	39.7
158	807	29.4	32.4	35.4	36.0	36.0	36.0	36.0
162	1128	30.4	33.4	36.4	37.0	37.0	37.0	37.0
163	1031	31.0	34.0	37.0	37.6	37.6	37.6	37.6
164	703	32.7	35.7	38.7	39.3	39.3	39.3	39.3
165	709	32.7	35.7	38.7	39.3	39.3	39.3	39.3
166	1070	31.2	34.2	37.2	37.8	37.8	37.8	37.8
167	788	32.7	35.7	38.7	39.3	39.3	39.3	39.3

Table 9.10: Predicted noise levels at nearest houses expressed as $L_{eq, 10min}$ dBA (continued)

House No	Distance to nearest turbine (m)	Predicted Noise Levels L90, dBA at various Wind Speeds (m/s)						
		4	5	6	7	8	9	10
168	752	33.2	36.2	39.2	39.8	39.8	39.8	39.8
169	580	35.2	38.2	41.2	41.8	41.8	41.8	41.8
170	635	34.8	37.8	40.8	41.4	41.4	41.4	41.4
171	582	35.0	38.0	41.0	41.6	41.6	41.6	41.6
172	557	35.4	38.4	41.4	42.0	42.0	42.0	42.0
173	577	35.9	38.9	41.9	42.5	42.5	42.5	42.5
175	742	32.1	35.1	38.1	38.7	38.7	38.7	38.7
176	1067	30.3	33.3	36.3	36.9	36.9	36.9	36.9
177	790	32.5	35.5	38.5	39.1	39.1	39.1	39.1
178	916	32.4	35.4	38.4	39.0	39.0	39.0	39.0
179	626	34.8	37.8	40.8	41.4	41.4	41.4	41.4
181	680	31.1	34.1	37.1	37.7	37.7	37.7	37.7
182	643	31.5	34.5	37.5	38.1	38.1	38.1	38.1
185	767	31.7	34.7	37.7	38.3	38.3	38.3	38.3
186	595	33.4	36.4	39.4	40.0	40.0	40.0	40.0
187	741	32.2	35.2	38.2	38.8	38.8	38.8	38.8
188	1015	30.8	33.8	36.8	37.4	37.4	37.4	37.4
190	1076	30.3	33.3	36.3	36.9	36.9	36.9	36.9
191	720	32.4	35.4	38.4	39.0	39.0	39.0	39.0
192	690	32.5	35.5	38.5	39.1	39.1	39.1	39.1
193	759	32.6	35.6	38.6	39.2	39.2	39.2	39.2
194	541	34.0	37.0	40.0	40.6	40.6	40.6	40.6
195	579	35.4	38.4	41.4	42.0	42.0	42.0	42.0
196	540	35.6	38.6	41.6	42.2	42.2	42.2	42.2
197	765	33.9	36.9	39.9	40.5	40.5	40.5	40.5
198	992	31.8	34.8	37.8	38.4	38.4	38.4	38.4
199	713	34.9	37.9	40.9	41.5	41.5	41.5	41.5
200	656	33.6	36.6	39.6	40.2	40.2	40.2	40.2
203	805	31.5	34.5	37.5	38.1	38.1	38.1	38.1
204	746	32.0	35.0	38.0	38.6	38.6	38.6	38.6
205	794	31.8	34.8	37.8	38.4	38.4	38.4	38.4
207	501	36.0	39.0	42.0	42.6	42.6	42.6	42.6
208	638	34.9	37.9	40.9	41.5	41.5	41.5	41.5
209	836	33.6	36.6	39.6	40.2	40.2	40.2	40.2
210	452	35.9	38.9	41.9	42.5	42.5	42.5	42.5
211	637	34.6	37.6	40.6	41.2	41.2	41.2	41.2
212	1100	28.0	31.0	34.0	34.6	34.6	34.6	34.6
213	844	31.8	34.8	37.8	38.4	38.4	38.4	38.4
214	765	32.8	35.8	38.8	39.4	39.4	39.4	39.4
216	872	30.9	33.9	36.9	37.5	37.5	37.5	37.5
217	942	30.2	33.2	36.2	36.8	36.8	36.8	36.8
218	997	29.4	32.4	35.4	36.0	36.0	36.0	36.0
219	781	30.6	33.6	36.6	37.2	37.2	37.2	37.2
220	1126	28.6	31.6	34.6	35.2	35.2	35.2	35.2
221	1014	28.9	31.9	34.9	35.5	35.5	35.5	35.5
222	824	30.2	33.2	36.2	36.8	36.8	36.8	36.8
223	888	29.6	32.6	35.6	36.2	36.2	36.2	36.2

Table 9.10: Predicted noise levels at nearest houses expressed as $L_{eq, 10min}$ dBA (continued)

House No	Distance to nearest turbine (m)	Predicted Noise Levels L90, dBA at various Wind Speeds (m/s)						
		4	5	6	7	8	9	10
224	1038	28.5	31.5	34.5	35.1	35.1	35.1	35.1
226	485	35.4	38.4	41.4	42.0	42.0	42.0	42.0
227	1118	28.8	31.8	34.8	35.4	35.4	35.4	35.4
228	1100	29.7	32.7	35.7	36.3	36.3	36.3	36.3
229	933	31.1	34.1	37.1	37.7	37.7	37.7	37.7
230	975	32.0	35.0	38.0	38.6	38.6	38.6	38.6
231	725	34.1	37.1	40.1	40.7	40.7	40.7	40.7
234	771	30.7	33.7	36.7	37.3	37.3	37.3	37.3
236	893	29.5	32.5	35.5	36.1	36.1	36.1	36.1

Table 9.10: Predicted noise levels at nearest houses expressed as $L_{eq, 10min}$ dBA (continued)

Plots have been produced of the derived background (L90) noise level. The plots (Figures 9.1 to 9.24 incl.) give the predicted turbine noise levels versus the background noise level + 5dB and the fixed lower noise limit. The predicted turbine noise levels are shown in red, the 45dBA and 43dBA lower limit in orange and the derived background +5dBA are shown in green in all figures. Noise contour maps are useful in showing the noise footprint of a development. A footprint of noise emission from the wind farm for 8m/s wind speed at 10m height expressed as L_{90} dBA is given in **Appendix M**.

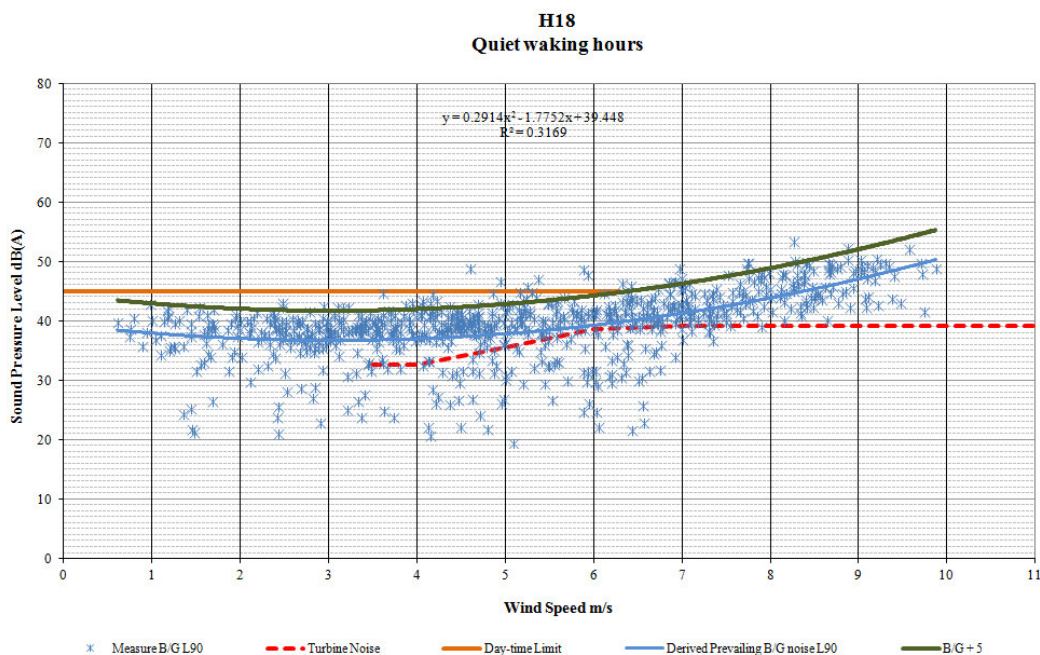


Figure 9. 1 shows that at H18 the total predicted turbine noise level is within the day time noise limit at all wind speeds

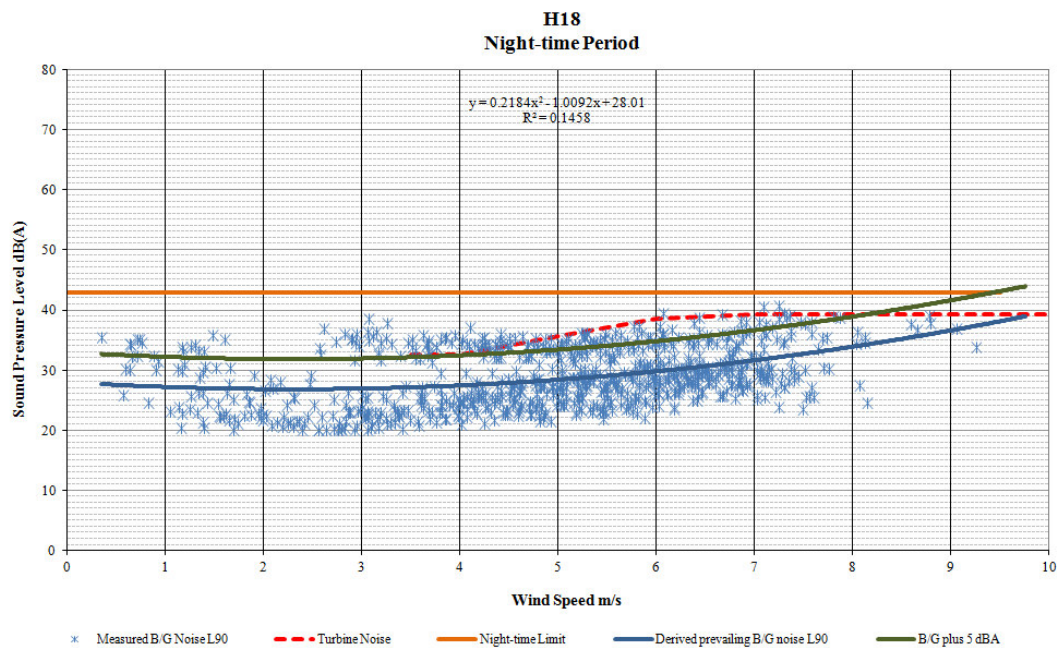


Figure 9.2: shows that at H18 the total predicted turbine noise level within the night time noise limit for all wind speeds

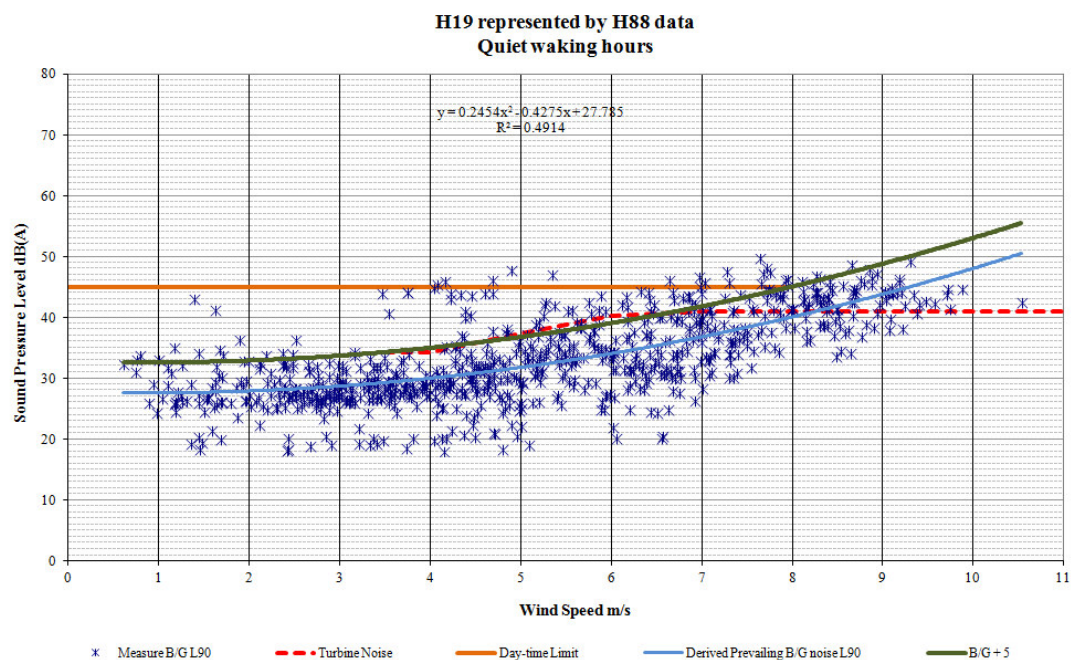


Figure 9.3 shows that at H19 the total predicted turbine noise level is within the day time noise limit at all wind speeds

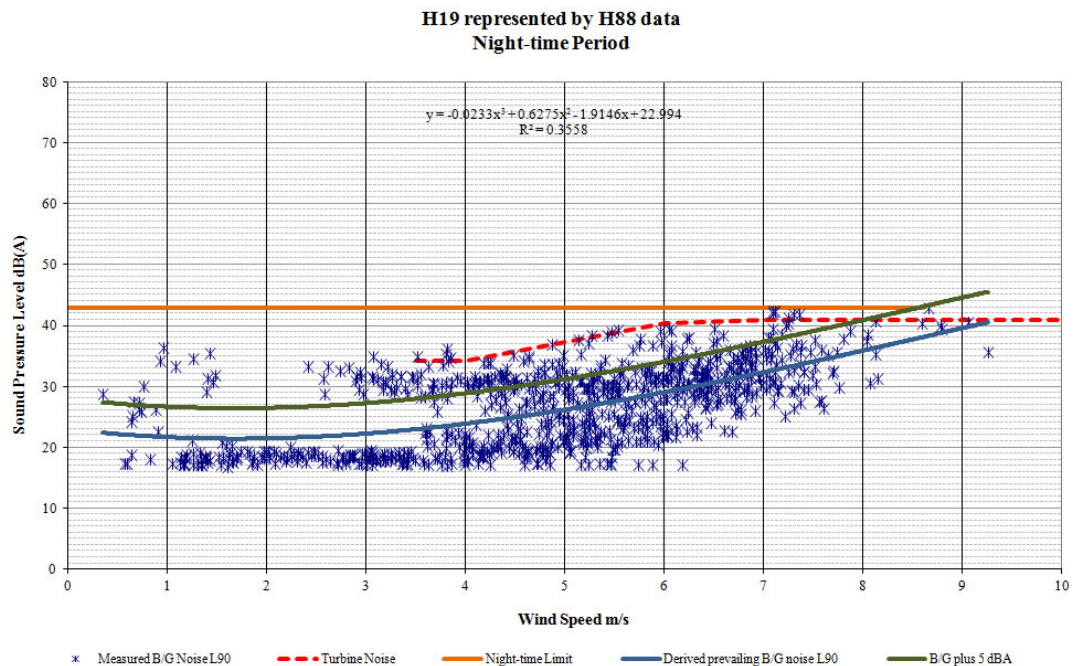


Figure 9.4 shows that at H19 the total predicted turbine noise level is within the night time noise limit at all wind speeds

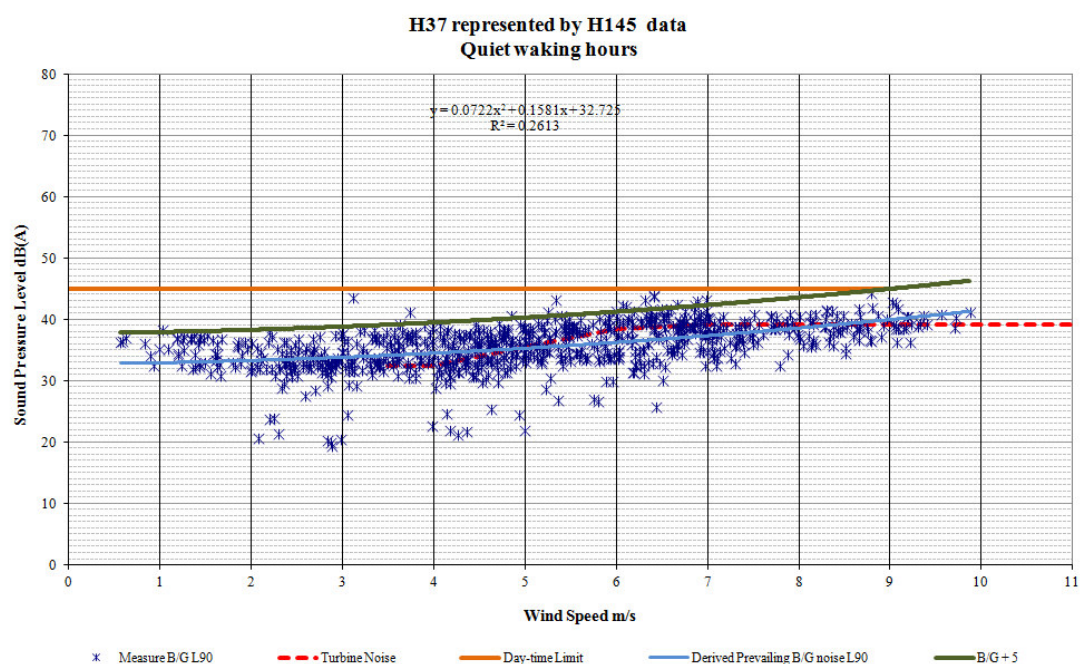


Figure 9.5 shows that at H37 the total predicted turbine noise level is within the day time noise limit at all wind speeds

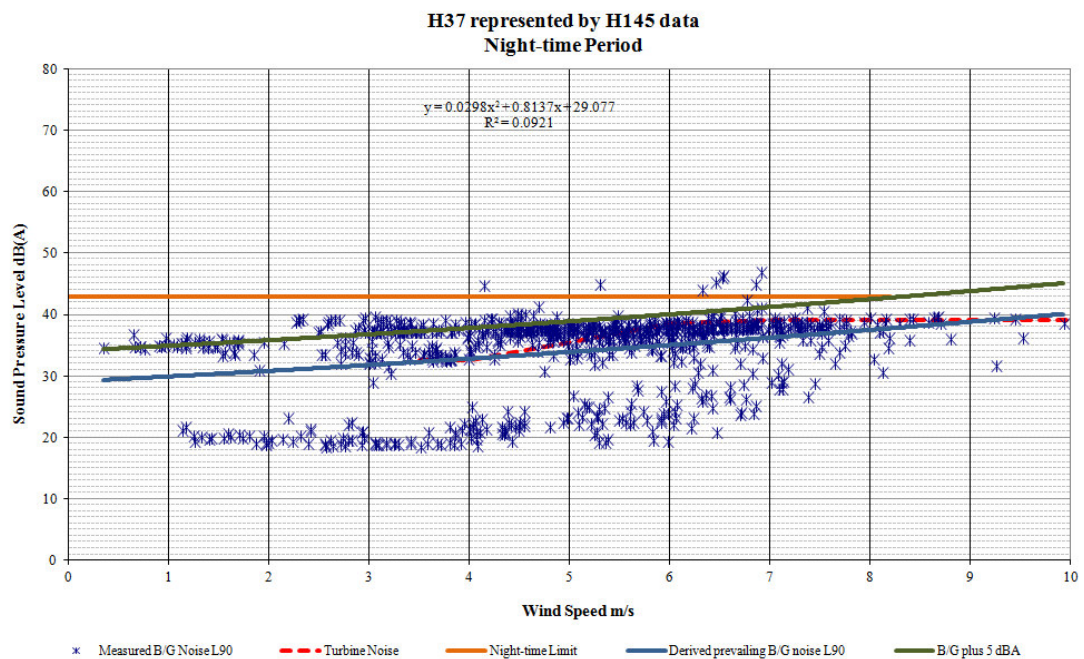


Figure 9.6 shows that at H37 the total predicted turbine noise level is within the night time noise limit at all wind speeds

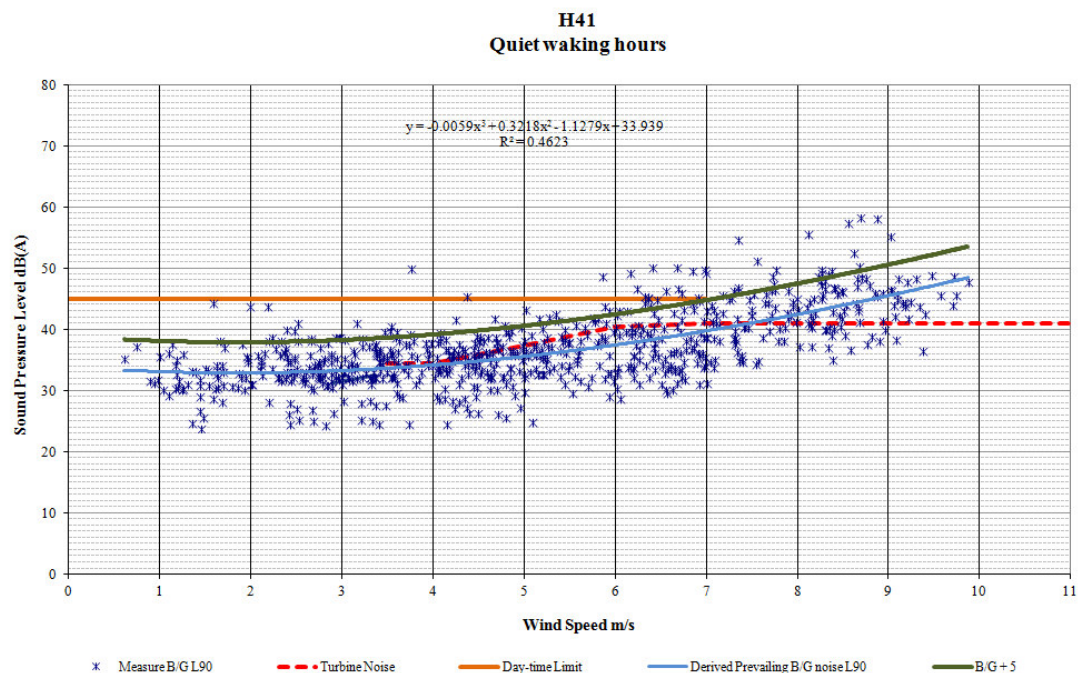


Figure 9.7 shows that at H41 the total predicted turbine noise level is within the day time noise limit at all wind speeds

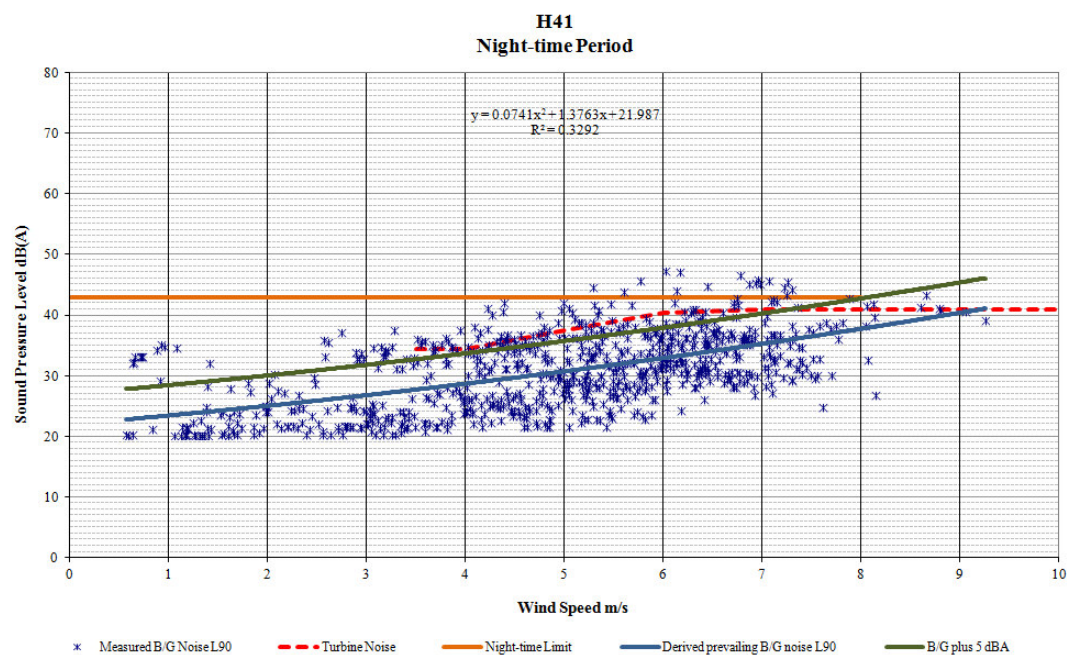


Figure 9.8: shows that at H41 the total predicted turbine noise level is within the night time noise limit at all wind speeds

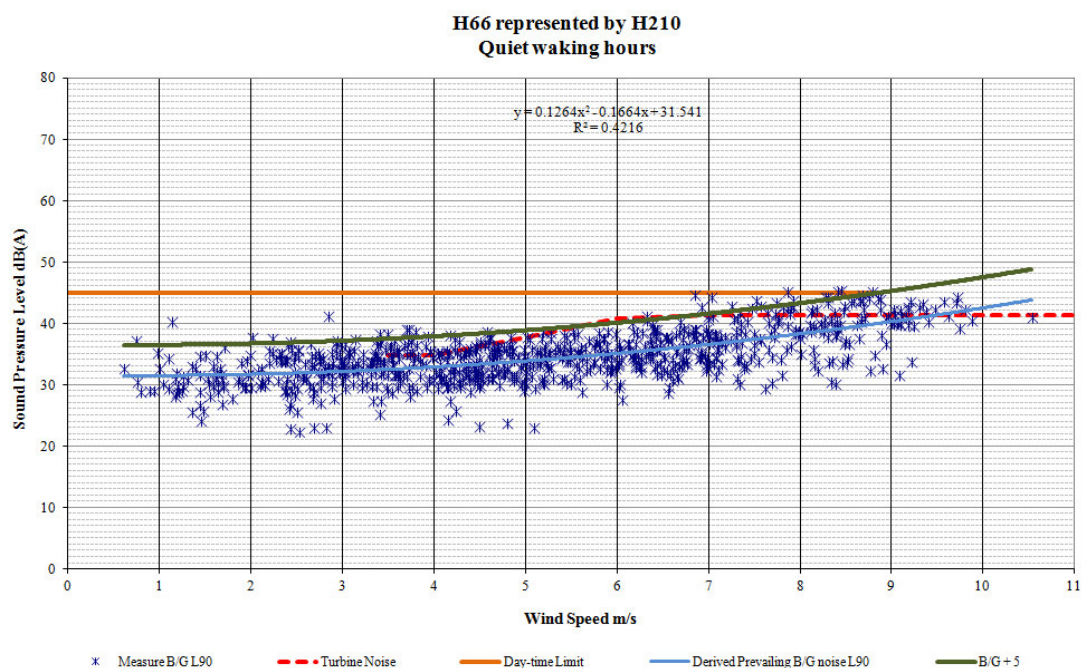


Figure 9.9: shows that at H66 the total predicted turbine noise level is within the day time noise limit at all wind speeds

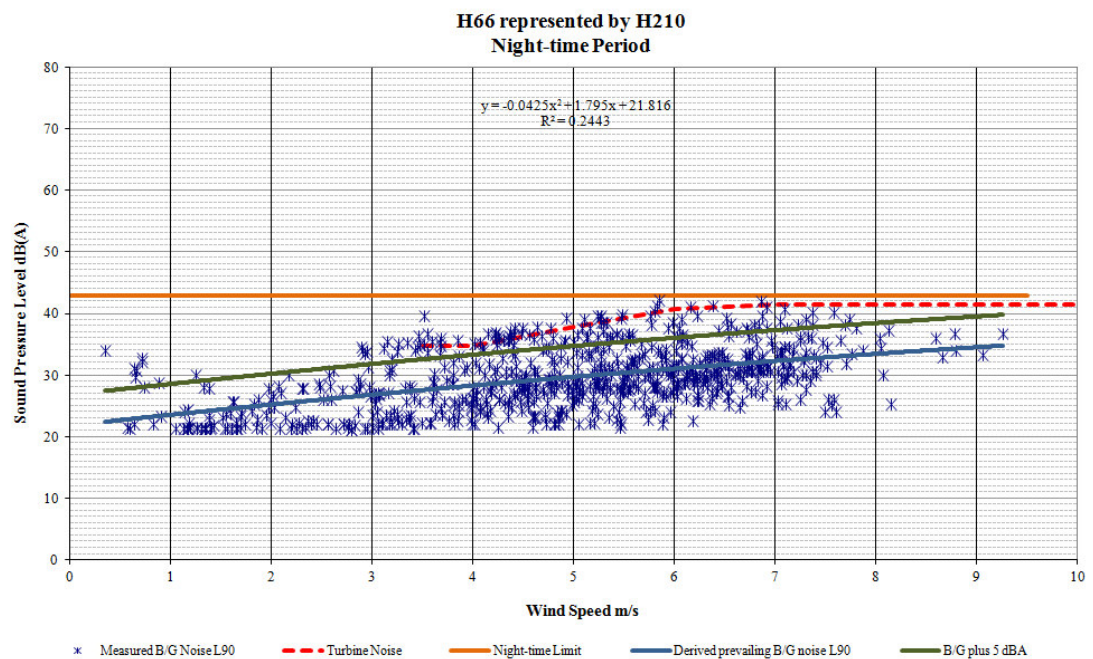


Figure 9.10: shows that at H66 the total predicted turbine noise level is within the night time noise limit at all wind speeds

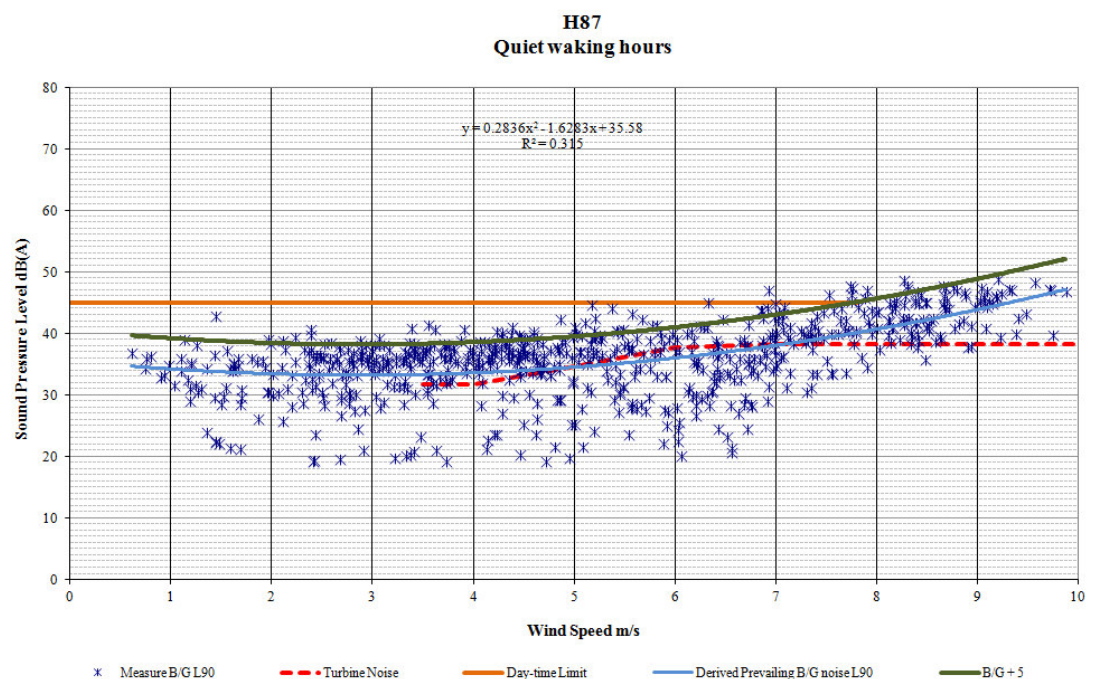


Figure 9.11: shows that at H87 the total predicted turbine noise level is within the day time noise limit at all wind speeds

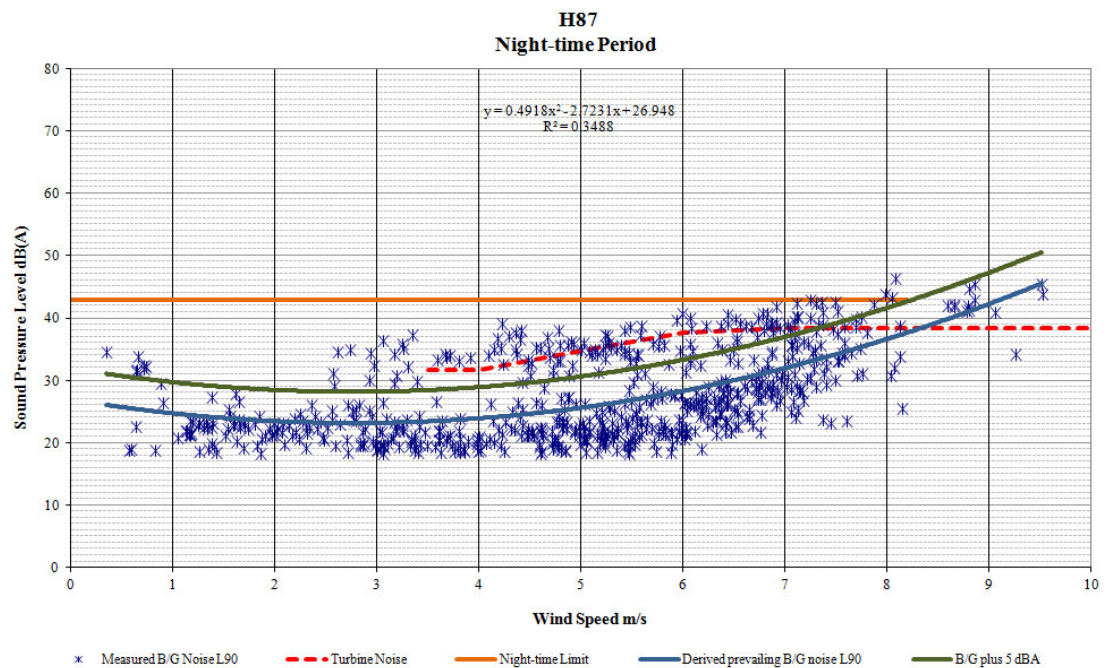


Figure 9.12: shows that at H87 the total predicted turbine noise level is within the night time noise limit at all wind speeds

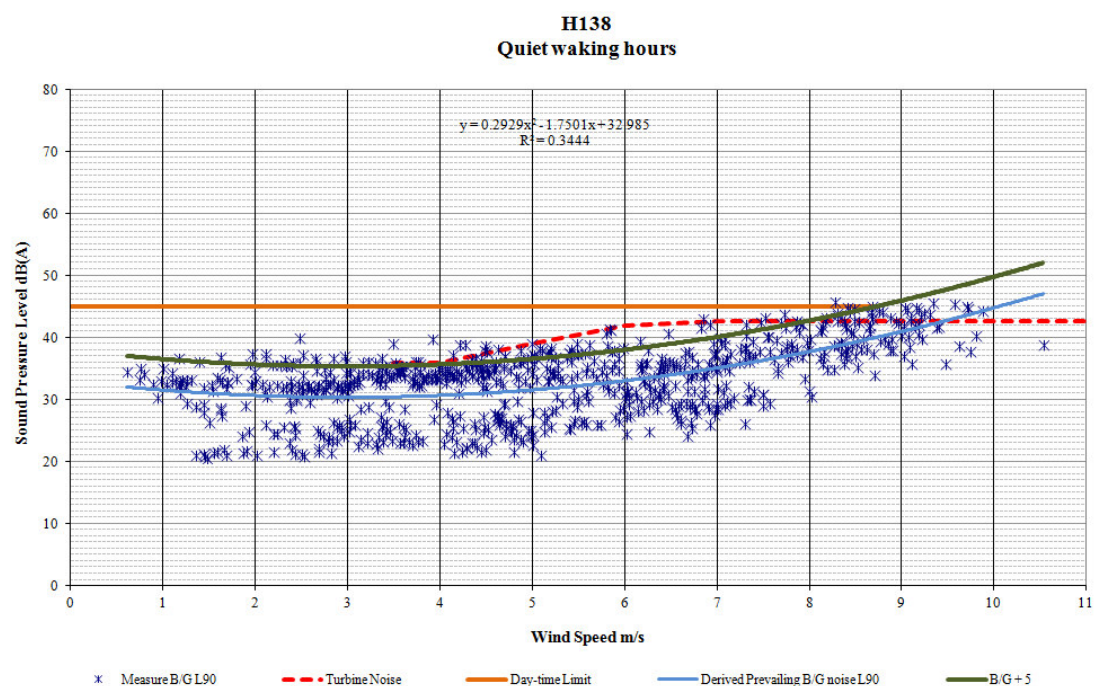


Figure 9.13: shows that at H138 the total predicted turbine noise level is within the day time noise limit at all wind speeds

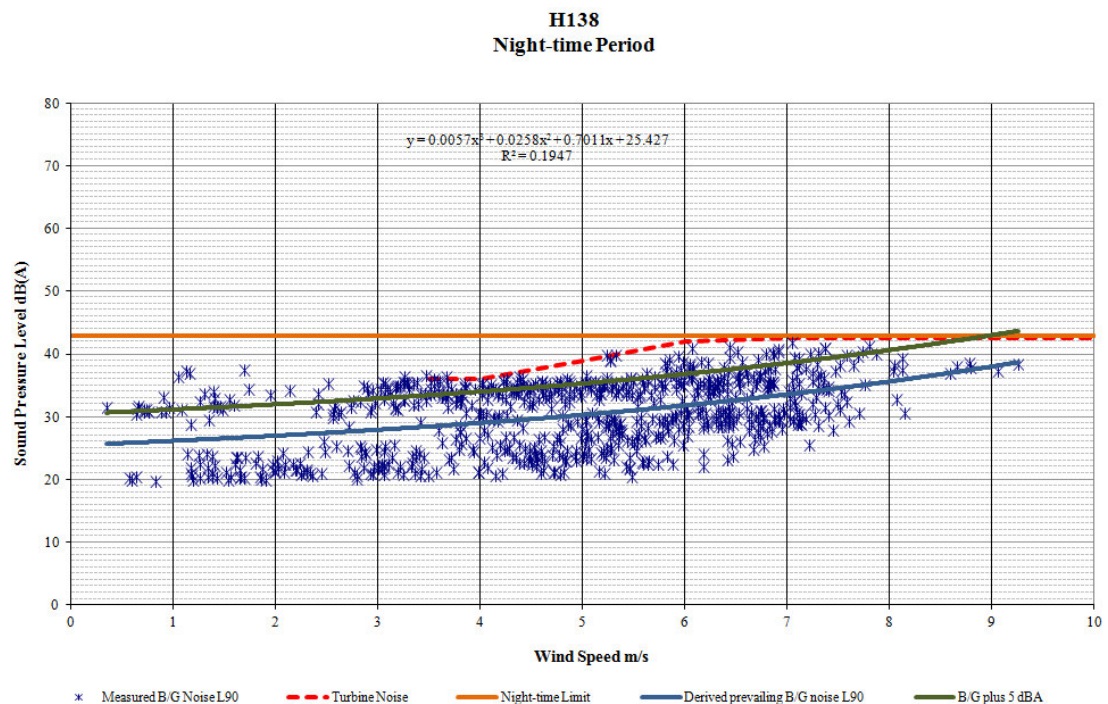


Figure 9.14: shows that at H138 the total predicted turbine noise level is within the night time noise limit at all wind speeds

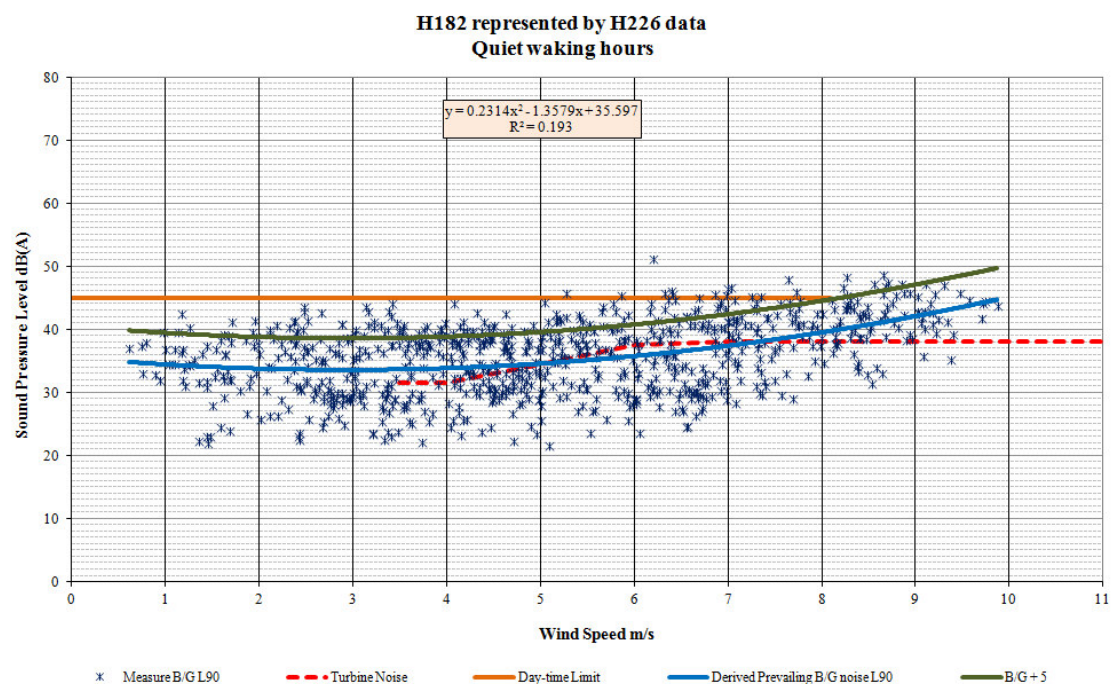


Figure 9.15: shows that at H182 the total predicted turbine noise level is within the day time noise limit at all wind speeds

