Bracklyn Wind Farm

Chapter 7: Water

Bracklyn Wind Farm Limited

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Contents

7.1 Introduction

7.1.1 Background and Objectives

This EIAR chapter provides an assessment of the likely and significant effects of the proposed Bracklyn Wind Farm near Raharney, Co. Westmeath and its associated grid connection infrastructure (which extends into County Meath) on water aspects (hydrology and hydrogeology) of the receiving environment.

The objectives of the assessment are to:-

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the proposed development;
- Identify likely positive and negative impacts of the proposed development on surface and groundwater during the construction, operational and decommissioning phases of the development;
- Identify mitigation measures to avoid, remediate or reduce likely or significant negative effects; and,
- Assess likely or significant cumulative effects of the proposed development as a result of other wind farms and other infrastructural developments.

7.1.2 Description of the Proposed Development

A full description of the proposed development is presented in **Chapter 3**. In summary, the proposed development comprises the following main components:-

- 9 no. wind turbines with an overall tip height of 185m, and all associated ancillary infrastructure;
- Upgrades to the turbine component haul route;
- Construction of a 110kV electricity substation and installation of 6.3km of underground electricity line between the proposed substation and the existing Corduff-Mullingar 110kV overhead electricity line; and
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure.

The majority of the proposed development is located within the administrative area of County Westmeath; while approximately 2.5km of underground electricity line and the proposed end masts will be located within County Meath. Additionally, candidate quarries which may supply construction materials are also located within County Meath.

The indicative turbine component haul route is also located within the counties of Waterford, Kilkenny, Carlow, Kildare and Dublin.

7.1.3 Statement of Authority

Hydro-Environmental Services (HES) are a specialist hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include upland hydrology and wind farm drainage design. We routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types, including wind farms and associated grid connections.

This chapter was prepared by Michael Gill and David Broderick.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 17 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael was involved in the preparation of Environmental Impact Statements (EIS) for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 no. other wind farm related projects.

David Broderick (BSc, H.Dip Env Eng, MSc) is a hydrogeologist with over 13 years' experience in both the public and private sectors. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into Environmental Impact Assessment Reports/Environmental Impact Statements (EIAR/EIS) for a range of commercial developments. For example, David was also involved in the preparation of Environmental Impact Statements (EIS)for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm related projects across Ireland.

7.1.4 Relevant Legislation

This chapter has been prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

Regard has also been taken of the requirements of the following legislation (where relevant):-

- Planning and Development Act 2000 (as amended);
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish Law;
- 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 2009;
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010; and,
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009.

7.1.5 Relevant Guidance

This chapter has been prepared in accordance with guidance contained in the following:-

- Guidance Document on Wind Energy Developments and EU Nature Legislation (European Commission, 2020);
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);
- Environmental Protection Agency (2017): Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation on Environmental Impact Statements) where relevant;
- Environmental Protection Agency (September 2015): Draft – Revised Guidelines on the Information to be Contained in Environmental Impact Statements where relevant;
- Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation on Environmental Impact Statements) where relevant;
- Environmental Protection Agency (2002): Guidelines on the Information to be Contained in Environmental Impact Statements where relevant;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Wind Energy Development Guidelines for Planning Authorities (2006);

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- Forest Services (Draft) Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures;
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;
- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters;
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses
- (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.
- Department of Housing, Planning & Local Government (2018) *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*;
- European Union (2017) Guidance *on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU);*
- *Westmeath County Development Plan 2021-2027*;
- *Meath County Development Plan 2013*-2019; and
- *Draft Meath County Development Plan 2021-2027*;

7.2 Methodology

7.2.1 Desk Study

A desk study of the proposed development site and surrounding area was completed in advance of undertaking the walkover survey, field mapping and site investigations. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological information for the proposed development and surrounding area. The desk study included consultation of the following data sources:-

- Environmental Protection Agency database (www.epa.ie); Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive/EPA Catchments Map Viewer (www.catchments.ie);
- Bedrock Bedrock Geology 1:100,000 Scale Map Series, Sheet 13 (Geology of Meath);
- Geological Survey of Ireland (2004); Groundwater Body Initial Characterization Reports;
- OPW Flood Hazard Mapping (www.floodinfo.ie);
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.epa.ie);

- CFRAM Flood Risk Assessment (PFRA and CFRAM) maps (www.cfram.ie); and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie);
- Meath Co. Co. and Westmeath Co. Co. Strategic Flood Risk Assessment Mapping;
- Ordnance Survey Ireland (OSI) – 6 inch and 1;5000 scale basemaps; and,
- Aerial photography (www.bing.com/maps, www.google.com/maps).

7.2.2 Site Investigations

Detailed drainage mapping, hydrological constraints mapping, and baseline monitoring was initially undertaken by HES on 21st February 2019. Intrusive site investigations (described below) and baseline monitoring were undertaken on 14th and 15th June and 4th September 2020. An additional site walkover was completed in February 2021.

In summary, site investigations to address and inform the preparation of this water chapter include the following:-

- Walkover surveys and hydrological mapping of the proposed development and the surrounding area were undertaken whereby water flow directions and drainage patterns were recorded;
- A trial pit (~2 – 3.5m depth) was undertaken at each of the turbine locations (or nearby) and the met mast) to investigate subsoil depth and lithology along with groundwater conditions (i.e. potential inflows). 13 no. trial pits in total were completed;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken to determine the origin and nature of surface water flows; and,
- Surface water sampling (3 no. samples) was undertaken to determine the baseline water quality of the primary surface waters originating from the wind farm site and grid connection.

7.2.3 Receptor Sensitivity / Importance / Impact Criteria

Using the National Roads Authority (NRA 2008) guidance, an estimation of the importance of the water environment within and downstream of the proposed development area are quantified by applying the importance criteria set out in **Table 7.1** and **Table 7.2**; the impact magnitude is assessed using **Table 7.3** and **Table 7.4** and the impact rating using **Table 7.5**.

Importance	Criteria	Typical Example
Extremely High	• Attribute has a high quality or value on an international scale.	• River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid Waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	• Attribute has a high quality or value on a regional or national scale.	• River, wetland or surface water body ecosystem protected by national legislation – NHA status. • Regionally important potable water

		source supplying >2500 homes. • Quality Class A (Biotic Index Q4). • Flood plain protecting more than 50 residential or commercial properties from flooding. • Nationally important amenity site for wide range of leisure activities.
High	• Attribute quality or value on a local scale.	• Salmon fishery Locally important potable water source supplying >1000 homes. • Quality Class B (Biotic Index Q3-4). • Flood plain protecting between 5 and 50 residential or commercial properties from flooding. • Locally important amenity site for wide range of leisure activities.
Medium	• Attribute has a medium quality or value on a local scale.	• Coarse fishery. • Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3). • Flood plain protecting between 1 and 5 residential or commercial properties from flooding.
Low	• Attribute has a low quality or value on a local scale.	• Locally important amenity site for small range of leisure activities. • Local potable water source supplying <50 homes. • Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1residential or commercial property from flooding. • Amenity site used by small numbers of local people.