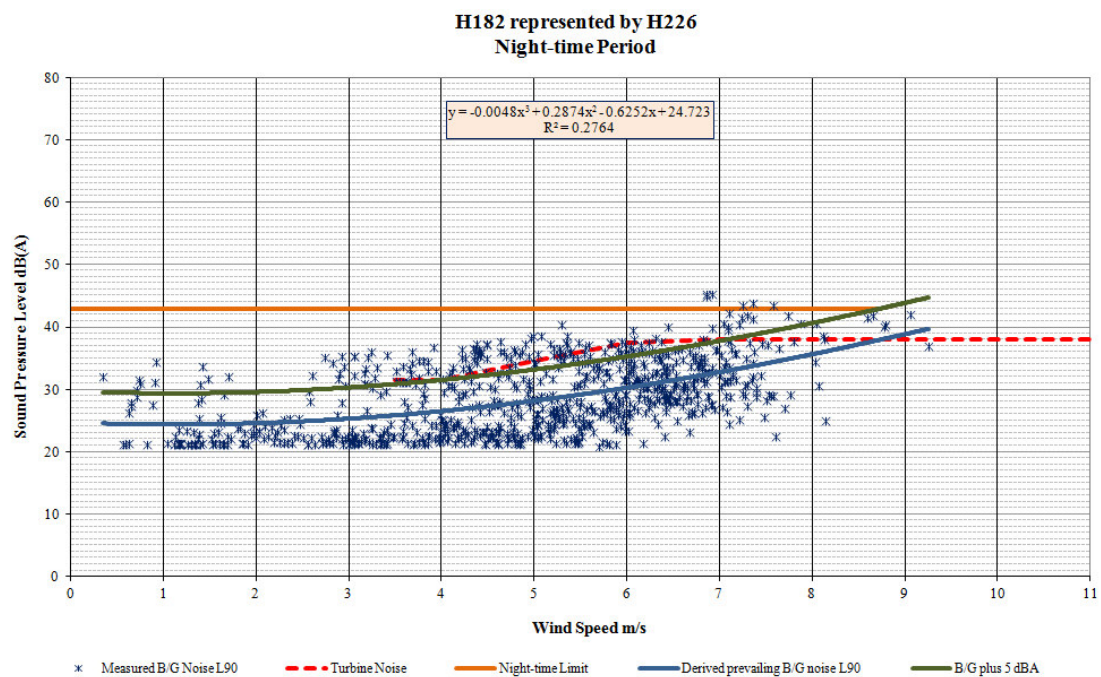


Figure 9.16: shows that at H182 the total predicted turbine noise level is within the night time noise limit at all wind speeds

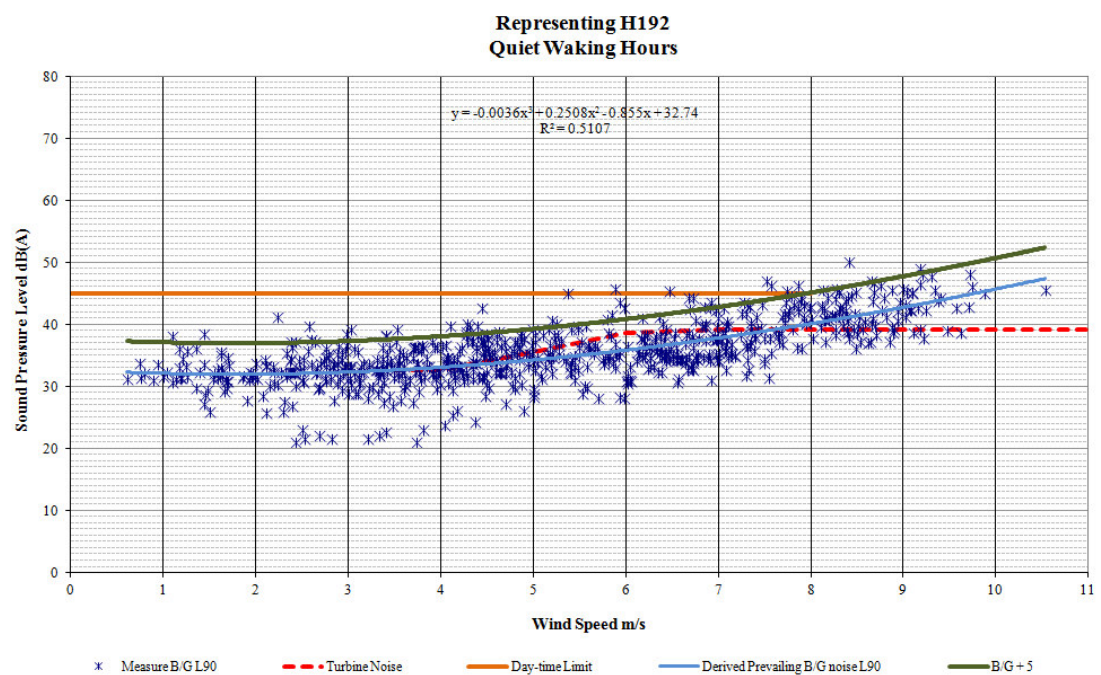


Figure 9.17: shows that at H192 the total predicted turbine noise level is within the day time noise limit at all wind speeds

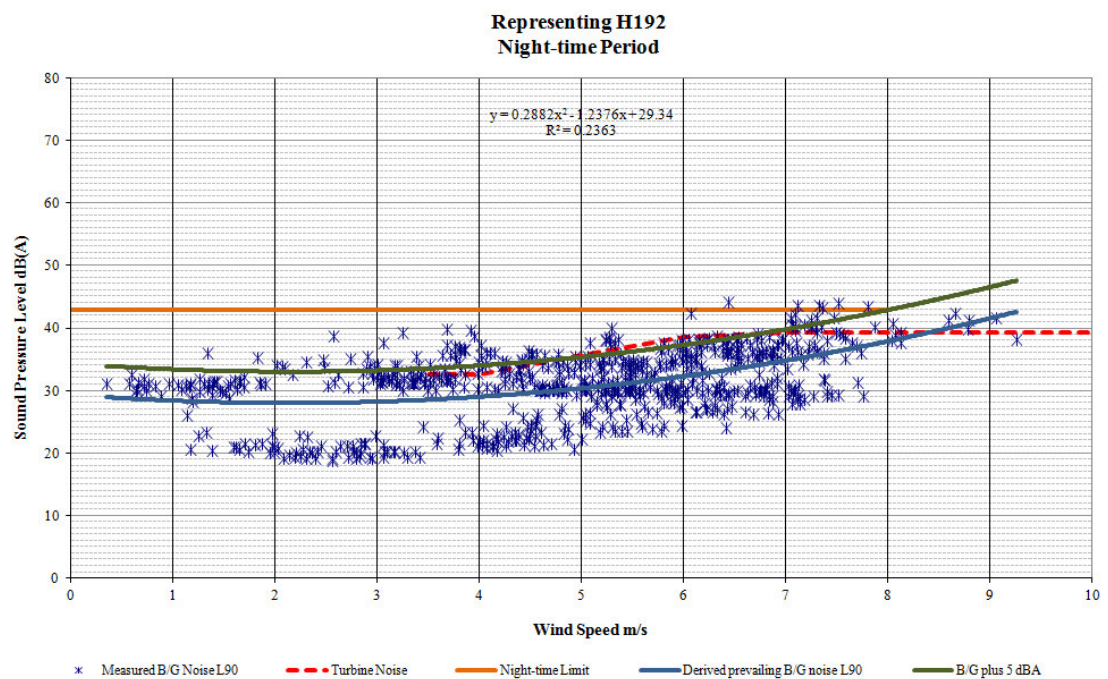


Figure 9.18: shows that at H192 the total predicted turbine noise level is within the night time noise limit at all wind speeds

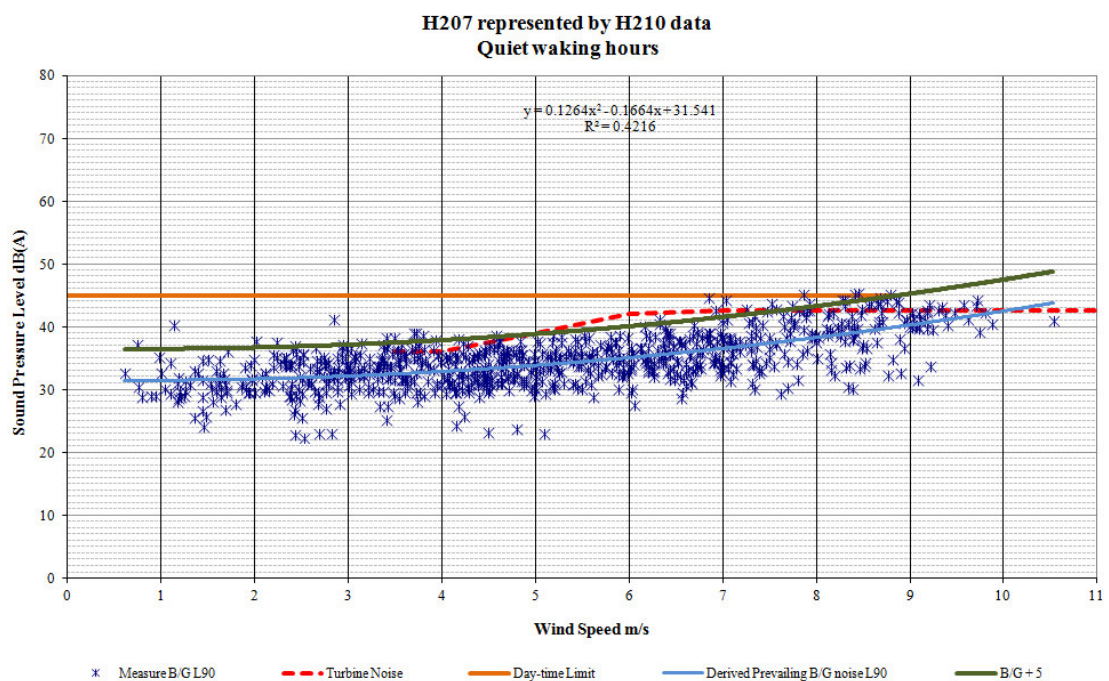


Figure 9.19: shows that at H207 the total predicted turbine noise level is within the day time noise limit at all wind speeds

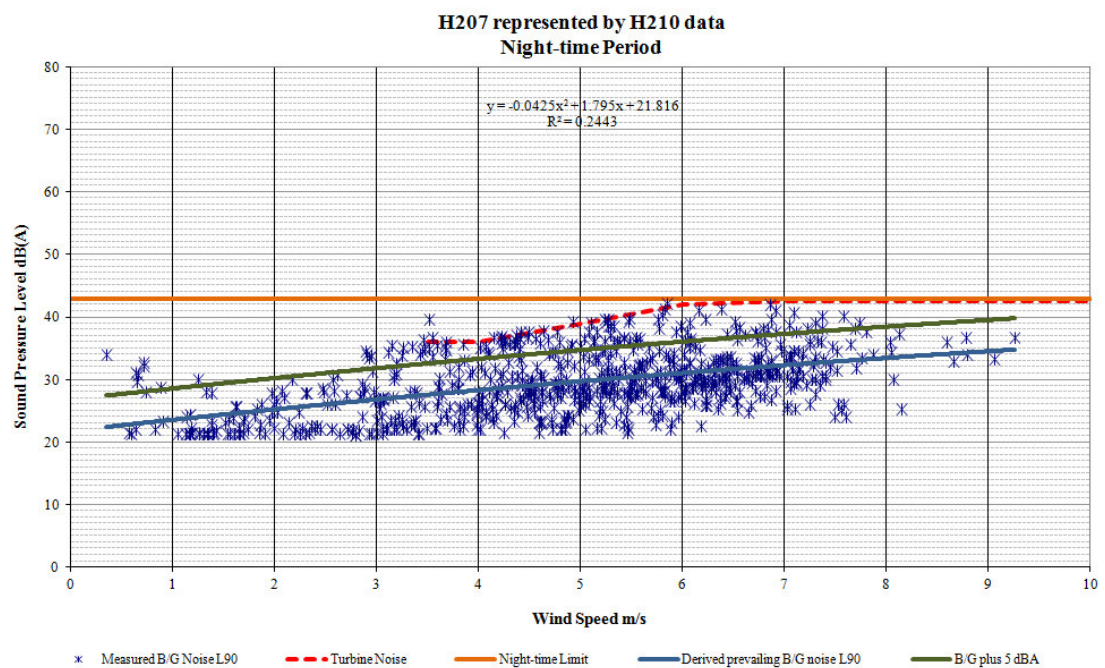


Figure 9.20: shows that at H207 the total predicted turbine noise level is within the night time noise limit at all wind speeds

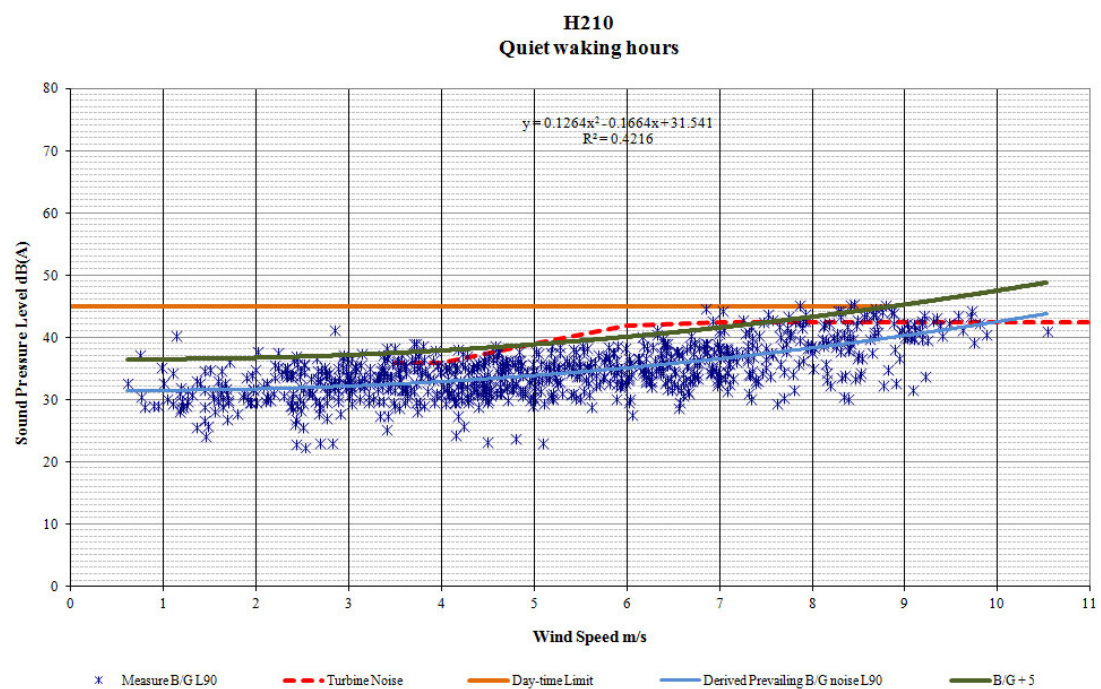


Figure 9.21: shows that at H210 the total predicted turbine noise level is within the day time noise limit at all wind speeds

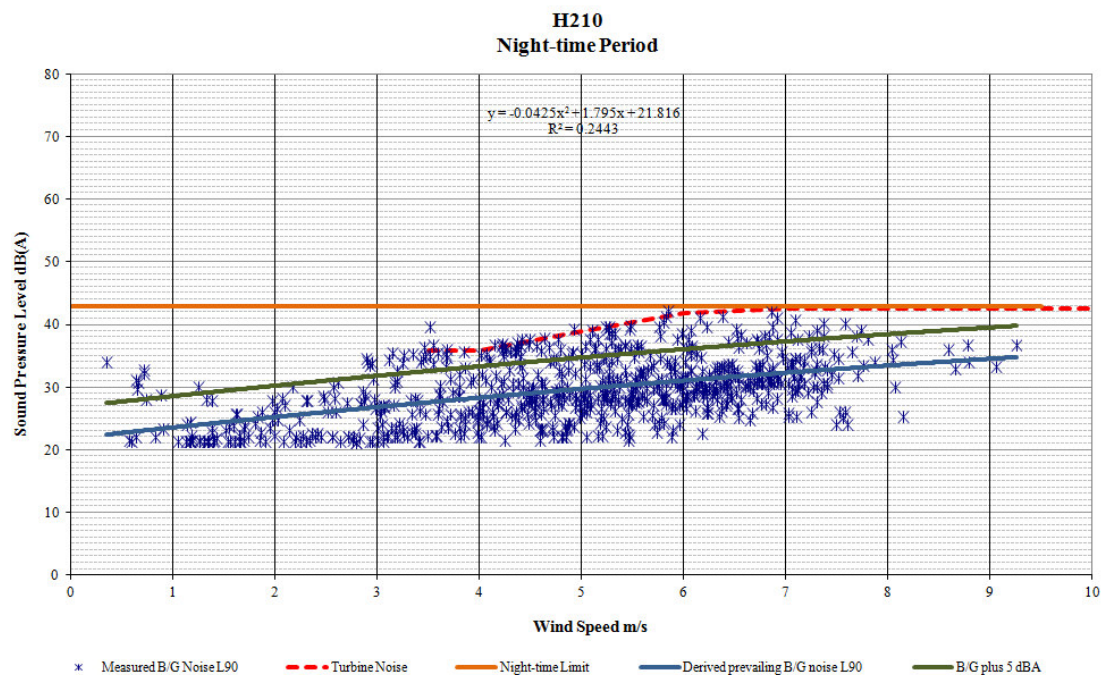


Figure 9.22: shows that at H210 the total predicted turbine noise level is within the night time noise limit at all wind speeds

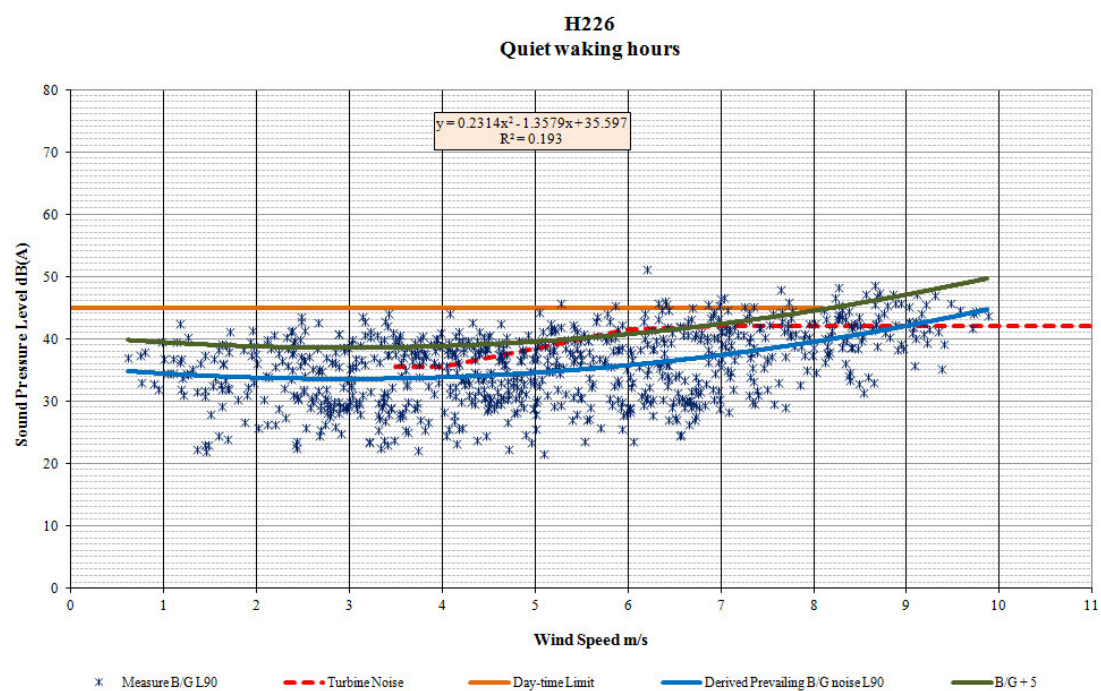


Figure 9.23: shows that at H226 the total predicted turbine noise level is within the day time noise limit at all wind speeds

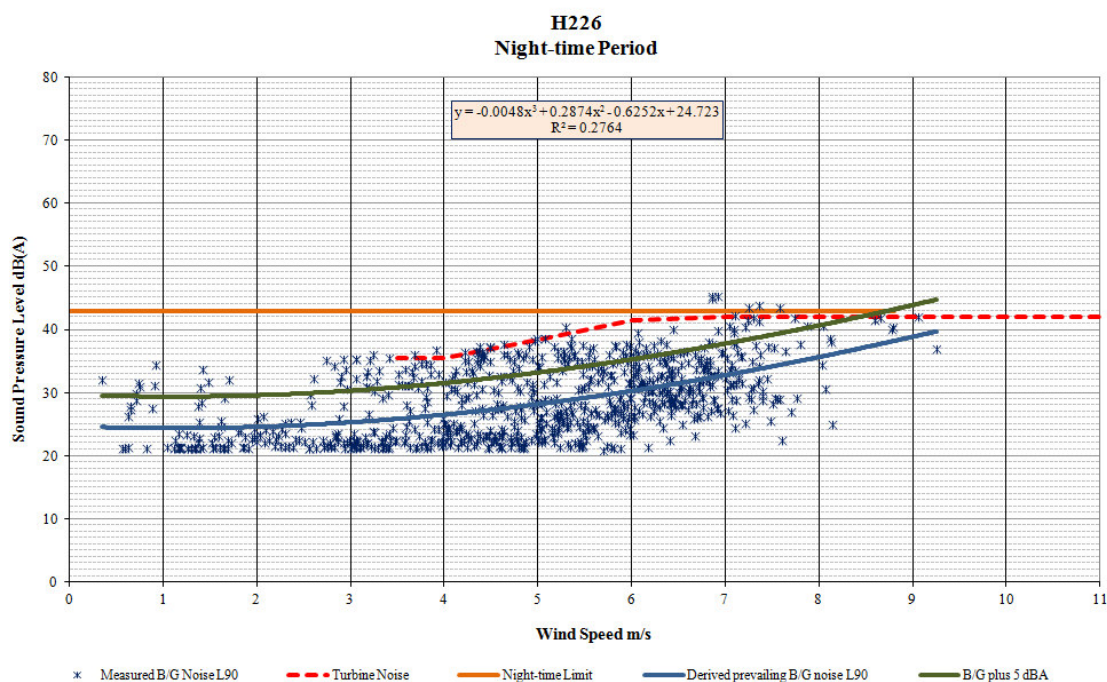


Figure 9.24: shows that at H226 the total predicted turbine noise level is within the night time noise limit at all wind speeds

9.3.3 Cumulative Impacts

There are no permitted wind farms within 2km of this proposal.

9.3.4 Assessment of Noise Levels

The predicted noise levels in Table 9.10 and examples shown in illustration Figures 9.1 to 9.24 inclusive shows that the predicted noise levels at all wind speeds are within the day time lower limit of 45dBA and night-time lower limit of 43 dBA at all receptors. The predicted noise level at H138 assumes down wind conditions simultaneously from turbines to the north-west and south-east, a condition that cannot occur in practice. The noise levels at H138 (and all of the nearby houses) will have noise levels more than 1dBA below that predicted in the model.

The modelled prediction is a worst case scenario with the prediction assuming that the wind will be downwind from all turbines at the same time which is an occurrence that cannot happen in practice.

9.3.5 Aerodynamic Modulation

Aerodynamic modulation (AM) is a highly complex field, and whilst general principles are understood there are still unanswered questions. AM is defined as

aerodynamic noise which displays a greater degree of fluctuation than usual, which can occur in some circumstances much more than normal blade swish. A study carried out by the University of Salford in 2007 into operating wind farms found that the incidence of wind farm noise and AM in the UK is low and AM was considered to be a factor in 4 of the 133 operating sites.

The recent; *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* published in May 2013 by the Institute of Acoustics gave no guidelines with respect to AM.

9.3.6 *Assessment of Construction Noise*

It is not possible to specify the precise noise levels emissions from the construction equipment until such time as a contractor is chosen and construction plant has been selected however, Table 9.11 indicates typical construction related noise levels. It is noted that noise generated by construction activities is associated with the short construction phase of the development.

Activity	L _{Aeq} at 10m
General Construction	70-84 dB(A)
Tracked excavator removing topsoil, subsoil for foundation	up to 87 dB(A)
Vibrating rollers	76-86 dB(A)

Table 9.11: Typical construction noise from construction activity

The construction activity at 500m from the operating point with attenuation by distance, ground absorption and air attenuation is 34 dB(A)] for distance and 4 dB(A) ground absorption and air attenuation) will result in typical noise levels of between 35 and 48 dB L_{Aeq} with maximum levels of 52 dB L_{Aeq} during intensive activity. The maximum levels will pertain for no longer than two weeks-equivalent at any residence.

Maximum Permissible Construction Noise Levels

The following are the local council environmental health office maximum allowable noise limits:

Monday to Friday	Maximum at Measurement Points
07:00 – 19:00	75 dB $L_{Aeq,12h}$
19:00 – 22:00	65 dB $L_{Aeq,1h}$
22:00 – 07:00	No noise audible
Saturday	Maximum at Measurement Points
08:00 – 13:00	75 dB $L_{Aeq,12h}$
13:00 – 22:00	65 dB $L_{Aeq,1h}$
22:00 – 07:00	No noise audible

No operation on Sundays.

The noise from the construction site will be kept well below the aforementioned targets.

Mitigation Measures for Construction Noise

All construction will be carried out in accordance with BS 5228-1: 2009 *Code of Practice for Noise and Vibration Control on Construction and Open Sites*. Accordingly all construction traffic to be used on site should have effective well-maintained silencers. Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery. Where possible the contractor will be instructed to use the least noisy equipment. With efficient use of well-maintained mobile equipment considerably lower noise levels than those predicted can be attained. The Project Engineer will closely supervise all construction activity. Construction activity due to its nature is a temporary activity and thus any impacts will be short term. All construction works will be carried out during the day-time period. Construction plant will be throttled down or turned off when not in productive use.

9.4 LOW FREQUENCY NOISE AND VIBRATION

The frequency range of audible sound is in the range of 20 to 20,000Hz and low frequency sound / noise is generally from about 2 to 200Hz. Low frequency sound is considerable audible at high amplitudes above 20Hz. Infrasound is sound that is generally inaudible to the human ear, at less than 20Hz, however it may still interact with the body or structures and may be felt as vibrations (examples could be blasting or a window vibrating when a large truck passing nearby at low speed).

Researchers such as Leventhall have studied low frequency noise and found that levels were found to be below the hearing threshold of most people, and the research concluded noise from the proposed wind farm installation in the low frequency (10 to 200Hz) range was unlikely to be a problem. However, significant research has also been carried out into low frequency noise in the area of blasting vibrations (air overpressure) which falls into the same frequency range, although with considerably higher magnitude. There appears to be little or no agreement about the biological effects of low frequency noise on human health and there is evidence to suggest that no serious consequences result to human health, from infrasound exposure from wind turbines.

There is always low frequency noise present in an ambient quiet background. It is generated by natural sources such as wind effects on vegetation, surf, water flow in streams and rivers and there are also emissions from many sources found in modern life, such as household appliances (e.g. washing machines, refrigerators, fans etc.). It can also be found in water flowing through pipes within your home and in water flow from municipal water supply. Vibration of structures can also be found in local activity in ones home by way of normal routine activity like climbing stairs, closing doors, walking on floors, etc.

A study of low frequency noise (infrasound) and vibration around a modern wind farm was carried out for ETSU and reported in ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'. The results showed levels of infrasound to be below accepted thresholds of perception even on the wind farm site. A recent study by the EPA in South Australia on low frequency noise near wind farms and in other environments found that 'Overall, the study demonstrates that low frequency noise levels near the wind farms in the study are no greater than levels in urban areas at comparable rural residences away from wind farms'. A paper presented at the 159th meeting of the Acoustical Society of America outlined the results of sound measurements from Siemens SWT-2.3 MW -93 turbines and concluded 'that at more than 1000ft (305m) the turbine model does not pose a low frequency noise or infrasound problem as it meets standards published by the American National Standards Institute (ANSI) for indoor levels for low frequency sound for bedrooms, classrooms and hospitals'.

9.5 MITIGATION MEASURES

When the wind farm is commissioned noise monitoring of the operation over a range of wind speeds and direction can be used to demonstrate compliance with the noise limits. The wind turbines have noise control systems in place whereby the noise emission of a turbine can be reduced by a number of means e.g. by wind direction, by time of day, by reducing power outputs.

Noise impacts from the construction and operation of the proposed development will not be significant.

9.6 CONCLUSION

An assessment of the likely noise impact of the proposed wind farm development has been carried out. Baseline noise levels measured at ten locations representative of the nearest residential properties to the proposed thirty two turbines, and noise levels were predicted based on a maximum hub height of 110m. The predicted noise levels are within the adopted 45dBA lower noise limit for day time and 43 lower limit for night-time and accordingly within the Wind Energy Development Guidelines, *Guidelines for Planning Authorities*, June 2006.

The modelled prediction is a worst case scenario with the prediction assuming that the wind will be downwind from all turbines at the same time which is an occurrence that cannot happen in practice. Furthermore the houses along the road north-west of T23 and T24 and south-east of T20, T23 and T22 will have noise levels of more than 1dBA below the predicted levels as the wind cannot be blowing simultaneously in opposite directions at the same time.

The prediction model is calculated as a worst-case scenario. As such, it has been shown by measurement-based studies that this model, like others, tends to over-estimate the noise levels at nearby dwellings.

The low frequency noise and vibration from the turbines of the proposed Yellow River Wind Farm is predicted to have a negligible impact on all residences in the locality.

Any impacts associated with the construction of the Yellow River Wind Farm will be of a temporary nature, associated with the site preparation works and erection of the wind turbines.

9.7 REFERENCES

Wind Energy Development Guidelines, *Guidelines for Planning Authorities*, June 2006

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ISO 1996-1 Acoustics-Description, measurement and assessment of environmental noise-Part 1: Basic quantities and assessment procedures, second edition 2003-08-01

BS 5228, 2009- Code of Practice for Noise and Vibration Control on Construction and Open Sites

ISO 9613 Part 2 'Acoustics-Attenuation of sound during propagation outdoors- Part 2: General method of calculation

IOA- Acoustics Bulletin March/April 2009- Prediction and Assessment of Wind Turbine Noise

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

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South Australia EPA- Low frequency noise near wind farms and in other environments. May 2013

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10.0 SHADOW FLICKER

10.1 INTRODUCTION

This assessment addresses the potential shadow flicker impacts of the proposed Yellow River wind farm on the surrounding dwellings in terms of:

- Predicting and assessing the extent of shadow flicker experienced by all houses within 10 diameters (1.13km) of the proposed Yellow River wind farm
- Specifying mitigation measures, where deemed necessary.

10.2 SHADOW FLICKER

Wind turbines, like other tall structures will cast a shadow on the neighbouring area when the sun is visible. Shadow flicker occurs under a special set of conditions when the sun passes behind the hub of a wind turbine and casts a shadow over neighbouring properties. When the blades rotate, shadows pass over the same point causing an effect called 'shadow flicker'. Shadow flicker effects occur in various situations: travelling by road through a tunnel or under overhanging trees (dappled shadow effects), or standing within the shadowed area of wind turbine blades.

Although there is no agreed standard for shadow flicker impact in Ireland, the Department of Environment, Community and Local Government in its Wind Energy Development Guidelines for Local Authorities considers that the potential for shadow flicker is very low beyond ten rotor diameters, in this case 1.13km, from a property. It should be noted that 194 houses are located within 1.13km of the proposed Yellow River wind farm development.

It is also recommended that shadow flicker at neighbouring offices and dwellings within 500m should not exceed either 30 hours per year or 30 minutes per day. It should be noted that there are 2 houses within 500 metres of Yellow River wind farm (H210 & H226). Both of these of which are associated with the wind farm development. Both houses consent to the turbines being located within 500 metres of the development. Two consent letters and the associated maps can be found in **Appendix M**. The closest dwelling which is referenced as H210, is located at a distance of 452 metres from the nearest turbine (T32), the occupants of H210 will

experience 7.48 actual hours of shadow flicker per year. This will be further reduced by the fact that the dwelling in question is surrounded by a mature forest plantation. The next closest house, H226 (located 485 metres from T19), will experience 2.31 hours per year of actual shadow flicker.

Shadow flicker within a house occurs if a wind turbine is close enough and of a specific orientation with the house and the sun. It will not happen where there is vegetation or other obstructions between the turbines and the house. It will not happen if windows facing a turbine are fitted with blinds or shutters. It will not happen if the sun is not shining brightly enough to cause shadows from a turbine. Shadow flicker is more often experienced as a minor short-term nuisance than as a health and safety issue.

The shadow-flicker frequency is related to the rotor speed and number of blades on the rotor. Most turbines operate at a rotor speed of between 10 – 25 revolutions per minute (RPM), which translates to a blade pass frequency of less than 1 Hz (less than 1 alternation per second). For the purposes of modelling the characteristics of the Siemens S113 turbine model, with a hub height of 122.5m and rotor diameter of 113m, has been chosen to represent the effect of shadow flicker on the Yellow River site. It is likely that the model selected will operate at an RPM of 6-18.5. The Department of Energy and Climate Change for England stated in its report Update of UK Shadow Flicker Evidence Base (2011) that *it is considered that the frequency of the flickering caused by the wind turbine rotation is such that it should not cause a significant risk to health*. Frequencies higher than 3 Hz but below 10 Hz are widely used in discotheques and the Epilepsy Foundation has made a statement that frequencies below 10 Hz are not likely to trigger epilepsy seizures.

According to the Danish Wind Industry Association – *“If you are farther away from a wind turbine rotor than about 500-1000 meters, the rotor of a wind turbine will not appear to be chopping the light²⁵, but the turbine will be regarded as an object with the sun behind it. Therefore, it is generally not necessary to consider shadow casting at such distances”*.

The distance and direction between the turbine and habitation or observer is of great significance because:

²⁵ <http://www.windpower.org/en/tour/env/shadowr.htm>

- The duration of the shadow will be shorter the greater the distance.
- The shadow flicker effect will be reduced the further a dwelling is from an operating turbine.
- Shadow flicker effects may be experienced within ten blade diameters distance from the nearest turbine (i.e. in this case within 1.13km). Beyond this shadow flicker effects will not be significant.

The shadow flicker is more likely to occur on sunny winter days, when the sun is lower in the sky and shadows are then cast over a larger distance. Shadow flicker is more likely to take place where turbines are sited to the east, south east, west or south west of dwellings.

Shadow flicker is generally not regulated explicitly by planning authorities. Offaly County Development Plan, 2009-2015 recommends that wind farms be developed in accordance with the Wind Energy Development Guidelines 2006, by the Department of the Environment, Community and Local Government which requests that neighbouring dwellings within 500 m should not exceed 30 hours per year or 30 minutes a day.

10.2.1 Methodology

House Survey

House surveys were undertaken in May 2013. This was to make certain that all houses were included in the assessment. All inhabitable and uninhabitable houses were recorded as well as any holiday / mobile homes. Locations were recorded using a GPS and subsequently refined using Ordnance Survey 1:5,000 maps. Co-ordinates represent the closest gable of the house to any turbine location. The survey covered all houses within 1.2km which equated to 243 houses. However, as it is only necessary to assess the houses within 10 rotor diameters, i.e. 1.13km, this number was reduced to one hundred and ninety four houses. Please note that the identifiers used for the houses have not been renumbered to account for this reduction. Please refer to **Figures 9.25 – 9.29** - House Locations Maps.

Shadow Flicker Calculation

This shadow flicker calculation is undertaken for all houses / buildings i.e. 194 houses located within approximately 1.13km of the Yellow River turbines.

The seasonal timing and duration of this effect has been accurately calculated from the geometry of each machine, its orientation relative to nearby houses and the latitude of the potential site, using WindFarm© computer software. Any properties, which may potentially be effected, can be identified and the risk calculated.

The computerised modelling calculates a theoretical worst case scenario, providing the highest possible shadow flicker for each house in a situation where the sun is shining all day from sunrise to sunset, the turbines are always moving, the wind direction is always perpendicular to the line from the turbine to the sun, a person is always home to view the moving turbines, and there are no vegetation or structures in between the moving turbines blades and the receptor.

The shadow flicker analysis was completed for the proposed Yellow River wind farm development using WindFarm© software as outlined above. Co-ordinates taken in relation to the houses approximate the middle of the houses within 1.13km of the proposed development. The ground contours, the coordinates of the wind turbines, latitude, and seasonal fluctuation of daylight/night time, rotor diameter, and hub height of the proposed wind farm development were input and the calculations run by the computer. The model utilises a 3° angle for the sun above the horizon.

Generic windows of 1 m squared of which the centre is 2 m above ground are applied to each side of the house. These windows represent an approximation of the existing windows on the house and provide an estimate of potential shadow flicker to a window on each side of the house. The software determines the times of year when the sun will be in line with the rotational components of the turbine, thereby casting intermittent shadows. The software outputs details of potential shadow flicker, in this case by mean and maximum duration of the shadow flicker events, days per year and times of occurrence and maximum hours per year of shadow flicker.

10.2.2 Shadow Flicker Analysis

Summarised details of the shadow flicker times for each house location can be found in Table 10.1.

Table 10.1 provides details on the maximum hours per day, the shadow days per year and the total hours per year in constant sunlight that shadow flicker is predicted to occur.

10.2.3 Assessment of Worst Case Shadow Flicker Impact

One hundred and ninety four houses could potentially experience an impact from shadow flicker as they are within ten rotor diameters of the proposed Yellow River wind farm. This figure is based on a “worst case” scenario and assumes the sun is always shining, that there is no cloud cover and the dwelling is always occupied. This calculation is also based on topography alone and excludes vegetation, buildings and other man made buildings. The existing forestry plantation that covers Yellow River is also not accounted for which in a “real” context would screen the flickering effect of the wind turbines.

It has been determined through the calculation completed that sixty three of the houses would theoretically experience greater than 30 hours of shadow flicker per year. All of these houses are outlined in Table 10.1. No shadow flicker is experienced at some dwellings due to the orientation of these dwellings with respect to the proposed turbines. Impacts from shadow flicker occur within 130 degrees either side of north from a turbine.

It should be noted that the calculation of nearest turbine to each house and the distance to each respective house are as calculated in the software. This also applies to the days of shadow flicker per year and the maximum and mean hours per year of shadow flicker experience.

10.2.4 Assessment of Actual Shadow Flicker Impact

Reduction of Shadow Flicker due to absence of Sunlight

However, the shadow flicker experienced can be greatly affected by the probability of sunshine occurrence. Ireland normally gets between 1100 and 1600 hours of sunshine each year. The sunniest months are May and June. During these months, sunshine

duration averages between 5 and 6.5 hours per day over most of the country. The extreme southeast gets most sunshine, averaging over 7 hours a day in early summer. December is the dullerest month, with an average daily sunshine ranging from about 1 hour in the north to almost 2 hours in the extreme southeast. Over the year as a whole, most areas get an average of between 3 1/4 and 3 3/4 hours of sunshine each day.

Historical met data is utilised to apply a reductive factor to be applied to the worst case total hours per year shadow flicker occurrence. The closest climatic station to the proposed Yellow River Wind Farm site is located in Birr. Data collected and analysed from this station revealed that the area received only 3.2 hours of average sunshine per day as recorded by between 1981 and 2008. The shadow flicker reduction factor can be calculated based on the following information:

- 4,500 hours of daylight per year at Birr.
- 1,169 hours of actual sunshine per year (based on 3.2 hours of average sunshine per day as recorded by Met Eireann at Birr between 1981 and 2008).

The actual hours of sunlight at Yellow River Wind Farm represents 26% of the total hours of daylight, therefore, shadow flicker will only potentially occur for 26% of the predicted worst case time.

Reduction of Shadow flicker due to non-operation during low wind conditions

As discussed, shadow flicker can only occur when the blades are rotating. The type of wind turbine proposed for this application will not operate below a wind speed of 3m/s or above a wind speed of 25m/s. According to the wind rose for the proposed Yellow River wind farm, wind speeds are in the range of 3 to 25m/s for 86% of the year. Therefore turbine will only potentially be operational 86% on average.

Reduction of Shadow flicker due to non-operation as a result of technical issues

Other factors including forced outage, planned maintenance and grid availability will result in down time for turbine operation up to 10%. A conservative estimate of 7% has been adopted in this assessment.

Reduction of Shadow flicker due to non-directional orientation of the turbine

The predicted values of shadow flicker assume that the wind direction is always the same direction as the angle of the sun to the receptor window. Wind turbines operate at right angles to the wind, therefore, they will not always be orientated at right angles

to houses. The orientation is determined by the predicted wind rose for the site. An alternative assumption of a random rotor position leads to a reduction to approximately 61% of the theoretical results.

By applying these reduction factors to the shadow flicker hours experienced by houses it has been determined that none of the houses / buildings experience greater than 30 hours of shadow flicker per year. Please refer to Table 10.1 for a list of the projected hours of shadow flicker experienced by the dwellings within 1.13km of the proposed development.