Table 7.1: Estimation of Importance of Hydrology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	• Attribute has a high quality or value on an international scale.	• Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	• Attribute has a high quality or value on a regional or national scale.	• Regionally Important Aquifer with multiple wellfields. • Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. • Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.

High	• Attribute quality or value on a local scale.	• Regionally Important Aquifer Groundwater • Provides large proportion of baseflow to local rivers. • Locally important potable water source supplying >1000 homes. • Outer source protection area for regionally. • important water source. • Inner source protection area for locally important water source.
Medium	• Attribute has a medium quality or value on a local scale.	• Locally Important Aquifer • Potable water source supplying >50 homes. • Outer source protection area for locally important water source.
Low	• Attribute has a low quality or value on a local scale.	• Poor Bedrock Aquifer Potable water source supplying <50 homes.

Table 7.2: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)

Magnitude	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Loss or extensive change to a waterbody or water dependent. Habitat Increase in predicted peak flood level >100mm. Extensive loss of fishery Calculated risk of serious pollution incident >2% annually. Extensive reduction in amenity value
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Increase in predicted peak flood level >50mm. Partial loss of fishery. Calculated risk of serious pollution incident >1% annually. Partial reduction in amenity value.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Increase in predicted peak flood level >10mm. Minor loss of fishery. Calculated risk of serious pollution incident >0.5% annually. Slight reduction in amenity value.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Negligible change in predicted peak flood level. Calculated risk of serious pollution incident <0.5% annually.

Table 7.3: Magnitude of Hydrology Impact (NRA, 2008)

Magnitude	Criteria	Typical Examples

Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

Table 7.4: Magnitude of Hydrogeology Impact (NRA, 2008)

	Magnitude of Impact			
Importance of Tribute	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/Moderate	Profound/Significant	Profound
High	Imperceptible	Moderate/Slight	Significant/Moderate	Profound/Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

Table 7.5: Estimation of Impact Rating (NRA, 2008)

7.2.4 Consultation

The scope for this assessment has also been informed by consultation with statutory consultees and other bodies with environmental responsibility.

This consultation process is outlined in **Chapter 1** of this EIAR. Issues, concerns and recommendations highlighted by the responses in relation to the water environment are summarised in **Table 7.6** below. The full responses from each of the below consultees are provided in **Annex 1.6.**

Consultee	Summary of Consultee Response	Issue Addressed in Section
Inland Fisheries Ireland (IFI)	The potential for soil erosion/ suspended solids generation is higher, during / after periods of prolonged rainfall. Systems should be put in place to ensure that there shall be no discharge of suspended solids or any other deleterious matter to watercourses during the construction / operational phase and during any landscaping works. Stockpiles of sand and other materials to be used in the works should be covered with sheeting when not in use to prevent washout of fines during rainfall. Stockpiles of topsoil and associated materials arising during site development such as turbine base excavations and installation of site road networks should be similarly protected. Silt traps should be constructed at locations that will intercept run-off to the drainage network. Traps should not be constructed immediately adjacent to natural watercourses. In designing silt traps account must be taken of the anticipated particle size(s) and the volumes of water likely to be focused through the trap(s). Retention time to allow appropriate settlement is a critical factor. A buffer zone should remain between silt trap(s) and watercourses with natural vegetation left intact so as to assist silt interception. During the construction process and operational phase, natural flow paths should not be interrupted or diverted so as to give rise to or create potential for erosion. Furthermore, excavation and installation of road(s)/access track(s) should be undertaken so as not to result in the creation of preferential flow paths that may result in erosion or which might otherwise interrupt the natural movement of waters for instance in peat bog areas. Where imported materials are used in road construction, these should be such as not to be liable to become crushed by vehicular movement, and lead to discharge of fine particulates to downstream receiving waters.	7.3.15, 7.3.16, 7.4.3.1, 7.4.4.1, 7.5.1.1 & 7.5.2.1

Department of Agriculture, Food and Marine	The interaction of these proposed works with the environment locally and more widely, in addition to potential direct and indirect impacts on designated sites and water, is assessed. Consultation with relevant environmental and planning authorities may be required where specific sensitivities arise (e.g. local authorities, National Parks & Wildlife Service, Inland Fisheries Ireland, and the National Monuments Service).	7.3.12, 7.4.3.8, 7.5.1.1 & 7.5.1.7
Irish Water (IW)	Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence/ present a risk to the quality of the water abstracted by IW for public supply.	7.3.13
Westmeath County Council	The application site is surrounded in peatlands. Impacts of the proposed development on the hydrology of adjoining peatlands should be given due consideration in the EIAR. Impacts on water quality including construction need to be assessed given the close proximity of the River Boyne and River Blackwater SAC.	7.3.14, 7.4.3.8 & 7.5.1.7
An Bord Pleanala (Statutory Pre-Application Consultation)	Consideration should be given to Bord na Móna (BnM) Bog Rehabilitation Plans for the bogs to the east, south east and south of the site.	Due to the decision of BnM to progress a planning application for a wind energy development on the adjacent bogs, it is unlikely that rehabilitation plans will affect the hydrology of the subject proposed development site.

Table 7.6: Summary of Scoping Responses

7.3 Description of the Existing Environment

7.3.1 Site Location and Description

The proposed development site, which is 275ha in area, is predominately located within a privately owned farm estate located ~4km north of Raharney, Co. Westmeath. The proposed wind farm and electricity substation is located entirely within a single landholding; while ancillary elements of the overall development, including grid connection infrastructure and haul route upgrade works, are located on both private lands and within the public road network.

Current land use within the proposed wind farm site is predominately agricultural grassland, with small pockets of deciduous woodland and conifer tree plantations. The wind farm site is bordered by intact raised bog to the north, east and south, and with grassland to the west. Much of the grassland along the periphery of the proposed wind farm site is reclaimed cutover raised bog.

The topography of the proposed wind farm site is 'gently sloping to undulating' with the overall site elevation ranging between approximately 90m and 110m OD (Ordnance Datum). The central area of the subject site comprises a gently sloping hill and the land falls away in all directions from this high point. Bracklyn House is located in the central area of the site with various farm buildings and surrounding fields being connected by a network of farm tracks.

The proposed 110kV electricity substation is located within the overall footprint of the proposed wind farm. In order to connect the proposed wind farm to the existing Corduff-Mullingar 110kV overhead electrical transmission line, it is proposed to install c. 6km of underground electricity line within agricultural lands and along a local public road. Off-road section of the underground electricity line will be accompanied by c. 2.5km of access track. The grid cable will tie into the 110kV overhead electrical transmission line via an end mast.

7.3.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall (1981-2010) recorded at Ballivor (Hill of Down), approximately 4.2 km southeast of the proposed wind farm site, are presented in **Table 7.7** below.

Ballivor (Hill of Down)												
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
85.2	60.5	68.6	62.2	60.7	71.6	71.3	81	71.4	94.3	84.2	86.1	897

Table 7.7: Local Average Long-Term Rainfall Data (mm)

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Mullingar, approximately 16km southwest of the proposed development site. The long-term average PE for this station is 448mm/yr. This value is used as a best estimate of the proposed development site's PE. Actual Evaporation (AE) at the site is estimated as 425mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:-

Effective rainfall (ER) = AAR – AE

= 897mm/year – 425mm/year

ER = 472mm/year

Based on recharge coefficient estimates from the GSI (www.gsi.ie), an estimate of 10% recharge is taken for the area of the site. This value is for "low to moderate permeability subsoil overlain by poorly drained gley soil" (*i.e.* tills as described in **Chapter 6**). The relatively high drainage density in the area, found to be present during the site walkover surveys, also suggest that surface drainage is the dominant flow regime at the site.

The recharge coefficient of 10% was used to calculate values for key hydrological properties. Therefore, annual recharge and runoff rates (90%) for the site are estimated to be ~47mm/year and ~425mm/year respectively.

Table 7.8 presents return period rainfall depths for the area of the proposed development. This data is taken from https://www.met.ie/climate/services/rainfall-return-periods and provides rainfall depths for various storm durations and sample return periods (1-year, 50-year, 100-year). These extreme rainfall depths have been incorporated into the proposed wind farm drainage design.

Duration	10-year Return Period (mm)	50-Year Return Period (mm)	100-Year Return Period (mm)
15 min	11.7	18.2	21.9
1 hour	18.8	28.2	33.4
6 hour	34.6	49.8	57.9
12 hour	43.9	62	71.5
24 hour	55.6	77.2	88.5

Table 7.8: Return Period Rainfall Depths for Bracklyn

7.3.3 Local and Regional Hydrology

On a regional scale, the proposed development is located in the Boyne River surface water catchment within the Eastern River Basin District (ERBD) in Hydrometric Area 07.

On a more local scale, the majority of the wind farm site (including all of the proposed 9 no. turbine locations) and the grid connection (including end masts) is located in the Stonyford River (Boyne_SC050) surface water catchment.

The Stonyford River flows into the Boyne River approximately 17km downstream of the proposed site.

A small area on the far west of the proposed site is located in the River Deel surface water catchment (Deel[Raharney]_SC_010). The River Deel flows into the Boyne River approximately 18km downstream of the proposed site. There is no proposed infrastructure located in the River Deel surface water catchment.

A Local hydrology map is shown below as **Figure 7.1.**

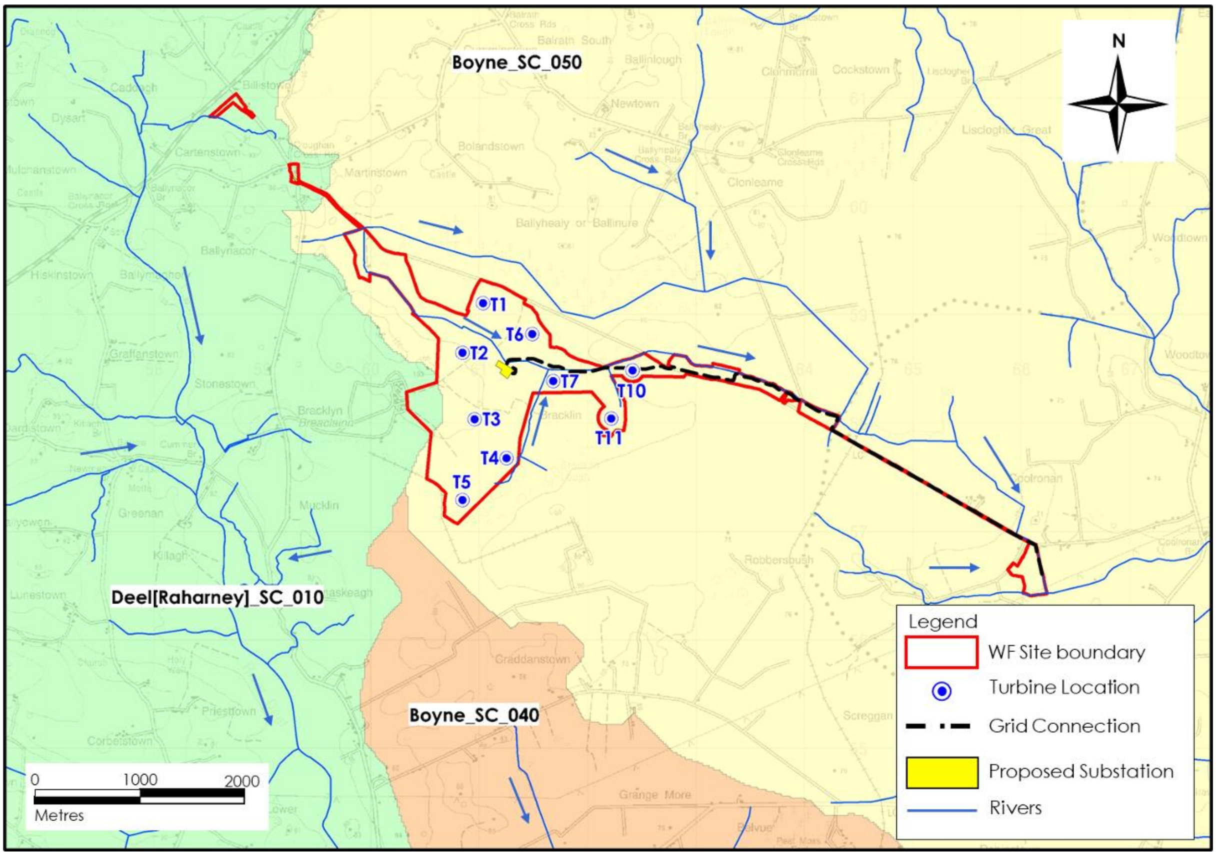


Figure 7.1: Local Hydrology Mapping

7.3.4 Wind Farm and 110kV Substation Site Drainage

In addition to numerous land drains, the majority of the wind farm and 110kV substation site is drained by 3 no. main streams which are headwater streams of the Stonyford River and River Deel. Stream A rises from just outside the south-eastern corner of the proposed development site where a lake and a wetland area are present. The lake is referred to as Bracklyn Lough and the wetland area is unnamed[1]. Stream B rises to the north west of the proposed development site and merges with Stream A close to the location of proposed turbine T7 before flowing off-site to the east. Both streams flow within deep channels (~1.5-2m deep) in the proposed wind farm site.

With respect to the main streams flowing through the site (i.e. Stream A and Stream B), there will be a requirement for 6 no. watercourse crossings and several drain crossings.

The southwestern section of the site drains to a headwater stream (referred to as Stream C) of the River Deel, but as stated above there is no proposed development in this area of the site.