It should also be noted that the actual shadow flicker hours experienced by houses listed in Table 10.1 will be significantly reduced further by the presence of existing vegetation and sheds and barns between the proposed turbines and the existing houses. **This reduction factor has not been applied in this assessment.**

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
1	248567	235952	87	7	1013	0	0.00	0.00	0.00	0.00
2	253125	234854	90	13	769	73	0.65	0.56	41.00	5.20
3	252847	235075	88	13	961	42	0.50	0.39	16.30	2.07
4	252814	235059	88	13	996	41	0.48	0.37	15.40	1.95
5	253151	234776	87	13	789	35	0.41	0.33	11.50	1.46
6	253312	234330	86	13	1024	0	0.00	0.00	0.00	0.00
7	253317	234312	86	13	1037	0	0.00	0.00	0.00	0.00
8	253320	234292	86	13	1054	0	0.00	0.00	0.00	0.00
9	253351	234320	86	13	1015	0	0.00	0.00	0.00	0.00
10	253352	234300	86	13	1032	0	0.00	0.00	0.00	0.00
11	253375	234293	86	13	1029	0	0.00	0.00	0.00	0.00
12	253399	234292	86	13	1020	0	0.00	0.00	0.00	0.00
13	253412	234315	86	13	994	0	0.00	0.00	0.00	0.00
14	253443	234315	86	13	983	0	0.00	0.00	0.00	0.00
15	253446	234304	86	13	992	0	0.00	0.00	0.00	0.00
16	248662	235946	86	13	964	0	0.00	0.00	0.00	0.00
17	247686	235439	88	2	1038	0	0.00	0.00	0.00	0.00
18	253533	234720	91	13	576	0	0.00	0.00	0.00	0.00
19	254679	235250	92	14	549	124	0.84	0.61	75.30	9.55
20	257540	239043	73	19	1108	64	0.45	0.34	21.90	2.78

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
21	257278	239056	74	19	957	61	0.50	0.42	25.70	3.26
22	251645	237031	87	11	1065	73	0.45	0.33	23.70	3.01
23	254330	242124	81	32	697	49	0.58	0.47	22.90	2.90
25	255208	235063	92	14	1109	52	0.45	0.35	18.40	2.33
26	255206	236003	89	15	854	42	0.54	0.42	17.80	2.26
29	255168	236052	87	15	825	43	0.56	0.44	18.80	2.38
30	255056	235079	98	14	963	94	0.52	0.36	34.10	4.32
32	253325	234255	88	13	1085	0	0.00	0.00	0.00	0.00
33	253325	234232	88	13	1105	0	0.00	0.00	0.00	0.00
36	255179	236937	77	16	778	0	0.00	0.00	0.00	0.00
37	255061	236912	76	16	738	0	0.00	0.00	0.00	0.00
41	247997	236211	89	4	662	105	0.59	0.42	43.90	5.57
42	253233	236099	77	13	1032	56	0.49	0.40	22.30	2.83
43	253451	234289	86	13	1004	0	0.00	0.00	0.00	0.00
44	253462	234280	86	13	1009	0	0.00	0.00	0.00	0.00
45	253470	234276	86	13	1010	0	0.00	0.00	0.00	0.00
46	253484	234274	87	13	1008	0	0.00	0.00	0.00	0.00
47	253493	234279	86	13	1000	0	0.00	0.00	0.00	0.00
48	253504	234288	86	13	988	0	0.00	0.00	0.00	0.00
49	253505	234299	86	13	977	0	0.00	0.00	0.00	0.00

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearset Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
50	253508	234312	86	13	964	0	0.00	0.00	0.00	0.00
51	253506	234321	86	13	956	0	0.00	0.00	0.00	0.00
52	253537	234323	87	13	945	0	0.00	0.00	0.00	0.00
53	253540	234316	87	13	951	0	0.00	0.00	0.00	0.00
54	253536	234301	87	13	967	0	0.00	0.00	0.00	0.00
55	253539	234294	87	13	973	0	0.00	0.00	0.00	0.00
56	253535	234280	87	13	987	0	0.00	0.00	0.00	0.00
57	253538	234274	87	13	992	0	0.00	0.00	0.00	0.00
58	253239	234858	89	13	670	59	0.62	0.48	28.20	3.58
59	256033	237147	75	18	809	44	0.41	0.33	14.50	1.84
60	252914	235036	90	13	902	47	0.53	0.42	19.60	2.49
61	252938	235015	91	13	884	51	0.54	0.42	21.30	2.70
62	253240	235150	91	13	561	80	1.26	0.86	68.90	8.74
63	253230	234878	90	13	667	65	0.72	0.59	38.40	4.87
64	253206	234827	88	13	715	39	0.47	0.37	14.50	1.84
65	254072	234708	91	13	593	0	0.00	0.00	0.00	0.00
66	253659	241041	81	30	622	129	0.71	0.57	73.10	9.27
67	247805	235869	87	2	772	0	0.00	0.00	0.00	0.00
68	251228	237472	106	11	1098	0	0.00	0.00	0.00	0.00
69	253243	234926	91	13	631	73	0.86	0.78	56.70	7.19

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearset Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
74	257892	238120	88	19	1127	35	0.42	0.33	11.60	1.47
75	257889	238079	89	19	1130	35	0.42	0.34	11.80	1.50
77	254061	238638	79	24	533	135	0.57	0.42	56.60	7.18
79	255853	237190	76	18	679	0	0.00	0.00	0.00	0.00
80	254136	234300	87	13	993	0	0.00	0.00	0.00	0.00
81	254085	234740	91	13	571	0	0.00	0.00	0.00	0.00
82	253241	235118	91	13	565	86	1.29	0.87	74.70	9.47
83	253107	235469	82	13	727	82	0.63	0.44	35.80	4.54
85	251205	237399	100	11	1023	25	0.29	0.24	6.00	0.76
86	250527	237235	84	11	764	35	0.44	0.35	12.10	1.53
87	251976	235986	79	12	852	87	0.55	0.42	36.60	4.64
88	255053	235825	96	15	696	97	0.66	0.46	44.80	5.68
89	255277	236775	76	16	967	0	0.00	0.00	0.00	0.00
90	255188	236882	76	16	829	0	0.00	0.00	0.00	0.00
91	255992	236980	76	18	930	0	0.00	0.00	0.00	0.00
92	256000	237349	74	18	633	88	0.51	0.42	36.90	4.68
93	256150	237164	74	18	871	0	0.00	0.00	0.00	0.00
94	256553	237273	73	19	995	78	0.45	0.39	30.40	3.85
95	256613	237376	73	19	882	0	0.00	0.00	0.00	0.00
98	255304	235274	86	15	1126	54	0.45	0.38	20.60	2.61

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
99	255275	235286	87	15	1095	89	0.45	0.36	32.50	4.12
100	254979	235261	91	14	828	59	0.58	0.45	26.60	3.37
102	255190	235126	94	14	1069	49	0.46	0.36	17.40	2.21
103	255140	235061	96	14	1047	64	0.47	0.36	23.10	2.93
104	254117	238648	78	24	547	64	0.56	0.48	30.60	3.88
105	254035	238637	78	24	525	124	0.56	0.39	48.50	6.15
106	255252	239287	79	20	593	156	0.94	0.63	97.80	12.40
107	255119	239662	81	20	943	85	0.53	0.42	36.00	4.56
108	255299	239972	79	20	1110	0	0.00	0.00	0.00	0.00
110	255240	240390	78	31	1041	0	0.00	0.00	0.00	0.00
111	254501	240623	85	31	509	33	0.43	0.34	11.20	1.42
112	254300	240602	84	31	569	87	0.52	0.38	32.70	4.15
113	255670	239696	79	20	745	27	0.35	0.27	7.20	0.91
114	256175	239631	81	20	803	77	0.58	0.51	39.20	4.97
115	256157	239657	81	20	815	71	0.57	0.49	35.10	4.45
119	257812	237829	87	19	1120	50	0.44	0.35	17.30	2.19
120	257738	237877	85	19	1034	54	0.48	0.37	19.90	2.52
121	257427	237822	76	19	780	44	0.50	0.40	17.70	2.24
122	257348	237814	74	19	719	0	0.00	0.00	0.00	0.00
123	257388	237816	75	19	750	21	0.27	0.21	4.50	0.57

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
124	257308	237806	74	19	692	0	0.00	0.00	0.00	0.00
125	256922	237544	75	19	716	0	0.00	0.00	0.00	0.00
126	253134	235422	84	13	687	88	0.66	0.44	39.10	4.96
127	253014	234962	92	13	826	64	0.58	0.46	29.40	3.73
129	251194	237368	98	11	990	33	0.38	0.31	10.20	1.29
130	252967	234994	91	13	861	55	0.56	0.43	23.80	3.02
131	252992	234975	92	13	843	59	0.57	0.45	26.40	3.35
132	255432	235683	89	15	1092	38	0.44	0.35	13.30	1.69
133	254782	235295	92	14	629	151	0.75	0.52	78.80	9.99
134	254751	235282	91	14	604	144	0.79	0.58	84.00	10.65
135	255271	236950	77	16	825	0	0.00	0.00	0.00	0.00
136	256580	237359	73	19	905	60	0.45	0.35	20.90	2.65
137	256764	237362	74	19	882	0	0.00	0.00	0.00	0.00
138	254349	238723	76	23	538	184	0.82	0.51	93.70	11.88
139	254521	238947	76	23	521	221	0.88	0.59	129.80	16.46
140	254550	238960	76	23	513	199	0.90	0.63	125.90	15.96
141	254905	239054	77	23	506	194	0.88	0.57	110.10	13.96
142	254929	239108	79	23	532	181	0.78	0.51	91.60	11.61
143	253136	235891	77	13	931	97	0.53	0.38	36.70	4.65
144	253157	235988	77	13	988	81	0.51	0.42	34.20	4.34

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
145	255399	236884	76	17	930	0	0.00	0.00	0.00	0.00
146	253043	234909	92	13	818	101	0.60	0.44	44.20	5.60
147	250459	237281	85	11	828	29	0.37	0.30	8.70	1.10
150	247773	235882	87	2	739	0	0.00	0.00	0.00	0.00
151	253250	234967	91	13	606	85	0.98	0.86	73.10	9.27
152	255344	236871	75	17	927	0	0.00	0.00	0.00	0.00
153	255467	237058	75	18	749	30	0.33	0.26	7.90	1.00
154	255198	235218	91	14	1050	43	0.46	0.36	15.60	1.98
155	255096	235307	90	14	931	46	0.51	0.40	18.30	2.32
156	255078	239295	78	23	747	138	0.62	0.42	57.60	7.30
157	255440	239556	80	20	673	78	0.66	0.59	46.30	5.87
158	257511	237922	77	19	807	94	0.61	0.52	48.60	6.16
162	255219	240255	79	31	1128	0	0.00	0.00	0.00	0.00
163	255322	239896	79	20	1031	5	0.06	0.05	0.30	0.04
164	255524	239623	80	20	703	55	0.59	0.50	27.60	3.50
165	255485	239615	80	20	709	61	0.61	0.52	31.60	4.01
166	255217	239886	78	20	1070	36	0.38	0.30	10.90	1.38
167	255254	239573	80	20	788	91	0.62	0.48	44.10	5.59
168	255200	239475	80	20	752	115	0.72	0.52	60.00	7.61
169	255210	239184	80	20	580	173	0.84	0.59	102.70	13.02

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
170	255025	239163	79	23	635	155	0.68	0.49	75.90	9.62
171	254949	239125	79	23	582	179	0.75	0.49	88.00	11.16
172	254551	239015	77	23	557	174	0.88	0.66	114.30	14.49
173	254312	238769	76	24	577	180	0.76	0.48	86.00	10.90
175	255714	239696	79	20	742	25	0.33	0.26	6.50	0.82
176	255247	240361	78	31	1067	0	0.00	0.00	0.00	0.00
177	255291	239603	80	20	790	81	0.60	0.51	41.50	5.26
178	255096	239603	80	20	916	66	0.53	0.41	27.20	3.45
179	254989	239163	78	23	626	178	0.68	0.46	82.10	10.41
181	257086	237641	78	19	680	0	0.00	0.00	0.00	0.00
182	257093	237687	77	19	643	0	0.00	0.00	0.00	0.00
185	256204	239568	80	20	767	93	0.63	0.49	45.80	5.81
186	255785	239548	81	20	595	63	0.71	0.60	37.80	4.79
187	255615	239684	79	20	741	33	0.44	0.35	11.60	1.47
188	255448	239926	79	20	1015	0	0.00	0.00	0.00	0.00
190	256750	239334	76	20	1076	79	0.44	0.35	27.30	3.46
191	256307	239403	78	20	720	112	0.65	0.47	52.80	6.70
192	256185	239484	79	20	690	97	0.69	0.46	44.60	5.66
193	254620	240381	83	31	759	0	0.00	0.00	0.00	0.00
194	254652	240610	86	31	541	0	0.00	0.00	0.00	0.00

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearset Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
195	254095	238602	80	24	579	135	0.60	0.43	57.40	7.28
196	254092	238643	78	24	540	148	0.59	0.44	65.60	8.32
197	253684	238390	82	24	765	0	0.00	0.00	0.00	0.00
198	253409	238094	82	25	992	0	0.00	0.00	0.00	0.00
199	254170	238194	76	22	713	262	0.64	0.47	122.80	15.57
200	251779	235993	79	12	656	119	0.71	0.52	61.80	7.84
203	251043	237236	89	11	805	49	0.53	0.43	21.10	2.68
204	251006	237187	88	11	746	57	0.56	0.48	27.20	3.45
205	250489	237255	84	11	794	33	0.42	0.34	11.30	1.43
207	253953	239994	83	28	501	186	0.88	0.52	96.40	12.22
208	254079	240060	84	28	638	148	0.70	0.47	69.40	8.80
209	254261	240143	83	28	836	114	0.55	0.42	47.90	6.07
210	253804	241176	82	32	452	120	0.65	0.50	59.80	7.58
211	254181	240585	83	31	637	105	0.59	0.41	43.20	5.48
212	254232	234223	89	13	1100	0	0.00	0.00	0.00	0.00
213	251956	235813	79	10	844	110	0.56	0.42	46.70	5.92
214	247785	235857	87	2	765	0	0.00	0.00	0.00	0.00
216	255108	240498	79	31	872	0	0.00	0.00	0.00	0.00
217	255281	240592	79	31	942	32	0.34	0.27	8.60	1.09
218	255460	240830	75	31	997	52	0.49	0.38	19.60	2.49

House No.	Easting ING (m)	Northing ING (m)	Altitude (m)	Nearst Turbine (m)	Distance (m)	Days per year (worst case)	Max hours per day (worst case)	Mean hours per day (worst case)	Total hours (worst case)	Projected Hours Based on 12.68% reduction factor
219	255285	241036	78	31	781	53	0.60	0.46	24.50	3.11
220	255608	240886	77	31	1126	38	0.43	0.34	13.10	1.66
221	255523	241106	80	31	1014	37	0.46	0.37	13.60	1.72
222	255330	241212	82	31	824	44	0.56	0.43	19.10	2.42
223	255322	241490	82	31	888	41	0.52	0.42	17.10	2.17
224	255299	241806	80	31	1038	49	0.47	0.36	17.80	2.26
226	256380	237956	73	19	485	42	0.55	0.43	18.20	2.31
227	255224	235079	92	14	1118	49	0.44	0.35	17.10	2.17
228	251226	237475	106	11	1100	0	0.00	0.00	0.00	0.00
229	252058	235989	80	12	933	79	0.51	0.39	30.60	3.88
230	255275	236764	76	16	975	0	0.00	0.00	0.00	0.00
231	253711	238425	82	24	725	0	0.00	0.00	0.00	0.00
234	253140	237956	80	13	771	0	0.00	0.00	0.00	0.00
236	255319	241508	82	31	893	42	0.52	0.41	17.20	2.18

Table 10.1 – Shadow Flicker Analysis of all houses within 1.13km

10.2.5 Mitigation Measures

The Shadow Flicker analysis presented is an indicative computer analysis that provides a measure of potential shadow flicker for the proposed Yellow River wind farm development. If the proposed Yellow River wind farm development is constructed and shadow flicker occurs in such a way that it is deemed to have an impact on the health and safety of nearby residents, mitigation measures will be put in place. To limit these effects, the developer will be responsible for implementing such mitigation measures, upon agreement with the house occupiers. This could involve the installation of appropriately designed blinds or screens to prevent any flicker nuisance. Furthermore vegetative screening could also be employed including treelines or hedgerows to limit or prevent shadow flicker occurrence.

In the unlikely event of validated records indicating a significant shadow flicker impact, the developer will implement further mitigation measures in the form of pre-programming of selected turbines to prevent their operation on the dates and times when shadow flicker could cause a nuisance.

10.3 CONCLUSION

Shadow Flicker is unlikely to cause a nuisance to nearby inhabited dwellings as there are only 2 houses located within 500 metres and these houses are located in areas where the levels of shadow flicker experience is below the limit of 30 hours per year. If it does become a nuisance appropriate mitigation measures can be implemented by the developer.

There are no significant shadow flicker impacts on dwellings in the vicinity of the proposed Yellow River Wind Farm development.

11.0 LANDSCAPE

11.1 INTRODUCTION

This chapter describes the landscape context of the proposed Yellow River Wind Farm and assesses the likely landscape and visual impacts of the scheme on the receiving environment. Although closely linked, landscape and visual impacts are assessed separately as the effects on the physical landscape and landscape character resulting from the development form the baseline of the assessment of visual impacts from key visual receptors.

Landscape Impact Assessment (LIA) relates to changes in the physical landscape, brought about by the proposed development, which may alter its character and how this is experienced. This requires a detailed analysis of the individual elements and characteristics of a landscape that go together to make up the overall landscape character of that area. By understanding the aspects that contribute to landscape character it is possible to make judgements in relation to its quality (integrity) and to identify key sensitivities. This, in turn, provides a measure of the ability of the landscape in question to accommodate the type and scale of change associated with the proposed development, without causing unacceptable adverse changes to its character.

Visual Impact Assessment (VIA) relates to changes in the composition of views as a result of changes to the landscape, how these are perceived and the effects on visual amenity. Such impacts are population based rather than resource based as in the case of landscape impacts. Visual impacts are measured on the basis of:

Visual Obstruction (blocking of a view, be it full, partial or intermittent) or;

Visual Intrusion (interruption of a view without blocking).

This landscape and visual impact assessment is based on:

Environmental Protection Agency (EPA) publication 'Guidelines on the Information to be contained in Environmental Impact Statements (2002) and the accompanying Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (2003)

Landscape Institute and the Institute of Environmental Management and Assessment publication entitled Guidelines for Landscape and Visual Impact Assessment – Third Addition (2013).

Scottish Natural Heritage (SNH) Environmental Assessment Handbook –Guidance on the Environmental Impact Assessment Process Appendix 1: Landscape and Visual Impact Assessment (2011)

Scottish Natural Heritage (SNH) Guidance Note: Cumulative Effect of Wind Farms (2005)

11.1.1 Statement of Authority

This assessment report was prepared by Richard Barker, Senior Landscape Architect, MosArt Landscape Architects, Wicklow. MosArt have extensive experience at both project level and strategic planning for wind farms in Ireland. A summary of relevant experience is included below:

- Assisted the Department of Environment, Heritage and Local Government (DoEHLG) in drafting the Landscape Section of the revised Wind Energy Development Guidelines (2006);
- Responsible for the landscape section of the national attitude survey to wind farms commissioned by Sustainable Energy Ireland (2003);
- Drafted the DoEHLG Landscape and Landscape Assessment Guidelines (2000);
- Completed a wind farm strategy for Waterford County Council (2004);
- Landscape character and sensitivity classification of County Cork for wind farm planning for Cork County Council (2003);
- Involved in landscape impact assessment of over 100 on-shore wind farm projects;

- Prepared the landscape impact assessment reports for the Arklow Bank, Codling Bank and Oriel offshore wind farm projects; and
- Presented papers at numerous national conferences concerning landscape assessment for strategic planning and also for the planning and design of wind farms

11.1.2 Description of the Proposed Development

The developer proposes to locate the wind farm between the settlement of Rhode and the M6 motorway in County Offaly. The proposed development comprises of the following main elements:

- 32 turbines – with a maximum blade tip height of up to 166m as well as associated areas of hard standing;
- One permanent wind measurement mast;
- One substation and compound and associated areas of hard standing;
- Access tracks – approximately 5.5m wide; and
- Underground electric cabling.

11.1.3 Definition of Study Area

The Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government specify different radii for examining the zone of theoretical visibility of proposed wind farm projects (ZTV). The extent of this search area is influenced by turbine height, on the basis that taller turbines would be visible at greater distances, as follows:

- 15 km radius for blade tips up to 100 m; and
- 20 km radius for blade tips greater than 100 m.

In the case of this project, the blade tips are up to 166m high and, thus, the ZTV radius required is 20 km from the outermost turbines of the scheme. This 20 km radius, therefore, defines the extent of the Study Area for this project.

11.2 METHODOLOGY

Production of this Landscape and Visual Impact Assessment involved desktop studies and fieldwork comprising professional evaluation by qualified and experienced Landscape Architects. This entailed the following:

11.2.1 Desk Study

- Establishing an appropriate Study Area from which to study the landscape and visual impacts of the proposed wind farm;
- Review of a Zone of Theoretical Visibility (ZTV) map, which indicates areas from which the development is potentially visible in relation to terrain within the Study Area;
- Review of relevant County Development Plans, particularly with regard to sensitive landscape and scenic view/route designations;
- Selection of potential Viewshed Reference Points (VRPs) from key visual receptors to be investigated during fieldwork for actual visibility and sensitivity;
- Preparation of an initial VRP selection map from which the visualisation consultant can prepare 'wireframe images' at each potential VRP location for use during fieldwork. Wireframe images depict the proposed wind farm within the context of a basic three dimensional view of the terrain as seen from each selected VRP location.

11.2.2 Fieldwork

- Recording of a description of the landscape elements and characteristics within the Study Area generally and within view from each VRP.

- Selection of a refined set of VRP's for assessment. This includes the capture of panoramic photography and grid reference coordinates for each VRP location for the visualisation specialist to prepare photomontages;

11.2.3 Impact Assessment Methodology

- Description of the geographic location and landscape context of the proposed wind farm site;
- General landscape description concerning essential landscape character and salient features of the Study Area, discussed with respect to; landform and drainage; vegetation and land use; centres of population and houses; transport routes and; public amenities and facilities;
- Consideration of design guidance, the planning context and relevant landscape designations.
- Assessment of predicted landscape impacts.
- Assessment of predicted visual impacts using standard ZTV maps and cumulative ZTV maps as well as photomontages prepared from selected VRP locations.
- Discussion of mitigation measures.
- Assessment of residual impacts following mitigation

11.2.4 Assessment Criteria for Landscape Impact

When assessing the potential impacts on the landscape resulting from a wind farm development, the following criteria are considered:

- landscape character, value and sensitivity
- Magnitude of likely impacts; and
- Significance of landscape effects

The sensitivity of the landscape to change is the degree to which a particular landscape receptor (Landscape Character Area (LCA) or feature) can accommodate changes or new features without unacceptable detrimental effects to its essential characteristics. Landscape Value and Sensitivity is classified using the following criteria;

Sensitivity	Description
Very High	Areas where the landscape character exhibits a very low capacity for change in the form of development. Examples of which are high value landscapes, protected at an international or national level (World Heritage Site/National Park), where the principal management objectives are likely to be protection of the existing character.
High	Areas where the landscape character exhibits a low capacity for change in the form of development. Examples of which are high value landscapes, protected at a national or regional level (Area of Outstanding Natural Beauty), where the principal management objectives are likely to be considered conservation of the existing character
Medium	Areas where the landscape character exhibits some capacity and scope for development. Examples of which are landscapes which have a designation of protection at a county level or at non-designated local level where there is evidence of local value and use.
Low	Areas where the landscape character exhibits a higher capacity for change from development. Typically this would include lower value, non-designated landscapes that may also have some elements or features of recognisable quality, where landscape management objectives include, enhancement, repair and restoration.
Negligible	Areas of landscape character that include derelict, mining, industrial land or are part of the urban fringe where there would be a reasonable capacity to embrace change or the capacity to include the development proposals. Management objectives in such areas could be focused on change, creation of landscape improvements and/or restoration to realise a higher landscape value.

Table 11.1: Landscape Value and Sensitivity

The magnitude of a predicted landscape impact is a product of the scale, extent or degree of change that is likely to be experienced as a result of the proposed development. The magnitude takes into account whether there is a direct physical impact resulting from the loss of landscape components and/or a change that extends beyond the proposal site boundary that may have an effect on the landscape character of the area.

Magnitude of Impact	Description
Very High	Change that would be large in extent and scale with the loss of critically important landscape elements and features, that may also involve the introduction of new uncharacteristic elements or features that contribute to an overall change of the landscape in terms of character, value and quality.
High	Change that would be more limited in extent and scale with the loss of important landscape elements and features, that may also involve the introduction of new uncharacteristic elements or features that contribute to an overall change of the landscape in terms of character, value and quality.
Medium	Changes that are modest in extent and scale involving the loss of landscape characteristics or elements that may also involve the introduction of new uncharacteristic elements or features that would lead to changes in landscape character, and quality.
Low	Changes affecting small areas of landscape character and quality, together with the loss of some less characteristic landscape elements or the addition of new features or elements.
Negligible	Changes affecting small or very restricted areas of landscape character. This may include the limited loss of some elements or the addition of some new features or elements that are characteristic of the existing landscape or are hardly perceivable.

Table 11.2: Magnitude of Landscape Impacts

The significance of a landscape impact is based on a balance between the sensitivity of the landscape receptor and the magnitude of the impact. The significance of landscape impacts is arrived at using the following matrix:

	Sensitivity of Receptor				
Scale/Magnitude	<i>Very High</i>	<i>High</i>	<i>Medium</i>	<i>Low</i>	<i>Negligible</i>
<i>Very High</i>	Profound	Profound-major	Major	Moderate	Slight
<i>High</i>	Profound-major	Major	Major-moderate	Moderate-slight	Slight-imperceptible
<i>Medium</i>	Major	Major-moderate	Moderate	Slight	Imperceptible
<i>Low</i>	Moderate	Moderate-slight	Slight	Slight-imperceptible	Imperceptible
<i>Negligible</i>	Slight	Slight-imperceptible	Imperceptible	Imperceptible	Imperceptible

Table 11.3: Landscape Impact Significance Matrix

Note that potential beneficial landscape impacts are not accounted for in the tables and matrix above. This is on the basis that commercial scale wind energy projects are very unlikely to generate beneficial landscape impacts. In the rare instances that this

might occur, perhaps by facilitating the rehabilitation of a degraded landscape, the benefits will be discussed in the assessment and the significance of impact would default to the lowest end of the range (Imperceptible).

11.2.5 Assessment Criteria for Visual Impact

As with the landscape impact, the visual impact of the proposed wind farm will be assessed as a function of sensitivity versus magnitude. In this instance the sensitivity of the visual receptor, weighed against the magnitude of the visual effect.

Sensitivity of Visual Receptors

Unlike landscape sensitivity, the sensitivity of visual receptors has an anthropocentric basis. It balances the visual susceptibility of the viewer against the value of the view on offer. The susceptibility of a viewer to changes in a particular view relates to the occupation or activity they are engaged in at that location and whether views of the surrounding landscape are an important aspect of that occupation or activity i.e. hill walkers versus commuters. By comparison, the value of the view relates to the visual setting of the viewer and whether this is recognised through county designations and guidebooks or is likely to just have local value. A list of the factors considered by MosArt in estimating the level of sensitivity for a particular visual receptor is outlined in Section 11.4.2 below and these are used in Table 11.7 to establish visual receptor sensitivity at each VRP.

Visual Impact Magnitude

The magnitude of visual effects is determined on the basis of two factors; the visual presence of the proposal and its effect on visual amenity.

Visual presence is something of a quantitative measure relating to how noticeable or visually dominant the proposal is within a particular view. This is based on a number of aspects beyond simply scale in relation to distance. Some of these include the extent of the view as well as its complexity and the degree of movement experienced i.e. within a busy street scene. The backdrop against which the development is presented and its relationship with other focal points or prominent features within the view is also considered. Visual presence is essentially a measure of the relative visual dominance of the proposal within the available vista and is often expressed as such i.e. minimal, sub-dominant, co-dominant, dominant, highly dominant.

For wind energy developments a strong visual presence is not necessarily synonymous with adverse impact as might be the case for a factory, a road or electricity pylons, for which the general consensus is likely to be almost wholly negative. Instead, the 2003 SEI funded survey of 'Attitudes towards the Development of Wind Farms in Ireland' found that "wind farms are seen in a positive light compared to other utility-type structures that could be built on the landscape".

Furthermore, a clear and comprehensive view of a wind farm might be preferable in many instances to a partial view of turbine components that are not so noticeable within a view. On the basis of these reasons, the visual amenity aspect of assessing impact magnitude is qualitative and considers such factors as the spatial arrangement of turbines both within the scheme and in relation to surrounding terrain and land cover. It also examines whether the development contributes positively to the existing qualities of the vista or results in distracting visual effects and disharmony.

It should be noted that as a result of this two-sided analysis, a high order visual presence can be moderated by a low level of effect on visual amenity and vice versa. Given that wind turbines do not represent significant bulk, visual impacts result almost entirely from visual 'intrusion' rather than visual 'obstruction' (the blocking of a view). The magnitude of visual impacts is classified in the following table:

Criteria	Description
Very High	The proposal intrudes into a large proportion or critical part of the available vista and is without question the most noticeable element. A high degree of visual disorder or disharmony is also generated, strongly reducing the visual amenity of the scene
High	The proposal intrudes into a significant proportion or important part of the available vista and is one of the most noticeable elements. A considerable degree of visual disorder or disharmony is also likely to be generated, appreciably reducing the visual amenity of the scene
Medium	The proposal represents a moderate intrusion into the available vista, is a readily noticeable element and/or it may generate a degree of visual disorder or disharmony, thereby reducing the visual amenity of the scene. Alternatively, it may represent a balance of higher and lower order estimates in relation to visual presence and visual amenity
Low	The proposal intrudes to a minor extent into the available vista and may not be noticed by a casual observer and/or the proposal would not have a marked effect on the visual amenity of the scene
Negligible	The proposal would be barely discernible within the available vista and/or it would not detract from, and may even enhance, the visual amenity of the scene

Table 11.4: Magnitude of Visual Impact

Visual Impact Significance

As stated above, the significance of visual impacts is a function of visual receptor sensitivity and visual impact magnitude. This relationship is expressed in the significance matrix in Table 11.5 below.

	Sensitivity of Receptor				
Scale/Magnitude	<i>Very High</i>	<i>High</i>	<i>Medium</i>	<i>Low</i>	<i>Negligible</i>
<i>Very High</i>	Profound	Profound-major	Major	Moderate	Slight
<i>High</i>	Profound-major	Major	Major-moderate	Moderate-slight	Slight-imperceptible
<i>Medium</i>	Major	Major-moderate	Moderate	Slight	Imperceptible
<i>Low</i>	Moderate	Moderate-slight	Slight	Slight-imperceptible	Imperceptible
<i>Negligible</i>	Slight	Slight-imperceptible	Imperceptible	Imperceptible	Imperceptible

Table 11.5: Visual Impact Significance Matrix

11.2.6 Characteristics of the Development

Full technical details of the project are given in Chapter 2, Project Description. The following is a summary of the characteristics of the development:

- Total site area **1,002.234 ha**
- Development footprint **20.58 ha**
- Peat Depth Range **0 – 3.6m**. Average peat depth **0.5 m** (Whitefords, Soils & Geology Report Chapter 6)
- Construction of foundations for 32 wind turbines (Excavations diameter 18m, Depth 2m)
- Hardstands, including turning area, set down area & ancillary crane area
Total Area 1,995m²
- Temporary construction compound, approximately **50 m x 30 m**.

- Clear fell of plantation forestry area 1.5 ha per turbine (four turbines T1; T25; T26 and T27 = 6 ha) plus part of T2 area = 0.77 ha plus areas felled for new roads, total clear felling 3.63 ha. (2,425m of road x 15 m wide corridor)
Overall Clear fell area Total 10.4 ha
- T11 scrub area to be felled = **1.5 ha**
- Construction of approximately **18,275 m** of new access tracks having a minimum finished width of 5 m with passing bays
- Upgrading of approximately **5,916 m** of tracks by widening, strengthening and bend improvement.
- Installation of site drainage network.
- Installation of underground ducts and cabling from each turbine to the substation. Cable trenches, which will typically be 0.5 – 1.0m wide and 0.75 – 1.00m deep, will generally follow the edge of the site access tracks and will be installed in conjunction with the tracks. The excavated material will be laid alongside the trench for use in reinstatement following the laying of cables.
- Construction of an Substation Control Buildings and Compound on site area **1,850 m²**
- Erection of 1 permanent meteorological mast, comprising a lattice steel tower.
- Stream/River crossings **9**
- Upgrade of existing bridges **1**
- The terrain is sloping with gradients between 1:25 and 1:100.

The development site does not require a borrow pit as required stone and gravel will be sourced from local quarries.

11.3 RECEIVING ENVIRONMENT

11.3.1 *Landscape Baseline*

The landscape baseline represents the existing landscape context and is the scenario against which any changes to the landscape brought about by the proposal will be assessed. This also includes reference to any relevant landscape character appraisals and the current landscape policy context (both are generally contained within County Development Plans).

A description of the landscape context of the proposed wind farm site and wider study area is provided below under the headings of landform and drainage, vegetation and land use, centres of population and houses, transport routes and public amenities and facilities and the site context. Although this description forms part of the landscape baseline many of the landscape elements identified also relate to visual receptors i.e. places and transport routes from which viewers can potentially see the proposed development. The visual resource will be described in greater detail in Section 9.3.2.

Landform and Drainage

This is generally a very flat landscape that is occasionally punctuated by small, but prominent hills. These hills tend to rise in the order of 50m to 100m above the prevailing ground level (80m a.s.l.). The highest is Croghan Hill near the centre of the study area, which reaches 234m a.s.l.

The study area is located on something of a midlands watershed with the head waters of several major river systems emanating in different directions from here. In this flat and peaty area these headwaters are often manifest as small and meandering streams and drains. Lough Ennell is the largest water body in the study area (northwest segment) and this drains via the River Brosna in a south-westerly direction towards the Shannon system. The Yellow River emanates in the centre of the study area and drains eastwards to join the River Boyne in its north-easterly journey to the east coast.

Vegetation and Land Use

The vegetation and land use within the study area is largely dictated by soil type. Substantial parts of the central and southern portions of the study area are contained

in peat bog with poorly drained peaty soils at the fringes. In such areas the principle land use in evidence is that of commercial scale peat extraction which was used to fuel the iconic peat fired power station at Rhode. The bog fringes tend to be in a combination of marginal pasture, unmanaged scrubland and extensive commercial conifer plantations. Surrounding the bogs in areas with better drainage, pastoral farmland and cropping become the predominant land uses. These occur as geometric fields defined by broadleaf hedgerows and tree lines.



Figure 11.1 **Elevated view over the central study area**

Centres of Population and Houses

The two most significant settlements within the study area are Mullingar in County Westmeath and Tullamore in County Offaly. Mullingar is located approximately 18km to the northwest of the site, whilst Tullamore is a similar distance to the southwest. Edenderry in County Offaly is also a substantial sized settlement and this is approximately 10km to the southeast of the site.

The nearest settlements to the proposal site are Rhode which is approximately 2km to the southeast and the crossroad settlement of Castlejordan which is a similar distance to the east. Three similar sized settlements line the old N6 (now the R446) including Milltownpass, Rochfortbridge and Tyrrellspass. These lie between 5 and 7km from the northwestern quarters of the proposal site. The settlements of Daingean and Kinnegad are similar distances to the south and northeast of the site respectively.

There are numerous small villages and crossroad settlements serving the dispersed rural communities throughout the wider study area. Farmsteads are spread relatively

evenly throughout the arable portions of the landscape with slightly higher concentrations in the vicinity of settlements.

Transport Routes

At a junction near Kinnegad the M4 motorway from Dublin veers northwest towards Mullingar and branches into the M6 motorway, which runs in a westerly direction towards Galway. Through the centre of the study area the M6 runs parallel to the northwest of the proposed turbine array. It remains less than 6km away from the nearest turbines for a distance of more than 10km. The M4 motorway is at its closest point to the site where it connects with the M6 at Kinnegad.

The N52 national secondary road runs southwards between Mullingar and Tyrrellspass to the northwest of the site and then between Kilbeggan and Tullamore along the western periphery of the study area. It is nearest the site where it links with the M6 at Tyrrellspass. The N80 national secondary route skirts the south-western periphery of the study area to the south of Tullamore.

There is a relatively dense network of regional roads throughout the study area. Those closest to the site include the R400 which dissects the proposed wind farm as it links from the M6 to Rhode. The old N6 national road has been reclassified as the R446 regional road since the completion of the M6 motorway. It runs parallel, several kilometres to the north of its successor and thus, it remains within 10km of the site from Kinnegad to Tyrrellspass.

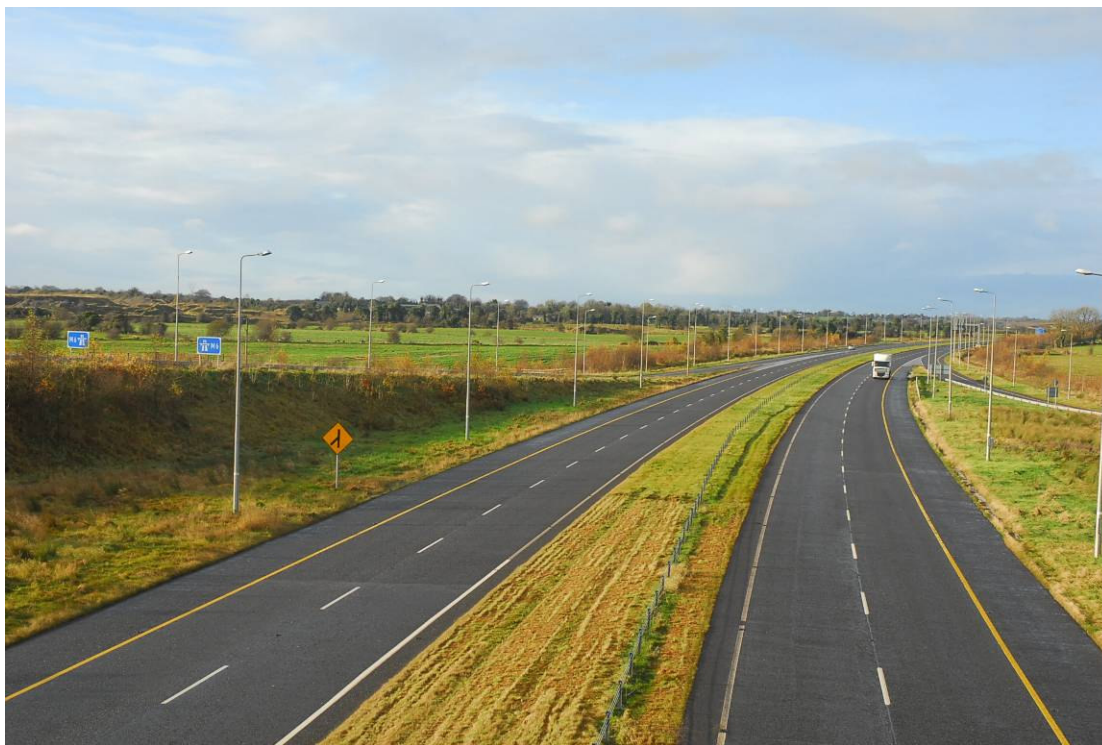


Figure 11.2 M6 motorway near Kinnegad

Public Amenities and Facilities

The key public recreational facility within the study area is the network of canals and tow path walks. These historic transport routes also link many of the towns and villages within the study area. The main arm of the Grand Canal connects from beyond Tullamore in the west and passes through the middle of the study area linking Daingean and Edenderry on its journey towards Dublin. Its associated walking path is known as the 'Grand Canal Way'. The Royal Canal also dissects the north-eastern portion of the study area as it links between Mullingar and Dublin. It is closely aligned with the national railway line from Dublin to the northwest, which runs adjacent to its southern bank for much of its journey through the study area. The towpath on the northern bank is known as the Royal Canal Way. A second arm of the Grand Canal, 'the Barrow Line' passes through Rathangan, which is near the south-eastern periphery of the study area. The canal then travels in a north-easterly direction before joining the main arm of the canal just to the southeast of the study area. Its associated walking path is known as the 'Barrow Way'.



Figure 11.3 Grand Canal and associated towpath (Grand Canal Way) at Ticknevin Bridge

Croghan Hill is an extinct volcano that lies a short distance to the southwest of the proposal site. It is a prominent hill in the context of the vast midland bogs and thus, it has been a focus of settlement in this area since the bronze age, based on the dating of a burial cairn on its summit. Although most of the hill appears to be in private ownership there are recognised local walking routes to the summit past an ancient graveyard high on its eastern slopes.

Lough Ennell is a popular location for fishing and boating as well as other passive recreational pursuits. Belvedere House is a popular tourist attraction on the eastern shores of the Lough. Lilliput at the southern end of the Lough has an adventure centre and coffee shop. Jonathan Swift Park at Lilliput is named in honour of the legend that the author was inspired by this location when writing Gulliver's Travels.

Site Context

The site is actually a relatively dispersed sequence of land holdings that run in a broadly linear pattern in parallel to the M6 motorway alignment. Whilst this area is largely contained in cutaway bog, only three of the proposed turbines are on this land cover type. The remainder are located on rehabilitated zones and scrubland at the fringes of the bog or within farmland adjacent to the bog.



Figure 11.4 Cutaway Bog near the centre of the proposal area – Lagan Cement plant in the background



Figure 11.5 Typical combination of land uses within the flat landscape context of the site

11.3.2 Landscape Policy Context and Designations

Department of Environment, Heritage and Local Government Wind Energy Development Guidelines (2006)

The Wind Energy Development Guidelines (2006) provide guidance on wind farm siting and design criteria for a number of different landscapes types. The proposal site is considered to be most characteristic of the 'Flat Peatland' landscape type from the Guidelines in terms of its flat terrain, openness and vast scale. However it also includes some elements of the 'Hilly and Flat Farmland' landscape type in terms of land cover pattern. Siting and design recommendations for these landscape types include the following:

Flat Peatland

Location – “Wind energy developments can be placed almost anywhere in these landscapes from an aesthetic point of view.”

Spatial extent - “The vast scale of this landscape type allows for a correspondingly large spatial extent for wind energy developments.”

Spacing - “Regular spacing is generally preferred, especially in areas of mechanically harvested peat ridges”

Layout - “In open expanses, a wind energy development layout with depth, preferably comprising a grid, is more appropriate than a simple linear layout.”

Height - “Aesthetically, tall turbines would be most appropriate.”

Hilly and Flat Farmland

Location – “Although hilly and flat farmland type is usually not sensitive in terms of scenery, due regard must be given to houses, farmsteads and centres of population.”

“Location on ridges and plateaux is preferred...”

“Elevated locations are also more likely to achieve optimum aesthetic effect.”

Spatial extent - “This can be expected to be quite limited in response to the scale of fields and such topographic features as hills and knolls”

Spacing - “The optimum spacing pattern is likely to be regular, responding to field pattern...However ... a balance will have to be struck between adequate spacing to achieve operability and a correspondence to field pattern.”

Layout - “The optimum layout is linear, and staggered linear on ridges and hilltops but a clustered layout would also be appropriate on a hilltop”

Height - “Turbines will tend not to be tall ... the more undulating the topography the greater the acceptability of an uneven profile.”

Offaly County Development Plan 2009 – 2015

The Offaly County Development Plan does not contain a Landscape Character Analysis, but objective O16-04 states that; “It is an objective of the Council to evaluate the need for Landscape Character Analysis in the county”. Nonetheless, a classification of landscape sensitivity for various landscape types is provided. This utilises three sensitivity categories including high, medium and low. General urban and farming areas fall into the low category, whilst cutaway bogs are identified as moderate sensitivity areas. A number of landscape features, habitats and natural heritage areas have been identified as being of a high sensitivity. These are included in table 16.1 of Volume I of the County Development Plan, an excerpt of which is provided below;

Areas of High Sensitivity and Areas of High Amenity	
Waterways, Wetlands	River Shannon, Grand Canal Lough Boora Parklands ¹ , Pallas Lake
Upland Areas	Slieve Bloom Mountains, Croghan Hill ²
Peatlands	Clara Bog, Raheenmore Bog
Eskers	Eiscir Riada, Clara Eskers Other Eskers
Archaeological and Historical	Clonmacnoise Durrow Monastic Site and Demesne

Excerpt of Table 16.1 from Volume I of the Offaly County Development Plan (2009 – 2015)

From table 16.1 the most relevant areas of high sensitivity and amenity with regard to this proposal are the Grand Canal, Croghan Hill, and Raheenmore Bog. The Grand Canal is approximately 5km to the south of the site at its nearest point, whilst Croghan Hill and Raheenmore Bog are approximately 2km and 4km respectively from south-western corner of the proposal site.

Table 16.2 of the development plan summarises the landscape sensitivity categories in terms of a description; acceptability for development and; need for landscaping and appropriate design. Table 16.2 is also provided below;

Landscape Sensitivity	Description	Acceptability of Development for consideration	Need for Landscaping and Appropriate Design
LOW	This class largely encompasses the county's main urban and farming areas. These areas comprise natural enclosing features (e.g. topography, vegetation) which have the capacity to absorb a range of new development.	A wide range of Development subject to appropriateness / conditions.	High
MODERATE	Areas which are generally 'open' in character with intrinsic quality and moderate capacity to absorb new development.	Some form of development subject to appropriateness / conditions.	Very High
HIGH	- Identified features or areas of natural beauty or interest which have extremely low capacity to absorb new development. - Areas included within this class are designated Areas of High Amenity.	Very limited development subject to appropriateness / conditions.	Essential

Excerpt of Table 16.2 from Volume I of the Offaly County Development Plan (2009 – 2015)

Table 16.5 of the County Development Plan provides a summary of the landscape characteristics and sensitivities of each of the previously identified High Sensitivity areas from table 16.1. The relevant text relating to the Grand Canal, Croghan Hill and Raheenmore Bog is provided below:

b) The Grand Canal Corridor

The Grand Canal traverses the county from Edenderry to Shannon Harbour, a distance of approximately 64 kilometres. It passes through the towns of Daingean, Edenderry (spur line) and Tullamore and the villages of Belmont, Rahan, Pollagh and Shannonharbour. There is a disused Kilbeggan branch line, which is now used as a walking route. The canal traverses large tracts of boglands and is bordered by hedgerows dating back 200 years and small fringes of wild vegetation along the canal bank.