The existing drainage regime at the proposed wind farm site is shown in **Figure 7.2**.

7.3.5 Grid Connection Drainage

Along the grid connection there will be a requirement for 4 no. watercourse crossings. Of these 4 no. mapped crossings, 3 no. will be required within the wind

[1] Fieldwork undertaken, including by others, did not indicate the presence of a lake and the area was noted as having become vegetated.

farm site itself along Stream B and the other 1 no. is an existing crossing along the public road. Within the wind farm site the grid cable will be placed within the proposed wind farm access roads at the crossing locations (i.e. no separate crossing will be required for the grid cable).

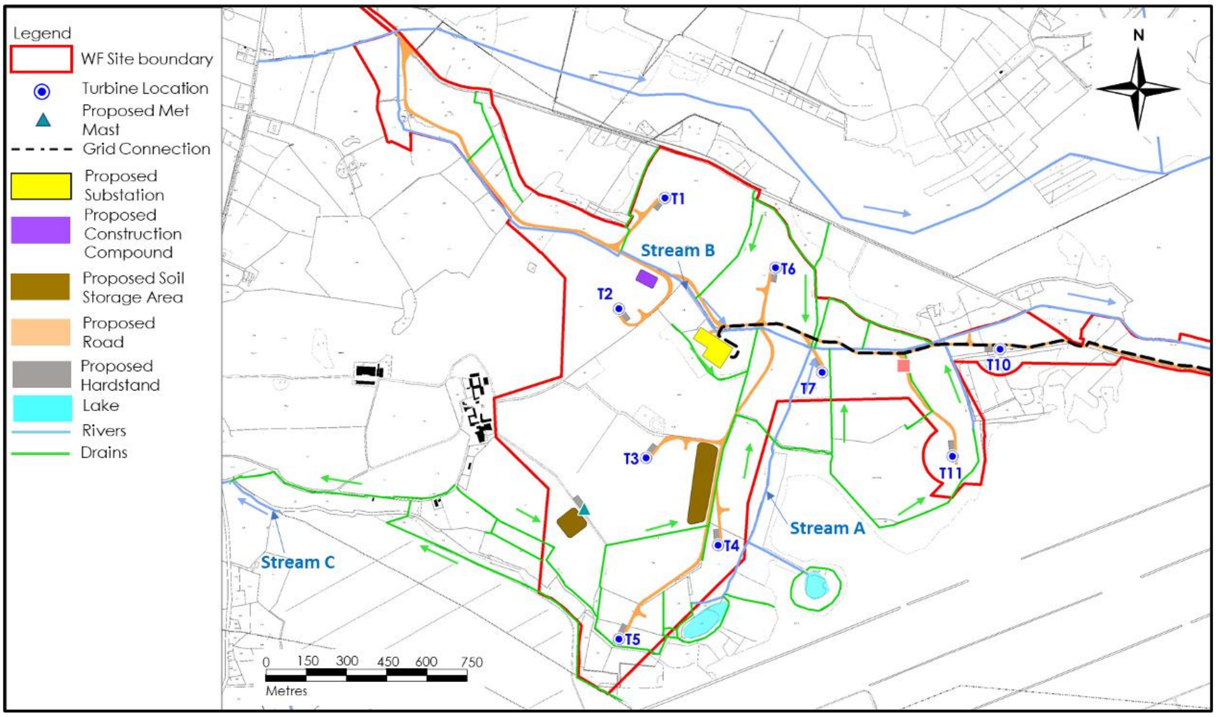


Figure 7.2: Windfarm Site Drainage Map

7.3.6 Flood Risk Identification

To identify those areas of the proposed development as being at risk of flooding, OPW's indicative river flood map (www.floodinfo.ie), Catchment Flood Risk Assessment and Management (CFRAM) Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie), and historical mapping (*i.e.* 6" and 25" base maps) were consulted.

There are no areas on the historical 6" or 25" mapping in the area of the wind farm site or grid connection route that are identified as an area that is "*Liable to Floods*". No recurring flood incidents were identified near the proposed wind farm site from OPW's Flood Hazard Mapping which is shown as on **Figure 7.3** below. The closest mapped flood event is along the Stonyford River near Delvin village, ~3km to the north of the site.

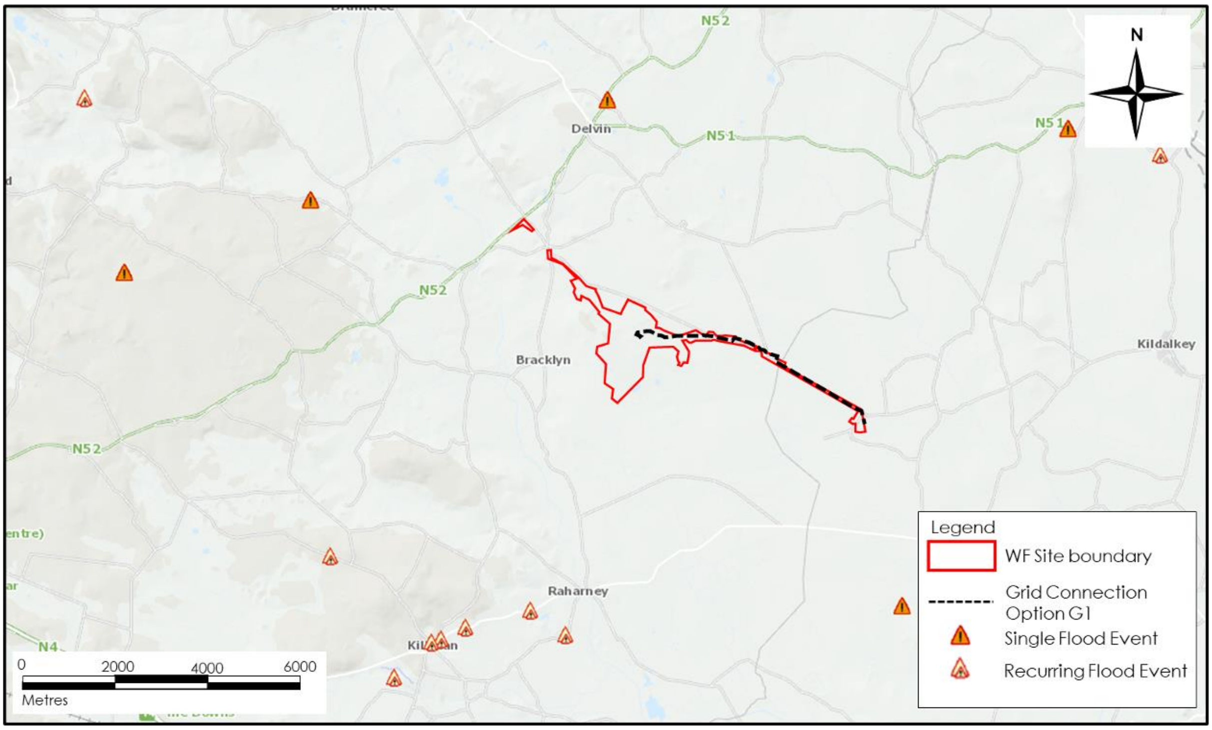


Figure 7.3: OPW Flood Hazard Mapping

Where complete the CFRAM Study OPW Flood Risk Assessment Maps are now the primary reference for flood risk planning in Ireland and supersede the PFRAM maps. There is no CFRAM mapping available for the area of the proposed development and therefore the PFRA mapping has been reviewed. The PFRA mapping is shown as **Figure 7.4** below.

The PFRA mapping shows a 100-year mapped flood on the northwest of the proposed wind farm site which intercepts the proposed arterial access track. The mapped fluvial flood zone is associated with an off-site stream which flows to the north of the site. However, the stream in question does not originate from within the proposed development site or pass through the site (where the flood zone is mapped) and therefore the PFRA flood zone mapping is incorrect.

There are no watercourses present where the PFRA mapped flood zone encroaches the proposed development site from the north. Additionally, each of the watercourses that emerge in the area of the proposed wind farm site are small headwater streams and therefore fluvial flood of any significance is not anticipated.

No other elements of the proposed WF infrastructure are located in a mapped PFRA flood zone.

The proposed 110kv substation is located centrally within the WF site and, as shown in **Figure 7.4** below, it is also located outside of a mapped PFRA flood zone.

The PFRA mapping also shows localised pluvial flood zones within the proposed wind farm site. Only short stretches of proposed access tracks are located within these mapped pluvial flood zones. Localised pluvial flood can be effectively managed by the proposed drainage design such that no significant effects will arise.

The end masts at the Mullingar-Corduff 110kV overhead electrical transmission line are located in a PFRA mapped 100-year fluvial flood zone. Due to the overhead nature of the end mast and the small foot print area there will be potential for increased fluvial flood risk at the end mast locations.

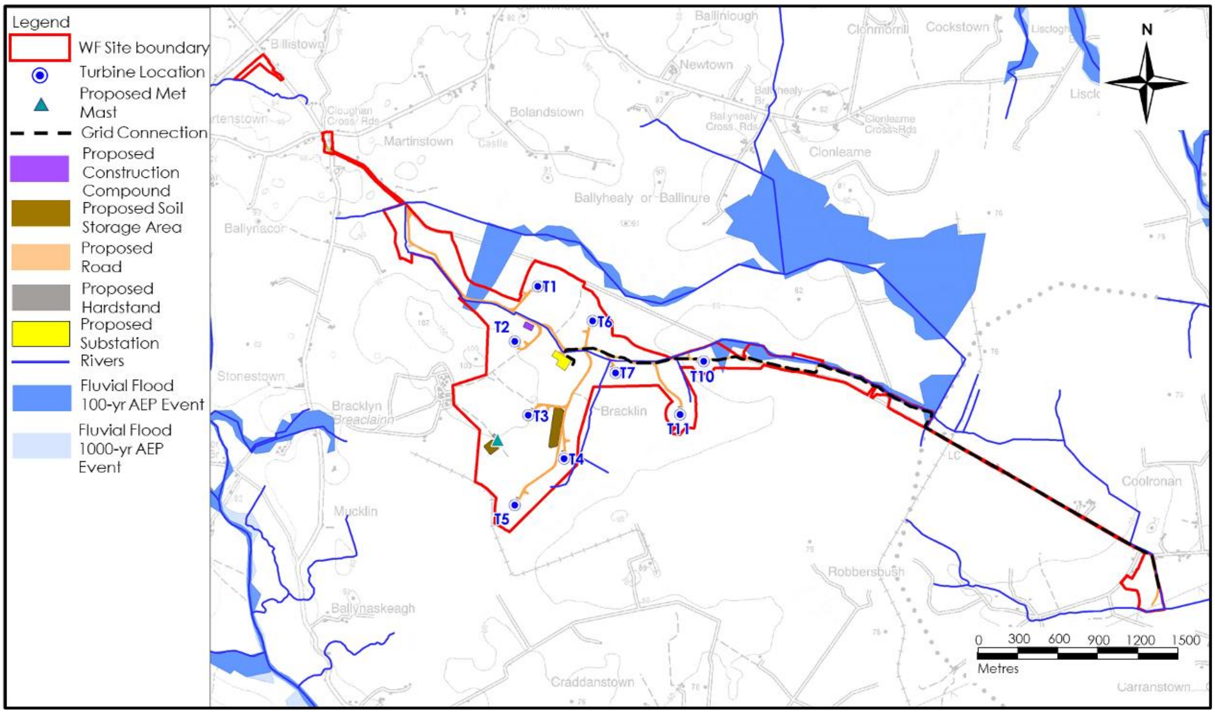


Figure 7.4: PFRA Flood Zone Mappingl

It is a key mitigation measure of the proposed development to ensure that all surface water runoff is treated (water quality control) and attenuated (water quantity control) prior to diffuse discharge at pre-existing Greenfield rates. As such, the mechanism by which downstream flooding, as a result of the proposed development, is prevented and controlled is through avoidance by design.

7.3.7 Surface Water Hydrochemistry

Q-rating data for EPA monitoring points are available on the River Deel and Stonyford River in the area of the proposed development.

Most recent data shows that the Stonyford River has a Moderate (Q3-4) to Good (Q4) Q-rating both upstream and downstream of the wind farm site and grid connection. The Deel River is reported to have a High Status (Q5) upstream of the WF site and reduces to Moderate (Q3-4) to Good (Q4) downstream of the WF site.

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units), temperature (^{0}C) and dissolved oxygen (DO) were taken from surface water features in the vicinity of the site on 4th September 2020 and the results are listed in **Table 7.9** below.

Electrical conductivity (EC) values for surface waters at the site area ranged between 278 and 290µS/cm which would be typical for the local mapped geology (*i.e.* limestone). The measurements were taken just after late summer and therefore the results are more representative of groundwater baseflow to streams.

It is considered that measurement in higher-flow conditions (during winter) is likely to result in an overall lower electrical conductivity range due to higher volumes of surface water runoff within streams.

The pH values, which ranged between 7.2 and 7.3, were generally near neutral, would be typical of catchments with mineral soil coverage. The dissolved oxygen concentrations are within the normal range for a Good to Moderate status watercourse during the summer months.

Surface water samples were taken from 3 no. sample locations within and downstream of the proposed development site. Sampling was undertaken on 4th September 2020 during a relatively dry spell of weather. Refer to **Figure 7.2** for sample locations.

Location	EC (µS/cm)	pH	Dissolved Oxygen (mg/L)
SW1	290	7.2	9.8
SW2	278	7.3	9.2
SW3	285	7.2	9.3

Table 7.9: Summary of Surface Water Chemistry Measurements

Results of analysis are shown alongside relevant water quality regulations in **Table 7.10** below. Laboratory reports are provided at **Annex 7.1**.