- The Grand Canal is a focus for a wide range of uses, in particular, for recreation and tourism purposes.
- The visual quality of the surrounding areas is intrinsic to maintaining the attractiveness of the Grand Canal corridor.
- Hence, the corridor particularly outside of settlements, is especially sensitive to large development structures, insensitively designed sporadic housing and large-scale land uses such as extractive industries.
- Offaly County Council will have regard to the Waterway Corridor Study 2002 (and any relevant successive studies) in the development management process.

e) Croghan Hill and its Environs

Croghan Hill and its environs including Raheenmore Bog (which was designated a nature reserve under the Wildlife Act 1976) and Cannakill Deserted Medieval Village, are the main elements of this high amenity area. Croghan Hill is an extinct

volcano which lies 234 metres above sea level and commands views over north and east Offaly and the surrounding counties.

- This is an area of archaeological and high amenity value and is highly sensitive to new developments.
- Croghan Hill, due to its elevated nature in comparison to its surrounding flat landscape, impacts on the visual quality of the surrounding area and is highly sensitive to developments of any nature, in particular sand and gravel extraction.
- The Council recognises the scenic quality and recreational value of the Croghan Hill area including Croghan Hill, Raheenmore Bog and Cannakill Deserted Medieval Village.

f) Bogland Areas

County Offaly contains a number of raised and blanket boglands. Clara bog, an important Natural Heritage Area (NHA), is also important for its visual amenities and scenic qualities. Other important bogland areas include the All Saints Bog, Sharavogue Bog, Slieve Bloom Blanket Bog and Raheenmore Bog.

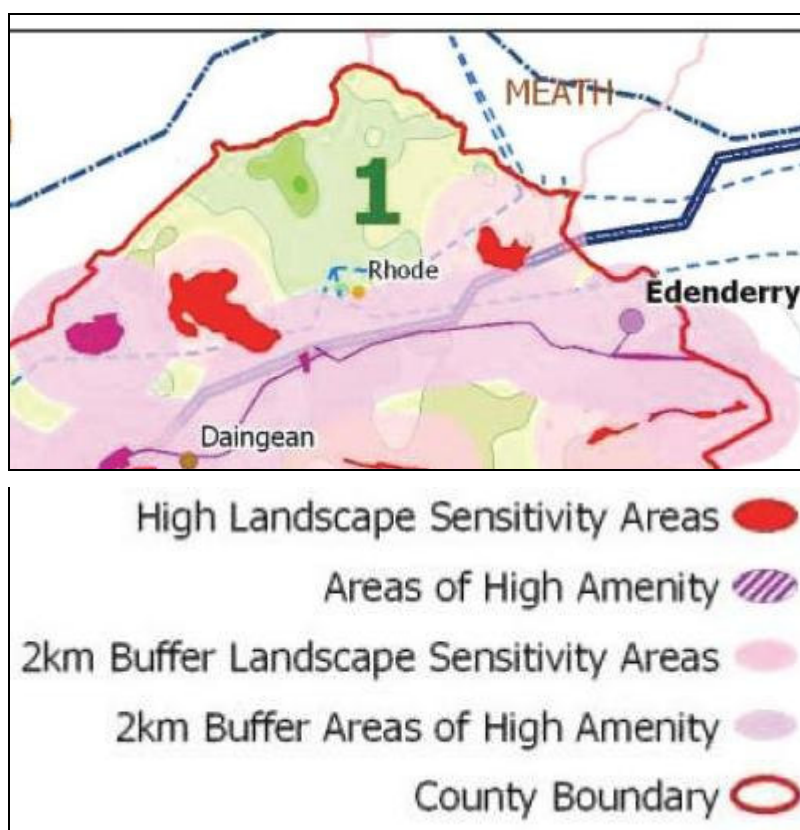
- Offaly County Council has a strong policy of conservation of a representative sample of peatlands and the protection of peatland habitats.

Relevant landscape policies include;

P16-02 It is Council policy to control development as per the county's landscape classification listed in Tables 16.2-16.5.

P16-03 It is Council policy to protect and preserve the county's Areas of High Amenity, including the Slieve Bloom Mountains, Clonmacnoise Heritage Zone, River Shannon, Lough Boora Parklands, Grand Canal, Croghan Hill, Raheenmore Bog, Pallas Lake, Clara Bog and eskers, Eiscir Riada, other eskers and Durrow High Cross, Abbey & surrounding area from development(s) which would be visually obtrusive or which would detract from the intrinsic character and environmental quality of the landscape.

A wind energy strategy has been prepared for Offaly, which forms part of the County Development Plan. Areas of high sensitivity are identified in the constraints mapping and this includes the Grand Canal, Croghan Hill and Raheenmore Bog in the vicinity of the proposal site. High sensitivity areas are allocated a 2km buffer zone, which leaves 12 residual areas within the county that are then rated in terms of suitability for wind energy development. The result of this analysis is that half of the residual areas are considered suitable and the other half, not suitable. The area in which the site is contained is identified as Area No. 1 'North of Rhode'.



Excerpt from Figure 8. 'Areas of Wind Energy Development Potential' in the Offaly Wind Energy Strategy 2009

The consideration for this area states:

"Having regard to proximity to existing substation access, roads, cutover bog, large landholdings, precedent of existing visually intrusive infrastructure, this area is highly suitable. There is some sensitivity to the overlooking of the western portion of this area from protected views."

The subsequent decision is that Area No. 1 'North of Rhode' is;

Suitable for large-scale Wind farms

Westmeath County Development Plan 2008 - 2014

The proposal site is adjacent to the border of County Westmeath to the north. Given the close proximity and therefore the potential to influence the landscape character of County Westmeath it is necessary to consider cross-boundary landscape designations and policies.

A Landscape Character Assessment has been prepared for County Westmeath and incorporated into the development plan. The area adjacent to the site is identified as being part of landscape character unit 10 – 'Lough Ennell and South-Eastern Corridor'. A description of this landscape unit and its associated relevant policies is provided hereunder;

10. Lough Ennell & SE Corridor

This area comprises of pasture land of mixed productivity. Lough Ennell is situated to the western side of this LCA and is designated as an Area of High Amenity, an SPA and an SAC. A number of preserved views are listed from the N4 between Tyrrellspass and Rochfortbridge. The area around Lough Ennell and particularly to the south of the Lake is characterised by scrub land with a mixture of marsh, bog, and poor pasture land. There is also a large tract of bog to the east of Rochfortbridge and Milltownpass along the County Boundary. The bog areas in this LCA are mainly exploited but some have been left intact. This area has a large number of old demesnes, these are easily recognisable in the landscape with the existence of fine mature hardwood trees and estate walls in some cases. Settlements within this landscape have developed mainly along the main road network. These include Kinnegad, Milltownpass, Rochfortbridge, and Tyrrellspass along the N6. Recreational areas have been developed on the shores of Lough Ennell including Ladestown, Liliput, and Tudenham. The N6 is currently being upgraded and this shall see a new N6 dual carriageway traversing the southern part of the LCA. The N52 bypass has also added to the transport corridor around Mullingar.

Wind Farms;

P-EH75 This area is considered as having medium capacity for wind farms. The area to the east of the LCA is considered to be potentially most suitable with extensive cutover peatland offering suitable sites as one area of potential.

Future of Cutaway Peatland;

P-EH76 Within the next 20–30 years, large areas of peatland will be exhausted and provide tracts of land that have potential for agriculture, habitat and amenity. The Council in consultation with relevant agencies will explore future potential of cut away peatlands that may offer opportunities for habitat creation or amenity and recreation areas such as community woodlands or parklands.

Meath County Development Plan 2007 - 2013

The proposal site lies a short distance from a section of the County Meath border and thus, it is deemed necessary to consider the landscape related designations and policies of the County Development Plan. As with County Westmeath, a landscape character assessment has been prepared for County Meath. The landscape character unit closest to the proposal site is No. 15 – ‘Southwest Lowlands’ (Map 02). The landscape sensitivity of each character unit is indicated on Map 03 and in the case of Unit 15 this is deemed to be ‘High’. Map 04 then indicates landscape capacity in relation to different development types within each landscape unit. For Unit 15 a medium capacity for wind turbines is indicated. This capacity is detailed further in the descriptive text for Unit 15 in the Landscape Character Assessment and is provided below:

Medium potential capacity to accommodate wind farms or single turbines because views within this LCA are generally short range and limited by topography and vegetation so there are opportunities for choosing locations where visual impacts are minimal. However, such development could cause the loss or degradation of hedgerows and trees and archaeology so location will be a critical consideration.

11.3.3 Visual Baseline

Only those parts of the study area that potentially afford views of the proposed wind farm are of interest to this part of the assessment. Therefore, the first part of the visual

baseline is establishing a 'Zone of Theoretical Visibility' and subsequently, identifying important visual receptors from which to base the visual impact assessment.

Zone of Theoretical Visibility (ZTV)

A computer automated study of the zone of theoretical visibility (ZTV) was carried out in respect of the proposal. The purpose of this exercise is to identify the 'theoretical' extent and degree of visibility of turbines. This is a theoretical exercise because it is based on topography only at 10 m contour intervals and does not allow for intermittent screening provided by, for example, hedgerows, forests or buildings and does not involve the actual height of crests (but using the nearest 10m contour below). Thus the ZTV map, assuming no screening, represents a 'worst-case-scenario' with respect to viewing exposure. For the purposes of this project a radius of 20 km was used for the ZTV as discussed earlier.

The following key points should be noted from the ZTV study:

- The vast majority of the landscape within 10km of the centre of the proposed development is afforded full theoretical visibility of all turbines. The only exception is an area in the 'view shadow' of Croghan hill to the southwest. This is a typical ZTV scenario for flat midland sites, but from experience there is a large discrepancy between theoretical and actual visibility in such landscapes due to hedgerow screening.
- Beyond 10km theoretical visibility reduces significantly in the western half of the study area corresponding to the broad corridor of the River Brosna which includes Lough Ennell. Theoretical visibility then increases again on the opposite shore of Lough Ennell at the north-western edge of the study area reflecting a gentle rise in the landform.
- Relatively comprehensive theoretical visibility occurs to the edge of the study area throughout the eastern quarters due to the flat nature of the landscape and the fact that the site lies at the head of the broad water catchments of the Boyne and Barrow Rivers. This is relevant because view sheds and watersheds are often closely related.

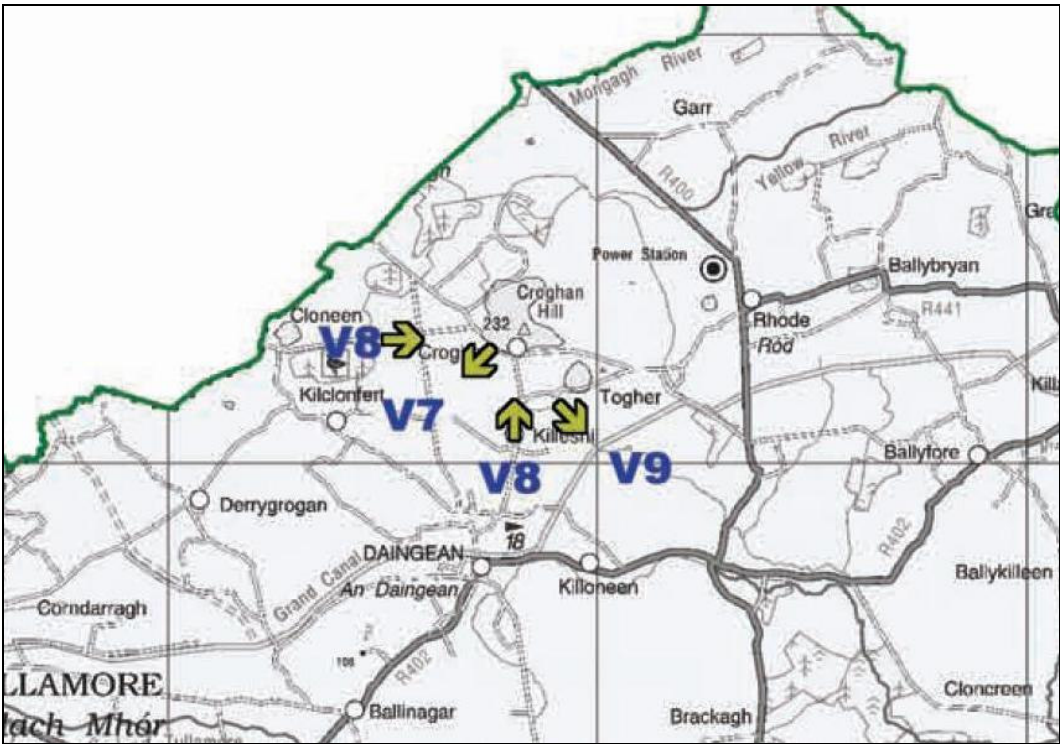
- Due to the diminishing scale of the proposed turbines at increased distances, actual visibility of the proposed development from beyond 10km is likely to be limited to elevated hills with very little in the way of foreground screening. From experience, ZTV maps are of limited value in flat rural landscapes.

Views of Recognised Scenic Value

Views of recognised scenic value are primarily indicated within County Development plans in the context of scenic views/routes designations, but they might also be indicated on touring maps, guide books, road side rest stops or on post cards that represent the area. The following sections set out the published views of scenic value known to occur in the area.

Offaly County Development Plan (2009-2015)

The Offaly County Development Plan (2009 – 2015) identifies a total of 19 ‘views and prospects of special amenity or special interest’ in table 16.6. These are also indicated on map 16.10. Four of these are potentially relevant to this proposal being clustered several kilometres to the south and west of the proposal site in the vicinity of Croghan Hill. As can be seen from map 16.10, Croghan Hill is considered as both a view and a prospect (views of and views from), but these are essentially reverse views to and from the south and west, whereas the proposal is to the northeast of the Hill. Nonetheless, these designated views were a key consideration in the Viewshed Reference Point (VRP) selection process for this proposal.

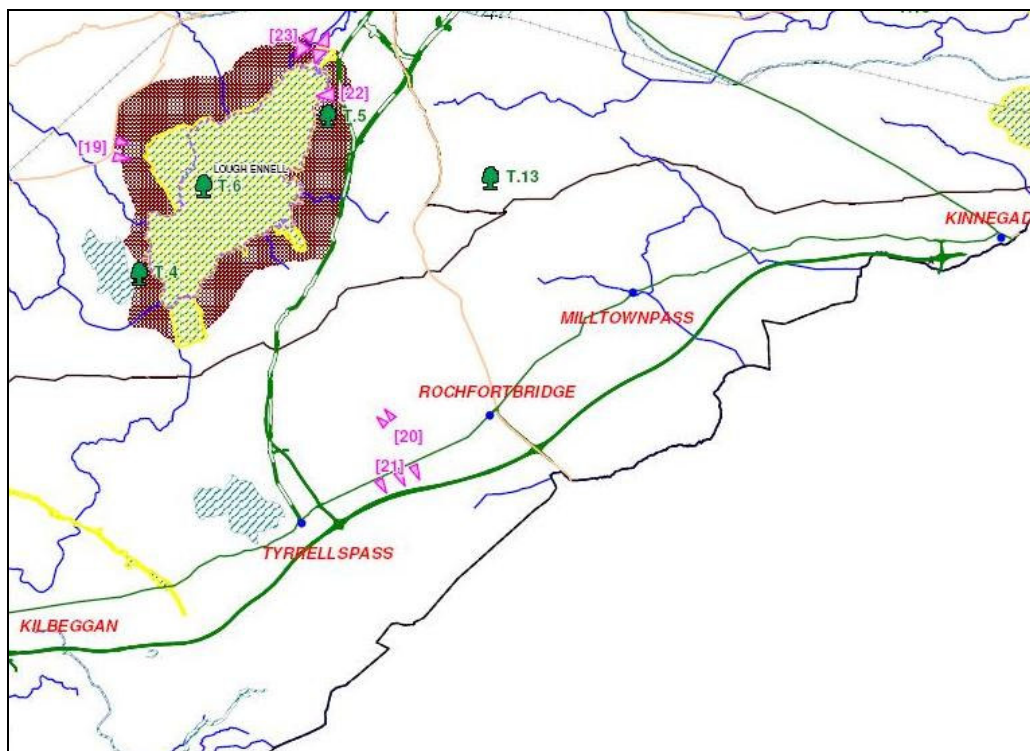


Map Ref	View From	View To
V7	Road No. L-01018 in the townlands of Cannakill and Croghan Demesne.	Slieve Bloom Mountains.
V8	Townlands of Barnan, Kilduff, Old Croghan, Croghan Demesne, Down.	Views towards Croghan Hill and Boglands.
V9	Townlands of Grovesend and Coole.	South to boglands.

Excerpts from Map 16.10 and table 16.6 of the Offaly County Development Plan (2009 – 2015)

Westmeath County Development Plan 2008 - 2014

The Westmeath County Development plan contains a ‘Countywide Designations’ map which includes ‘Views to be preserved or improved’. Views 19 and 21 are potentially relevant to the proposal being within the study area and oriented in the direction of the scheme. These were both investigated during fieldwork and subsequently only view No. 21 from the old N6 was retained as a VRP from which to assess the visual impact of the proposal.



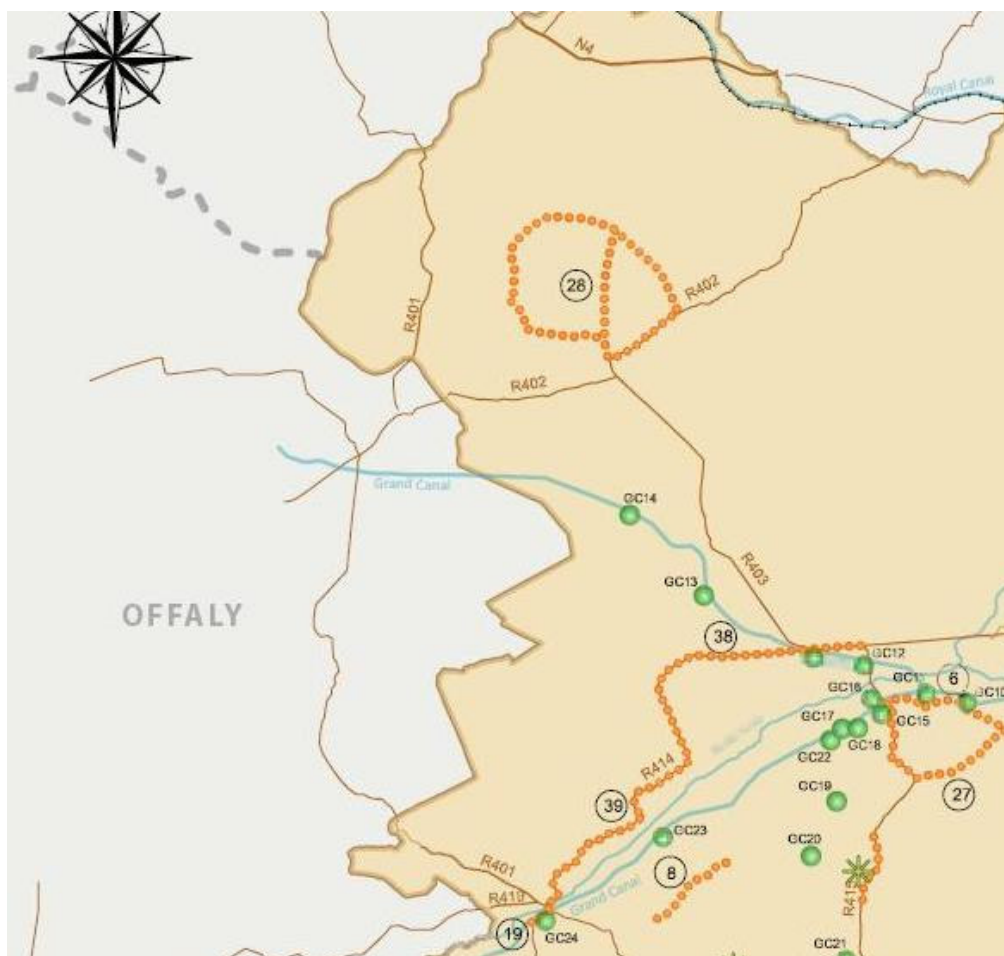
Excerpt from Map 8.3.4 of the Westmeath County Development Plan (2008-2014) showing views to be preserved (pink)

Meath County Development Plan 2007 - 2013

Map 05 – ‘Visual Amenity’ of the Meath landscape Character Assessment which is incorporated into the Meath County Development Plan 2007 – 2013 indicates protected views. Only one potentially relevant view with regard to this proposal is shown. This is described as ‘Views over Rathmoylan Farmland’ and it is at the north-eastern perimeter of the study area. This was investigated during fieldwork for potential inclusion as a VRP in this visual assessment, but a view of the proposed development would not be afforded.

Kildare County Development Plan 2011-2017

Map 14.3 of the Kildare County Development Plan indicates scenic routes and viewpoints. Within the study area there are two relevant scenic routes (Nos. 28 and 38). Whilst there are also several scenic views they relate to contained views of the Grand Canal. The two scenic routes were investigated during fieldwork and VRPs have been selected on each of them for assessment herein.



Excerpt from Map 14.3 of the Kildare County Development Plan (2011-2017) scenic routes and scenic views

Identification of Viewshed Reference Points as a Basis for Assessment

The results of the ZTV analysis provide a basis for the selection of Viewshed Reference Points (VRP's), which are the locations used to study the landscape and visual impact of the proposed wind farm in detail. It is not warranted to include each and every location that provides a view of this development as this would result in an unwieldy report and make it extremely difficult to draw out the key impacts arising from the project. Instead, the assessors endeavoured to select a variety of location types that would provide views of the proposed wind farm from different distances, different angles and different contexts.

The visual impact of a proposed development is assessed using up to 6 categories of receptor type as listed below:

- Key Views (from features of national or international importance);

- Designated Scenic Routes and Views;
- Local Community views;
- Centres of Population;
- Major Routes; and
- Amenity and heritage features;

Where a VRP might have been initially selected for more than one reason it will be assessed according to the primary criteria for which it was chosen. The characteristics of each receptor type vary as does the way in which the view is experienced. These are described below.

Key Views

These VRP's are at features or locations that are significant at the national or even international level, typically in terms of heritage, recreation or tourism. They are locations that attract a significant number of viewers who are likely to be in a reflective or recreational frame of mind possibly increasing their appreciation of the landscape around them. The location of this receptor type is usually quite specific.

Designated Scenic Routes and Views

Due to their identification in the County Development Plan this type of VRP location represents a general policy consensus on locations of high scenic value within the Study Area. These are commonly elevated, long distance, panoramic views and may or may not be mapped from precise locations. They are more likely to be experienced by static viewers who seek out or stop to take in such vistas.

Local Community Views

This type of VRP represents those people that live and/or work in the locality of the wind farm, usually within a 5km radius of the site. Although the VRP's are generally located on local level roads they also represent similar views that may be available from adjacent houses. The precise location of this VRP type is not critical, however, clear

elevated views are preferred, particularly when closely associated with a cluster of houses and representing their primary views. Coverage of a range of viewing angles using several VRP's is necessary in order to sample the spectrum of views that would be available from surrounding dwellings.

Centres of Population

VRP's are selected at centres of population primarily due to the number of viewers that are likely to experience that view. The relevance of the settlement is based on the significance of its size in terms of the Study Area or its proximity to the site. The VRP may be selected from any location within the public domain that provides a clear view either within the settlement or in close proximity to it.

Major Routes

These include national and regional level roads and rail lines and are relevant VRP locations due to the number of viewers potentially impacted by the proposed development.

The precise location of this category of VRP is not critical and might be chosen anywhere along the route that provides clear views towards the proposal site, but with a preference towards close and/or elevated views. Major routes typically provide views experienced whilst in motion and these may be fleeting and intermittent depending on screening by intervening vegetation or buildings.

Amenity and Heritage Features

These views are often one and the same given that heritage locations are often important tourist and visitor destinations and amenity areas or walking routes are commonly designed to incorporate heritage features. Such locations or routes tend to be sensitive to development within the landscape as viewers are likely to be in a receptive frame of mind with respect to the landscape around them. The sensitivity of this type of visual receptor is strongly related to the number of visitors they might attract and, in the case of heritage features, whether these are discerning experts or lay tourists. Sensitivity is also heavily influenced by the experience of the viewer at a heritage site as distinct from simply the view of it. This is a complex phenomenon that is likely to be different for every site. Experiential considerations might relate to

the sequential approach to a castle from the car park or the view from a hilltop monument reached after a demanding climb. It might also relate to the influence of contemporary features within a key view and whether these detract from a sense of past times. It must also be noted that the sensitivity rating attributed to a heritage feature for the purposes of a landscape and visual assessment is not synonymous with its importance to the Archaeological or Architectural Heritage record.

<i>VRP No.</i>	<i>Location</i>	<i>Direction of view</i>
KV1	Sliabh na Callaighe	S
KV2	Hill of Tara	SW
DR1	R446 at Garrane	E
DR2	Local Road at knockcor	W
DR3	Local Road at Kilcorby	NE
DR4	Local Road at Down	NNE
DR5	R414 at Lullymore	NW
LC1	Local Road at Baltinoran	S
LC2	Local Road near Castlejordan	W
LC3	Local Road at Croghan Hill	NE
LC4	Local road at Togher	N
LC5	Garr Road at Corbetstown Bridge	NW
LC6	Garr Road at Garr	E&W
LC7	Local Road at Ballyburley	NW
CP1	Milltownpass	S
CP2	Rochfortbridge	SE
CP3	Tyrrellspass	E
CP4	Rhode	N
CP4 North	Rhode (Garr Road roundabout)	NE
CP5	Edenderry	NW
CP6	Mount Lucas	N
CP7	Clonbulloge	NNW
MR1	N4 at The Downs	S
MR2	M6 overpass at Kinnegad	SW
MR3	M6 at Hardwood	S
MR4	R400 overpass of M6	SE
MR5	R400 at Derrynagreenagh	E & W
AV1	R161 / Royal Canal Way at Molrick	SW
AV2	Grand Canal Way at Rathmore	NW

Table 11.6: Outline Description of Selected Viewshed Reference Points (VRPs)

11.4 POTENTIAL IMPACTS OF THE DEVELOPMENT

11.4.1 *Landscape Impact*

Landscape Character, Value and Sensitivity

Effects on landscape character will be considered at both the localised scale of the site and its immediately surrounding landscape as well as the broader scale of the study area.

As described above, the landscape directly surrounding the site is mainly that of pastoral farmland, conifer forests and vast areas of peatland fringed by marginal scrubland and rehabilitated cutaway bog. A significant motorway corridor skirts just to the north of the site and a regional road passes through the middle of it. In terms of large scale industry and infrastructural developments there is the familiar form of the Lagan Cement plant near Kinnegad as well as electricity peaking plants at Rhode and Ballykilleen. Thus, the character of this landscape is strongly influenced by human intervention and modification, particularly in relation to energy production. The most distinctive aspects of the immediate site context are the vast openness of the peat bogs and the scale of the extractive operations that occur on them. There is little in the way of land form containment in this area other than Croghan Hill which is only prominent in the context of the otherwise flat surroundings. Overall it is considered that the site and its immediately surrounding landscape has a productive landscape character with few sensitive features. Furthermore, the scale of the production and infrastructure in terms of peat harvesting, energy generation, forestry and the major transport corridor provide a sense that this landscape serves a regional or national demand rather than just a local one.

Several sensitive landscape features occur in relatively close proximity to the south of the site including Raheenmore Bog, Blackcastle Bog, Croghan Hill, and the Grand Canal. The bogs are not particularly distinctive landscape features in the context of the vast peatlands surrounding them. Raheenmore Bog is the deepest raised bog known in Ireland and is therefore sensitive in a geological and hydrological sense due to its rarity. Both of these bogs have habitat value, however, in the broader context they have little influence on the landscape character of this area.

Croghan Hill is a distinctive landscape feature that influences the surrounding landscape character on the basis that it is an isolated, prominent landform in an

otherwise vast, flat landscape. *“Croghan owes its prominence to its unique geology – which gives it a distinct ecological character also – but it also has special cultural significance, because there is a magnetism about hills like this that draws the eye and stirs the imagination ...”* (Feehan 2011). It acts as a familiar reference point within the local landscape and has been considered a strategic feature in this region for millennia, based on evidence of settlement and use. Therefore, Croghan Hill has landscape value in terms of both the distinctiveness of the land form and its cultural heritage associations.

The Grand Canal was once an important transport corridor linking the River Shannon and the midlands with Dublin. Its current value primarily relates to recreation and as a public right of way. It is a pleasant linear waterway that affords some visual amenity, but due to its containment it has little influence on the landscape beyond a short distance either side of the canal corridor. It has more influence on the townscape of the settlements it passes through, such as Daingean and Tullamore, as it has dictated urban form and has become a defining feature.

The sensitive landscape features outlined above are relatively isolated from each other in a physical sense and also in terms of the particular nature of their sensitivities. Only Croghan Hill influences the surrounding landscape character to a noticeable degree. This is appropriately reflected in the Offaly County Development plan, which identifies these features as being sensitive in landscape terms, but limits their protection to a 2km buffer from wind farm development.

The broader landscape in the southern half of the study area is typical of that described for the site and its immediate surrounds. The flat landscape is cloaked in a combination of pastoral farming and some tillage, with large cutaway bogs particularly to the south of Mount Lucas. Again, the transitional land between these landscape types is contained in scrub or coniferous forest plantations.

In the northern half of the study area beyond the R466 (the old N6), the terrain becomes slightly more undulating with a subtle plateau of comparatively high ground to the east of substantial sized Lough Ennell. This elevated zone is also a pastoral landscape, but in a more classical sense with tall broadleaf tree lines and several demesne landscapes. When coupled with the naturalistic influence of Lough Ennell, the pleasant rural character of this area is considered to be of a high integrity.

There are currently no operational wind farms within the study area and such development, whilst not being an unfamiliar component of the wider region, is not characteristic of this locality.

In summary, there are specific landscape features within relatively close proximity to the site that are deemed to be of high sensitivity in accordance with the development plan designations. However, other than Croghan Hill they have limited influence on the landscape character even in relatively close proximity. There are also parts of the wider landscape that have an anthropogenic rural character, but of a relatively high degree of integrity with modest levels of development. Notwithstanding, the landscape character in the immediate context of the site is strongly anthropogenic being influenced by strategic scale transport infrastructure, peat extraction, power generation and timber production. The fact that commercial scale wind farms do not currently exist within the study area makes it marginally more sensitive to the introduction of this new form of development. On balance of all of these factors, landscape sensitivity is deemed to be **low**.

Magnitude of Landscape Effects

The physical landscape as well as the character of the site and its immediate surrounds is affected by the proposed turbines as well as ancillary development such as access and circulation roads, areas of hard standing for the turbines, the permanent meteorological mast and the substation. By contrast, for the wider landscape of the study area, landscape impacts relate almost exclusively to the influence of the proposed turbines on landscape character.

It is considered that the proposed wind farm development will have a relatively minor physical impact on landscape within the site as none of the proposed development features (turbines, substation, anemometer mast) have a significant 'footprint'. The topography and land cover of the site will remain largely unaltered with excavation being limited to tracks and areas of hard standing for the turbines. Within a flat landscape such as this, earthworks requirements are considerably less than on upland or sloping sites. Excavations will tie into the existing contours and will be the minimum required for safe working. Any temporary excavations or stockpiles of material will be re-graded to marry into existing site levels and reseeded appropriately in conjunction with advice from the project ecologist. The land cover of the site will only be interrupted as necessary to build the structures of the

development and to provide access. The current grazing and forestry regimes will be able to continue below the wind turbines without significant disruption following the construction phase.

The principal landscape impact will be the change in character of the immediate area due to the introduction of large scale structures with moving components. These will be a prominent landscape feature within the local landscape as would be the case for a commercial scale wind farm placed into almost any landscape context. Nonetheless, this is generally a vast open landscape context, within which, the proposed wind farm will be easily assimilated in terms of scale. The least open landscape context of the study area is the pastoral one. This is due to the moderate degree of enclosure provided by hedgerows. However, within the site and its immediate surrounds, field sizes tend to be large and there is unlikely to be a sense of scale disparity between the turbines and the land use patterns below.

The proposed wind farm represents the introduction of a new and uncharacteristic form of development within both the immediate and wider landscape context of the study area. Thus, the landscape impact is marginally greater than if wind farms were already a familiar feature of the study area. Nonetheless, the proposal will be accompanied by some degree of expectation within the local population given the commencement of construction on a similar sized scheme at Mount Lucas (10km south). Until recently wind farms in Ireland were synonymous with upland areas, but due to improving turbine technologies and various other factors, lowland sites have become viable. In landscape terms, there is a strong thematic relationship and natural synergy between the generation of energy from peat extraction and the harnessing of wind energy on the same sites. Despite the modal shift these areas can continue a considerable legacy as 'energy landscapes' in the public perception.

Site activity will be at its greatest during the construction phase due to the operation of machinery on site and movement of heavy vehicles to and from site. This phase will have a more significant impact on the character of the site, but it is a temporary impact that will cease upon completion of the scheme (approximately 2 years). Furthermore, the volume of heavy traffic will be familiar in the context of other land uses in and around the site.

In summary, there will be physical impacts on the land cover of the site as a result of this development, but in the context of the surrounding peat extraction and forestry

activities this will be barely discernible and will take place on already modified land. This strategic scale of development can be comfortably assimilated into this broad and open landscape context without undue conflicts of scale with underlying land form and land use patterns. There is also a sense of progression within this energy landscape from a non-renewable, extractive form of power generation (peat harvesting) to a modern renewable form (wind turbines). Although this represents a relatively new form of development within the study area it is not an unfamiliar or unexpected one. For these reasons the magnitude of the landscape impact is deemed to be low.

Significance of landscape impact

As outlined in section 11.2.4 above, the significance of landscape impacts is a function of landscape sensitivity weighed against the magnitude of the landscape impact. This is established using the significance matrix (Table 11-3) within which, a 'low' sensitivity judgement coupled with an impact magnitude of 'low' results in a **Slight-imperceptible** significance of landscape impact.

11.4.2 Visual Impact

The assessment of the visual sensitivity of the viewshed reference points is based on the criteria set out below. The following table (11.7) indicates whether the VRP is generally considered to be sensitive or not sensitive to each criterion on a graduated scale. No relative importance is inferred by the order of listing in the criteria set out in the table.

Recognised scenic value of the view (County Development Plan designations, guidebooks, touring maps, postcards etc). These represent a consensus in terms of which scenic views and routes within an area are strongly valued by the population because in the case of County Development Plans, at least, a public consultation process is required;

Views from within highly sensitive landscape areas. Again, highly sensitive landscape designations are usually part of a county's Landscape Character Assessment, which is then incorporated with the County Development Plan and is therefore subject to the public consultation process. Viewers within such areas are likely to be highly attuned to the landscape around them and views tend to be valued to a higher degree than in less sensitive landscape areas;

Amenity views from dwellings. Whilst dwelling occupants tend to be in the higher category of receptor sensitivity the amenity value of views afforded from dwellings can vary widely. Where dwellings have been located and oriented to take in a particular vista or landscape feature the amenity value of the view will be higher than from those dwellings that are afforded restricted and/or unremarkable views;

Intensity of use, popularity. This relates to the number of viewers likely to experience a view on a regular basis and whether this is significant at county or regional scale;

Connection with the landscape. This considers whether or not receptors are likely to be highly attuned to views of the landscape i.e. commuters hurriedly driving on busy national routes versus hill walkers directly engaged with the landscape enjoying changing sequential views over it;

Provision of elevated panoramic views. This relates to the extent of the view on offer on the basis that higher amenity value tends to be associated with broad, elevated vistas.

Absence of wind energy development or other significant built infrastructure within the view. This criterion gives a sense of whether the character of the existing view is currently influenced by wind turbines or other development of a significant scale or intensity.

Sense of remoteness and/or tranquillity. Receptors taking in a remote and tranquil scene, which is likely to be fairly static, are likely to be more receptive to changes in the view than those taking in the view of a busy street scene, for example;

Degree of perceived naturalness. Where a view is valued for the sense of naturalness of the surrounding landscape it is likely to be highly sensitive to visual intrusion by distinctly manmade features;

Presence of striking or noteworthy features. A view might be strongly valued because it contains a distinctive and memorable landscape feature such as a promontory headland, lough or castle;

Historical, cultural and / or spiritual significance. Such attributes may be evident or sensed by receptors at certain viewing locations, which may attract visitors for the purposes of contemplation or reflection heightening the sense of their surroundings;

Rarity or uniqueness of the view. This might include the noteworthy representativeness of a certain landscape type and considers whether the receptor could take in similar views anywhere in the broader region or the country;

Integrity of the landscape character. This looks at the condition and intactness of the landscape in view and whether the landscape pattern is a regular one of few strongly related components or an irregular one containing a variety of disparate components;

Sense of place. This considers whether there is special sense of wholeness and harmony at the viewing location; and

Sense of awe. This considers whether the view inspires an overwhelming sense of scale or the power of nature.

Those locations which are deemed to satisfy many of the above criteria are likely to be in the higher order of magnitude in terms of sensitivity and vice versa. The overall sensitivity judgement may be a result of a number of these factors or, alternatively, a strong association with one or two in particular. Whilst the final sensitivity judgement is cognisant of the trends highlighted in the table, it is ultimately a matter of professional opinion based on experience rather than the simple quantifying of results.

Analysis of Visual Receptor Sensitivity at Viewshed Reference Points

Scale of sensitivity for each criterion

Strongly Sensitive		Moderately Sensitive							Mildly Sensitive							Not Sensitive													
	KV1	KV2	DR1	DR2	DR3	DR4	DR5	LC1	LC2	LC3	LC4	LC5	LC6	LC7	CP1	CP2	CP3	CP4	CP4N	CP5	CP6	CP7	MR1	MR2	MR3	MR4	MR5	AV1	AV2
Recognised scenic value of the view																													
Views from within highly sensitive landscape areas																													
Amenity views from dwellings																													
Intensity of use, popularity (number of viewers)																													
Viewer connection with the landscape																													
Elevated panoramic views																													
Absence of wind energy development / other significant scale development																													
Sense of remoteness / tranquillity at the viewing location																													

[illegible]

Notes: N = Negligible; L = low sensitivity; M = medium sensitivity; H = high sensitivity; VH = very high sensitivity

Table 11.7: Analysis of Visual Receptor Sensitivity at Viewshed Reference Points

11.4.3 Estimation of Visual Impacts at VRPs

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
KV1	Sliabh na Callaighe	S	36km	12
Representative of:	• A National Monument – megalithic complex • A recreational area • A tourist attraction			
Receptor Sensitivity	Very High			
Existing View	This is a vast elevated vista from the megalithic tomb on the summit of Sliabh na Callaighe. This southerly view takes in hilly farmland in the foreground characterised by pastoral fields defined by scrubby hedgerows and tree lines. Forest plantations and a quarry are also noticeable features in the nearer aspects of the view. The landscape beyond is generally flatter and is perceived as a continuous pattern of fields and hedgerows with no containment out to the flat horizon.			
Visual Impact of Yellow River Wind Farm	At this distance the proposed turbines are unlikely to be discernible at all to the casual observer. They would be seen with little tonal contrast above the distant horizon and their visibility would be further reduced by atmospheric perspective (the fading of distant objects). Therefore, the visual presence of the scheme is deemed to be minimal. On the basis of the low degree of visual presence within the vast vista afforded from here there will be no measurable effect on the amenity of the scene and overall the magnitude of the visual impact is judged to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Very High	Negligible	Slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
KV2	Hill of Tara	SW	41km	12
Representative of:	• A Candidate World Heritage Site • A recreational area • A popular tourist attraction			
Receptor Sensitivity	Very High			
Existing View	This is a vast elevated view to the southwest from the summit of the Hill of Tara. Immediately below the hill the landscape spreads as an expansive flat plain with no containment out to the distant horizon. The singular pattern of fields and hedgerows becomes more condensed with distance until a continuous band of vegetation is perceived.			

Visual Impact of Yellow River Wind Farm	At this distance the proposed turbines are unlikely to be discernible at all to the casual observer. They would be seen with little tonal contrast above the distant horizon and their visibility would be further reduced by atmospheric perspective (the fading of distant objects). Therefore, the visual presence of the scheme is deemed to be minimal. On the basis of the low degree of visual presence within the vast vista afforded from here there will be no measurable effect on the amenity of the scene and overall the magnitude of the visual impact is judged to be negligible.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Very High	Negligible	Slight

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR1	R446 at Garrane	E	4.3km	12
Representative of:	- An area identified on the ZTV map as having a theoretical view of all 32 of the proposed turbines - A designated scenic route - A major route			
Receptor Sensitivity	Medium			
Existing View	This is a slightly elevated view to the south from the old N6 (now R446) where several dwellings are clustered around cross roads. There is a relatively open foreground due to the absence of roadside screening and a large field that falls away gently to the south. Hedgerow vegetation including some mature trees along the eastern boundary of the field screens much of the context beyond to the southeast. Lower vegetation and lower ground levels along the southern boundary of the field reveal glimpses of the landscape beyond. This is seen as a band of vegetation comprising hedgerows that are stacked in perspective. The profile of Cloghan Hill is just discernible through an intervening section of mature trees on the otherwise flat skyline in the distance.			
Visual Impact of Yellow River Wind Farm	A linear cluster of approximately 8 of the proposed turbines rises above a section of the middle ground hedgerow to the extent that their blade sets are fully revealed. This represents the nearest group of turbines, which are seen at a comparatively larger scale than those sited beyond the R400 to the east. The blades of several of these more distant turbines are visible in lower sections of the intervening hedgerow to the left of the main cluster. From this location the eye is naturally drawn southwards along the foreground field towards the most extensive aspect of the vista. The proposed turbines will be a noticeable feature, but they are somewhat peripheral within this panoramic vista. The visual presence of the scheme is deemed to be in the order of co-dominant to sub-dominant.			

	The main cluster of turbines are seen in silhouette against the sky with a generous spacing that avoids overlapping. There is some visual clutter and ambiguity generated by the partially revealed turbines rotating on and just above the nearer hedgerow. This is exacerbated slightly by the electricity pylon that is visible within the most prominent cluster of turbines. However, this effects only a small section of the view the turbines do not intrude on the main axis of the vista to the south. On balance of the reasons outlined above the magnitude of visual impact is judged to be medium.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Medium	Medium	Moderate

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR2	Local Road at knockcor	W	12.3km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines. - A designated scenic route.			
Receptor Sensitivity	Medium			
Existing View	This section of road affords intermittent views to the east over a pleasant pastoral landscape of gently rolling terrain, mature tree lines and woodlands. The combination of these landscape elements tends to limit views to a relatively short distance even though there is not a strong degree of enclosure.			
Visual Impact of Yellow River Wind Farm	Although there are occasional open views to the west between elements of foreground screening (as depicted in the photomontage) the wooded skyline will prevent the proposed turbines from being visible at this distance. Even if the occasional turbine blade tip emerged in views from this section of road it would be within a 'fuzzy' skyline context at a distance of beyond 10km. Thus it would be almost impossible for the casual observer to discern. For this reason the visual impact is deemed to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Medium	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR3	Local Road at Kilcorby	NE	3.4km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of between 1 and 8 of the proposed turbines - A designated scenic view - A local community view			
Receptor Sensitivity	Medium			
Existing View	This is a relatively contained view towards Croghan Hill, which lies a short distance to the east. Hedgerow vegetation to the left and right of the marshy foreground field tends to channel the view towards this focal point. Clumps of mature trees line the base of the hill with more open pasture emerging above.			
Visual Impact of Yellow River Wind Farm	As can be seen in the wireframe image that accompanies the photomontage for DR3, the proposed turbines would be theoretically visible above the lower northern slopes of Croghan Hill and on the plains further north. However, intervening hedgerow vegetation screens all of the turbines from view. A veiled view of turbine blades within the branches of these trees might be afforded during winter months, but they would remain difficult to discern. Nonetheless, the distinctive profile of Croghan hill would be unaffected by the proposal. For these reasons the visual impact magnitude is deemed to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Medium	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR4	Local Road at Down	NNE	5.6km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of between 1 and 8 of the proposed turbines - A designated scenic view - A local community view			
Receptor Sensitivity	Medium			
Existing View	This is a confined view towards Croghan Hill from a local road to the south. Several dwellings line the western side of road, whilst mature conifers flank it to the right. The profile of Croghan hill rises above foreground dwellings and associated vegetation and it is also seen in the context of a cluster of utility poles that line the road.			

Visual Impact of Yellow River Wind Farm	Whilst the blade sets of several turbines are potentially visible in the low saddle between the two crests of Croghan Hill when seen from this stretch of road, they will be largely screened from view by a band of vegetation that occupies the intervening slopes. Even where they might emerge between screening elements, views are likely to be limited to blade tips within a complex visual context. The profile of Croghan Hill will be unaffected. On the basis of these factors the visual impact magnitude is judged to be negligible.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Medium	Negligible	Imperceptible

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
DR5	R414 at Lullymore	NW	19.5km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A designated route			
Receptor Sensitivity	Medium			
Existing View	This is a vast horizontal vista to the north across a peatland context that includes cutaway bog, scrub and conifer plantations. The most distinctive aspect of this vista is the openness due to the absence of containment from topography and vegetation. Nonetheless, there is a sense of a gentle rise in ground level to the north.			
Visual Impact of Yellow River Wind Farm	The slightly raised profile of the distant forest plantations to the northwest are barely discernible in the context of a generally flat, scrubby skyline. However, they are high enough to fully screen the proposed turbines from view at this considerable distance. Even in a future scenario where these mature plantations have been harvested, the distant turbines will be difficult for the casual observer to identify. This is on the basis of their low level of contrast against the sky and the effects of atmospheric perspective (the fading of distant objects). For the above reasons the magnitude of visual impact is deemed to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Medium	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC1	Local Road at Baltinoran	S	0.9km	9
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A local community view			
Receptor Sensitivity	Low			
Existing View	This is a short distance view to the south and west from a local crossroad that is intended to represent typical views of the proposed development from within the local area. The view is contained at a short distance by hedgerow vegetation in all directions. These hedgerows range in nature from low clipped sections to sporadic tree lines, which together line the pastoral fields in this area.			
Visual Impact of Yellow River Wind Farm	The eastern half of the scheme is seen at a significant scale throughout the southern and western aspects of this view. The nearest and largest turbines are immediately to the west. The westernmost turbines (beyond the R400) are seen at a much smaller scale and tend to be screened by the foreground hedgerows. Other than the nearest turbine, which is almost fully revealed, only the blade sets and upper tower sections of the remaining close turbines are revealed above the vegetated skyline. This tends to diminish their perceived height even though the visible components are seen at a considerable scale. The turbines will be the most distinctive feature within this otherwise homogenous short range view and when coupled with the scale and extent of the scheme the visual presence is deemed to be dominant. In terms of visual amenity, the turbines are generally well spaced avoiding undesirable overlap. Nonetheless, there is a sense of being surrounded by them through the southern and western quarters due to the considerable lateral extent of the scheme experienced at this location. The view of blade sets rotating just above the vegetated skyline generates a degree of visual ambiguity as turbine scale in relation to distance is not clear. However, the blades rotate freely above the skyline vegetation avoiding the less desirable effect of rotating against it, which could otherwise increase the sense of visual clutter within the scene. Overall the magnitude of the visual impact at LC1 is considered to be high.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	High	Moderate-slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC2	Local Road at Clongall Bridge	W	2.8km	7
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - Local Community views			
Receptor Sensitivity	Low			
Existing View	This is a pleasant pastoral view across a slightly more rolling landscape than exists in much of the central study area. The view is contained at a moderate distance by a series of low tree lined ridges. Yellow River, which is a fairly minor watercourse at this point passess under the viewer but adds to the sense of rural tranquillity at this location.			
Visual Impact of Yellow River Wind Farm	Although all of the proposed turbines are potentially visible to some extent from here in one extensive cluster, only the nearest turbines at the centre of the cluster are visible due to foreground and middle ground screening. The blade sets can be seen rising above the vegetation at a fairly modest scale despite their proximity. In the context of the vista they are judged to be co-dominant in terms of visual presence. Compositionally, the proposed turbines are seen at a scale and extent that compliments other elements of the vista. There will be some minor instances of blades rotating against intervening tree tops, but this is ameliorated by a clearer view of their cohorts. For the reasons outlined above, the magnitude of the visual impact is deemed to be medium.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Medium	Slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC3	Local Road at Croghan Hill	NE	2.5km	18
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines. - A sensitive landscape feature - Local community views - A recreation and heritage location			
Receptor Sensitivity	High			

Existing View	This is a vast, elevated panorama to the north from the highest point on a local road that crosses Croghan Hill. The pastoral land cover context of the foreground sweeps down into the plains below. The large fields of improved grassland then gradually give way to a broad and more informal pattern of cutaway bog, conifer plantations and scrub on the marginal land between these uses. The commanding vista gives the viewer some sense of why Croghan Hill has been a strategic and iconic landscape feature within the otherwise flat midland landscape for millennia. The value and sensitivity of this vista relates to its vastness and the cultural heritage associated with the viewing location and not for any sense of the naturalistic. Indeed, the landscape below is testimony to decades of industrial scale peat extraction for energy production. The other land uses contribute to a sense that this is a productive landscape, which is valued as such.			
Visual Impact of Yellow River Wind Farm	The proposed turbines provide a distinctive vertical counterpoint to the strongly horizontal nature of the view. They are by far the most noticeable built structures within the view, which otherwise tends to be read as a land use pattern rather than as a combination of particular landscape features. Despite the fact that they are eye catching, they are not spatially overwhelming in the context of this vast vista. Whilst the half dozen turbines presented immediately to the north of the viewer are seen at a considerable scale, the remaining turbines trickle away quickly to the east and are much more peripheral within the view. On balance of all of these factors, the visual presence of the scheme is deemed to be co-dominant. Aesthetically, this is striking view of the proposed development, which adds a picturesque quality to the vista. The turbines are fully revealed to the viewer in an unambiguous manner so that the layout of the scheme is readily comprehended. There is a minor detraction caused by the overlapping of two pairs of the nearest turbines and yet, the spacing between these pairs and the neighbouring turbines remains consistent. The turbines may be a new and distinctive manmade feature within this view, but they are consistent with its underlying character of production. Energy production, no less. From this viewpoint the synergy between large scale peat extraction and the harnessing of renewable wind power is most apparent. Thus, the proposed wind farm reinforces this as an 'energy landscape'. The broad land use patterns also comfortably assimilate the scale of the development. An interesting consideration for the assessor in this instance is whether the proposed wind farm is likely to detract from the existing view to an extent that visitors would no longer be attracted to this prominent location to take in the vista. It is considered that this would not be the case and, in fact, the number of visitors may even increase given the opportunity to view a wind farm from this somewhat unique perspective. On the basis of this reason and those outlined above, the magnitude of the visual impact is deemed to be low. Note: Flashing warning lights will be mounted on the hubs of turbines 1 – 7 as a mitigation measure to reduce the potential for Whooper Swan turbine collision during poor light conditions or inclement weather (fog etc.). These lights will be in use from November to March inclusive, for 1 or 2 hours at dusk. Whilst the lights will generate a brief visual impact during these periods, this will always coincide with times when the amenity of the vista is at its lowest due to poor visibility. Similar levels of impact will be by the warning lights at other viewing locations, particularly in the local area.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual	Receptor	Visual Impact	Significance of Visual

	Sensitivity	Magnitude	Impact
	High	Low	Moderate-slight

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC4	Local road at Togher	N	3.4km	31
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A sensitive landscape area - Local community views			
Receptor Sensitivity	Medium			
Existing View	This is a broadly panoramic vista to the northeast from a slightly elevated location associated with Croghan Hill. There are several houses on this crest of high ground oriented to take in the vista. The view encompasses an open pastoral context in the foreground, which gives way to cutaway bog, conifer plantations and scrub on the plains to the northeast. Several low hills in the distance reveal further pastoral land use, which is typical in this area where comparatively better drainage occurs. The Lagan Cement factory is a distinctive feature on the distant skyline at the centre of the depicted view.			
Visual Impact of Yellow River Wind Farm	The proposed turbines are spread right across this north-easterly vista at a range of scales depending on relative distance. The nearest turbines are seen at a considerable scale, but they do not appear overwhelming in relation to the underlying land form and land use patterns. The easternmost cluster of turbines is seen at a much less noticeable scale and they are partially screened by vegetation. The proposed turbines are easily the most distinctive feature within the vista and they occupy the vast majority of it in terms of lateral extent. For these reasons the development is deemed to have a dominant visual presence. The proposed wind farm is seen in a legible arrangement where the three dimensional layout clearly accounts for the range in apparent turbine size. The generous linear spread of the turbines largely avoids turbine overlap and reduces the potential for visual clutter. The other side to this is that the lateral extent of the scheme is fairly unrelenting across the broad vista. Contextually, the turbines have a strong thematic relationship with the underlying cutaway bog in terms of the association with energy production. The turbines are also well assimilated in relation to scale and extent within the flat terrain and broad land cover pattern. On balance of the reasons outlined above the visual impact magnitude is deemed to be high.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Medium	High	Major-moderate	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC5	Garr Road at Corbetstown Bridge	NW	0.55km	7
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - Local community views			
Receptor Sensitivity	Low			
Existing View	This is a relatively uncontained yet short distance vista to the northwest. The low degree of containment compared to much of the local area is due to the low height of roadside vegetation and hedgerows in the foreground. Nonetheless, this vegetation and a low ridge limits the view to several hundred metres. Otherwise this is a typical view in the local rural context of fields, hedgerows and occasional dwellings.			
Visual Impact of Yellow River Wind Farm	The northernmost cluster of turbines are seen at a considerable scale from this short distance and will be easily to most noticeable element within the view. The turbines are fully revealed to the viewer and occupy much of the available view to the northwest in terms of lateral extent. For these reasons the proposed wind farm is considered to have a Highly dominant visual presence from here. Aesthetically, the turbines are seen in a clear and comprehensible manner with a strong sense of perspective generated between the nearest and furthest units. However there is a conflict of scale between the turbines and the finer grain of the fields and houses in the foreground. Overall, the magnitude of the visual impact is deemed to be high.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	High	Moderate-slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC6	Garr Road at Garr	E&W	1.3km	19
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - Local community views			
Receptor Sensitivity	Low			
Existing View	This location on the Garr Road affords 360° views with only a minor degree of containment by hedgerow vegetation due to the absence of tall vegetation at the roadside. However, the view is not particularly expansive given the flat terrain.			

	The typical rural view consists of pastoral fields to the north and south of the road with a range of tree lines and lower hedgerows containing them.		
Visual Impact of Yellow River Wind Farm	The turbines to the east are seen at a considerably larger scale than those to the west due to the comparative viewing distance. Although the scale of turbines is not dominating at this distance there is a sense of being surrounded by turbines with little respite. Consequently, the visual presence of the development is deemed to be dominant. The proposed turbines are seen in a relatively unambiguous manner overall, but with some instances of turbine overlap and blade sets rotating against intervening vegetation in perspective. The scale of the turbines does not contrast strongly against other elements of the view, but the appearance of turbines throughout a number of aspects of the vista has a negative effect on visual amenity. For the reasons outlined above the magnitude of the visual impact is judged to be high.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Low	High	Moderate-slight

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
LC7	Local Road at Ballyburley	NW	1.2km	9
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - Local community views			
Receptor Sensitivity	Medium			
Existing View	This is a broad open vista to the northwest from a local road at Ballyburley. In this vicinity the slight increase in ground level in comparison to the basin landscape to the north results in more panoramic views from the surrounding dwellings. Thus there is an increased degree of receptor sensitivity in comparison to most of the other Local Community (LC) views assessed. As well as the slightly increased elevation there is also a low level of screening in the foreground, which also contributes to the extent of available views. Otherwise this is typical rural scene for this area with large pastoral fields, mixed species hedgerows and occasional farmsteads.			
Visual Impact of Yellow River Wind Farm	Three of the proposed turbines are seen at a considerable scale due to their close proximity to the VRP. The remainder are seen in two clusters at a smaller scale and they are substantially screened by intervening hedgerow vegetation. The proposed wind energy development will be the most distinctive element within the view but is not overwhelming in terms of scale. It has a broad lateral extent, but many of the more distant turbines are barely visible due to screening. On balance the visual presence is in the order of dominant to co-dominant.			

	In terms of aesthetics, the three most prominent turbines draw the eye and they are seen in a clear and comprehensible manner. They do not cause a dramatic conflict of scale in relation to other landscape elements in this broad vista. The more distant turbines are seen in a more ambiguous manner with blade sets rotating within the tops of intervening trees and hedgerows. This is ameliorated considerably by the degree of screening. Due primarily to the visual presence of the scheme at this short distance, the magnitude of the visual impact is deemed to be high.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Medium	High	Major-moderate

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CPI	Milltownpass	S	4.3km	5
Representative of:	- An area identified on the ZTV map as having a theoretical view of the proposed turbines - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is a limited view to the south from the R446 as it passes through the settlement of Milltownpass. Views to the south are largely screened by buildings and vegetation within the village. It is accepted that there may be some localities particularly within the private realm where clearer vistas are available. The foreground of this vista is typical of an urban fringe with several houses lining the road with small fields and sporadic trees and low hedgerows beyond. These foreground trees provide windows of view between them to the south.			
Visual Impact of Yellow River Wind Farm	The proposed turbines are substantially screened by foreground vegetation at this location, although several can be seen in a gap between screening elements. Only the blade sets of these turbines are revealed above a more consistent band of vegetation in the middle ground. Although these will be barely discernible to passing motorists they will be a permanent part of the vista for some local residents who may also see a greater number of the proposed turbines. Even in the worst case scenario the turbines are likely to be sub-dominant within the southerly vista from Milltownpass. Aesthetically, the partial view of turbine blades rotating just above intervening vegetation, such as this, can lead to visual clutter and ambiguity. The paradox is that a clearer view of the turbines might lead to a higher degree of visual presence, but a lesser degree of ambiguity. Under either scenario the magnitude of visual impact from Milltownpass is deemed to be low.			

Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.
	Visual Receptor Sensitivity Visual Impact Magnitude Significance of Visual Impact
	Low Low Slight-imperceptible

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP2	Rochfortbridge	SE	3.2km	4
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines. - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is a southerly view from the southern outskirts of Rochfortbridge. The view is aligned with the R400 regional road which goes on to dissect the site, however, not before it passes over the M6 motorway. The R400 can be rising up the motorway embankment in the distance. Another significant feature of this view is a large electricity pylon and its associated lines. When coupled with the lighting poles that link to the M6 there is a high degree of visual clutter associated with this view. Views to the south are not readily afforded from within the settlement of Rochfortbridge. Even where foreground screening might allow extended views, these tend to be truncated by the overpass embankments of the M6 motorway.			
Visual Impact of Yellow River Wind Farm	Several of the proposed turbines are visible from this location, but they are substantially screened by intervening vegetation and structures. Two turbine blade sets rise above the vegetation on the alignment of the R400. Despite the degree of screening these components will be seen at a noticeable scale and they will be highlighted by their rotation against the treetops. In the context of this relatively complex vista and given the level of screening, the visual presence is deemed to be sub-dominant to minimal. The proposed turbines will add to the existing sense of visual clutter at this location both as additional structures within the view and also due to the rotation of blades amongst the tree tops in alignment with the R400. Given the low order visual presence of the scheme and the existing context of the view, these effects will only be minor. For the reasons outlined above, the magnitude of visual impact is judged to be low.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Low	Slight-imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP3	Tyrrellspass	E	5.3km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of between 9 and 16 of the proposed turbines - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is an easterly view from the eastern outskirts of Tyrrellspass. A low clipped hedge defines the southern side of the substantial road corridor at this location. Beyond this is a rolling pastoral farming context contained within a shallow basin. This is defined to the east by the embankment of the N52 national secondary road as it links between the R446 and the M6 motorway, forming an overpass of the latter. A line of electricity pylons runs across the near skyline in combination with the lighting poles that line the N52.			
Visual Impact of Yellow River Wind Farm	Whilst the blade sets of a small cluster of the proposed turbines are theoretically visible from here according to the wireframe image, in reality they are screened by foreground vegetation. There are very few other locations within the settlement that are likely to afford a glimpse of the proposed development and thus, its visual presence is deemed to be minimal. Consequently the magnitude of visual impact is negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP4	Rhode	N	0.88km	12
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is a relatively open view to the northwest from the northern outskirts of Rhode. This is facilitated by a large field in the foreground with low hedgerow boundaries. Clumps of taller broadleaf trees provide some enclosure to the scene, which otherwise takes in a planar landscape of farmland in the foreground and peatland beyond. Other distinctive features			

	within the view are the Rhode electricity peaking plant in the central middle ground surrounded by various forms of electricity pylons. The view to the northeast is fully screened by mature vegetation at the roadside.		
Visual Impact of Yellow River Wind Farm	A dozen of the proposed turbines can be seen on the plains beyond the peaking plant. They are seen at a reasonable, but not dominating scale and the visible cluster is relatively confined within the view in terms of lateral extent. The accumulation of foreground structures associated with the peaking plant makes the wind farm a less distinctive feature than it might otherwise be. For these reasons the visual presence is deemed to be co-dominant. The proposed wind farm is well assimilated within the scene in a thematic sense as there is a clear relationship between the turbines and the infrastructure associated with energy production. The cutaway bog is not an obvious feature in this low angle view, but for residents of Rhode it need not be seen to have a thematic influence as it is the defining feature of this area in terms of identity and employment. Whilst the turbines themselves are relatively well spaced and presented in a legible fashion, there is a degree of visual clutter generated in conjunction with the pylons and structure of the peaking plant. On balance of the factors outlined above the visual impact magnitude is judged to be medium.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor	Visual Impact	Significance of Visual Impact
	Low	Medium	Slight

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP4 North	Rhode (Garr Road roundabout)	NE	0.67km	7
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is a fairly unremarkable view approaching the Garr Road roundabout on the R400 from the village of Rhode. The foreground of the view is dominated by the recently upgraded road and new intersection with its associated fencing, light poles and signage. Several dwellings and farm sheds line the road and intersection. On either side of the viewer pastoral farmland can be seen for a short distance before the view is truncated by mature tree lines and hedgerows.			
Visual Impact of Yellow River Wind Farm	A cluster of three turbines occurs a short distance from the viewer just to the right of the intersection and these are seen at a considerable scale above foreground vegetation. Only glimpses of several other turbines are afforded			

	at widely disparate viewing angles between foreground trees. In comparison to the nearer cluster, these are hardly noticeable. In the context of this dynamic vista the visual presence of the turbines is considered to be in the order of dominant to co-dominant. Aesthetically, the trio of close turbines are relatively well presented with a strong sense of perspective between the nearest and furthest. This ameliorates any sense of stacking and the cluttering effect of overlap, which can otherwise occur for turbines with a close lateral association. There is a greater degree of visual ambiguity generated by the remaining turbines appearing sporadically in vegetation gaps throughout the northern quarters of this vista. This is exacerbated by blades sets rotating within the branches of intervening trees in several instances. The character and amenity of this strongly anthropogenic vista is not unduly affected by the proposed turbines. On the basis of these reasons the magnitude of the visual impact is deemed to be high.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Low	High	Moderate-slight

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP5	Edenderry	NW	9km	3
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A centre of population - A major route			
Receptor Sensitivity	Low			
Existing View	This is a view from the centre of Edenderry adjacent to the Grand Canal. There is rare a window of visibility to the northwest at this location on axis with a side street from a slightly elevated location. This is a typical main street setting made up of two storey shops and businesses providing consistent definition to the street.			
Visual Impact of Yellow River Wind Farm	Although the wireframe image indicates that the proposed turbines are theoretically visible from here, in reality, they are screened by a combination of buildings and vegetation. Consequently, the magnitude of the visual impact is deemed to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP6	Mount Lucas	N	8.4km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A centre of population - An intersection of major routes			
Receptor Sensitivity	Low			
Existing View	This is a northward vista from the crossroad settlement of Mount Lucas, which occupies a ridge of slightly elevated ground. This particular view takes in the rear yards of dwellings that line the R400 near its intersection with the R402. These are bounded by a series of small pastoral fields with low hedgerows. The skyline is defined by a band of vegetation on the crest of a low ridge a short distance away.			
Visual Impact of Yellow River Wind Farm	Despite all of the proposed turbines being theoretically visible from here, the screening provided by buildings and, in particular, the vegetation on the near skyline restricts this. As a result, the magnitude of the visual impact is negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
CP7	Clonbulloge	NNW	12.5km	1
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A centre of population			
Receptor Sensitivity	Low			
Existing View	This is a broad, open view to the north from a short distance to the west of the settlement of Clonbulloge. A large pastoral field occupies the foreground and this is flanked by a mature conifer plantation to the east. At a much greater distance to the north the flat skyline is defined by a band of vegetation that includes conifer plantations and hedgerows stacked in perspective. The most distinctive singular feature within view is the new ESB power peaking plant at Ballykilleen. This tall structure and associated chimney is seen in silhouette on the skyline.			
Visual Impact of Yellow River Wind Farm	The blade tips of the proposed turbines will be seen just above the band of vegetation that defines the skyline. The rotation of the blades against the skyline is likely to highlight them within the vista. However, this is			

	balanced against the effects of atmospheric perspective (the fading of distant objects) at this considerable distance, particularly as they will have a low tonal contrast against a backdrop of sky. On balance the visual presence is considered to be minimal. Aesthetically, the view of turbine blades rotating against the skyline in silhouette is undesirable as it can lead to visual irritation and ambiguity. However, in this instance these effects are strongly diluted by the low order visual presence described above. Overall, the magnitude of the visual impact is deemed to be low.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Low	Low	Slight-imperceptible

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR1	N4 at The Downs	S	10.8km	0
Representative of:	An area identified on the ZTV map as having a theoretical view of all of the proposed turbines A major route An amenity feature (The Royal Canal and Royal Canal Way)			
Receptor Sensitivity	Low			
Existing View	This is a brief window of view to the southwest between sections of roadside vegetation on the N4 national route near the significant settlement of Mullingar. It also represents a point at which the Royal Canal and its associated walking route run immediately adjacent to the road. The viewing location is dominated by this major transport route corridor including the Canal and towpath. The break in vegetation affords a view of a heavily vegetated pastoral landscape beyond to the south.			
Visual Impact of Yellow River Wind Farm	Despite the foreground window of view towards the proposed wind farm, the secondary layer of screening provided by the dense band of broadleaf trees beyond effectively screens the development. Consequently the magnitude of visual impact is deemed to be negligible.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR2	M6 overpass at Kinnegad	SW	5.2km	20
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - An intersection of major routes (R148/M6) - A centre of population (Kinnegad)			
Receptor Sensitivity	Negligible			
Existing View	This is a slightly elevated panoramic vista to the southwest from the R148 overpass of the M6 motorway near Kinnegad. The view is dominated at the lower level by the M6 motorway corridor and the associated 'on' and 'off' ramps including four chains of light poles. Above the motorway cutting the terrain rises gently to the south enclosing the vista with a low ridge a short distance away. A prominent feature on this ridge is the substantial scale Lagan cement factory consisting of several tall silo structures and a chimney. Otherwise the skyline is defined by layers of hedgerow vegetation.			
Visual Impact of Yellow River Wind Farm	The majority of the proposed turbines will be seen rising above the vegetated skyline to varying degrees depending on relative proximity. The upper halves of two of the nearest turbines are revealed, whilst only the blade sets and blade tips of the remainder can be seen. In the context of this busy and cluttered vista the turbines will be a noticeable, but not dominating feature. Equally, the scale and lateral extent of the scheme is reasonable, but not overwhelming within this panoramic vista. Thus, the level of visual presence is considered to be in the order of co-dominant to sub-dominant. Aesthetically, the proposed turbines make a significant contribution to the already considerable level of visual clutter within this view. Turbine blades rotating on the skyline also causes some visual irritation and ambiguity. An example of this type of effect is the turbine seen in close alignment with the cement factory as this confuses the scale and spatial relationship between these elements. On the basis of the above factors and in the context of this already complex and cluttered vista, the magnitude of impact is deemed to be medium.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Negligible	Medium	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR3	M6 at Hardwood	S	2.4km	22
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A major route			
Receptor Sensitivity	Low			
Existing View	This is a broad and relatively open vista from a section of the M6 motorway that is 'at grade' with the surrounding landscape. The viewing location is dominated by the road corridor and ancillary drainage and fencing. Beyond this to the south is a combination of marshy scrubland and marginal pasture. This is followed by a band of mature conifer forests that provide a low level of containment to the vista in the middle distance.			
Visual Impact of Yellow River Wind Farm	The proposed turbines will be seen rising above the conifer plantations throughout the southerly aspects of the vista at relatively close quarters. The nearest cluster of turbines occurs at an oblique angle to the road immediately to the southeast. Comparatively smaller turbines can be seen beyond this initial cluster. A loosely spaced string of turbines then leads to the southwest where another dense grouping of turbines is aligned with the road. The turbines will be the most distinctive element in this relatively uncomplicated view. When this is added to the close proximity and broad lateral extent of the scheme it is considered to have a visual presence in the order of dominant to co-dominant. The turbines are well assimilated in this productive landscape setting and will not unduly alter the character of the view. In terms of aesthetics, the partially screened view of the turbines beyond the band of conifer forests impacts negatively on the visual legibility of the scheme. The three dimensional layout of the scheme is not apparent other than in the scale differential between turbine clusters. Instead, the uneven profile of the development contrasts against the flat terrain and other horizontal landscape elements. On balance of the above reasons, the magnitude of visual impact is judged to be high.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	High	Moderate-slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR4	R400 overpass of M6	SE	2.4km	17
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A major route			
Receptor Sensitivity	Low			
Existing View	This slightly elevated location on the overpass affords a broad panoramic vista to the south. Aside from the road corridor and associated structures, the foreground of this vista is contained in pastoral farmland. This gives way to a belt of scrub and conifer plantations in the middle distance. The planar landscape is interrupted on the skyline by the domed form of Croghan Hill.			
Visual Impact of Yellow River Wind Farm	Even though the proposed wind farm wraps around a considerable section of this vista, it is the cluster of turbines to the west of the R400 that are most apparent. The substantially screened and comparatively smaller scale eastern cluster will be less noticeable in the context of this nearer cluster. The turbines are seen at significant, but not overbearing scale. They will be a new and distinctive feature of the vista and they are also aligned with Croghan Hill, which is an existing focal point within the view. Overall the scheme is considered to be in the order of dominant to co-dominant in terms of visual presence in the context of this broad and relatively complex vista. The elevated viewing location gives a sense of the landscape context into which the turbines are placed. This provides legibility to the layout pattern and a frame of reference for the differential scale of the turbines. The turbines are also consistent with the productive character of the landscape in view. The loose spacing of the turbines somewhat counteracts the fact that they occupy most of the southerly aspect of the available vista. Although Croghan Hill will remain clearly visible between turbines, there is a sense of intrusion on the view of this locally iconic landscape feature. On the basis of these reasons the magnitude of the visual impact is deemed to be high.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	High	Moderate-slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
MR5	R400 at Derrynagreenagh	E & W	1.4km	27
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - A major route			
Receptor Sensitivity	Low			
Existing View	This location affords views across vast cutaway bog for almost 360°. Regenerating scrub can be seen at the fringes of the peatland along with narrow horizontal bands of conifer plantations lining the distant horizons. Croghan Hill is a distinctive feature of the westerly vista that also provides a variation in the land use and relief from the strongly horizontal nature of the view. Although there is little built development in view, the landscape has a post-industrial character.			
Visual Impact of Yellow River Wind Farm	The proposed turbines will completely surround a viewer at this location but not with an intensity or scale that is overwhelming or uncomfortable. Despite this VRP being located near the geographical centre of the proposed development none of the individual turbines is in close enough proximity that it is seen at a large scale or significantly greater scale than the remaining turbines. The turbines will undoubtedly be the most prominent and defining feature of this homogenous vista. Thus, the visual presence of the development is deemed to be dominant. From this location the proposed turbines are seen in a clear and comprehensible manner. Although they are generally located in the landscape beyond the fringes of the cutaway bog, they are perceived to be a part of the peatland landscape from this VRP. This has positive connotations for the energy production relationship between these landscape elements. The viewer gets a sense that one declining land use that has been important to the local economy and identity for several decades is being replaced by a compatible and sustainable alternative. The only minor issue is the intrusion of one of the turbines on the view of Croghan Hill. On balance of the high order visual presence and low order affect on visual amenity, the magnitude of visual impact is judged to be medium.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Low	Medium	Slight	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
AV1	R161 / Royal Canal Way at Molrick	SW	12.5km	0
Representative of:	- An area identified on the ZTV map as having a theoretical view of between 9 and 16 of the proposed turbines - An amenity feature - A major transport route			
Receptor Sensitivity	Medium			
Existing View	This is a pleasant pastoral view to the west from an elevated bridge over both a national railway line and the Royal Canal at Molrick. This is a relatively contained vista due to the mature broadleaf tree lines that define the field boundaries in the vicinity. A low ridge also assists in truncating the view to the west.			
Visual Impact of Yellow River Wind Farm	Although the wireframe image indicates that some of the proposed turbines would be theoretically visible from here, the level of screening will prevent this from occurring in reality.			
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.			
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact	
	Medium	Negligible	Imperceptible	

Viewshed Reference Point		Direction of View	Distance to nearest turbine:	Number of turbine nacelles visible:
AV2	Grand Canal Way at Ticknevin Bridge	NW	15.2km	1
Representative of:	- An area identified on the ZTV map as having a theoretical view of all of the proposed turbines - An amenity feature			
Receptor Sensitivity	Medium			
Existing View	This is a north westerly view along the Grand Canal and its adjacent towpath from an elevated bridge over it. This is a channelled vista defined on either side of the Canal by mature broadleaf vegetation. Consequently, the only long distance aspect of the vista is directly to the northwest along the Canal. Several dwellings line the Canal at this bridge crossing giving the setting a strong sense of place.			
Visual Impact of Yellow River Wind Farm	Only one of the proposed turbines will be visible from here, but it will occupy the focal point of the vista on the axis of the canal. Despite the considerable viewing distance of nearly 20km the viewer's eye will be naturally drawn towards the turbine. Several factors will counter the prominent location of the turbine including; its small scale; its low level of			

	tonal contrast against the sky and; the effect of atmospheric perspective (the fading of distant objects). On balance, the visual presence is deemed to be sub-dominant. Aesthetically, the single turbine has a sculptural quality that adds to the picturesque nature of this vista by providing a distant focal point. The positive connotations of this are actually diminished somewhat by the low level of visual presence. Overall, the magnitude of the visual impact is judged to be low.		
Summary	Based on the assessment criteria and matrices outlined in section 11.2.5 the significance of visual impact is summarised below.		
	Visual Receptor Sensitivity	Visual Impact Magnitude	Significance of Visual Impact
	Medium	Low	Slight

11.4.4 Cumulative Impacts

The Scottish Natural Heritage (SNH) Guidelines relating to the Cumulative Effects of Wind Farms (2005) identify that cumulative impacts on visual amenity consist of combined visibility and sequential effects. The same categories have also been subsequently adopted in the Landscape Institute's 2013 revision of the Landscape and Visual Impact Assessment Guidelines.

'Combined visibility occurs where the observer is able to see two or more developments from one viewpoint. Combined visibility may either be in combination (where several wind farms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various wind farms).'

'Sequential effects occur when the observer has to move to another viewpoint to see different developments. The occurrence of sequential effects may range from frequently sequential (the features appear regularly and with short time lapses between, depending on speed of travel and distance between the viewpoints) to occasionally sequential (long time lapses between appearances, because the observer is moving very slowly and / or there are large distances between the viewpoints.)'

Cumulative impacts of wind farms tend to be adverse rather than positive as they relate to the addition of moving manmade structures into a landscape and viewing context that already contains such development. Based on guidance contained within the SNH Guidelines relating to the Cumulative Effects of Wind Farms (2005) and the DoEHLG Wind Energy Guidelines (2006), cumulative impacts can be experienced in

a variety of ways. In terms of landscape character, additional wind energy developments might contribute to an increasing sense of proliferation. A new wind farm might also contribute to a sense of being surrounded by turbines with little relief from the view of them. The term 'skylining' is used in the SNH Guidelines to describe the effect *"where an existing wind farm is already prominent on a skyline the introduction of additional structures along the horizon may result in development that is proportionally dominant. The proportion of developed to non-developed skyline is therefore an important landscape consideration"*.

In terms of visual amenity, there is a range of ways in which an additional wind farm might generate visual conflict and disharmony in relation to other wind energy developments. Some of the most common include visual tension caused by disparate extent, scale or layout of neighbouring developments. A sense of visual ambivalence might also be caused by adjacent developments traversing different landscape types. Turbines from a proposed wind farm that are seen stacked in perspective against the turbines of nearer or further developments tend to cause visual clutter and confusion. Such effects are exacerbated when, for example, the more distant turbines are larger than the nearer ones and the sense of distance is distorted. Table 12.9 below provides criteria for assessing the magnitude of cumulative impacts.

Magnitude of Impact	Description
Very High	• The proposed wind farm will strongly contribute to wind energy development being the defining element of the surrounding landscape. • It will strongly contribute to a sense of wind farm proliferation and being surrounded by wind energy development. • Strongly adverse visual effects will be generated by the proposed turbines in relation to other turbines.
High	• The proposed wind farm will contribute significantly to wind energy development being a defining element of the surrounding landscape. • It will significantly contribute to a sense of wind farm proliferation and being surrounded by wind energy development. • Major adverse visual effects will be generated by the proposed turbines in relation to other turbines.
Medium	• The proposed wind farm will contribute to wind energy development being a characteristic element of the surrounding landscape. • It will contribute to a sense of wind farm accumulation and dissemination within the surrounding landscape. • Adverse visual effects might be generated by the proposed turbines in relation to other turbines.
Low	• The proposed wind farm will be one of only a few wind farms in the surrounding area and will be viewed in isolation from most receptors. • It might contribute to wind farm development becoming a familiar feature within the surrounding landscape. • The design characteristics of the proposed wind farm accord with other schemes within the surrounding landscape and adverse visual effects are not likely to occur in relation to these.
Negligible	• The proposed wind farm will most often be viewed in isolation or occasionally in conjunction with other distant wind energy developments. • Wind energy development will remain an uncommon landscape feature in the surrounding landscape. • No adverse visual effects will be generated by the proposed turbines in relation to other turbines.

Table 11.9: Magnitude of cumulative impact

Cumulative Baseline

The only other wind energy development within the study area is the 28turbine Mount Lucas Development, which is currently under construction. This lies within an area of Bord na Mona owned, cutaway peatland approximately 10km to the south of the Yellow River proposal site.

Department of Environment, Heritage and Local Government (DoEHLG) 'Wind Energy Development Guidelines' (2006)

The above guidelines provide direction on wind farm siting and design criteria for a number of different landscape types. This proposal site is considered to be contained within a landscape context that is consistent with elements of both the 'Flat Peatland' and 'Hilly and flat farmland' landscape types identified within the guidelines. The guidance with respect to cumulative impact in these landscape types is;

Flat Peatland - "The openness of vista across these landscapes will result in a clear visibility of other wind energy developments in the area. Given that the wind energy developments are likely to be extensive and high, it is important that they are not perceived to crowd and dominate the flat landscape. More than one wind energy development might be acceptable in the distant background provided it was only faintly visible under normal atmospheric conditions".

Hilly and flat farmland - "It is important that wind energy development is never perceived to visually dominate. However, given that these landscapes comprise hedgerows and often hills, and that views across the landscape will likely be intermittent and partially obscured, visibility of two or more wind energy developments is usually acceptable".

The proposed Yellow River Wind Farm will almost never be viewed in conjunction with the Mount Lucas Wind Farm due to the level of screening within this predominantly flat landscape. The only locations that may afford views of both schemes are likely to be on elevated ground in the vicinity of Croghan Hill, which lies between the developments. In such cases the two wind farms will be visible in opposite directions or at widely disparate viewing angles. It is therefore considered

that the proposal is not in contradiction to the Wind Energy Guidelines (2006) with regard to cumulative effects.

Cumulative Zone of Theoretical Visibility

The cumulative ZTV map indicates that there would be a relatively high degree of intervisibility between the proposal and the Mount Lucas development. As was discussed in relation to the standard ZTV map, these maps are of little value in a flat landscape where hedgerow vegetation and other forms of screening limit views to a relatively short distance. This was reinforced by the assessment of visual impacts from Viewshed Reference Points, where little or no visibility tends to occur beyond 5km of the development except from elevated vantage points.

Cumulative Impact Assessment

As discussed above, the Mount Lucas Wind Farm and the proposed Yellow River Wind Farm will seldom be visible in conjunction with each other. Where this might occur from elevated locations between the developments, the nature of the cumulative view will be 'successional' with the viewer having to turn to see each wind farm separately. The only receptor affording 'sequential' views is the R400 Regional road, which dissects the proposed Yellow River Wind Farm and passes a short distance to the east of the Mount Lucas development. Given the distance between the developments, the travelling time and the fact that they each only become apparent in relatively close proximity, this sequential cumulative effect is relatively minor.

In terms of the cumulative effect on the overall landscape character of the study area wind farms will no longer be a novel landscape feature. Instead, there will be a sense that they are becoming a familiar form of development in and around the cutaway peatland areas of County Offaly. At the present levels of development this is more likely to have positive consequences for additional developments by establishing wind farms as a characteristic feature of the receiving landscape. More so than negative consequences in terms of cumulative impacts.

In accordance with the criteria set out in table 11.9 above, the additional cumulative impact generated by the proposal is deemed to be **Low**.

11.5 MITIGATION MEASURES

Given the highly visible nature of commercial wind energy developments it is not generally feasible to screen them from view using on-site measures as would be the primary form of mitigation for many other types of development. Instead, landscape and visual mitigation for wind farms must be incorporated into the early stage site selection and design phases. A principal consideration in this regard was the Department of Environment, Heritage and Local Government's Wind Energy Development Guidelines (2006).

11.5.1 DoEHLG Wind Energy Development Guidelines (2006)

As outlined at section 11.3.2 above the Wind Energy Development Guidelines (2006) provide guidance on wind farm siting and design criteria for a number of different landscape types. The proposal site is considered to have characteristics of both the 'Flat Peatland' and 'Hilly and Flat Farmland' landscape types from the Guidelines.

It is considered that the flat and open nature of the site is most characteristic of the 'flat peatland' landscape type, whilst only the land cover characteristics are reflective of the 'Hilly and flat farmland' landscape type. Thus, for most of the criteria it is the flat peatland guidance that is most applicable. The design of the proposed wind farm is in general accordance with this, particularly in respect of the spatial extent of the development and the height of turbines. The sinuous organic layout of the scheme is somewhat in contradiction to both the peatland and farmland sets of guidance, which suggest a more formal arrangement. However, this layout responds to the irregular shape of the peatlands and the marginal scrub areas that provide a transition to the more regular patterns of farmland. This is considered to be an appropriate response that acknowledges the intent of the guidelines, but adapts to the site specific factors.

A number of general mitigation measures are also included below:

- matt non-reflective finishes will be used on all turbine components;
- transmission lines between individual turbines and the substation will be placed underground;
- counter rotation of blade sets will be avoided;

- the number and extent of new access tracks will be kept to a minimum and properly landscaped immediately following completion of works. Such landscaping will include reinstating original vegetation along verges and repairing any wheel ruts;
- special care will be taken to preserve any features, which contribute to the landscape character of the study area. Any damage to existing hedgerows from transporting the turbines will be rectified; and

A high standard of design will be applied to all structures associated with the substation considering not only its function but also the aesthetic quality, in order to minimise any sense of intrusion. The proposed development will provide colour harmony and adequate screening of the substation using tree species typical of the surrounding area.

11.6 RESIDUAL IMPACTS

Landscape and visual mitigation measures have been incorporated into the design of the scheme from its early stages. Therefore, the proposed wind farm presented as the subject of this application already incorporates any landscape and visual mitigation measures. Unlike for many of the other EIA topics, the residual impacts of the proposed wind farm are essentially the same as assessed in the predicted landscape and visual impacts section (11.3) above.

11.7 CONCLUSION

A summary table is provided below, which collates the assessments of landscape and visual impacts. A discussion of the results is provided thereafter.

Landscape Impact			
Landscape Sensitivity		Landscape Impact	Landscape impact Significance
Low		Low	Slight-imperceptible
Visual Impact			
VRP	Visual Receptor Sensitivity	Magnitude of visual impact	Visual Impact Significance
KV1	Very High	Negligible	Slight
KV2	Very High	Negligible	Slight
DR1	Medium	Medium	Moderate
DR2	Medium	Negligible	Imperceptible
DR3	Medium	Negligible	Imperceptible
DR4	Medium	Negligible	Imperceptible
DR5	Medium	Negligible	Imperceptible
LC1	Low	High	Moderate-slight
LC2	Low	Medium	Slight
LC3	High	Low	Moderate-slight
LC4	Medium	High	Major-moderate
LC5	Low	High	Moderate-slight
LC6	Low	High	Moderate Slight
LC7	Medium	High	Major-moderate
CP1	Low	Low	Slight-imperceptible
CP2	Low	Low	Slight-imperceptible
CP3	Low	Negligible	Imperceptible
CP4	Low	Medium	Slight
CP4North	Low	High	Moderate-slight
CP5	Low	Negligible	Imperceptible
CP6	Low	Negligible	Imperceptible
CP7	Low	Low	Slight-imperceptible
MR1	Low	Negligible	Imperceptible
MR2	Negligible	Medium	Imperceptible
MR3	Low	High	Moderate-slight
MR4	Low	High	Moderate-slight
MR5	Low	Medium	Slight
AV1	Medium	Negligible	Imperceptible
AV2	Medium	Low	Slight
Cumulative Impact			Low

Table 11-10: Summary Impact Assessment

11.7.1 Landscape Impacts

The assessment of landscape impacts is based on a comparison of landscape sensitivity against the magnitude of effects on the physical landscape and on landscape character. In this instance the judgement of sensitivity is 'Low' on the basis

that although there are some specific landscape features of high sensitivity within the study area its overriding landscape character is a robust and anthropogenic one often based on a variety of strategic land uses and values associated with productivity.