Parameter	EQS	Sample ID		
		SW1	SW2	SW3
Total Suspended Solids (mg/L)	25(+)	6	<5	<5
Ammonia (mg/L)	≤0.065 to ≤ 0.04(*)	0.02	0.07	1.01
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	0.16
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	0.07
Nitrate - NO_3 (mg/L)	-	16.3	21.7	22.8
Nitrogen (mg/L)	-	6.3	6.4	6.8
Phosphorus (mg/L)	-	<0.1	<0.1	0.15
Chloride (mg/L)	-	20	17.2	17.9
BOD	≤ 1.3 to ≤ 1.5(*)	2	2	2

(+) 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.

Table 7.10: Analytical Results of Surface Water Sampling

Total suspended solids, which ranged between <5 and 6mg/L, were all below the S.I. No. 293 of 1988 MAC of 25mg/L.

Nitrite values were below the laboratory detection limit of 0.05 mg/L in SW1 and SW2 and was reported as 0.16mg/L in SW3. Nitrate ranged between 16.3 and 22.8mg/L.

Ortho-phosphate ranged between <0.02 to 0.07mg/L. In comparison to the

Environmental Objectives Surface Water Regulations (S.I. 272 of 2009), results for SW1 and SW2 were below the "High Status" threshold. SW3 exceeded the "Good Status" threshold.

In relation to Ammonia N, which ranged between 0.02 and 1.01mg/L, the results exceeded the "Good Status" threshold in SW2 and SW3 but SW1 was below "High Status" threshold.

BOD was reported as 2mg/L in all samples, which exceeds the "Good status" threshold limit.

7.3.7 Hydrogeology

The limestones which underlie the proposed development are classified by the GSI (**www.gsi.ie**) as a Locally Important Aquifer (Bedrock which is Moderately Productive only in Local Zones) and a Poor Aquifer.

A bedrock aquifer map is shown below as **Figure 7.5.**

The limestones generally have an absence of inter-granular permeability, and most groundwater flow is expected to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3m thick, a zone of interconnected fissuring 10m thick, and a zone of isolated poorly connected fissuring typically less than 15m.

Groundwater levels in this bedrock type elsewhere have been measured mainly 0-5m below ground level. Groundwater flowpaths are likely to be short (30-300m), with groundwater discharging to nearby streams and small springs. Water strikes deeper than the estimated interconnected fissure zone suggests a component of deep groundwater flow, however shallow groundwater flow is thought to be dominant. Groundwater flow directions are expected to follow topography and therefore groundwater directions within the site are expected to be towards the primary streams within the valleys of the site (GSI, 2004).

Baseflow contribution to streams tends to be low, particularly in summer as the groundwater regime cannot sustain significant summer baseflows due to low storativity with the aquifer. Local groundwater flow directions will mimic topography, whereby flowpaths will be from topographic high points to lower elevation points at streams and rivers.

In terms of local Groundwater Bodies (GWBs), the proposed development is located in the Athboy GWB (IE_EA_G_001).

Based on criteria shown in **Table 7.2** above, the bedrock aquifer at the proposed development site have a Low Importance.

Based on the trial pit investigation, the groundwater table in the areas of limestone tills are more than 2.5 – 3m below ground level. However, in areas of cutover bog, the underlying silts/clays were generally found to be saturated. Groundwater levels in areas of cutover bog will be between 1 and 1.5m below ground level.

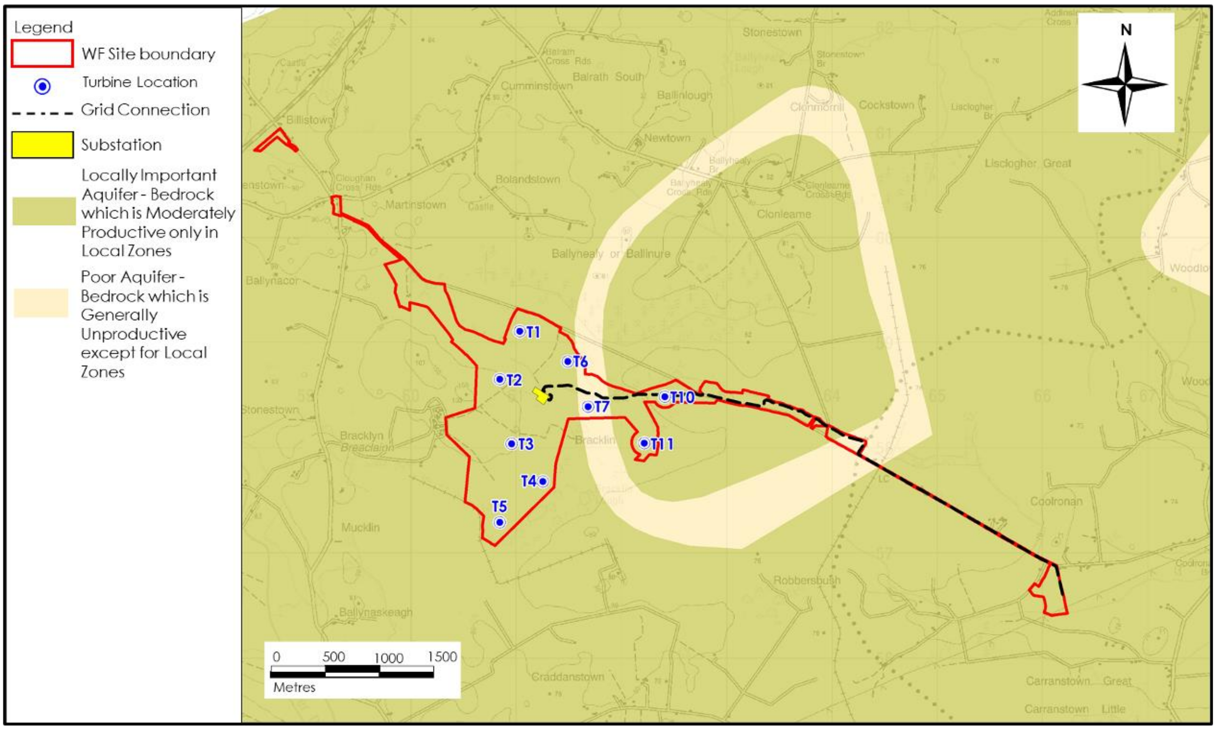


Figure 7.5: Bedrock Aquifer Mapping

7.3.8 Groundwater Vulnerability

The vulnerability rating of the aquifer beneath the proposed wind farm and substation site is mapped as "Low" to "High". The low vulnerability reflects the peat covered areas and the high vulnerability areas are typically mineral subsoils. The moderate vulnerability areas are in the transition zone between the peat and the mineral subsoils.

The vulnerability rating along the proposed grid connection is mainly "Low" to "Moderate" vulnerability.