In terms of the magnitude of landscape impacts, there will be physical impacts on the land cover of the site as a result of this development. These will be very minor in the context of already highly modified land and of a scale that is typical of other land uses in the vicinity. With regard to landscape character, the scale and nature of the development is well assimilated into this open landscape with broad land use patterns. There is also a strong thematic synergy between the cutaway peatlands and the wind turbines with respect to energy production. For these reasons the magnitude of landscape impact is deemed to be low.

On the basis of the judgements relating to landscape sensitivity and the magnitude of the landscape impact expected from this proposal, the overall significance of impact on the landscape is deemed to be 'Slight-imperceptible'.

11.7.2 Visual Impacts

Visual impacts were assessed on the basis of visual receptor sensitivity versus the magnitude of the visual impact. The magnitude itself is the function of the visual presence of the proposal and its effect on visual amenity. Visual impacts were assessed at 29 visual receptors throughout the study area.

As can be seen from the summary table above, visual receptor sensitivity ranges considerably from Very High to Negligible, but with the vast majority (26 of the 29) in the range of medium to low. This reflects the strongly anthropogenic nature of the study area generally as well as the rarity of iconic visual receptors or vast elevated views. The main exception being the view from Croghan Hill (LC3), which is deemed to be of high sensitivity. This level of sensitivity relates mostly to the vast nature of the view and the cultural heritage values associated with this feature rather than any sense of the naturalistic. Views from Sliabh na Callaighe and the Hill of Tara were also considered at the request of Meath County Council. Although these are considered to be receptors of very high sensitivity they are both approximately twice the distance of the principle study area boundary.

The visual presence of the development varies widely across the range of viewpoints, and is strongly dictated by distance from the development, but not in the traditional sense. For most wind farms in upland areas scale in relation to distance has a more linear relationship with visual presence. In this instance a third factor comes into play and this is how the scale of the turbines in relation to viewing distance is affected by the relative distance of screening elements, particularly hedgerows. The pattern that emerges is that within the flat rural landscape (the majority of the study area) the proposed turbines become almost completely screened from view beyond approximately 3-5km. The visual presence judgments from VRP's within this range tends to be in the order of highly dominant to co-dominant, whereas, immediately beyond this threshold the visual presence falls away abruptly to sub-dominant and minimal. Finding VRP locations in the outer half of the study area with even potential views of the proposed wind farm was one of the more challenging aspects of this assessment.

In many cases the effect of the proposal on visual amenity has an inverse relationship to its visual presence and is also related to screening. From close or elevated locations where the full height of the turbines and the spatial characteristics of the layout are revealed to the viewer, there is a high degree of visual legibility. The complimentary relationship between the turbines and the cutaway bog in terms of both scale and function is also most apparent from these locations. The best example of this is the view from Croghan Hill (LC3). Conversely, from VRP locations where substantial portions of the turbines are screened by vegetation, visual ambiguity arises in relation to the relative scale of turbines and the undulating profile of the scheme within the flat landscape. Instances of turbine blades rotating in an irritant manner against intervening tree tops also become much more frequent within such views. These effects are typified by the view from LC1, but as illustrated above, they are limited to a fairly narrow concentric band before the turbines become fully screened.

On the basis of the factors of visual presence and visual amenity described above, the magnitude of visual impacts ranges between High and Negligible, but with all of the high level impacts occurring within 3km of the site.

11.7.3 Cumulative Impacts

There is currently only one other wind energy development within the study area and this is the 28 turbine Mount Lucas development that is currently under construction

10km to the south of the proposal site in a similar landscape context. There is likely to be a 'succession' view (opposite directions) of both developments afforded from some elevated locations around Croghan Hill, but from almost nowhere else. There will also be a delayed 'sequential' view of both developments for people travelling along the R400 regional road between Rochfortbridge and Portarlinton. Overall, the cumulative effect is deemed to be Low.

11.7.4 Overall Significance of Impact

The highest significance of impact is judged to be Major-moderate and this occurs at LC4 and LC7 due to the combination of a medium level of receptor sensitivity and a high magnitude of visual impact. This is not considered to be a critical level of impact in this instance as the value of the views relates to their vastness, whereas the context of the views is largely cutaway bog and productive rural landscape. The proposed wind farm is, therefore, well assimilated in the vista in regards to its scale and function. In all other instances that a high visual impact magnitude is attributed the overall significance is diminished by the low level of sensitivity at that receptor. Likewise, at the only visual receptor within the study area considered to have a high level of sensitivity (LC3 at Croghan Hill), the low order magnitude of impact balances the overall significance. This is due to the remarkable assimilation of the proposed wind farm within the view and the landscape context coupled with few adverse aesthetic considerations. It is notable that 19 of the 29 VRP's register an impact significance of slight or imperceptible.

Based on the assessment contained herein, the overall significance of impact for the proposed Yellow River Wind Farm is considered to be consistent with a Moderate impact as defined in the EPA Guidelines. That is; *"An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends"*.

11.8 REFERENCES

Wind Energy Development Guidelines, Department of Environment, Heritage and Local Government, 2006

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Irishtrails: <http://www.irishtrails.ie/>

Discover Ireland: <http://www.discoverireland.ie/>

12.0 MATERIAL ASSETS

12.1 INTRODUCTION

This chapter describes the potential impacts the proposed Yellow River Wind Farm development could have on physical material assets. The potential impact of the proposal on the lands within the site and the surrounds is discussed under the following headings:

- Agriculture and Forestry
- Natural Resources of Economic Value

The impact of the construction of the proposed wind farm on access roads and local community is discussed under the following heading:

- Road Network
- Local Tourism Amenity

This chapter also describes the potential impacts the proposed development could have on other physical material assets in the area, including the following:

- ESB Network
- Telecommunications
- Air Traffic

For each topic a description of the existing environment is provided along with an analysis of what, if any, impact could be predicted and the mitigation measures that can be implemented to reduce or remove the impact.

12.2 EXISTING ENVIRONMENT

According to the Agroclimatic Atlas of Ireland published by AGMET, the Joint Working Group on Applied Agricultural Meteorology, in 1996, the midlands of Ireland are generally unsuited to tillage crops and are generally more suited to grazing and peat harvesting.

The majority of the proposed site for the Yellow River Wind Farm development is covered by improved agricultural grassland and flat cutover peatland. The site of the proposed development has the following characteristics:

- The elevation of the site ranges from 75 to 93 mOD.
- The site is relatively flat and consists of mainly pasture land with a couple of land holdings being used as arable land.
- There are also areas within the development in which a turf cutting operation and quarry are in place.
- A number of residential properties and farm buildings are located within the site boundaries.
- The prevalent weather pattern is wet and windy.

12.3 AGRICULTURAL PROPERTIES

12.3.1 Introduction

This section describes the regional and local agricultural practices as well as those specific to the site. A description of the effects, if any, the proposed development may have on local agricultural practices, along with mitigation measures designed to reduce or remove negative effects, where possible, is also outlined.

12.3.2 Predicted Impact

The total land take of the turbine foundations ($255 \text{ m}^2 \times 32 = 8,160 \text{ m}^2$) and hardstands ($1,250 \text{ m}^2 \times 32 = 40,000 \text{ m}^2$) is approximately $48,160 \text{ m}^2$ and the upgrading of existing roads ($5,916 \text{ m} \times 2 \text{ m}^{26} = 11,832 \text{ m}^2$) and construction of new trackways ($18,275 \text{ m} \times 5.5 \text{ m} = 100,512.5 \text{ m}^2$) and splays ($32,917 \text{ m}^2$) totals $193,421.5 \text{ m}^2$ or 19.34 hectares. The electrical compound will occupy an area of 0.18 hectares of lands located in an industrial business park. The existing internal road infrastructure has been utilised as much as possible so as to minimise the construction of new access roads. The overall effect of the proposed wind farm will be to remove from availability for agricultural use approximately 2 % of the total site area (1,002.234 ha) under the control of the developer.

²⁶ Assuming average upgrade from 3.5m to 5.5m

A description of the land type at each turbine location is set out in Table 12.1.

<i>Turbine Number</i>	<i>Land type</i>
1	Conifer woodland
2	Conifer woodland
3	Improved agricultural grassland
4	Improved agricultural grassland
5	Improved agricultural grassland
6	Improved agricultural grassland
7	Cutover bog
8	Cutover bog
9	Cutover bog / deep peat bogland
10	Cutover bog
11	Woodland/scrub
12	Improved agricultural grassland
13	Improved agricultural grassland
14	Improved agricultural grassland
15	Improved agricultural grassland
16	Improved agricultural grassland
17	Improved agricultural grassland
18	Improved agricultural grassland
19	Improved agricultural grassland
20	Improved agricultural grassland
21	Improved agricultural grassland
22	Improved agricultural grassland
23	Improved agricultural grassland
24	Improved agricultural grassland
25	Conifer plantation
26	Conifer plantation
27	Conifer plantation
28	Improved agricultural grassland
29	Improved agricultural grassland
30	Semi-improved grassland/marginal bogland
31	Improved agricultural grassland
32	Improved agricultural grassland

Table 12.1 – Description of Land Type at each turbine.

Twenty-one turbines are located in improved agricultural grasslands, four turbines are located in cutover bog, six turbines are located within conifer plantation/woodland/scrub, one turbine is located in semi-improved/marginal bogland and three turbines are located in arable land.

The grassland areas are used predominantly as pastureland. Grazing practices can continue unimpeded at these locations. A small area of arable land and conifer plantation will be lost to the development footprint, although these practices can also continue during the operational phase of the wind farm. Therefore, minimal impact is

predicted on agricultural practices at the lands in and around the proposed Yellow River Wind Farm development area.

12.3.3 Mitigation Measures

No significant impacts are predicted on agricultural practices. Therefore no mitigation measures are required.

12.3.4 Conclusion

No significant impacts are predicted on agricultural practices.

12.4 FORESTRY

12.4.1 Introduction

This chapter describes the potential impacts the proposed Yellow River Wind Farm development could have on forestry, along with mitigation measures designed to reduce or remove negative effects, where possible.

12.4.2 Predicted Impact

There are approximately 275 hectares of forestry in the vicinity of the Yellow River Wind Farm site. Four of the proposed turbines are located within forested areas: T1; T25; T26 and T27, and one turbine, T2, is partially located within forestry.

Felling and thinning will be necessary to accommodate the construction and erection of these four turbines and associated works.

Provision of the construction area at each turbine location will require approximately 1.5 hectares for turbines T1; T25; T26 and T27, and approximately 0.77 hectares for T2, which totals 6.77 hectares. These areas include all hardstanding and assembly areas. The estimated loss of forestry due to access roads is approximately 3.63 hectares based on the requirement for approximately 2,425 metres of new access road. This gives a total area for tree felling as a result of the development of approximately 10.4 hectares of the total forested area of approximately 275 hectares. The total area of tree felling required for the proposed development represents approximately 3.8% of the total forested area.

It is not anticipated that there is any requirement for felling to reduce the wake effect from the trees affecting the turbine performance. Mature trees will not be allowed to exceed a height of 20 metres in the immediate vicinity of the turbine. The forested areas on site could be classified as good yield with good tree heights.

It should be noted that manufacturers have different requirements for wake felling. A detailed wake analysis model will be undertaken prior to turbine procurement at which stage the extent of any felling will be determined.

12.4.3 Mitigation Measures

All felling works will be subject to the grant of a felling license from the Forest Service.

Areas totalling 100% of the areas clearfelled will be acquired (10.4 ha) for forestry reinstatement, in accordance with the Forest Service Policy on the Granting of Felling Licenses for Wind Farm Development.

12.4.4 Conclusion

No significant impacts are predicted on forestry.

12.5 NATURAL RESOURCES OF ECONOMIC VALUE

12.5.1 Introduction

This section evaluates the effect on the natural resources of the site and also the resources, which will be used in the locality during the construction phase. Such resources include quarries, hydrocarbon fuels and precious metals.

12.5.2 Existing Environment

There are three active quarries within a 15km radius of the site boundary. The closest quarry, Kilmurrays Quarry, is located adjacent to the proposed site, close to turbine 6 in the townland of Derryarkin. Roadstone quarry is located immediately north of Kilmurrays quarry in the townlands of Derryarkin and Derrygreenagh. Lagan cement plant is located in Killaskillen, Kinnegad, Co. Meath, approximately 5km north of the proposed site. Peat cutting has taken place in the past, and is currently in progress to the south of turbines 8, 9 and 10.

12.5.3 Predicted Impact

By the nature of this project, in that it is relatively non-invasive, no negative affect can be predicted for the site or region. The proposal will take approximately 3 % of the overall site area (990 ha), most of which is under agricultural use. Overall, no significant negative impact on natural resources of economic value can be predicted as a result of this development. No borrow pits are proposed as part of the development. There will be a small positive on the local economy resulting from the utilisation of resources from local quarries for construction of roads and hardstandings.

12.5.4 Mitigation Measures

As no negative impacts are predicted, no mitigation measures are required.

12.5.5 Conclusion

No significant impacts are predicted on the natural resources in the area.

12.6 ROAD NETWORK

12.6.1 Introduction

This section describes the proposed delivery traffic haul route to the site in terms of the national, regional and local road network. A description of the effects from the proposed development is provided along with mitigation measures designed to reduce or remove negative effects where possible.

12.6.2 Proposed Haul Route

It is proposed that all the turbine parts including the tower sections will travel via the Haul Route to the site as shown on **Figure 12.1**. On this route, the delivery traffic will travel from Dublin Port via the Port Tunnel, M50, M4, M6 and R400 to the site. Much of this route is motorway.

Please refer to **Appendix G** for further discussion and photos of the proposed haul route to site.

12.6.3 Predicted Impact

During the construction of site roads, crane hardstands, turbine foundations and substation building, a worst case scenario estimates that the maximum number of

loads to be delivered to site would be approximately **13,989** (total for Civil Works). This includes loads of stone, concrete, reinforcing steel, geo-textiles, electrical cable, switchgear and general building materials. It is proposed to source all imported stone from local quarries.

Due to the underlying ground conditions of the site, there is no possibility that on-site borrow pits will be used to source road making materials. These materials would be delivered to site over a period of 16 months i.e. approximately **876** loads per month or an average of **40** loads per day excluding weekends and bank holidays. All civil construction material would be delivered to site using standard rigid lorries, low-loaders and ready-mix lorries etc.

Turbine parts would be delivered to site over a period of 8 months, after civil works are completed. It is estimated that approximately **304** loads of the various turbine and crane parts would be delivered during this period. The majority of these loads would be classified abnormal loads, and the relevant approvals and permits will be obtained by the developer or appointed haulage contractor in advance of the delivery period.

Following the completion of all construction works, it is estimated that a maximum of **100** loads will be required to remove all temporary on-site equipment and materials e.g. temporary compound, fencing, cabins, storage containers etc.

Therefore, the total number of delivery vehicle visits to the site during the construction phase is estimated to be **14,393**. It is to be noted that this is a 'worst case scenario', based on the assumption that all stone to be used for construction is to be imported. In practice, there may be some localised areas where surplus excavated material (e.g. gravel) can be used for road construction.

The majority of the haul route will follow National and Regional Roads therefore it is not anticipated that any significant widening or strengthening of roads will be required along these sections for delivery vehicles along the haul route.

Works will be required to create a new exit off the Garr Road roundabout.

Road widening to local roads will be carried out in the following locations;

- Widening of approximately 720m of the Greenhills road (L-50112-1) will be required.
- Widening of approximately 535m of Carrick Lane (L-10081-1) will be required.

12.6.4 Mitigation Measures

Prior to the delivery to site of the turbine components, the Developer would consult with Dublin, Offaly and Westmeath County Council Roads Departments, An Garda Siochana, and the National Roads Authority to discuss the requirement for the provision of a Garda escort and any other requirements the various statutory bodies may have. The Developer would also make known the intended timescale for deliveries, and all efforts would be made to avoid school bus runs, church services, peak traffic times etc. Furthermore, all local residents along the affected route would be notified of the timescale of deliveries.

The developer will be required to lodge a bond with the local authority to pay for the full cost of repair to the public roads used for access to the site. The developer will also be required to repair any damage to the roads that has arisen as part of the development pending more permanent repair after construction is complete. However, due to the high standard of roads on the haul route to the site, there will not be any significant damage to the roads.

Other measures will be undertaken to minimise road impact include:

- Any road works/modifications involving the public roads would be discussed and agreed with the roads section of Offaly County Council prior to the commencement of the development.
- A structural assessment of all bridges on the haul route including the stone arch bridge on the R400 should be carried out prior to commencement of construction. Smaller culverts can be temporarily strengthened by placing steel plates on the road surface to give a better distribution of vehicle loads.
- Section 50 consent will be obtained from The Office of Public Works for any new culvert/bridges.
- The condition of all bridges, culverts and road surfaces should be continuously monitored throughout the construction period. In the event that any

deterioration is observed, appropriate remedial action should be agreed with the roads department of Offaly County Council and completed as soon as practical.

- Prior to delivery of turbine components, any overhanging hedgerows should be cut back.
- Abnormal load permits shall be acquired by the turbine supplier prior to delivery, and where necessary, Garda escorts will be utilised to assist the delivery of the largest loads.
- Warning vehicles will be used for the delivery of all large turbine components.
- A trial run to the site with an empty turbine delivery vehicle should be conducted prior to the construction period. Should the trial run highlight any problematic areas, the additional work required would then be discussed and agreed with Offaly County Council.

12.6.5 Conclusion

It is concluded that the proposed route offers the least amount of disruption to local road users. The proposed haul route and any associated works and traffic management plans shall be discussed and agreed with Offaly County Council prior to the commencement of construction.

12.7 ESB NETWORK

12.7.1 Introduction

This section describes the Local ESB network and the anticipated grid connection option. A description of the effects, if any, that would arise from the Yellow River Wind Farm development is provided along with mitigating measures designed to reduce or remove negative effects, where possible.

A developer must apply to the relevant system operator (i.e. ESB Networks or EirGrid) to connect a wind farm. Initially the application is 'queued', along with all other generator connection applications. The regulator, the Commission for Energy Regulation (CER), sets out the criteria to determine when the application enters the connection offer process. At the end of this process the developer will be issued a connection offer. If the terms of the offer are acceptable the developer can sign the offer. Once the offer is executed it then becomes a connection agreement. The processing method for wind farms is discussed further in Chapter 2.

A connection application has been submitted for Yellow River Wind Farm.

12.7.2 Existing Environment

Local Transmission and Distribution Network

The proposed Yellow River Wind Farm is located approximately 1.6 km north of Rhode, Co. Offaly. North Offaly is well serviced with transmission infrastructure with Thornsberry 110kV substation in Tullamore, Cushaling 110kV substation 3km North of Clonbullogue and Derryiron 110kV substation in Rhode. Kinnegad 110kV substation in Westmeath is also located approximately 15km North of Rhode. The Oldstreet –Woodland 400kV line runs approximately 2km South of Rhode while the Shannonbridge –Maynooth 220kV line runs approximately 10km North of Rhode.

Two other 110kV Circuits from Derryiron also traverse the area.

The distribution network in the area consists of a 38kV substation in Edenderry and 2 38kV substations in Tullamore. A 10/20kV network supplies the residential properties in the area.

Please refer to Figure 12.2 for an illustration of the transmission network in the area.

Grid 25

In EirGrid's 2025 Grid Development Strategy (GDS) approximately €310M is expected to be spent on upgrading and new transmission infrastructure in the Midlands region. Grid development in the region will include;

- An additional investment of approximately €310m through upgrading 225km of transmission network and new circuit build;
- Tapping into the existing 400kV line to strengthen the 110kV network around Portlaoise providing capacity to supply the continuing strong growth in Kildare and Laois;
- Reinforcement to cater for continued demand growth in the gateway towns of Athlone, Mullingar and Tullamore;

- Upgrading will facilitate power flows from both renewable and conventional sources and maximise the use of existing power corridors.

Each year the Grid 25 Eirgrid targets are updated in an annual Forecast Statement. The following Grid developments for the Midlands area are listed in Eirgrids 2012 - 2018 Transmission Forecast Statement

- 2013: Cushaling –Mount Lucas – Thornsberry 110kV Line .
- 2014: Balgriffin 110kV Substation
- Beyond 2015: New 220kV Substation at Finntown and establishment of Inchicore –Finnstown – Maynooth 110kV Circuit
- Beyond 2015: Laois 400kV Substation
- Beyond 2015: Mullingar –Kinnegad 110kV Line

Existing, Gate 3 and Gate 4 generation in Co. Offaly

Mount Lucas Wind Farm is currently under construction and will potentially export 79.2 MW of wind generated power to the Grid. Clashnevin Wind Farm is consented to export 3 MW of wind generated power to the Grid.

12.7.3 Predicted Impact

At this early stage the connection method, cost and timeline should only be viewed as indicative. It is particularly difficult to suggest connection methods for a post Gate 3 Project at a stage when there still are uncertainties on the connection methods for Gate 3 projects. The potential connection methods for Yellow River Wind Farm should be straight forward, however, there are still a number of uncertainties. The Derryiron 110kV substation has the capacity to take the 96 MW that could potentially be generated by Yellow River Wind Farm. This connection option should only be viewed as indicative as there is a risk that it could change after EirGrid completes detailed connection studies.

Once a connection offer is executed the time to get consent, procure and construct the connection will depend on the connection assets required. The connection timeline is based on EirGrid's standard timelines. The connection method proposed for Yellow River Wind Farm, without the requirement of any new High Voltage Assets requiring Planning Permission, should facilitate a relatively fast connection time. It is anticipated that the likely connection date of the wind farm will be 2016 at the earliest.

12.7.4 Mitigation Measures

No mitigation measures are specified at this stage due to the uncertainty of connection methods and routes.

12.7.5 Conclusion

At this stage in the connection process there is a level of uncertainty regarding the connection method, costs and timelines for Yellow River Wind Farm. However, there is an extensive, strong and growing transmission network in North Offaly, with 110kV, 220kV and 400kV transmission assets in the immediate vicinity.

12.8 TELECOMMUNICATIONS

Early consultation with Vodafone, Meteor and O2 established that there was no impact on the networks as a result of the wind farm development.

2RN (formerly RTE NL) were consulted during the initial scoping phase of the project. The standard protocol agreement was signed between both 2RN and Green Wind Energy (Wexford) Ltd, should any interference arise during the operational phase of the wind farm.

UPC Communications Ltd. confirmed that they do not have any record of underground services in the locations indicated in the Yellow River Wind Farm drawings and that they have no issue with the turbine locations.

The written responses from the network operators can be seen in **Appendix F**.

12.8.1 Predicted Impact

No significant impact is predicted in terms of telecommunications.

12.8.2 Mitigation Measures

The standard protocol agreement was signed between both 2RN and Green Wind Energy (Wexford) Ltd, should any interference arise during the operational phase of the wind farm.

12.8.3 Conclusion

No significant impact is predicted in terms of telecommunications.

12.9 AIR NAVIGATION

12.9.1 Introduction

Any tall object, particularly on an elevated site has the potential to affect air traffic.

12.9.2 Existing Environment

The closest commercial airport to the site is Dublin airport, situated approximately 60 km east of the site. The Irish Parachute Club are based in Clonbulloge Airfield, Edenderry, Co Offaly, approximately 13 km southeast of the site.

12.9.3 Predicted Impact

A consultation exercise was undertaken with the Irish Aviation Authority (IAA). No impact to aviation was predicted provided the development complies with aeronautical lighting and positional data requirements. Their written response can be seen in **Appendix F**.

12.9.4 Mitigation Measures

Although no significant impacts are predicted, it is standard policy of the IAA Safety Regulation Division to request an Obstruction Survey for wind farms. This survey is designed to collate data on the height, latitude, longitude, elevation and dimensions of any structures or feature that the IAA deems necessary. An Obstruction Survey will be undertaken at the pre-construction phase.

The IAA will be consulted on the lighting and positional data requirements prior to the erection of the turbines and meteorological mast. The IAA will also be issued with the grid co-ordinates of the turbines upon completion of the project.

12.10 HOUSE PRICES

12.10.1 Introduction

Any proposed new development can lead to a temporary fluctuation in house prices. However, there is no evidence that a wind farm has a lasting negative effect on house prices.

12.10.2 Existing Environment

Unfortunately to date there have been no studies carried out in Ireland regarding the relationship between wind farms and house prices, and as there are no operational wind farms in Co Offaly, we can only refer to published studies for information.

Below are brief overviews of the major studies conducted on wind energy facilities and their correlation with property values.

US Office of Energy Efficiency and Renewable Energy

This 2009 study commissioned by the US Office of Energy Efficiency and Renewable Energy, performed by the Ernest Orlando Lawrence Berkeley National Laboratory, found no evidence of negative impact on property values in the communities near wind farms. The study looked at the sales of 7,500 single family homes that were located within ten miles of wind farms in 9 different U.S. states.

Royal Institute of Chartered Surveyors/Oxfords Brookes University

This 2007 study looked at 919 property sales surrounding a 5 mile radius of 3 separate wind farms during the period of 2000 to 2007. This study, controlled for other major factors that could have a potential impact on property values such as large mines, properties that were outliers in terms of price, as well as waterfront properties, found that there was no significant evidence that wind farms had an impact on surrounding communities.

Renewable Energy Policy Project

Another major report on land values and wind turbine development was prepared for the US Government in 2003. Entitled "*The Effect of Wind Development on Local*

Property Values" and prepared by the Renewable Energy Policy Project, the Report looked at land values associated with every US wind farm installation that came on-line between 1989 and 2001, and had an installed capacity of 10MW or greater.

Specifically, the Report examined the values of land from which the turbines were visible (called a "view shed") that extended up to 5 miles (8 kilometers) from the installation. Property values were collected for a 6 year period centered on the opening date of each wind farm. To allow valid comparisons, property values from similar communities without wind farms were also obtained. In all, more than 25,000 records of property sales were subject to statistical analysis.

The study found that, for 80-90% of the wind farms, properties values within the 5 mile radius increased faster than the properties outside of the 5 mile radius of the wind farms.

The report stated:

If property values had been harmed by being within the view-shed of major wind developments, then we expected that to be shown in a majority of the projects analyzed. Instead, to the contrary, we found that for the great majority of projects the property values actually rose more quickly in the view shed than they did in the comparable community.

Moreover, values increased faster in the view shed after the projects came on-line than they did before.

Finally, after projects came on-line, values increased faster in the view shed than they did in the comparable community.

In all, we analyzed ten projects in three cases; we looked at thirty individual analyses and found that in twenty six of those, property values in the affected view shed performed better than the alternative.

The conclusion of the report authors was that:

The statistical evidence does not support a contention that property values within the view shed of wind developments suffer or perform poorer than in a comparable

region. For the great majority of projects in all three of the Cases studied, the property values in the view shed actually go up faster than values in the comparable region.

Wind Farm Proximity And Property Values – Jennifer L. Hinman

This study was published in 2010 by a Masters student with Illinois State University. The study looked at 2,851 home sales from the past decade around the Twin Groves wind farm in Illinois. This study replicated the findings of the REPP study, finding that property values seemed to increase at a greater rate closer to the wind farm. This study also found a correlation between the fears prior to the actual construction of the wind energy project and a temporary reduction in property values.

The Impact of Land Values of the Crookwell Wind Farm

In 2006 Henderson & Horning Pty Ltd conducted a study on the impact of land values of the Crookwell Wind Farm in New South Wales, Australia.

Their study examined the change in values:

- resulting from alterations in agricultural productive capacity of land on which wind turbines were sited
- from the improved viability of the land for agricultural purposes when the income stream derived from the wind turbines was factored into total farm income
- of land on which wind turbines were not sited but were clearly visible

Of the potential change in values resulting from altered productive capacity, the report states:

It is clear that the underlying agricultural productive capacity of the land subject to the wind farm and the surrounding property is not in any measured way affected by the development of the Crookwell Wind Farm meaning there has been no reduction in [land] values.

The report goes on:

Indeed the property subject to the [wind turbine] development enjoys additional revenue and has some added benefits from improved roads, erosion control and passive wind protection for stock from the sub stations and turbine tower structures.

The report stated that in the fifteen years prior to the study, the Crookwell area had been characterized by a change in land-use from larger grazing properties to smaller, rural residential holdings. However, the presence of the wind farm *"has the potential to slow down the process of productive agricultural land changing to rural residential uses in the short to medium term with the shift caused by the additional income generated from the wind farm making the agricultural use viable."*

But what about land where no income was derived from the wind turbines but from which they were visible?

The report states: *"...we can see no measurable reduction in values for those properties that have a sight line to the [wind turbine] development"*.

It goes on to state that: *"...factors such as soils, improvements and access to services are more important drivers in determining value than the visual amenity of the wind farm"*.

12.10.3 Predicted Impact

The reports examined show no statistical evidence of a drop in property prices nor do they support the case that proximity to wind farms results in a decline in property values.

12.10.4 Mitigation Measures

No mitigation measures are required as no significant impacts are envisaged on property values.

12.10.5 Conclusion

The reports we have examined show no statistical evidence of a drop in property prices nor do they support the case that proximity to wind farms results in a decline in property values.

12.11 CONCLUSION

No significant impacts are predicted on agricultural practices, forestry, natural resources, ESB Networks, aviation or property prices.

12.12 REFERENCES

1. Central Statistics Office (CSO) Census 2006 www.cso.ie
2. CER Gate 3 Direction issued 16 December 2008, CER/08/260
3. CER, Criteria for Gate 3 Renewable Generation Offers and Related Matters – Proposed Direction to the System Operators, 12 November 2008, CER/08/226
4. EirGrid, June 2010 Connection Offers Disclosure of Applications
5. EirGrid, 2025 Grid Development Strategy
6. EirGrid, Transmission Forecast Statement 2010-2016
7. <http://www.windlab.com/landowners/values> Land values
8. Royal Institution of Chartered Surveyors (2007) *“What is the impact of wind farms on house prices”*

13.0 CULTURAL HERITAGE

13.1 INTRODUCTION

13.1.1 Background

Irish Archaeological Consultancy Ltd has prepared this report on behalf of Greenwind Energy Ltd to assess the impact, if any, on the archaeological, architectural and cultural heritage resource of the proposed Yellow River Wind farm at Derryarkin, Derryiron, Coolcor, Coolville, Ballyburly, Greenhills, Bunsallagh, Derrygreenagh, Knockdrin, Wood, Killowen, Corbetstown, Carrick, Garr and Dunville, County Offaly (OS Sheet 3, 4 and 11, Figure 1).

This study determines, as far as reasonably possible from existing records, the nature of the cultural heritage resource in and within the vicinity of the application area using appropriate methods of study. Desk-based assessment is defined as a programme of study of the historic environment within a specified area or site that addresses agreed research and/or conservation objectives. It consists of an analysis of existing written, graphic, photographic and electronic information in order to identify the likely heritage assets, their interests and significance and the character of the study area, including appropriate consideration of the settings of heritage assets (IFA 2012). This leads to the following:

- Determining the presence of known archaeological and built heritage sites that may be affected by the proposed development;
- Assessment of the likelihood of finding previously unrecorded archaeological remains during the construction programme;
- Determining the impact upon the setting of known cultural heritage sites in the surrounding area;
- Suggested mitigation measures based upon the results of the above research.

The study involved detailed interrogation of the archaeological, historical and architectural background of the development area. This included information from the Record of Monuments and Places of County Offaly, the County Development Plan,

the topographical files of the National Museum of Ireland and cartographic and documentary records. Aerial photographs of the study area held by the Geological Survey and Ordnance Survey of Ireland were also consulted. A field inspection was carried out on the 10th October 2012 and 4th May 2013 in an attempt to identify any known cultural heritage sites and previously unrecorded features, structures and portable finds within the proposed development area.

An impact assessment and a mitigation strategy have been prepared. The impact assessment is undertaken to outline potential adverse impacts that the proposed development may have on the cultural heritage resource, while the mitigation strategy is designed to avoid, reduce or offset such adverse impacts.

13.1.2 The Development

It is proposed to construct a wind farm, comprising of 32 turbines (excavations diameter 18m, Depth 2m), within proximity to the Yellow River in County Offaly. The proposed wind farm stretches over an area measuring 20.58 ha. The development includes for the construction of c. 18,275 m of new access tracks having a minimum finished width of approximately 5.5 m and the upgrading of c. 5,916 m of tracks by widening, strengthening and bend improvement. The scheme will also include the construction of a Substation Control Buildings and Compound on site area 1,850 m². Please refer to Chapter 2 & 3 and Figure 2.9 for further information.

13.1.3 Definitions

In order to assess, distil and present the findings of this study, the following definitions apply:

‘Cultural Heritage’ where used generically, is an over-arching term applied to describe any combination of archaeological, architectural and cultural heritage features, where –

- the term ‘archaeological heritage’ is applied to objects, monuments, buildings or landscapes of an (assumed) age typically older than AD 1700 (and recorded as archaeological sites within the Record of Monuments and Places)
- the term ‘architectural heritage’ is applied to structures, buildings, their contents and settings of an (assumed) age typically younger than AD 1700

- the term 'cultural heritage', where used specifically, is applied to other (often less tangible) aspects of the landscape such as historical events, folklore memories and cultural associations. This designation can also accompany archaeological or architectural designation.

For the purposes of this report the terms 'architectural heritage' and 'built heritage' have the same intended meaning and are used interchangeably.

Impact Definitions

Imperceptible Impact

An impact capable of measurement but without noticeable consequences

Slight Impact

An impact that causes noticeable changes in the character of the environment without affecting its sensitivities.

Moderate Impact

An impact that alters the character of the environment in a manner that is consistent with existing or emerging trends.

Significant Impact

An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.

Profound Impact

An impact that obliterates sensitive characteristics.

Impacts as defined by the EPA 2002 Guidelines (pg 23).

13.1.4 Consultations

Following the initial research a number of statutory and voluntary bodies were consulted to gain further insight into the cultural background of the background environment, receiving environment and study area, as follows:

- Department of Arts, Heritage and the Gaeltacht – the Heritage Service, National Monuments and Historic Properties Section: Record of Monuments and Places; Sites and Monuments Record; Monuments in State Care Database; Preservation Orders; Register of Historic Monuments;
- National Museum of Ireland, Irish Antiquities Division: topographical files of Ireland;
- National Inventory of Architectural Heritage: County Offaly
- Offaly County Council: Planning Section;
- Trinity College Dublin, Map Library: Historical and Ordnance Survey Maps

13.2 BASELINE ENVIRONMENTAL STUDY

13.2.1 Methodology

Research has been undertaken in two phases. The first phase comprised a paper survey of all available archaeological, architectural, historical and cartographic sources. The second phase involved a field inspection of the proposed development area.

13.2.2 Paper Study

This is a document search. The following sources were examined and a list of areas of archaeological, architectural and cultural heritage potential was compiled:

- Record of Monuments and Places for County Offaly;
- Sites and Monuments Record for County Offaly;
- Monuments in State Care Database;

- Preservation Orders;
- Register of Historic Monuments;
- Database of current archaeological investigation licences (2010-2013);
- Topographical files of the National Museum of Ireland;
- Cartographic and written sources relating to the study area;
- County Offaly Development Plan 2009–2015;
- National Inventory of Architectural Heritage;
- Place name analysis;
- Aerial photographs;
- Excavations Bulletin (1970–2009)

Record of Monuments and Places (RMP) is a list of archaeological sites known to the National Monuments Section, which are afforded legal protection under Section 12 of the 1994 National Monuments Act and are published as a record.

Sites and Monuments Record (SMR) holds documentary evidence and field inspections of all known archaeological sites and monuments. Some information is also held about archaeological sites and monuments whose precise location is not known e.g. only a site type and townland are recorded. These are known to the National Monuments Section as ‘un-located sites’ and cannot be afforded legal protection due to lack of locational information. As a result these are omitted from the Record of Monuments and Places. SMR sites are also listed on the recently launched website created by the DoAHG – www.archaeology.ie.

National Monuments in State Care Database is a list of all the National Monuments in State guardianship or ownership. Each is assigned a National Monument number whether in guardianship or ownership and has a brief description of the remains of each Monument.

The Minister for the Department of Arts, Heritage and the Gaeltacht may acquire national monuments by agreement or by compulsory order. The state or local

authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not **be interfered with without the written consent of the Minister.**

Preservation Orders List contains information on Preservation Orders and/or Temporary Preservation Orders, which have been assigned to a site or sites. Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Register of Historic Monuments was established under Section 5 of the 1987 National Monuments Act, which requires the Minister to establish and maintain such a record. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Database of current archaeological investigation licences is a listed held by the National Monument Section of the DoAHG that provides details of licences issued that have yet to appear within the Excavations Bulletin (2009–2011).

Topographical files of the National Museum of Ireland is the national archive of all known finds recorded by the National Museum. This archive relates primarily to artefacts but also includes references to monuments and unique records of previous excavations. The find spots of artefacts are important sources of information on the discovery of sites of archaeological significance.

Cartographic sources are important in tracing land use development within the development area as well as providing important topographical information on areas of archaeological potential and the development of buildings. Cartographic analysis

of all relevant maps has been made to identify any topographical anomalies or structures that no longer remain within the landscape.

William Larkin's Map of King's County (1809)

Ordnance Survey 6" maps of County Offaly (1840, 1885-6, 1908-10)

Documentary sources were consulted to gain background information on the archaeological, architectural and cultural heritage landscape of the proposed development area.

Aerial photographic coverage is an important source of information regarding the precise location of sites and their extent. It also provides initial information on the terrain and its likely potential for archaeology. A number of sources were consulted including aerial photographs held by the Ordnance Survey and Google Earth.

Place Names are an important part in understanding both the archaeology and history of an area. Place names can be used for generations and in some cases have been found to have their roots deep in the historical past.

Development Plans contain a catalogue of all the Protected Structures and archaeological sites within the county. The County Offaly Development Plan (2009–2015) was consulted to obtain information on cultural heritage sites in and within the immediate vicinity of the proposed route.

The National Inventory of Architectural Heritage is a government based organisation tasked with making a Nation wide record of significant local, regional, national and international structures, which in turn provides county councils with a guide as to which structures to list within the Record of Protected Structures. The architectural survey for County Offaly was completed during 2004. The NIAH have also carried out a nation wide desk based survey of historic gardens, including demesnes that surround large houses. This has also been completed for County Offaly and was examined in relation to the surviving demesnes within the surrounding area of the proposed development.

Excavations Bulletin is a summary publication that has been produced every year since 1970. This summarises every archaeological excavation that has taken place in

Ireland during that year up until 2009 and since 1987 has been edited by Isabel Bennett. This information is vital when examining the archaeological content of any area, which may not have been recorded under the SMR and RMP files. This information is also available online (www.excavations.ie) from 1970–2009.

13.2.3 Field Inspections

Field inspection is necessary to determine the extent and nature of archaeological and architectural remains, and can also lead to the identification of previously unrecorded or suspected sites and portable finds through topographical observation and local information.

The archaeological and architectural field walking inspection entailed:

- Walking the proposed development area and its immediate environs.
- Noting and recording the terrain type and land usage.
- Noting and recording the presence of features of archaeological, architectural or cultural heritage significance.
- Verifying the extent and condition of recorded sites.
- Visually investigating any suspect landscape anomalies to determine the possibility of their being anthropogenic in origin.

13.3 RESULTS AND ANALYSIS – ARCHAEOLOGY

13.3.1 Archaeological and Historical Background

General

The area of proposed development is located within the townlands of Bunsallagh, Derryarkin, Derryiron, Coolville, Ballyburly, Greenhills, Wood, Killowen, Garr, Corbetstown and Carrick, in the Parishes of Croghan, Ballyburly and Castlejordan, and Baronies of Lower Philipstown and Warrenstown, County Offaly. The site mostly comprises of upland marginal terrain located along the Yellow River. The

northern-most boundary of the proposed wind farm, the Mongagh River, also forms the county boundary between Offaly, Meath and Westmeath.

The landscape surrounding the proposed wind farm is characterised by marginal bogland and dry bog islands. The Derrygreenagh complex of bogs is made up of a series of raised bogs comprising some 10,000 hectares. Portions of two peatland areas known as Ballybeg bog and Derryarkin bog from the Derrygreenagh complex are located within the proposed development lands. Proposed turbines 8–12 are located within the north-eastern edge of Ballybeg bog and proposed turbines 1, 5 and 3 are located within the south-western edge of Derryarkin peat bog. The land holdings are traversed by a multitude of small water courses and drains which are part of the industrial drainage of the bogs. The R400 runs north-west from Rhode towards Rochfortbridge, which is located *c.* 3km north. The twin industries of Rhode are turf extraction and electricity generation and the landscape reflects this.

Prehistoric Period

There is substantial evidence for activity during the prehistoric period within proximity to the proposed wind farm. The majority of the sites have been identified through intensive surveys of peatland undertaken by the Irish Archaeological Wetland Unit (IAWU) of University College Dublin (UCD) in recent years. Drumman and Derryarkin Bogs were surveyed by the IAWU in 2001 and 2002. A total of 65 sites, seven artefacts and two possible artefacts were recorded in the bogs. A small sample of sites were dated to the early Neolithic and the middle to late Bronze Age while a Bann Flake dated to the late Mesolithic. A cluster of these sites are located *c.* 200m north and north-east of proposed Turbines 1 and 3 in Bunsallagh (RMP OF003-011–25 and OF027–031) and Derrygreengagh (RMP OF003-032-34) townlands. Archaeological remains such as wooden trackways, wooden platforms, artefacts and many other site types are preserved in peat due to the anaerobic and waterlogged nature of the peat layers. Trackways (toghers) or short stretches of trackways (tertiary and secondary toghers) were constructed to traverse the peatbogs or provide a foot holding along certain stretches of wet bog. Wooden platforms most likely functioned as hides or hunting platforms in order to exploit the natural flora and fauna of the peatbogs ([O' Carroll, 2001](#)). A number of trackways, wooden platforms, occupation features, artefacts and miscellaneous wooden structures have been uncovered in the Derryarkin and Ballybeg bogs (IAWU, 2003).

Two artefacts dating to the Neolithic have been previously recovered from Derryarkin and Derrygreenagh townlands. A stone axe-head (1969:863) recovered from Derryarkin was recorded as being found in Derrygreenagh Works, on Derrygreenagh Hill to the south-east of proposed Turbine 6 (IAWU, 2003 4). A stone axe-head (1959:751) was recovered from Derrygreenagh townland in either Drumman or Derryarkin Bogs.

Evidence for further Bronze Age activity to the south of Derrygreenagh Hill is implied by the presence of five recorded fulachta fiadh (OF004-017–21), c. 440m south of proposed Turbines 24 and 25. The most common Bronze Age site within the archaeological record is the burnt mound or fulacht fiadh. Over 4500 fulachta fiadh have been recorded in the country making them the most common prehistoric monument in Ireland. Although burnt mounds of shattered stone occur as a result of various activities that have been practiced from the Mesolithic to the present day, those noted in close proximity to a trough are generally interpreted as Bronze Age cooking/industrial sites. *Fulachta fiadh* generally consist of a low mound of burnt stone, commonly in horse-shoe shape and are found in low lying marshy areas or close to streams and rivers. Often these sites have been ploughed out and survive as a spread of heat shattered stones in charcoal rich soil with no surface expression in close proximity to a trough. A possible burnt mound site was identified c. 50m east of proposed Turbine 17 in Wood townland.

A standing stone (OF011-002) is located c. 1.2km south-east of proposed Turbine 14 in Ballyburly townland on an elevated ridge with extensive views. Standing stones, usually single upright orthostats, are a common feature in the landscape. They are known by various names including *Gallán*, *dallán*, *leacht* and long stone (Power et. al. 1992, 45). Although it is thought that the standing stones were erected across a wide time span and had multiple functions they are most often associated with the Bronze Age. They are generally unworked stones and often have packing stones around their base providing additional support. A large number of standing stones are orientated on a northeast–southwest axis corresponding with those of other megalithic architecture, such as stone rows or circles (Ronan, Egan and Byrne 2009, 22). A wide variety of functions have been attributed to these stones, such as burial markers and route or territorial markers; whereas more recent stones have been erected as scratching posts for cattle.

Croghan Hill, located c. 3km south-west of the proposed wind farm, was a significant sacred place during the Bronze Age and Iron Age and is one of the most prominent landmarks in the area. The mountain was known as '*Cruachán Brí Éile*' meaning mound/hill of *Brí Éile* which in turn gave a name to the surrounding bogland – '*Móin Éile*' or Bog of Allen (O' Brien, 2006). In legends Brí Éile is the daughter of the King of Tara and sister to Queen Maeve of Connaught and she is reputed to be buried at Croghan Hill. It commands extensive views of the surrounding landscape, overlooking the proposed development area. A Bronze Age burial mound (RMP OF010-004001) and a ring barrow (RMP OF010-010008) are located on the summit of the hill and several sites located within the vicinity may be associated with this. Iron Age bog body 'Oldcroghan Man' was found on the south side of the hill and it is suggested that his burial may be associated with a former royal estate (Kelly 2006a, 26). O' Brien (2006) records that the mountain had been claimed by the O' Connors of the *Uí Failghe* tribe by the 5th century. In 475 the King of Tara defeated the Laigin tribe in a battle at Croghan Hill and following the battle of Drum Derge in c. 516 a divide boundary was drawn across Croghan Hill between Leinster and Meath (*ibid.*). The hill functioned as an inauguration site for the *Uí Failghe*, after which the county Offaly is named (Kelly, 2006b).

A hilltop enclosure (RMP OF004-004) is recorded in the townland of Killowen c. 860m ESE of proposed Turbine 19. Hilltop enclosures are located at the peak of a domed hill top and can have either a ceremonial or settlement function. They can date from the prehistoric period to the late medieval period.

Early Medieval Period (AD500–1100)

Ireland underwent radical change from the 5th century AD. An upsurge in grasses and weeds is demonstrated in the pollen record, associated with increased pasture and arable farming. A combination of factors led to a revolution in the landscape. Foremost amongst these was the introduction of Christianity in the early 5th century. The new religion was readily accepted and it spread throughout the country in the 5th and 6th and later centuries presenting a catalyst for change. Population expansion was also central to the transformation that swept across Ireland around this time which resulted in a complete, if uneven, spread of settlement across the country.

This area was also of strategic importance during the early medieval period as the *Slighe Mhór*, one of the five major route ways in Ireland, is thought to have run along the ridge, to the north of the proposed wind farm, between the towns of Tyrrellspass and Rochfortbridge (O Lochlainn, 1940).

Secular habitation sites in the early medieval period include *crannógs*, cashels and ringforts. Given the marginal wetland nature of the surrounding landscape the area of proposed development would not have provided an ideal location for settlement. The islands of dry land would therefore have been sought after sites for activity. While no ringforts or *crannóga* are recorded within proximity to the proposed wind farm there are four enclosures in the local (RMP OF003-003, OF004-003, OF003-004 and OF004-008).

This period was also characterised by the foundation of a large number of ecclesiastical sites throughout Ireland during the centuries following the introduction of Christianity in the 5th century AD. Testing carried out at a site adjacent to the medieval church at Ballyburly (OF004-013) in 1997 (Mullins, 1997; 97E0321) revealed evidence of a ditch (OF004-013006) that possibly originally encircled an earlier medieval ecclesiastical site. Early medieval sites on Croghan hill include a church site and graveyard (OF010-004(02) which was reputedly founded by Bishop *Mac Caille* at *Cruchan Brí Éile* before his death around 490AD (Fitzpatrick and O'Brien, 1998) The deliberate siting of the church at this site of pagan worship and royal inauguration would have facilitated the conversion to Christianity and also forged links with the secular rulers. The continued importance of Croghan Hill as a sacred landscape is indicated in the Life of Saint Bridget where it is recorded that Brigit received her veil from Bishop MacCaille in the church at Croghan Hill (O'Brien, 2006). One account of her consecration includes the miraculous appearance of a 'straight bridge' across the marshland below the hill. O'Brien (*ibid.*) suggests this may be a reference to the Togher of Croghan which runs along the base of the mountain. A holy well and cultivation ridges are also associated with this church site (OF010-004-07 and 08). The well is known as 'Finnenashark' derived from '*Fionnabhair Na Searc*' meaning 'the well of the lovers' (*ibid.*)

Medieval Period (AD1100–1600)

The piecemeal conquest by the Anglo-Normans of Ireland had a fundamental impact on the Irish landscape. By the end of the 12th century the Anglo-Normans had succeeded in conquering much of the country. The Anglo-Norman invasion stimulated the development of towns and while some stone castles were constructed, earthen mottes or motte-and-bailey castles were more typical of the era.

Moated sites are also apparent within the manorial extents of the time. They were defined by a square or rectangular ditch or moat usually filled with water by means of diverting existing streams/rivers in to them via a series of channels and leats. They are thought to have been farmsteads of Anglo-Norman manorial free tenants and used as homesteads rather than military bases (Keegan 2005, 35–37). A moated site (OF004-009) is located to the immediate east of the proposed haulage route, *c.* 200m south of proposed Turbine 17 in the townland of Wood. An associated settlement may be indicated by a network of earthworks and crop marks shown on aerial photographs of the site. Two potential enclosures (AAP 2 and 3) are located within the immediate vicinity of proposed Turbine 16; indicated on the aerial photographs of the area. The 2009 images show a potential D-shaped enclosure (AAP 2) on the southern bank of the Yellow River, adjoining the original course of the river. A large moated site was excavated at Kilree 4, Co. Kilkenny which overlooked a possible fording point on the River Nore (Whitty, Coughlan and Lynch, forthcoming). A number of kilns and other settlement activity were identified associated with the enclosure.

The site of a Franciscan Convent (OF004-011) is located *c.* 360m west of the proposed haulage route and 660m west of Turbine 13 in the townland of Coolcor. There is no evidence of masonry with the site now appearing as a grass-covered mound. This convent was dependent on the nearby Franciscan monastery at Monasteroris (OF011-011). A portion of a late medieval wayside cross (OF004-011004) originally from Coolcor is now located in front garden of the parochial house in the nearby village of Rhode. The cross shaft consists of four carvings one on each face depicting the Crucifixion, Virgin and Infant, a Bishop and a Monk with inscription below reading 'Blessed are the poor in spirit'. These buildings may be represented on a map from 1560 annotated as Kilcor (Horner 2006, 4). A number of large houses are annotated in the eastern district in 1560 at Baliburley (Watre and Playne-Warren), Kilowen and Clonmon (Clonmore). A large house is illustrated to

the north of the Yellow River within a wooded area annotated as 'Bali cove' (now Carrick) however this is not shown on later mapping.

In the 1560s map the wind farm appears to be located within two districts or 'tuatha' annotated as 'TOVO CROGHAN' and 'NETHER TOV MVY'. A togher is annotated to the south in the vicinity of Rhode village crossing the 'tuathe' boundary and a second crossing is shown between Ballyburley and Clonmore. This togher runs towards Kilclonfert, Durrow and Clonmacnoise (O' Brien, 2006). A number of battles are recorded to have been sited near this significant togher including one recorded in the Annals in 1385 between Morogh O' Conor (Lord of the Uí Failghe) and English of Meath (*ibid.*). Following three centuries of political strife the O' Connors eventually submitted to the English forces in 1549 and their lands were confiscated (*ibid.*).

Post Medieval Period (AD1600–1900)

During the 16th century the county was subject to partial plantation and as part of this was renamed King's County. Daingean town, located c. 6km south-west of the proposed wind farm, was renamed 'Philipstown' at this time. The development of this settlement was hindered by the development of nearby newly established Tullamore. The new baronial divisions appear to broadly adhere to older 'tuathe' divisions (*ibid.*, 5). This is true of the barony boundary between Lower Philipstown and Warrenstown which divides the area of proposed development.

The site of a late 17–18th century house (OF004-012001) is located to the south of Ballyburly House in Ballyburly townland. This house is thought to have been built on the site of a castle which was burnt in 1888 (www.archeology.ie). The earlier castle (OF004-012002) is surmised to have been a pre-plantation castle fortified in the 16th century. The late 17th century house was probably built by John Wakely who was MP for Kilbeggan in 1692 and died c. 1713; or by his son Thomas (*ibid.*). This later house was rebuilt to the design of James Franklin Fuller following its destruction in a fire in the late 19th century (*ibid.*).

A church was built at the Ballyburly estate in 1686 according to an inscription on an armorial plaque (OF004-013005-) over the doorway by J. Wakely (Lewis 1837, 125). It was partly destroyed in 1972 and has since been levelled (www.archaeology.ie). A

memorial slab dated 1617 with carved effigy of Capt. Wakley with his lance, sword and shield is now in the National Museum (JRSAI 1865 332-3) and a grave-slab (OF004-013004) which was in west wall said to be from Coolcor monastic site (OF004-011002) (*ibid.*). Testing was carried out at a site adjacent to the church at Ballyburly (OF004-013) in 1997 (Mullins, 1997; 97E0321) which revealed evidence of a ditch (OF004-013006) that possibly originally encircled an earlier medieval ecclesiastical site.

The arrival of the Grand Canal to the area by 1798 opened the region up for industrial development and expansion. A canal supply course is shown on Larkins map of 1809 running south of the Yellow River. In 1837 Rhode comprised of a small hamlet with “12 houses, situated in the midst of a rich grazing district, on the estate of J. Wakely, Esq., whose residence, Ballyburley, adjoins the hamlet” (Lewis, 1837). The nearby estates of “Rathmoyle, the residence of George Rait, Esq., Clonin of S. Rait, Esq.; Coolville of T. Grattan, Esq. and Greenhill, of F. L. Dames, Esq.” were associated with demesne lands shown on the first edition OS map (*ibid.*).

Coote's survey of King's County (1801) determined that 43.8% of the land could be characterised as ‘bog, mountainous and waste’ (Horner 2006, 8). In 1813 Warrenstown barony was recorded as having the second lowest population density in Offaly (*ibid.*, 9) which is not surprising given the large coverage of bog land. During the 20th century the surrounding region was primarily characterised by industrial peat cutting. A large portion of the surrounding peatland was depleted and land reclamation was undertaken in the mid-late 20th century.

13.3.2 Summary of Previous Archaeological Fieldwork

A review of the Excavations Bulletin (1970–2009) and the database of archaeological licences held by the Department of Arts, Heritage and the Gaeltacht (2010–2013) has revealed that a number of investigations have been carried out within proximity to the proposed development area. A substantial amount of investigation has been undertaken by the Irish Archaeological Wetland Unit (IAWU) of University College Dublin (UCD) within proximity to the proposed development area. The sites identified as part of these works are included within the RMP for the county and as such are detailed in **Appendix O**.

Peatland Surveys

Derryarking Bog

Derryarkin bog totals 789 hectares of peatland and has been in industrial production since the early 1960's. It is located c. 2.5km south of Rochfordbridge and to the west of the R400. The northern edges of the bog are fringed by industrial quarrying and agricultural land while the Yellow River flows along the southern boundary. This bog has been largely milled out and currently comprises of fen peat, ancient carr woodland inundated with modern woodland scrub and vegetation while some parts of which were partially flooded. Subsoil was also evident in areas of this peatbog.

Derryarkin Bog was surveyed as part of the Peatland Survey in 2002 (Murray, 2002; Licence Ref: 02E0942). A total of 28 sites were recorded, including the find spot of a late Mesolithic Bann Flake recovered by the IAWU in 2000. The remaining sites occurred in two principal concentrations: 23 in the south-western corner of the bog and five on the eastern fringe. The south-western concentration located in Bunsallagh townland consists primarily of small deposits of wood and the remains of three linear sites or trackways (OF-BSL 001-23). Two of these sites have been radiocarbon dated to the late and middle Bronze Age (cal. 1937-1644BC and 1686-1414BC) suggesting that the majority of the aforementioned archaeological sites are prehistoric in date. All of these were in a much degraded state owing to long-term exposure and were mostly recorded as 'destroyed' or 'being destroyed' in the survey.

To the east in Derryarkin and Derrygreenagh townlands a cluster of small wood deposits and a substantial plank trackway were recorded. The trackway which measured 68.5m in length, 3.74m in width and 0.26m in depth, was oriented north-south and extends from Derrygreenagh Hill towards Corghan Hill (OF-DYN001-2 and OF-DGH001-3). A plank from the trackway was dated to the early Neolithic (3643±9BC), making this the earliest dated trackways in Ireland. A small chert scraper was recovered from the vicinity of this site. To date no archaeological excavations of the sites discovered through the IAWU 2002 survey have been undertaken in Derryarkin peatbogs.

Ballybeg Bog

Ballybeg bog, to the south-west of the proposed wind farm, represents 808 hectares of the total Derrygreenagh works and has been in milled peat production since 1958. Lough Nashade is located in the central portion of Ballybeg Bog. It was marked on early OS maps and may have been the focus for much of the archaeological activity in this bog during the prehistoric period. The lake was drained in the early 1960s.

Ballybeg Bog was surveyed by the IAWU in 2001 and a total of 105 sites and 25 artefacts were recorded. These sites consisted of nine secondary trackways, 26 tertiary trackways, one platform, 29 pieces of worked wood *in situ*, 26 unworked wood *in-situ*, a wooden trough, a pre-historic occupation site, a barrow and an archaeological complex. The majority of the sites lay along the line of a palaeo-channel or old stream. A sample of the sites dated from the early Neolithic to the Iron Age. A total of 65 of the sites were recorded as being destroyed or destroyed at the time of the survey. A large number of artefacts were also uncovered from Ballybeg bog during the IAWU survey, including twelve pieces of flint, four stone artefacts, a wooden bow stave of yew and a beautifully carved wooden carved yoke. Subsequent excavations were carried out on 19 sites as part of the Bord na Móna project (O' Carroll, 2002) to allow resumption of peat cutting.

Excavations revealed a sub-square stone enclosure, a series of stone hearths and associated charcoal spreads, a series of trackways located within a palaeo-channel, a hurdle panel and some small wooden trackways/platforms and miscellaneous wooden structures (*ibid.*). The enclosure and associated hearths were constructed in a Neolithic pine and birch forest and the occupation activity has been dated to the early Neolithic. The function of this site is unclear and it may have simply been a hunting pen or hide for exploitation of the animals and birds which lived in and on the surrounding fen.

A series of wooden structures/ trackways and a wooden platform were identified over a length of 350m along the palaeo-channel. These have been dated to the middle and late Bronze Age. The channel would have been a natural route across a peat bog that would have been a large expanse of treacherous *Sphagnum* pools and overgrown grasses, and the platform may have been used as a hide or hunting platform to provide access to animals and plants that were not readily available on the dryland fringes.

Drumman Bog

Drumman Bog in the north of Bord na Móna's Derrygreenagh works was surveyed in 2001 (McDermott, 2002; Licence Ref.: 01E0667). Small sections in the southern and central parts of the bog are in milled peat production; the remainder has been largely milled out, and there is a block of forestry in the eastern part of the bog. A total of 23 archaeological sites were recorded during the survey. These consisted of seven toghers, traceable for 15m or less, 13 small deposits of worked and unworked wood, and three post rows of varying lengths. The largest concentration of sites, two of which are dated to the middle and late Bronze Age, are on the fringes of Derrygreenagh Hill. A barbed and tanged arrowhead, chert scraper and two fragments of animal horn were also recovered from disturbed contexts. A small *in situ* scrap of leather was found close to the main concentration of sites (*ibid.*).

Additional Archaeological Investigations

Monitoring was carried out in 2002 of mechanical peat removal before the construction of the new cement-block factory in Derryarkin Bog, Co. Offaly (Whitaker, 2002; Licence Ref.: 01E1126 ext.). This part of the site had previously been forested and there was very little peat remaining above the subsoil. The peat was mechanically removed, exposing the pre-bog marl and gravel layers. The peat closest to the bog surface was quite disturbed by tree-root systems and their removal. No archaeological features were identified.

Monitoring took place at a proposed quarry site at Derryarkin in 2006 (Corcoran, 2006; Licence Ref.: 06E1064). The depth of topsoil and peat ranged between 0.3–2m. No archaeological features or objects were identified.

Testing was carried out at a site adjacent to the late medieval church at Ballyburly (OF004-013) in 1997 (Mullins, 1997; 97E0321). Evidence of a ditch (OF004-013006-) that possibly originally encircled the ecclesiastical site and disturbed human remains on the cemetery side of this ditch were identified. Monitoring of ground works in 1998 revealed no further evidence of the ditch (Mullins, 1998; Licence Ref.: 97E0321 ext.). While no clearly identifiable archaeological features were discovered during the course of monitoring, it certainly appears that some archaeological material exists over the general area of the site, particularly on the northern and western sides.

13.3.3 Cartographic Analysis

Unknown Cartographer, Map of Eastern Laois and Offaly, 1560 (Horner, 2006)

The area of proposed development is shown as partially wooded, bound to the north by the 'Muingagh' River and traversed by the Yellow River (not named). The proposed wind farm appears to be located within two districts or 'tuatha' annotated as 'TOVO CROGHAN' (west) and 'NETHER TOV MVY' (west). Croghan Hill is shown within the western district; however the lands to the north (including Derryarkin and Bunsallagh) are shown as undeveloped bog with two patches of forestry. In the eastern district a number of large houses are annotated in Kilcor, Baliburley (Watre and Playne-Warren), Kilowen and Clonmon. The buildings shown in 'Kilcor' may represent the religious buildings (OF004-011) now recorded in Coolcor. A togher is annotated to the south in the vicinity of Rhode village crossing the 'tuathe' boundary. A second togher is illustrated crossing bog from Ballyburley to Clonmore. A large house is illustrated to the north of the Yellow River within a wooded area annotated as 'Bali cove' (?). Derrygreenagh Hill is shown as a dry island annotated as 'Drind'.

William Larkin's Map of Part of The Bogs of Allen within the King's County, 1809 (Figure 3)

The area of proposed development is largely comprised of unsettled bogland. The building illustrated on the earlier map north of the Yellow River is no longer present and the area is now annotated as Carrick. The Yellow River flows east-west along a dryland area. A single road leading north from the village of Road crosses the Yellow River before splitting to run west towards County Westmeath and east towards County Meath. Derryarkin, Derrygranagh, Knockbrin, Deragharee, Derriren, Coolcor, Crockaunrow, Carrick, Ballyburly, Shra, Greenhills, Clonan and Stonehouse are annotated in dryland spots surrounded by bog. Lands to the east of Carrick and to the west of the Mongagh River are annotated as Rockfield. No structures are shown within the landholding for the proposed wind farm.

Greenhills House (RPS 07-03, NIAH 14904008) is shown surrounded by landscaped demesne lands and the Wood of Killina are annotated to the north of this. Ballyburly house and outbuildings (NIAH 14904007) are also shown with demesne lands to the south of Greenhills. Coolville House (RPS 16-13, NIAH 14911012) and Clonin

House are also shown to the north of Road. A small farm is shown in Rockfield in the north-east of the development and Corbetstown House is illustrated to the south-east of this. 'Road' village is illustrated at a crossroads south of the proposed wind farm site. A small number of houses line both sides of the road. A structure is shown south of a quarry at the site of windmill (RPS 16-14, NIAH 14911014). A canal supply water course runs south through bogland from the Yellow River to empty into the Grand Canal c. 5km to the south.

First Edition Ordnance Survey Map, 1840, scale 1:10560 (Figures 4a–4c)

This map shows the first detailed cartographic representation of the proposed wind farm. Proposed Turbine 1 is located within an area marked as boggy in the townland of Bunsallagh (Figure 4a). The townland boundary between Bunsallagh and Derryarkin to the east passes through the bogland without physical markers. Proposed Turbines 2–7 are located within undeveloped bog in Derryarkin townland. Two farmyards are located within the landholding for the wind farm to the south the Yellow River. The river has been partially canalized by this time although it maintains some of its natural course. A number of 'foot sticks' are illustrated within the fields to the south. The haulage route passes through similar boggy peatland.

Proposed Turbines 8–12 are located to the south-east of this in the townland of Derryiron (Figure 4a). There are no structures or features of archaeological significance shown within the footprint of the turbines. The canal supply is shown running south from Yellow River and a mill race (CH 1) runs south-east from the same watercourse. The Yellow River runs through the landholding and along the northern limit to the north of the mill race. Three farmyards are shown to the east of the road (now R400). Road village has grown slightly since the earlier mapping and now comprises c. 18 buildings including a Roman Catholic Chapel. Windmill (RPS 16-14, NIAH 14911014) is shown to the south of the proposed wind farm adjacent to a lime kiln. A number of small houses are shown along the road to the east of Rhode including BH 3. The haulage route passes through the peatland crossing the mill race (CH1) three times. A short section of track leads south from the main road to the north of this area.

To the east of the road proposed Turbine 13 is located in pasture within the townland of Coolville (Figure 4c). The footprint of the turbine is located within demesne lands

associated with Coolville House, which is located c. 100m south of the proposed haulage route. Several small isolated houses are located along the roadway including vernacular cottage (RPS 07-07, NIAH 14904016) in Coolcor townland. Clonin House is shown as a large house with associated outbuildings and a small demesne. There are no features of archaeological significance shown within the location of RMP site OF004-011. A small cottage (BH 1) is shown fronting onto the local road immediately north of the Coolville Demesne.

Further to the east proposed Turbines 14 and 15 are located in pasture within Ballyburly townland (Figure 4b). The demesne lands associated with Ballyburly House and outbuildings (NIAH 14904007) are located c. 1.04km to the east. Two castle sites (RMP OF004-012001–2) and church site (RMP OF004-013) are shown adjacent to Ballyburly House. Greenhills demesne is located to the immediate north-east of proposed Turbine 15 and the proposed haulage route travels along the southern perimeter before turning north along the avenue leading to the main house. The haulage route passes c. 150m east of the main house and stables (RPS 07-03, NIAH 14904008). Nothing of archaeological or architectural significance is shown within the footprint of the proposed turbine sites or haulage route.

The haulage route rejoins the roadway running north to Wood townland. There are no features of archaeological or architectural significance within the footprint of the proposed Turbines 16–17 in Wood townland or proposed Turbines 18–19 in Killowen townland. There is no indication of the possible enclosure (AAP 2) near proposed Turbine 16. The surrounding landscape is characterised by irregular enclosed fields through which the Yellow River flows. Proposed Turbines 16 and 17 are located within Wood townland in fields of pasture on the southern bank of the Yellow River (Figure 4c). The moated site (RMP OF004-009) is shown as a sub-rectangular enclosure planted with trees. The field boundaries may indicate that the medieval settlement associated with the moated site extended to the east in Killowen townland.

There are no features of archaeological or architectural significance within the footprint of the proposed Turbines 22 and 23 in Garr townland. There is no indication of enclosure (RMP OF004-008) shown on the northern banks of the river in Garr townland. A number of small farmyards are dotted within proximity. Gortnatemple graveyard (RMP OF004-002) is annotated 600m to the west of the proposed haulage route. To the west of this the *fulachta fiadh* (RMP OF004-017–21) are unmarked

within an area of bog. The house recorded in the NIAH survey at Stonehouse is shown to the east (NIAH 14904003).

There are no features of archaeological or architectural significance within the footprint of the proposed Turbines 20–21 and 24–25 in Corbetstown townland. The surrounding landscape is characterised by irregular enclosed fields bordered to the west by large tracts of bog. Turbines 20, 21 and 24 are located within undeveloped fields, while Turbine 25 is located within peatland. Several small farmyards are interspersed in the area however none are located within the proposed development area.

Proposed Turbines 26–32 are located within Carrick townland within the northern boundary for County Offaly. No features of archaeological or architectural significance were identified within the footprint of the proposed Turbines or haulage route. Proposed Turbines 26–30 area located within the vicinity of a farmyard annotated as Derrygawny. Approximately nine small farmyards are located within the north-east corner of the townland to the south of Mongagh River, which also forms the townland, Parish, Barony and County boundary. The remaining two proposed turbines (31 and 32) are located on the southern bank of the Mongagh River within an area marked as 'liable to flood'. Cottage (BH 18) and hollow way are shown to the north of the haulage route with associated farm buildings located within the path of the haulage route to the north-west. Baltinoran Bridge (RPS 07-01, NIAH 14904001) is shown to the east of the proposed landholding crossing the Mongagh River. To the north of this bridge Baltinoran House is shown in ruins.

Ordnance Survey Map, 1908–10, scale 1:2500

There are no major changes shown within the footprints of the proposed Turbines. Some small changes have occurred within the surrounding landscape including the disappearance of small farmsteads and the subdivision of land parcels. A network of drains have been excavated within Bunsallagh and Derryarkin townlands dividing the large tract of bog into regular rectangular plots.

A small farmyard shown on the first edition OS map within the landholding to the south of proposed Turbine 13 has been removed. The extent of the buildings at Ballyburly House has grown with large stables (NIAH 14904007) located to the east

of the main house. A landscaped garden is located to the north of the house. The moated site (RMP OF004-009) in Wood townland is shown as a sub-rectangular enclosure, outlined with hachures.

Garr School (BH 11) is shown adjacent the proposed haulage route in Garr townland. The land surrounding proposed Turbine 23 is annotated as Killhill for the first time. The bridge previously annotated as Thomastown Bridge is now known as Corbetstown Bridge. Killowen house and farm (BH 22) is shown for the first time to the south of proposed Turbine 19.

Third Edition Ordnance Survey Map, 1908–10, scale 1:10560 (Figures 2a–2c)

As this edition was published at the same time as the 25" mapping (described above) there are no major changes shown within the area of proposed development.

13.3.4 County Development Plan

The Offaly County Development Plan (2009–2015) aims to conserve, protect and enhance Offaly's archaeological heritage where possible. A total of 86 RMP sites are located within c. 2km of the proposed wind turbines. There are no National Monuments located within the vicinity of the proposed wind farm.

No RMP site will be directly impacted by the current turbine layout; however the moated site and associated features (RMP OF004-009) are immediately adjacent to the proposed haulage route in Wood townland. This site comprises of a large rectangular moated site associated with a possible field system/ settlement activity to the south. A large number of wetland sites, including wooden trackways/ toghers, are located c. 130–200m north of the wind farm landholding in Bunsallagh townland.

Of the 86 RMPs listed, 29 are recorded as Redundant Records. The majority of these 29 sites were recorded by the Irish Archaeological Wetland Unit (UCD) Survey of Derryarkin and Drumman Bogs in 2002 as isolated wooden stakes/posts. The evidence was however not sufficient to warrant their acceptance as the remains of archaeological monuments.

RMP Ref.:	Location	Type	Distance to nearest Turbine
OF004-009	Wood	Moated site	Adjacent to haulage route
OF003-021-27	Bunsallagh	Road/togher (x2), redundant record (x4)	130m north
OF003-010	Bunsallagh	Redundant record	130m north
OF003-028-31	Bunsallagh	Redundant records	130-150m north
OF003-011-20	Bunsallagh	Road/ togher (x5) Redundant record (x6)	180-200m north
OF004-003	Stonehouse	Enclosure	440m north-east
OF003-032-34	Derrygreenagh	Road - class 1 togher, redundant record x2	460m north-east
OF004-017-21	Garr	<i>Fulachta fiadh</i>	460m south
OF004-008	Garr	Enclosure	570m west
OF004-011001-4	Coolcor	Religious House (Franciscan Nuns), Building, Redundant Record, Wayside cross	580m west
OF004-002	Garr	Burial ground	650m south
OF004-023-25	Garr	Redundant Records	780m west
OF004-004	Killowen	Hilltop enclosure	900m east
OF004-001	Garr	Redundant record	930m south
OF004-007	Srah	Earthwork	1.1km north-west
OF004-012001, 2	Ballyburly	Castles – unclassified	1.15km south-east
OF004-013001-6	Ballyburly	Church, graveyard, wall monument, Ecclesiastical enclosure, graveslab and wall monument	1.15km south-east
OF003-003	Ballyfore	Enclosure	1.24km south
OF003-002	Derrycoffey	Road - togher	1.2km west
WM034-018-21	Pass of Kilbride	Road/togher (x2), redundant record (x2)	1.3km north
OF011-002	Ballyburly	Standing stone	1.35km south-east
OF004-022	Srah	Bullaun Stone	1.4km north-west
OF003-035-050	Derrygreenagh	Toghers (x9), post-rows (x2) Redundant records (x5)	1.4km north-east
OF003-006	Garr	Motte	1.4km north-west
OF003-004	Ballyfore	Enclosure	1.5km south
OF011-003	Ballyburly	Mound	1.5km south-east
OF003-051-54	Knockdrin	Post rows (x3), redundant record (x1)	1.6km north
OF011-055	Ballymorán (Fahy)	Ring barrow	1.66km south-east
ME046-012	Kilkeeran	Church	1.75km north-east
OF004-005	Garr	Earthwork	1.75km north-west
OF011-056	Road	Cross - Wayside cross	1.8km SSW
OF011-001	Clonin	Ring-barrow	1.9km south-west
ME052-002	Castlejordan	Motte and bailey	2km east
ME052-002001	Castlejordan	Tower house	2km east

13.3.5 Aerial Photographic Analysis

Aerial photographic coverage of the proposed development area held by the Ordnance Survey (1995, 2000 and 2005) and Google Earth (2005 and 2009) were examined as part of this assessment.

The moated site (RMP OF004-009) located within Wood townland is clearly visible on all aerial photographs of the site, but is very clear in Google Earth images from 2009. A large field system is also indicated in the fields to the south and south-east of the moated site. Possible structures are indicated to the immediate south of the moated site.

To the north-east of the moated site the original course of the Yellow River is indicated to the south of its current course and to the immediate north of proposed Turbine 16. A potential D-shaped enclosure is indicated on the 2009 image adjoining the original river course; however this is not shown on any other imagery and as such interpretation is tentative. For the purpose of this report the site has been designated as an Area of Archaeological Potential (AAP 2).

No further sites of archaeological potential were identified within the vicinity of the proposed turbines; however some of the sites comprised rough ground and forestry lands which may have hindered identification.

13.3.6 Field Inspection

The field inspection sought to assess the site, its previous and current land use, the topography and whether any areas or sites of archaeological potential were present. During the course of the field investigation the proposed development area and its surrounding environs were inspected for known or previously unknown archaeological sites (Figures 2a–2c). The western part of the proposed wind farm was inspected on the 10th October 2012 and the eastern part of the proposed wind farm was inspected on the 4th May 2013.

Proposed Turbines 1–7

A substantial portion of the peatland in Bunsallagh and Derryarkin townlands has been milled and land reclamation was undertaken in the mid-late 20th century. The drains and cut peat faces were inspected for archaeological deposits. To the north of the

proposed development area a section of partially milled, scrubby, flooded peatland was noted. This peatland was c. 1–1.5m higher than the fields to the south (Plate 1). Three wooden toghers and isolated worked wood samples (RMP OF003-010–031) were recorded in this section of bog in 2002; however no remaining surface evidence of these were identified during field inspection. The IAWU survey records them as ‘being destroyed’ in 2001. The northeast–southwest running Bord na Móna drains are largely overgrown with evidence of pine tree stumps which pre-date the development of the peat. The peat noted during the site inspection and walkover was largely fen reed peat characteristic of the lower levels of peat development. Gravel subsoil was noted in places during the walkover.

Proposed Turbine 1 is located within a plot of densely planted spruce wood (Plate 2). It was not possible to identify anything of archaeological significance due to the density of the planting.

Proposed Turbines 2–6 are located within relatively flat reclaimed land to the south of the remaining peatland and east of the forested area (Plates 3–7). The ground is mostly waterlogged and all but two of the fields are in use as pasture. A narrow plot located to the south of proposed Turbine 3 and north of proposed Turbine 2 is partially wooded. A deep scarp, measuring c. 1.5m, revealed grey marl and gravel representing the base of the peat deposit (Plate 8). The fields are separated by wide drainage channels which are largely overgrown and waterlogged. Two trackways run NNW–SSE through the landholdings. Nothing of archaeological significance was identified within these areas.

A large gravel quarry is located within Derryarkin townland to the south of proposed Turbine 4 (Plate 10). The quarry works have been underway for a number of years and as such the lands have been subject to a substantial disturbance. A large earthen embankment has been constructed along the southern and western perimeter of the site. Derrygreenagh farm is located to the south of proposed Turbine 6. A number of large farm buildings have been constructed to the rear of the farmyard.

The lands to the south of the Yellow River are undulating pasture land surrounding a farmyard. Proposed Turbine 7 is located to the east of this farmyard and south of the river adjacent to a small area of raised scrubby peat (Plate 9). The lands to the south

and west of the turbine location appear to be reclaimed pasture bound to the south by a water course.

The line of the narrow gauge railway (CH 2) associated with the Bord na Móna works runs along the eastern perimeter of the landholding within proximity to proposed turbines 6 and 7 in Derryarkin townland. The rail track crosses the access road in Derrygreenagh townland before heading south towards Derryiron townland (Plate 10). The railway continues south-east along the western perimeter of the proposed landholding within proximity of proposed Turbines 8–10.

The proposed haulage route runs along an existing trackway, crossing railway CH 2; however it does cross pasture to reach individual turbine sites.

Proposed Turbine 8–12

The sites identified in 2001 and 2002 by the IAWU in Ballybeg Bog are located *c.* 1.5km south of the proposed development, therefore this area was not inspected at this time. Proposed Turbines 8–12 are located within the north-eastern extent of Ballybeg bog in areas of hand cut and sausage peat development associated with various turbary plots (Plates 11–16). This section of bog was inspected and all high peat faces were examined to determine if any archaeological remains were present.

The proposed turbines are located in two distinct peat zones. The high bog which is located at the south-western portion of the development area comprised sphagnum raised bog overlying fen and reed bog peat. There was over 4m of peat present in this area of high bog in places. *Calluna* (heather) was growing in abundance on the peat surface and some drainage ditches had been inserted into this peat zone in the past (Plate 12). The lower peat zone which has been in private peat production for many decades comprised mainly of fen peat characteristic of early peat development. Peat briquettes were piled high in areas throughout this zone for bagging and selling. The high peat face which divided the two peat zones was walked and although some natural wood was recorded along the interface between the fen and sphagnum peat nothing of archaeological significance was noted. The low peat zone area, which is currently under sausage peat production by numerous individuals, was also walked and inspected; however nothing of archaeological significance was recorded in this area.

Proposed Turbines 8–10 are located within a section of peatland which is currently subject to manual turf cutting. The north-facing receding peat face is aligned northwest–southeast in Derryiron townland, south of the Yellow River. The proposed location of Turbine 8 is situated within the north-west corner of the plot c. 80m north of the active peat face. The area has been subject to significant peat cutting (c. 1.5–2m in depth) and drains in the area show the grey clay marl and gravel c. 1m beneath the current ground surface (Plate 11). The exposed peat face revealed sterile deposits of fen peat with infrequent natural wood (Plate 13). The line of an overgrown mill race, shown on the first edition OS map, runs northwest–southeast along the lower peat bog (Plate 14).

Proposed Turbine 9 is located on cutaway peat however this area is overgrown with thick heather and is much degraded (Plate 15). Proposed Turbine 10 is located south of Turbine 9 on the surface of cut peat (Plate 16). Small towers of stacked turf sods are located across the landholding. No sites of archaeological significance were identified within the peat surface.

Proposed Turbine 11 is situated within a severely overgrown area of high ground to the north of the Yellow River (Plate 17). The ground was densely overgrown with birch and heather. It was not possible to identify anything of archaeological significance as the ground surface was heavily covered. Proposed Turbine 12 appears to be located in a field of reclaimed pasture on the southern bank of the Yellow River (Plate 18).

The proposed haulage route runs along an existing trackway however it does cross peatland and mill race (CH 1) to reach individual turbine sites.

Proposed Turbines 13–15

Proposed Turbine 13 is located within the northern limit of the Cooleville Demesne in a field of rough waterlogged pasture (Plate 19). Coolville House (RPS 16-13, NIAH 14911012) and ancillary buildings are located to the south. A deep water-filled drain divides the field to the south. Nothing of archaeological significance was identified in the flat field.

Proposed Turbine 14 is located in Ballyburly townland within a field of rough waterlogged pasture covered with dense rush growth (Plate 20). The field is bound to the west by a narrow wooded border. A small watercourse crossed the forest track to the west to run into the field drain.

Proposed Turbine 15 is located within a field of reclaimed pasture adjacent to a large area of scrub land. The site will be accessed by an existing farm/woodland trackway from the south (Plate 21). The proposed haulage route runs east from this site across a number of fields of pasture before turning north onto an existing track/road through Greenhills Demesne.

Proposed Turbines 16–19

The proposed haulage route travels north along a narrow track through Wood townland passing to the west of moated site (RMP OF004-009). As shown on the image of Google Earth from 2009 an extensive network of associated features and field system are present to the south of the moated site (Plate 22). A deep drain runs along the western side of the existing trackway.

The site of proposed Turbine 16 is located within a raised area in a field of pasture on the southern bank of the Yellow River. The line of a paleo-channel for the river is evident to the immediate north of the turbine site as a linear, slightly sunken area, with differing vegetation. The potential D-shaped enclosure (AAP 2) stretches south from this paleo-channel in the immediate vicinity of the proposed turbine (Plate 23). The south-west embankment rises *c.* 1m from the surrounding area. A second smaller raised area, also extending south from the paleo-channel, was noted in the western limit of this field which has been designated as AAP 3. While AAP 2 and AAP 3 may represent natural features associated with original river course given the proximity of moated site (RMP OF004-009) it is possible that these represent settlement activity.

Proposed Turbine 17 is located in a field of pasture to the east of Turbine 16. The site comprises of rough partially waterlogged pasture on the bank of the Yellow River (Plate 24). A small oval rise in the ground (*c.* 30m x 15m) is located to the north and east of the proposed turbine and haulage route. Given its riverside location this may represent a burnt mound or *fulacht fiadh* site and as such has been designated as AAP 4.

The proposed haulage route continues east across undeveloped pastureland to access proposed Turbine 18 (Plate 25) and Turbine 19 (Plate 26). Nothing of archaeological significance was identified in any of these areas.

The route of the Yellow River, which runs east–west north of Turbines 16–19, currently comprises of a deep canalised drainage ditch in sections (Plate 27). Riversides are an ideal location for settlement activity and as such have potential for surviving archaeological features.

Proposed Turbines 20–26

The proposed haulage route crosses the Yellow River twice to access proposed Turbines 20 and 21 and Turbines 22 and 23. Turbines 20 and 21 and associated haulage route are located in arable land in Corbetstown townland (Plates 28 and 29). A number of field boundaries have been removed in recent years which are visible as slight linear rises.

Proposed Turbines 22 and 23 and associated haulage route are located within rough pasture in Garr townland (Plates 30 and 31). The surrounding lands comprise of mixed pasture and arable land bound by mature tree and hedgerows.

Proposed Turbines 24 and 25 are located in the northern limits of Corbetstown townland. The surrounding area is characterised by managed woodland and rough scrubland. The proposed haulage route runs north from Garr townland using a short section of local road; at which point it passes in close proximity to Garr School (BH 11). The haulage route runs north and west through rough pasture (Plate 32) to access site of Turbine 24. The sites of proposed Turbines 25 and 26 are located within rough vegetation surrounded by dense tree planting. Nothing of archaeological significance was identified in this area.

Proposed Turbines 27–32

The proposed haulage route runs north to join a forestry track in Carrick townland. The site of proposed Turbine 27 is located within dense woodland and as such nothing of archaeological significance was identified in this area. The forest track runs along the southern boundary of farm lands which contains proposed Turbines 28 and 29. Both sites are located within flat, well-drained arable land to the south of a

pig farm (Plate 33 and 34). The haulage route continues north to cross a local road to access proposed Turbine 30 which is located in rough waterlogged pasture (Plate 35). Lands to the north-west comprise of milled peatland and rough scrub. The remains of a vernacular farmyard are present 100m to the west of the haulage route.

The haulage route runs east along a local access road in Carrick townland before turning north at an existing junction to access proposed Turbine 32. The haulage route passes in proximity to the ruins of a vernacular cottage and associated hollow way (BH 18) shown on the first edition OS map (Figure 4c). The plot is largely overgrown and is set back from the road. The haulage route passes through a field of pasture with a distinct south-facing slope before continuing north to access proposed Turbine 32 (Plate 37). A number of field boundaries have been removed since the third edition OS map and no evidence for the farm buildings shown in this map within the haulage route are present now. This site is located on the southern bank of the Mongagh River which forms the County, Barony and Parish boundary.

Further to the east the haulage route continues on the local road for a short distance before running north through two large fields of relatively flat pasture (Plate 36). Nothing of archaeological significance was identified in any of these areas.

13.3.7 Conclusions

The proposed wind farm is located within the north-east limits of County Offaly to the north of Rhode village and bordering the Yellow River. The landscape is characterised by partially eroded/ extracted peatland and reclaimed boggy pasture. The bog has been subject to substantial turf cutting over the last 150 years and as such the locations of some of the proposed turbines have been completely depleted of peat supply, exposing marl and gravel deposits. The landscape in which the proposed wind farm is located has been identified as an area of archaeological potential (AAP 1). Whilst the area has been significantly altered due to generations of peat cutting and land reclamation the potential for discovery of *in situ* archaeological remains still exists.

A total of 86 RMP sites were identified within 2km of the proposed turbine locations. Of these 31 are located within a c. 500m radius and 42 within a 1km radius. A large number of wetland sites, including wooden trackways/ toghers, are located c. 130–200m north of the wind farm landholding in Bunsallagh townland. Of the 86 RMPs

listed, 29 are recorded as Redundant Records; the majority of which are sites that were recorded by the IAWU in 2002 as isolated wooden stakes/posts.

No RMP site will be directly impacted by the current turbine layout; however the moated site and associated features (RMP OF004-009) are located immediately adjacent to the proposed haulage route in Wood townland. This site comprises of a large rectangular moated site associated with a possible field system/ settlement activity to the south. This site is shown on all editions of the OS maps and is very clear in the aerial photography. Upon field inspection the earthworks were clearly visible with a lot of activity noted to the south of the moated enclosure.

Wetland areas are ideal locations for the preservation of organic finds and features such as wooden track ways or wooden artefacts, both of which have been identified within proximity to the proposed wind farm in Bunsallagh and Derryarkin townlands. A substantial amount of turf cutting and land reclamation has been undertaken in the last century and as such the potential for discovery of intact archaeological sites has been reduced. There will be no impact on any archaeological sites recorded from the IAWU surveys and subsequent excavations.

Burnt mounds (*fulachta fiadh*) are commonly identified in wetland areas and are indicative of temporary prehistoric settlement in the area. They are typically located on the wetland/ dryland margin where there is a readily available water source, often in proximity to a river or stream or in places with a high water table. In wet landscapes such as this, dryland islands would have been the ideal locations for settlement and as such must be treated as areas of archaeological potential also. A possible burnt mound was identified during field inspection to the north and west of proposed Turbine 17 and haulage route, which has been designated AAP 4.