Due to the low permeability nature of the peat surrounding the proposed development site, groundwater flow paths will typically be short (<300m), with recharge emerging close by at seeps and surface streams within the site. This means surface water bodies such as rivers and streams are more vulnerable than groundwater at this site.

7.3.9 Groundwater Hydrochemistry

There is no groundwater quality data for the proposed development site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting as groundwater quality impacts are not to be anticipated.

Based on data from the GSI publication on the Athboy GWB, alkalinity is expected to be in the range of 10 to 470 mg/l $CaCO_3$. The groundwaters are typically calcium-magnesium-bicarbonate type waters with conductivities ranging from 80 to 470µS/cm.

7.3.10 Groundwater Body Status

Local Groundwater Body (GWB) status information is available from www.catchments.ie. The Athboy GWB (IE_EA_G_001) underlies the proposed development.

The Athboy GWB is assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

7.3.11 Surface Water Body Status

River Water Body status information is also available from www.catchments.ie. River Water Body status information is available for the Stonyford River, River Deel and the River Boyne in the area of the proposed development.

Upstream of the proposed development, the River Deel has been assigned an overall 'Moderate Status' which improves to 'Good Status' downstream of the proposed development site.

The Boyne River directly downstream of the proposed development (i.e. the Stonyford River catchment) has been assigned an overall 'Moderate Status' but improves further upstream at the River Deel confluence where it has been assigned a 'Good Status'.

Taking the view that all watercourses are required to have at least "Good Status" in terms of the Water Framework Directive and by applying the criteria in **Table 7.1** above, local and downstream watercourses have a High to Very High Importance.

7.3.12 Designated Sites & Habitats

Within the Republic of Ireland, designated sites include National Heritage Areas (NHAs), Proposed National Heritage Areas (pNHAs), candidate Special Areas of Conservation (cSAC), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs).

The closest designated site to the proposed development is the River Boyne and River Blackwater SAC/SPA. The River Deel and the Stonyford River form part of this SAC/SPA.

The proposed wind farm is located approximately 7km upstream of the River Boyne and River Blackwater SAC/SPA within the Stonyford River catchment.

Therefore, the proposed development is hydrologically connected to the River Boyne and River Blackwater SAC/SPA.

Local designated sites in the area, and downstream, of the proposed development are shown at **Figure 7.6** below.

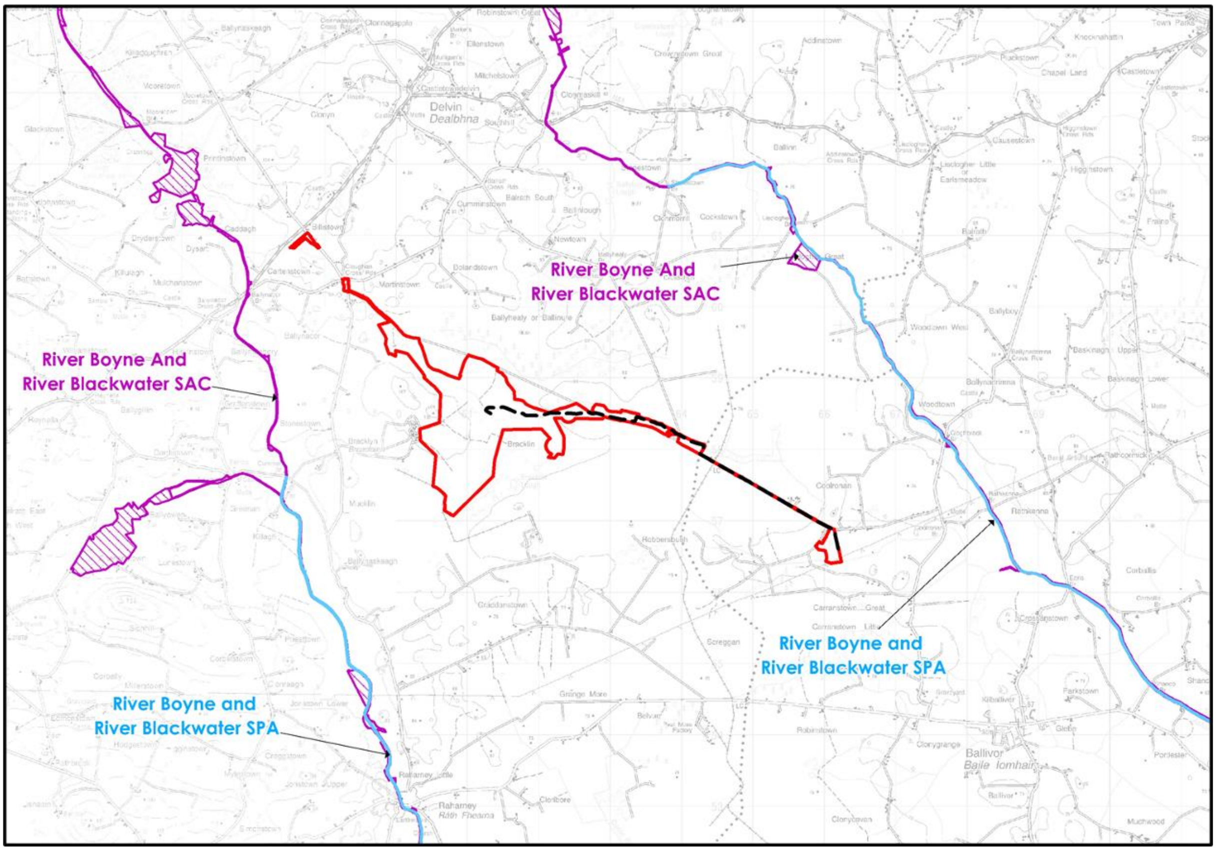


Figure 7.6: Designated Sites

7.3.13 Water Resources

There are no mapped groundwater source protection areas for either public water supplies or group water schemes in the area of the proposed development (National Federation Group Water Schemes only).

Private well locations (accuracy of <50m only) were reviewed using GSI well database (www.gsi.ie) and no wells are mapped within 1km of the proposed wind farm site. Wells along the grid connection were not assessed as no impacts on groundwater are expected due to the shallow nature of these proposed works.

GSI mapped wells with accuracy greater than 50m were not assessed due to the poor information/accuracy regarding their location. To overcome the poor accuracy, it is conservatively assumed that every private dwelling in the area (shown on **Figure 7.7**) has a well supply and this impact assessment approach is described further below.

The private well assessment undertaken below also assumes the groundwater flow direction underlying the site mimics topography, whereby flow paths will be from topographic high points to lower elevated discharge areas at local streams which flow through the site.

Using this conceptual model of groundwater flow, dwellings that are potentially located down-gradient of the footprint of the proposed development footprint are identified and an impact assessment for these actual and potential well locations is undertaken if required.