Aerial photographic analysis has identified one site of potential archaeological significance within the immediate proximity of proposed Turbine 16 in Wood townland. A potential D-shaped enclosure is indicated on a 2009 image adjoining the original river course; however this is not shown on any other imagery and as such interpretation is tentative. During field inspection a significant embankment (c. 1m in depth) was noted curving along the southern side of the feature however it was no clear if this continued to the north-east. For the purpose of this report the site has been designated as an Area of Archaeological Potential (AAP 2). To the west of this a

second smaller raised area was identified on the banks of the paleo-channel which may have archaeological potential (AAP 3). While AAP 2 and AAP 3 may represent natural features associated with original river course given the proximity of moated site (RMP OF004-009) it is possible that these represent settlement activity.

13.4 RESULTS AND ANALYSIS – ARCHITECTURE

13.4.1 Built Heritage Background

The area of proposed development comprises open bog land that has largely remained unsettled until the 19th century. The lands are marginal and water logged in most cases and do not provide a suitable setting for settlement. In 1813 Warrenstown Barony was the second least densely populated region in Offaly. The first and second edition OS maps show a sparsely settled landscape with several large houses to the south of the Yellow River and a number of small farmsteads.

The built heritage of the area was identified from a number of sources including the County Development Plan, the National Inventory of Architectural Heritage Survey and field inspection. Within this report these sites are referenced with their RPS/NIAH numbers if present or by a Built Heritage designation (i.e. BH 1) if they were identified during field inspection.

The built heritage within the wider area is typified by the vernacular cottage and associated outbuildings, much of which are shown on the first edition OS map. Vernacular architecture is defined in James Steven Curl's Encyclopaedia of Architectural Terms as 'a term used to describe the local regional traditional building forms and types using indigenous materials, and without grand architectural pretensions', i.e. the homes and workplaces of the ordinary people built by local people using local materials. This is in contrast to formal architecture, such as the grand estate houses of the gentry, churches and public buildings, which were often designed by architects or engineers. The majority of vernacular buildings are domestic dwellings. Examples of other structures that may fall into this category include shops, outbuildings, mills, lime kilns, farmsteads, forges, gates and gate piers.

Typically the single storied thatched cottage would be considered to represent the real vernacular style in Ireland. Following c. AD1700, settlement clusters were likely to have consisted primarily of single-storey thatched cottages with associated farm

buildings. Whilst there are no structures recorded within the RPS or NIAH within the proposed development area a number of vernacular structures were noted within the wider area. The thatch cottage at Coolcor (RPS 07-07, NIAH 14904016) fronts onto the R400 and comprises of a typical five-bay single store, direct entry house built c. 1800. A number of other vernacular cottages were noted within the wider landscape during field inspection in the townlands of Fahy (BH 3 and 4), Sruh (BH 7 and 8), Garr (BH 10), Corbetstown (BH 13 and 14) and Carrick (BH 15, 16 and 18).

A number of two-storey farmhouses/ houses were also noted during field inspection at Fahy (BH 6) Corbetstown (BH 12), Carrick (BH 17) and Corbetstown (BH 12). A traditional early 19th century farmhouse is recorded at Stonehouse (NIAH 14904003) a mid-19th century detached five-bay two-storey house is recorded at Dunville (RPS 16-03, NIAH 14803004).

Aalen (1997, 161) states that up until the late 19th century most rural labourers lived in one or two-roomed mud or sod dwellings that were dispersed singly on small plots of potato land, often on the edge of commons, moors and bogs. The Labourers' Act (1883) enabled local authorities to erect almost 50,000 new cottages for landless labourers by 1921. Most cottages were single or semi-detached located along roadways in 0.2ha allotments (*ibid.*). A small cottage (BH 1) is located fronting onto a local road in Coolcor townland north of Coolville Demesne. A second similar cottage (BH 21) is located in Fahy townland. This masonry cottage is in good condition and complies with a typical style developed by the Congested Districts Board. The Congested Districts Board for Ireland was established by the Chief Secretary, Arthur Balfour in 1891 to alleviate poverty and congested living conditions in the west of Ireland.

The remains of a freestanding circular wind mill (RPS 16-14, NIAH 14911014), built c. 1770, are located c. 1.8km south of the proposed Turbine 13. The wind mill is situated on an elevated position within the townland of Ballystrig. The NIAH survey concludes that while the structure is in a state of ruin it remains as a vestige to a past era when those within the community relied on the wind to grind their flour.

Three 19th century bridges are recorded within proximity to the proposed wind farm. Baltinoran Bridge at Carrick (RPS 07-01, NIAH 14904001) crosses the Mongagh

River. Sheep Bridge at Clonmore (NIAH 14904004) and Garr Bridge in Derryiron (NIAH 14904005) crosses the Yellow River.

A small village, Rhode (marked as Road on the first edition OS map) is present c. 750m south of the proposed wind farm landholding. In 1837 Rhode comprised of a small hamlet with “12 houses, situated in the midst of a rich grazing district, on the estate of J. Wakely, Esq., whose residence, Ballyburley, adjoins the hamlet” (Lewis, 1837). The nearby estates of “Rathmoyle, the residence of George Rait, Esq. (RPS 16-01-2, NIAH 14803001–3), Clonin of S. Rait, Esq.; Coolville of T. Grattan, Esq. (RPS 16-13, NIAH 14911012) and Greenhill, of F. L. Dames, Esq. (RPS 07-03, NIAH 14904008) were mostly environed by plantations” (*ibid.*). The first edition OS map shows the outline of six demesnes within c. 2km of the proposed wind farm. Five of these are associated with the houses named by Lewis while the remaining demesne associated with Grovesend House is located adjacent to Ballyburly House. Of these the original main houses at Cooleville (NIAH 14911012, RPS 16-13) and Rathmoyle (NIAH 14803001-3, RPS 16-01-2) are still extant. Ancillary buildings associated with two other demesnes survive at Greenhills (NIAH 14904008, RPS 07-03) and at Ballyburly (NIAH 14904007).

Several buildings in the village are recorded within the RPS and the NIAH survey including St. Peter's RC Church (RPS 16-05, NIAH 14803006), Rhode House (RPS 16-04, NIAH 14803005), the surgery (RPS 16-06, NIAH 14803007), house (NIAH 14803008), the Parochial Hall/ curates house (RPS 16-07, NIAH 14803010) and house (RPS 16-08, NIAH 14803011). A 19th century water pump is also recorded in Rhode village near Marian Terrace (NIAH 14803009). Two further water pumps are recorded in the NIAH survey within proximity to the proposed development at Corbetstown (NIAH 14904002) and Clonmore (NIAH 14904012).

More recent structures are also recorded by the NIAH and the RPS including two post boxes dating between the late 19th century and the early 20th century at Clonmore (RPS 07-04, NIAH 14904011) and Ballystrig (RPS 16-20, NIAH 14911024).

13.4.2 Cartographic Analysis

See section 3.3 for details

13.4.3 County Development Plan

County Offaly hosts a rich heritage of buildings and structures. The Offaly Development Plan (2009–2015) seeks the protection and conservation of buildings and structures of architectural, historical, archaeological, artistic, cultural, scientific, social and technical importance. The principal mechanism for protection of these buildings and structures is through their inclusion on the Record of Protected Structures (RPS). In all 862 structures are included within the current Development Plan.

A total of 15 RPSs are located within c. 2km of the proposed Yellow River Wind Farm. All of the structures listed on the RPS are also included within the NIAH Survey (see below). Details of these structures are included within **Appendix O**. No structures are impacted directly by the proposed development.

RPS Ref.:	Location	Type	Distance to nearest turbine	Report Ref.:
16-13	Cooleville	Coolville House	590m south	14911012
07-03	Greenhills	Stables	860m east	14904008
07-01	Carrick	Bridge	950m east	14904001
07-07	Coolcor	Vernacular cottage	1.04km west	14904016
16-03	Dunville	House	1.2km south	14803004
16-01, 2	Rathmoyle	Country House, Outbuildings, gate lodge	1.4km south	14803001–3
16-05	Road	Church/ Chapel	1.7–1.8km SSW	14803006
16-04	Rathmoyle	County House		14803005
16-06	Road	Surgery/clinic		14803007
07-04	Clonmore	Post box	1.7km south-east	14904011
16-07	Road	House	1.7–1.8km SSW	14803010
16-08	Road	House		14803011
16-14	Ballystrig	Wind mill	1.8km south	14911014
16-20	Ballystrig	Postbox	1.8km south	14911024

13.4.4 National Inventory of Architectural Heritage

A review of both the architectural survey and garden survey was undertaken as part of this assessment. An area up to 2km surrounding the proposed wind farm was examined in order to identify any buildings or areas of architectural significance. The results of this survey are summarised below and detailed in **Appendix O**.

13.4.5 Building Survey

A total of 24 structures are located within c. 2km of the proposed wind farm. Of these 15 are also listed on the Record of Protected Structures (see above). No structures are impacted directly by the proposed development.

NIAH Ref.:	Location	Type	Distance to nearest turbine	RPS Ref.:
14911012	Coolville	Coolville House	590m south	16-13
14904002	Corbetstown	Water pump	750m north	
14904003	Stonehouse	House	760m north-east	
14904008	Greenhills	Stables	860m east	07-03
14904001	Carrick	Bridge	950m east	07-01
14904016	Coolcor	Vernacular cottage	1.04km west	07-07
14904007	Ballyburly	Outbuilding	1.04km east	
14803004	Dunville	House	1.2km south	16-03
14803001-3	Rathmoyle	Country House, Outbuildings, gate lodge	1.4km south	16-01-2
14803008	Laurencetown	House	1.4km SSW	
14904005	Derryiron	Bridge	1.5km north-west	
14904010	Clonmore/ Kilowen	House	1.7km south-east	
14904011	Clonmore	Post box	1.7km south-east	07-04
14904012	Clonmore	Water pump	1.7km south-east	
14803005	Rathmoyle	County House	1.7-1.8km SSW	16-04
14803006	Road	Church/ Chapel		16-05
14803007	Road	Surgery/clinic		16-06
14803010	Road	House		16-07
14803009	Road	Water pump		
14803011	Road	House		16-08
14911014	Ballystrig	Wind mill	1.8km south	16-14
14911024	Ballystrig	Postbox	1.8km south	16-20

13.4.6 Garden Survey

A review of the NIAH Garden Survey, undertaken as part of this assessment, revealed six demesne landscapes of varying sizes within c. 2km of the proposed wind farm. Three of the six demesnes are partially located within the landholding for the proposed wind farm. Proposed Turbine 13 is located within the northern limit of Coolville Demesne. Proposed Turbines 14 and 15 are located on the edge of Ballyburly Demesne and Greenhills Demesne respectively.

The gardens of the former Coolville Demesne are recorded within the NIAH survey (NIAH Ref.: OF-49-N-535347). These are largely located within the landholding of the proposed development. The proposed Turbine 13 is located within the northern limit of the demesne lands. While the boundary of the demesne is retained the survey

determined that much of the peripheral landscape of this site is indistinguishable from the surrounding farmland.

The demesne lands associated with Greenhills House are also recorded by the survey (NIAH Ref.: OF-49-N-551361). The demesne is traversed by the proposed haulage route. While the survey is limited to paper research at present it concluded that few features of the designed landscape shown on the 1836–1846 OS map are visible in aerial photography.

The demesne lands associated with Ballyburly House are located to the immediate south and south-east of the proposed wind farm (NIAH Ref.: OF-49-N-552352). Again while the boundary has been retained, many of the original features are not apparent on the aerial photography and the structural woodland shown on the 1836–1846 OS map has been removed.

Clonin House and Demesne are located to the south and south-west of the proposed development, to the west of the R400 road (NIAH Ref.: OF-49-N-530342). Modern agricultural/industrial units have been constructed in the core landscape and virtually none of the original features are remaining.

Other smaller demesnes are located farther to the south surrounding Rathmoyle House (NIAH Ref.: OF-49-N-542334) and Grovesend House (NIAH Ref.: OF-49-N-560345). The survey determined that the main features at Rathmoyle were substantially present with some loss of integrity while there are no surviving features associated with Grovesend.

13.4.7 Field Inspection

The area of proposed development was inspected for evidence of built heritage. Nothing of architectural significance was identified within the footprint of the proposed turbine sites however a number of structures with built heritage merit were noted within proximity to the development (see table below and **Appendix O**). The surrounding landscape is typified by small isolated farmsteads, isolated vernacular cottages in the poorer land and a number of small demesnes and houses in the better land to the south of the proposed development.

The proposed haulage route passes through or adjacent to three demesne landscapes – Cooleville, Greenhills and Ballyburly. Coolville House (RPS 16-13, NIAH 14911012), approached via a tree-lined avenue from the west, is associated with a coach house and various ancillary buildings located around a rear courtyard. The coach house and farm buildings are in a state of partial disrepair (Plate 38). The proposed haulage route passes within c. 80m of the main house and outbuildings before turning north through several fields of rough pasture. No demesne features were noted in the fields to the north however some designed landscape features were noted in the garden surrounding the main house to the south. The western boundary of the demesne is delineated by an earthen bank and hedge row with several mature trees aligned along its axis.

Greenhills Demesne is located to the north-east of Cooleville and was shown as a larger area on the first edition OS map. The proposed haulage route runs along the southern boundary of the demesne lands (which also forms the northern boundary of Ballyburly Demesne) before turning north and joining an existing access road. This curving road forms the original avenue leading to the main house as shown on the first edition OS map. While the boundary of the demesne is maintained none of the original landscape features exist. The principal house no longer stands although some of the stables are present (NIAH 14904008). Several fields containing woodland are present to the north of the house site and a tree-lined trackway runs north to Wood townland (Plate 39).

The proposed haulage route runs along the northern boundary of Ballyburly Demesne. The boundary of the demesne is preserved however the main house is no longer present. Some of the outbuildings, shown on the 25" OS map, are still extant (NIAH 14904007) which are accessed by the original avenue (Plate 40). The local road which bisects the demesne lands is bound by short stone walls. None of the ornamental garden and landscape features survive and the demesne lands largely comprise of pastureland.

Rathmoyle Demesne, located further to the south by Rhode village, appears to retain much more of its original landscape features. The northern limit of the demesne is delineated by a low stone wall and a line of mature trees. Most of the main features are extant including the house, gate lodge and outbuildings (NIAH 14803001-3, RPS 1601-2).

A total of 22 buildings (or groups of buildings) of built heritage significance were identified within c. 2km of the proposed development during the field inspection. No structures are directly impacted by the proposed turbines although the proposed haulage route will pass in proximity to the school in Garr (BH 11) and ruined cottage in Carrick (BH 18).

BH No.	Location	Description	Distance to Development
BH 1	Coolcor 253225, 234885	CDB Cottage	720m south-east of Turbine 13, 60m north of haulage route
BH 2	Fahy 254401, 233842	Rectory, 2-storey house	1.5km south of Turbine 13
BH 3	Fahy 255288, 234064	Vernacular cottage	1.9km south-east of Turbine 13
BH 4	Fahy 255375, 234124	Vernacular cottage	1.95km south-east of Turbine 13
BH 5	Fahy 255567, 234210	Fahy Post Office	1.85km south-east of Turbine 14
BH 6	Fahy 255479, 234247	Stone faced, 2-storey house	1.85km south-east of Turbine 14
BH 7	Sruth 253209, 236500	Vernacular cottage, half structure, overgrown	1.3km north-west of Turbine 15
BH 8	Sruth 253198, 236581	Vernacular cottage and farmyard, derelict	1.3km north-west of Turbine 15
BH 9	Garr 252877, 237605	Farmyard complex and Garr House	1.9km west of Turbine 16
BH 10	Garr 253711, 238425	Vernacular cottage, derelict	700m south of Turbine 24
BH 11	Garr 254309, 238741	School house	Adjacent to haulage route, 560m south-east of Turbine 24
BH 12	Corbetstown 254563, 239047	House and farmyard	200m east of haulage route, 570m north of Turbine 23
BH 13	Corbetstown 255350, 239923	Vernacular cottage	1.1km north of Turbine 20
BH 14	Corbetstown 255221, 240263	Vernacular cottage	1.2km SSE of Turbine 31
BH 15	Carrick 255277, 240623	Vernacular cottage, renovated	920m south-east of Turbine 31
BH 16	Carrick 254067, 240071	Vernacular cottage and farmyard	780m east of Turbine 28
BH 17	Carrick 253949, 239998	2-storey farmhouse and farmyard	650m east of Turbine 28
BH 18	Carrick 254103, 241018	Vernacular cottage, ruins	Immediately south of haulage route, 400m south of Turbine 32
BH 19	Baltinoran 255348, 241049	2-storey house and vernacular farmyard	820m east of Turbine 31
BH 20	Baltinoran 255535, 241121	Baltinoran House, ruins	1km east of Turbine 31
BH 21	Fahy 255059, 234142	Cottage	1.7km south of Turbine 13

BH No.	Location	Description	Distance to Development
BH 22	Killowen 257509, 237925	Killowen House and farm	820m SSE of Turbine 19

13.4.8 Conclusions

Whilst the landscape surrounding the proposed wind farm is characterised by peatland and flat reclaimed bogland, a number of buildings of local architectural significance were identified in the area. The village of Rhode has developed since the late 18th century and a number of houses here date to the early-mid 19th century.

A total of 24 structures located within c. 2km of the proposed wind farm are recorded in the NIAH survey. Of these structures 15 are also listed on the Record of Protected Structures for County Westmeath. None of these structures are located within 500m of a proposed Turbine site however five are located within c. 1km radius. The proposed haulage route passes within close proximity to two sites – Coolville House and Greenhills stables; both of which are recorded in the NIAH and RPS.

Several small demesnes are located to the north and north-east of Rhode located along the southern limit of the proposed wind farm. No structural demesne features will be directly impacted by the proposed developments however the haulage route will traverse greenfield areas in Coolville, Greenhills and Ballyburly Demesnes.

The proposed haulage route passes within c. 60m of the main house at Cooleville however it passes to the rear of the property and does not directly impact on any demesne features. Only a short section of the haulage route will be visible from the roadway. Proposed Turbine 13 is located within the northern limit of the demesne and two further proposed turbines are located within the immediate vicinity of the demesne boundary.

It is not proposed to locate any turbines within the boundary of Greenhills demesne however the haulage route travels through a significant proportion of it. The route runs along the southern boundary of the demesne before running north along the original avenue for the main house. The main house no longer exists however some of the original stables are recorded (NIAH 14904008, RPS 07-03). While the boundary of the demesne is preserved many of the designed landscape features are no

longer present. The surrounding lands comprise of pastureland and a wooded area to the north, divided by deep drainage ditches.

The proposed haulage route runs along the northern boundary of Ballyburly Demesne however it does not impact directly on any significant features. The demesne lands comprise of rough pasture bound to the south by a short stone wall. While the outline of the original main house and gardens is present the only extant structures of historic interest are the outbuildings (NIAH 14904007) which are accessed from the south.

A total of 22 buildings (or groups of buildings) of built heritage significance were identified within c. 2km of the proposed development during the field inspection. Of these four sites are located within c. 200m of the proposed haulage route while only one structure (BH 18) is located within c. 500m of a proposed Turbine site. No built heritage structures will be directly impacted by the proposed development the haulage route will pass in close proximity to Garr School (BH 11) and a ruined vernacular cottage (BH 18).

13.5 RESULTS AND ANALYSIS – CULTURAL HERITAGE

The proposed wind farm is located within the townlands of Bunsallagh, Derryarkin, Derryiron, Coolville, Ballyburly, Greenhills, Wood, Killowen, Garr, Corbetstown and Carrick. The surrounding townlands consist of Derrygreenagh, Ballyfore, Ballybeg, Coolcor, Knockdrin, Dunville, Srah, Grovesend, Fahy, Ballymorán, Stonehouse, Tooreen, Ballyheasill, Clonmore, Kilkeeran (Meath), Baltinoran (Meath), Derryhinch (Meath), Pass of Kilbride (Westmeath), Milltown (Westmeath) and Drumman (Westmeath). These townlands are located within the parishes of Croghan, Ballyburly and Castlejordan, within the Baronies of Lower Philipstown and Warrenstown, County Offaly. The northern limit of the proposed wind farm is located on the county border between Offaly, Westmeath and Meath. The 820m east of Turbine 31 of Upper Moyfenrath (Meath) and Fartullagh (Westmeath) are located to the immediate north-east and north-west respectively.

13.5.1 Place Name Analysis

Townland and topographic names are an invaluable source of information on topography, land ownership and land use within the landscape. They also provide information on history; archaeological monuments and folklore of an area. A place name may refer to a long forgotten site, and may indicate the possibility that the

remains of certain sites may still survive below the ground surface. The Ordnance Survey surveyors wrote down townland names in the 1830's and 1840's, when the entire country was mapped for the first time. Some of the townland names in the study area are of Irish origin and through time have been anglicised. The main reference used for the place name analysis is *Irish Local Names Explained* by P.W Joyce (1870). A description and possible explanation of each townland name in the environs of the proposed route are provided in the below table.

These townland names largely refer to topographical features while Coolville and Corbetstown are more modern constructions.

Name	Derivation	Possible Meaning
Derryarkin	<i>Doire Ardcaein ?</i>	Beautiful high oak grove
Bunsallagh	<i>Bun Saileach</i>	The bottom of the willow grove
Derryiron	<i>Doire Iron</i>	Oak grove, iron oxide in the ground
Coolville	<i>Cuil or cul, Cor Ville - house</i>	Corner or back of a rounded hill (Coolcor) – Coolville is a 19th century subdivision of Coolcor townland created with the construction of Coolville House
Ballyburly	<i>Bhaile an Bhuirléigh</i>	Town of ...
Greenhills	-	Wooded area
Wood	-	Woods
Killowen	<i>Coill abhainn</i>	Woods by the river
Garr	<i>Garrdha or Garbh</i>	Garden or rough ground
Corbetstown	-	Corbet's town
Carrick	<i>Carraig</i>	Rock

13.5.2 Townlands

The townland is an Irish land unit of considerable longevity as many of the units are likely to represent much earlier land divisions. However, the term townland was not used to denote a unit of land until the Civil Survey of 1654. It bears no relation to the modern word 'town' but like the Irish word *baile* refers to a place. It is possible that the word is derived from the Old English *tun land* and meant 'the land forming an estate or manor' (Culleton 1999, 174). The proposed route passes through a total of five townlands.

Gaelic land ownership required a clear definition of the territories held by each sept and a need for strong, permanent fences around their territories. It is possible that boundaries following ridge tops, streams or bog are more likely to be older in date than those composed of straight lines (*ibid.* 179).

The vast majority of townlands are referred to in the 17th century, when land documentation records begin. Many of the townlands are mapped within the Down Survey of the 1650s, so called as all measurements were carefully 'laid downe' on paper at a scale of forty perches to one inch. Therefore most are in the context of pre-17th century landscape organisation (McErlean 1983, 315).

In the 19th century, some demesnes, deer parks or large farms were given townland status during the Ordnance Survey and some imprecise townland boundaries in areas such as bogs or lakes, were given more precise definition (*ibid.*). Larger tracks of land were divided into a number of townlands, and named Upper, Middle or Lower, as well as Beg and More (small and large) and north, east, south and west (Culleton 1999, 179). By the time the first Ordnance Survey had been completed a total of 62,000 townlands were recorded in Ireland.

The proposed wind farm is located within the northern limit of County Offaly and as such is bordered by Meath and Westmeath. The county boundary is formed by the Mongagh River. The wind farm is located within the Baronies of Lower Philipstown and Warrenstown. The boundary between these boundaries is partially formed by the Yellow River but the majority passes unmarked through bogland. The proposed wind farm is divided between three parishes of Croghan, Castlejordan and Ballyburly. The Yellow River forms part of the parish boundaries. The proposed haulage route crosses 11 townlands which are listed above.

13.5.3 Cultural Heritage Sites

The term 'cultural heritage' can be used as an over-arching term that can be applied to both archaeology and architectural. However, it also refers to more ephemeral aspects of the environment, which are often recorded in folk law or tradition or possibly date to a more recent period.

A mill race runs south from the Yellow River adjacent to proposed Turbines 8, 9 and 10 in Derryiron townland. This watercourse divides with one branch running south, annotated as 'canal supply' to meet the Grand Canal in Tober Daly townland. The eastern branch runs south-east to Coolcor townland – possibly supplying a mill associated with the church and monastery (RMP OF004-011). The canal supply is shown on Larkin's Map of 1809 and by the time of the first edition OS map (1840) the mill race is annotated. The mill race/canal supply has been designated as CH 1 for

the purpose of this assessment. The mill race will be crossed three times by the proposed haulage road.

The proposed wind farm is located within a landscape that is characterised by flat peatlands. The main economic industry of the area is turf cutting and the tracks of the Bord na Móna narrow gauge railway are still present in the vicinity. A branch of the trackway runs north-west to south-east to the east of Turbine 5 and 6 and to the west of Turbines 8, 9 and 10. This section of track is located in the townlands of Derryarkin, Derrygreenagh and Derryiron and crosses the Yellow River north-west of Turbine 8. Although a relatively modern addition to the landscape this track way is designated as a site of cultural heritage (CH 2) for the purpose of this assessment.

A concrete handball alley is present in Fahy townland fronting onto a local road, c. 1km south of the proposed landholding. The alley is not shown in the 1908–1910 OS maps therefore it was constructed after this. The alley has been designated as a site of cultural heritage (CH 3) for the purpose of this assessment.

13.5.4 Conclusions

A review of the townlands names within which the proposed development will be contained has revealed some common topographical terms, which were used to describe portions of the landscape. These gradually became anglicised and lost their original form, although it still is possible to investigate their original structure. Most of the townland names are descriptive of the environment and topography of the area and as such are likely to be of some age. A number of townland boundaries are located within proximity to the proposed turbines however none are directly impacted by the current layout. These comprise of rivers and small watercourses, field boundaries and unmarked arbitrary lines within peatland.

Three sites of cultural heritage, mill race (CH 1), narrow gauge railway tracks (CH 2) and a handball alley (CH 3), were identified during field inspection within proximity to the proposed development.

13.6 ASSESSMENT OF POTENTIAL IMPACTS

13.6.1 Construction Stage - Archaeology

- The proposed wind turbines will not directly impact any previously recorded archaeological remains in Derryarkin or Ballybeg peatbogs as these were largely removed following the IAWU Survey in 2002. No additional sites of archaeological potential were identified in during the field inspection within the peatland areas. However as wetland environments are ideal for preservation of archaeological remains the peatland and reclaimed peatland has been designated as an Area of Archaeological Potential (AAP 1). There may be a significant or profound impact on previously unrecorded archaeological features or deposits that have the potential to survive beneath the current ground level in AAP 1. This will be caused by ground disturbances associated with the proposed development.
- The proposed haulage route passes to the immediate east of the moated enclosure and associated field system (RMP OF004-009) in Wood townland. There may be a significant or profound impact on archaeological features or deposits associated with this site. This would be caused by ground disturbances associated with widening of the haulage route.
- Two potential enclosures were identified in Wood townland (AAP 2 and AAP 3) within the immediate proximity of proposed Turbine 16 on the bank of the paleo-channel for the Yellow River. There may be a significant or profound impact on previously unrecorded archaeological features or deposits associated with AAP 2 and 3. This would be caused by ground disturbances associated with construction of Turbine 16 and haulage route.
- A possible burnt mound (AAP 4) was identified adjacent to proposed Turbine 17. Given the riverside location there may be a significant or profound impact on previously unrecorded archaeological feature or deposits that have the potential to survive beneath the current ground level which may be associated with burnt mounds. This would be caused by ground disturbances associated with construction of Turbine 17 and haulage route.

13.6.2 Construction Stage - Architecture

- The proposed haulage route passes in the immediate vicinity of BH 11 School and BH 18 cottage. Current design indicates that there will not be a direct negative impact on these structures. It is possible however that there may be an indirect negative impact on these structures caused during construction phase and use of the proposed haulage route associated with the proposed development.
- The proposed route leading east through Cooleville Demesne will have a moderate direct adverse impact on the demesne landscape. The road will run to the rear of the house and outbuildings and will have a minimal impact on the direct setting of the house and gardens.
- The proposed haulage route runs through a significant portion of the Greenhills Demesne; however a large percentage of this will use an existing road. As such there will be a moderate direct adverse impact on the demesne landscape. This will be caused by widening of the existing roadway.
- The proposed haulage route will run along the northern perimeter of Ballyburly Demesne. As the demesne has lost most of its original features and the area comprises of rough pasture the proposed development will have a slight direct adverse impact on the demesne landscape

13.6.3 Construction Stage - Cultural Heritage

- There will be a direct negative impact on mill race (CH 1) in Derryiron townland. This would be caused by construction and use of a haulage route associated with proposed Turbines 8, 9 and 10.
- There will be a direct negative impact on narrow gauge railway (CH 2) in Derrygreenagh and Derryarkin townlands. This would be caused by construction and use of a haulage route adjacent to proposed Turbine 7.

13.6.4 Operational Stage - Archaeology

- A moderate indirect adverse impact is predicted for the setting of moated site (RMP OF004-009). Three turbines are located within the immediate vicinity

of the medieval settlement which negatively impact on the visual setting of the site. The visual impact is relevant for 30 years and the life span of the wind farm. As such the visual impact is temporary.

- A slight indirect adverse impact is predicted for the settings of the following sites. Turbines are located within relative proximity and will be visible within the surrounding landscape. The relative remoteness of the monuments and views in other directions will remain intact. The turbines will not impinge upon public understanding of the monuments. The visual impact is relevant for 30 years and the life span of the wind farm. As such the visual impact is temporary.
 - Religious house, cross and building, OF004-011
 - Enclosure, OF004-008
 - Enclosure, OF004-003
 - Hilltop Enclosure, OF004-004
- An imperceptible indirect adverse impact is predicted for the settings of the following sites as the turbines are located at a sufficient distance that they will not dominate the monuments. The relative remoteness of the monuments and views in other directions will remain intact. The turbines will not impinge upon public understanding of the monuments. The visual impact is relevant for 30 years and the life span of the wind farm. As such the visual impact is temporary.
 - Enclosures, OF003-003 and OF003-004
 - Bullaun Stone, OF004-022
 - Earthworks, OF004-007 and OF004-005
 - Castle/ motte, OF004-006
 - Castles, OF004-012
 - Church, wall and ecclesiastical enclosure, OF004-013

- Standing Stone, OF011-002
- Mound, OF011-003
- Ring barrows, OF011-055 and OF 011-001
- Wayside cross, OF011-056
- Burial Ground, OF004-002
- *Fulachtaí Fiadh*, OF004-017–021
- Church, ME046-012
- Motte and Bailey, Tower House, ME052-002001
- No impact on the settings of wetland sites (RMP OF003-002, 010–054 and WM034-018–021) as these have largely been excavated or removed through milling of peatland.
- No impact on the settings of redundant records (RMP OF004-023–025 and OF004-001) is anticipated as they are no longer deemed to be of archaeological significance.

13.6.5 Operational Stage - Architecture

- A slight indirect adverse impact on the settings of the following structures is predicted as they are located within the immediate receiving environment of the proposed wind farm. The turbines are located within proximity and will be visible to the north-east and north-west of the structures. However, views in other directions will remain intact. The turbines will not impinge upon public understanding of the structures or affect their immediate landscape context. The visual impact is relevant for 30 years and the life span of the wind farm. As such the visual impact is temporary.
 - Cooleville House, NIAH 14911012/ RPS 16-13
 - House, NIAH 14904016/ RPS 07-07
 - Greenhills Stables, NIAH 1494008/ RPS 07-03

- An imperceptible indirect adverse impact on the settings of the following structures is predicted as they are located within the wider receiving environment of the proposed wind farm. The turbines are located at a sufficient distance that they will not dominate the setting of the structures. Views in other directions will remain intact. The turbines will not impinge upon public understanding of the structures or affect their immediate landscape context. The visual impact is relevant for 30 years and the life span of the wind farm. As such the visual impact is temporary.
 - Outbuildings, NIAH 14904007
 - House, NIAH 14803004/ RPS 16-03
 - Windmill, NIAH 14911014/ RPS 16-14
 - Post-boxes, NIAH 14911024/RPS 16-20, NIAH 14904011/RPS 07-04
 - House, gate lodge, NIAH 14803001-3/ RPS 16-01,02
 - Buildings in Rhode, NIAH 14803005-11/ RPS 16-04–8
 - Bridges, NIAH 14904005 and NIAH14904001/ RPS 07-01
 - Houses, NIAH 14904010, 14904003 and 14803008
 - Water pumps, NIAH 14904002, 14904012
 - Cottages, school and farmyards, BH 1–22

13.6.6 Operational Stage - Cultural Heritage

- There is no anticipated impact to the cultural heritage resource during the operational phase of the proposed development.

13.7 RECOMMENDATIONS AND MITIGATION MEASURES

13.7.1 Construction Phase - Archaeology

- It is recommended that all ground disturbances, such as topsoil stripping or site investigations, associated with the proposed development in existing peatland or greenfield areas (including AAP 1) be monitored by a suitably qualified archaeologist. This includes the three crossings of the now canalised Yellow River. Full provision should be made for the resolution of any archaeological features/deposits that may be discovered, should that be deemed the appropriate way to proceed.
- Any impact on Recorded Monument (OF004-009) by the proposed development should be avoided. Should the access track require widening to function as a haulage route it is recommended that widening occur on the western side of the road. If widening on the eastern side is unavoidable, it is recommended that archaeological testing be undertaken within the zone of archaeological potential for the RMP site. Testing should be carried out prior to any ground disturbance to assess the impact on any features associated with the moated site and field system. This work should be undertaken by a licence eligible archaeological in consultation with the National Monuments Service of the DoAHG. Full provision should be made for the resolution of any archaeological features/deposits that may be discovered, should that be deemed the appropriate way to proceed.
- It is recommended that a program of archaeological testing be carried out within the footprint of the proposed development (Turbine 16 and 17 and haulage route) in the two fields containing potential enclosures (AAP 2 and AAP 3) and possible burnt mound (AAP 4) in Wood townland. This work should be undertaken by a licence eligible archaeological in consultation with the National Monuments Service of the DoAHG. Full provision should be made for the resolution of any archaeological features/deposits that may be discovered, should that be deemed the appropriate way to proceed.

13.7.2 Construction Phase - Architecture

- It is recommended that any impact on the built heritage resource, especially Garr school (BH 11) and vernacular cottage (BH 18), be avoided during the construction phase of the proposed development.
- It is recommended that a full written and photographic record of the setting of Coolville Demesne and House be undertaken prior to any construction works being undertaken. This should pay particular attention to the western boundary which will be partially removed to allow access to the haulage route.
- It is recommended that a full written and photographic record of the setting of Greenhills Demesne be undertaken prior to any construction works being undertaken. This should pay particular attention to the southern boundary and access avenue along which the haulage route will run.
- It is recommended that a full written and photographic record of the setting of Ballyburly Demesne be undertaken prior to any construction works being undertaken. This should be undertaken in conjunction with the record of Greenhills Demesne which abuts the northern limit of this estate.

13.7.3 Construction Phase - Cultural Heritage

- It is recommended that any impact on mill race (CH 1) and narrow gauge railway (CH 2) be avoided during the construction phase of the proposed development. Should this not be possible it is recommended that any ground disturbance be monitored and recorded by a qualified archaeologist.

13.7.4 Operational Phase - Archaeology

- The predicted indirect moderate impact upon the landscape setting of moated site OF004-009 cannot be adequately addressed with mitigation measures. Measures such as screening of the site are not appropriate as it would have a greater impact on the landscape setting of the site when compared to the nature of the slight temporary visual impact of the proposed wind farm.

- The predicted indirect slight impacts upon the landscape setting of monuments OF004-011, OF004-008, OF004-003 and OF004-004 cannot be mitigated. Screening each site is not appropriate as it would have a greater impact on the landscape setting of the sites when compared to the minor nature of the temporary visual impact of the proposed wind farm.
- The predicted indirect imperceptible impacts upon the landscape setting of monuments OF003-003, OF003-004, OF004-022, OF004-007, OF004-005, OF004-006, OF004-012, OF004-013, OF011-002, OF011-003, OF011-055, OF 011-001, OF011-056, OF004-002, OF004-017-021, ME046-012, ME052-002001 cannot be adequately addressed with mitigation measures. Screening each site is not appropriate as it would have a greater impact on the landscape setting of the sites when compared to the minor nature of the temporary visual impact of the proposed wind farm.

13.7.5 Operational Phase - Architecture

- The predicted slight adverse impact upon the setting of Cooleville House (NIAH 14911012/ RPS 16-13), House (NIAH 14904016/ RPS 07-07) and Greenhills Stables (NIAH 1494008/ RPS 07-03) could be mitigated against with screening. However, erecting screening around these structures would impact on the immediate setting of the structures, and be out of context with their landscape setting. This would result in a greater impact on the setting than the temporary indirect impact of the proposed wind farm.
- The predicted indirect imperceptible impacts on the landscape setting of the following structures cannot be mitigated. Screening each site is not appropriate as it would have a greater impact on the landscape setting of the structures when compared to the minor nature of the temporary visual impact of the proposed wind farm.
 - Outbuildings, NIAH 14904007
 - House, NIAH 14803004/ RPS 16-03
 - Windmill, NIAH 14911014/ RPS 16-14
 - Post-boxes, NIAH 14911024/RPS 16-20, NIAH 14904011/RPS 07-04

- House, gate lodge, NIAH 14803001-3/ RPS 16-01,02
- Buildings in Rhode, NIAH 14803005-11/ RPS 16-04–8
- Bridges, NIAH 14904005 and NIAH14904001/ RPS 07-01
- Houses, NIAH 14904010, 14904003 and 14803008
- Water pumps, NIAH 14904002, 14904012
- Cottages, school and farmyards, BH 1–22

13.7.6 Operational Phase - Cultural Heritage

- None required.

13.7.7 Monitoring

Due to the nature of the proposed development (i.e. the narrow corridor of required land and small footprint of the turbines) along with the relatively low potential for discovery of archaeological remains within the lands to be made available, it is appropriate that a recommendation of archaeological testing be made (in those specified areas) to be undertaken as a condition of planning. Should archaeological material be discovered in the areas of archaeological potential, any impact is predicted to be minimal (due to footprint size) and as such it would be possible to provide further mitigation (in discussion with the Department of Arts, Heritage and the Gaeltacht).

13.7.8 Residual Impacts

There will be no residual adverse impacts upon the archaeological and architectural resource due to the construction of the proposed wind farm.

As there is little in the way of mitigation measures that can be utilised, the residual magnitude of the impacts on the settings of the sites and structures will not change.

Please note that all recommendations are subject to approval by the National Monument Section of the Heritage and Planning Division, Department of Arts, Heritage and the Gaeltacht.

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14.0 INTERACTIONS OF THE FOREGOING

14.1 INTRODUCTION

None of the foregoing topics exists in isolation from the others and, because of this, any impact on one element of the environment may also impact on another. The cumulative slight impact on a number of topics may result in a significant impact on another topic.

14.2 PREDICTED IMPACT

A matrix of all topics is presented in **Table 14.1**, which illustrates the overlap or interaction of topics. Interaction in the matrix, however, does not imply a cumulative impact.

TOPIC	HB	F&F	S&G	Water	A&C	L	CH	MA
Human Beings		*	*	*	*	*	*	*
Flora and Fauna	*		*	*		*		
Soils & Geology	*	*		*		*		*
Water	*	*	*					
Air and Climate	*							
Landscape	*	*	*					
Cultural Heritage	*							
Material Assets	*		*					

Table 14.1 Interaction matrix

As each diagonal half of the matrix is a mirror image of the other only the vertical side will be described in descending order from the first interaction – Human Beings and Flora and Fauna etc.

Human Beings and:

- i.** Flora and Fauna
- ii.** Soils and Geology
- iii.** Water
- iv.** Air and Climate
- v.** Cultural Heritage
- vi.** Material Assets
- vii.** Landscape

Any negative affect on the environment as a result of this project is produced by Human Beings and, because it is the environment we live in, any negative affect will also affect us as Human Beings. For example, the use of fossil fuels (Material Assets) for electricity generation produces greenhouse gases and fumes (Air and Climate affect) which affects weather patterns and, in turn, agriculture (Human Beings). The partial removal of the reliance on fossil fuels for electricity generation as a result of the project can therefore be seen as having positive overlapping impacts on Material Assets, Air and Climate and Human Beings. Because no negative affect has been predicted for Human Beings there are no negative interactions with the other overlapping topics.

No further mitigation measures are proposed.

Flora and Fauna and:

- viii.** Human Beings
- ix.** Soils and Geology
- x.** Water
- xi.** Landscape

The interrelationship of Flora and Fauna with the topics Soils and Geology and Water is very close. A negative affect on one topic has the potential to affect the other two and vice versa. This is particularly true where vegetation removal decreases soil stability, which can result in surface water runoff with high suspended solids content. Conversely, reduced water quality or the removal of large areas of soil would result in negative effects on plant and animal species.

It is anticipated that this complex interrelationship will be dealt with by reducing the vegetated area which is to be affected, by carefully controlling the movement of vehicles during construction. Any surface water runoff, which originates at, or passes over exposed soil or peat, particularly at road construction, will be drained into settling ponds to allow the suspended solids to be removed before joining natural watercourses.

These potentially negative affects are only expected to occur at construction stage and are considered to be adequately mitigated by the measures outlined in the respective chapters.

Affects on Flora and Fauna can also affect landscape in terms of vegetation. In the case of this site there is a small proportion of conifer trees to be removed and replanted, the majority of the site is unenclosed bogland. The total area to be removed from existing land use within the site will be a small proportion of the available habitat, taking up approximately 3 %, therefore no significant negative effects can be predicted and no mitigation measures are proposed.

Soils and Geology and:

- xii.** Human Beings
- xiii.** Flora and Fauna
- xiv.** Water
- xv.** Landscape
- xvi.** Material Assets

Several of these interactions have been described above.

The reaction between Soils and Geology and Landscape is concerned with the changes the landscape undergoes as a result of changes in the soil coverage or geological makeup. Landscape is usually viewed at a distance and the removal of small quantities of soil and rock should not be visible from even nearby viewpoints.

The interrelationship of Soils and Geology and Water is also very close. A negative affect on one topic has the potential to affect the other and vice versa. This is particularly true where soil removal can result in surface water runoff with high suspended solids content.

No negative effects are predicted and no further mitigation measures are proposed.

Water and:

- xvii.** Human Beings
- xviii.** Flora and Fauna

xix. Soils and Geology

These three interactions have been discussed above. No negative effects are predicted and no further mitigation measures are proposed.

Air and Climate and:**xx. Human Beings****Landscape:****xxi. Flora and Fauna****xxii. Soils and Geology****Cultural Heritage and:****xxiii. Landscape****xxiv. Human Beings****Material Assets:****xxv. Human Beings****xxvi. Soils and Geology**

These interactions have been discussed above. No significant negative impacts are predicted for these sections and as a result no negative interaction can be foreseen.

14.3 MITIGATION MEASURES

No mitigation measures are required.

14.4 CONCLUSION

Following the assessment of the interactions of the foregoing topics it can be concluded that no significant interactive negative effects from the proposed Yellow River Wind Farm are predicted.