Based on the above approach, no private dwelling houses were identified to be located immediately down-gradient (i.e. downslope; nearest dwelling located in excess of 700m from the location of a proposed wind turbine) of the proposed development (and in particular turbine locations) and, therefore, there is no likelihood to significant effects on groundwater supplies. This assessment was focused on the turbine locations as this is where the deepest excavations will be required. All excavations required for access tracks, compounds and substations will be shallow and therefore there is no likelihood for significant impacts on groundwater supplies.

Based on criteria shown in **Table 7.2** local wells have Low Importance.

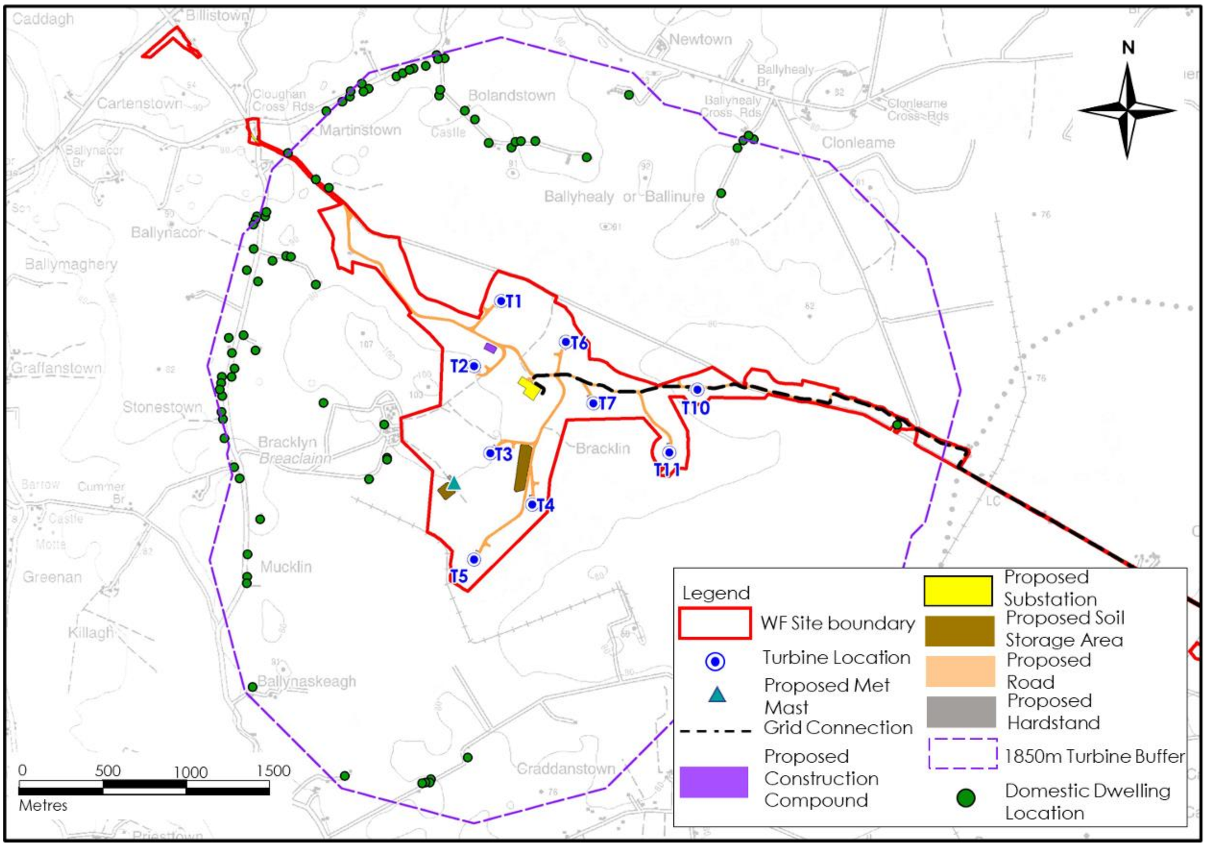


Figure 7.7: Private Dwelling Locations

7.3.14 Assessment of Changes in Site Runoff Volumes

The following water balance assessment gives a preliminary indication of the highest monthly average volume of surface water runoff expected. The calculations are carried out for the month with the highest average recorded rainfall versus evapotranspiration, for the current baseline site conditions, in terms of subsoil type and thickness (**Table 7.11**). It represents, therefore, the average wettest monthly scenario in terms of volumes of surface water runoff from the study area pre-development.

The rainfall depths presented in this section, which are long term averages, are not used in the design of the sustainable drainage system for the proposed development. As outlined in **Section 7.5.1.1** below, a '1-in-100 year 6-hour return' period will be used for design purposes.

The surface water runoff co-efficient for the site is estimated to be 90%, based on the low permeability peat and subsoil coverage at the site. The highest long-term average monthly rainfall recorded at Ballivor (Hill of Down) over the period 1981 – 2010 occurred in October, at 93.4mm. The average monthly evapotranspiration for the synoptic station at Mullingar over the same period in October was 16.2mm. The calculation is carried out for the entire site (~275ha). The balance indicates that a conservative estimate of surface water runoff for the site during the highest rainfall month is 193,050m³/month, which equates to an average of 6,227m³/day, as outlined in **Table 7.12.**

Water Balance Component	Depth (m)
Average October Rainfall (R)	0.0934
Average October Potential Evapotranspiration (PE)	0.0162
Average October Actual Evapotranspiration (AE = PE x 0.95)	0.0154
Effective Rainfall October (ER = R - AE)	0.078
Recharge (10% of ER)	0.008
Runoff (90% of ER)	0.07

Table 7.11: Water Balance and Baseline Runoff Estimates for Wettest Month (October)

Approx. Area (ha)	Baseline Runoff per month (m³)	Baseline Runoff per day (m³)
275	193,050	6,227

Table 7.12: Baseline Runoff for the Landholding

Baseline Runoff/month (m³)	Baseline Runoff/day (m³)	Permanent Footprint Area (m²)	Footprint Area 100% Runoff (m3) (m³)	Footprint Area 90% Runoff (m³)	Net Increase/month (m³)	Net Increase/day (m³)	% Increase from Baseline Conditions (m³)
193,050	6,227	80,926	6,312	5,681	631	20.4	0.33

Table 7.13: Baseline Runoff for the Wind Farm Site

The emplacement of the proposed development footprint, as described in **Chapter 3**, (assuming emplacement of impermeable materials) could result in an average total site increase in surface water runoff of 631m³/month, for the month of highest average recorded rainfall. This equates to an average increase of 20.4m³/day (**Table 7.13**). This represents a 0.33% increase in the average daily/monthly volume of runoff from the site in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from a relatively small area of the overall study area being developed. Specifically, the proposed permanent development footprint is approximately 8.09ha, representing 2.9% of the total site area of 275ha.

The additional runoff volume is low due to the fact that the runoff potential from the site is already naturally high (90%) due to the prevailing baseline conditions at the site. Also, this calculation assumes that all hardstanding areas will be impermeable which is a conservative approach given that access tracks and crane hardstands will be constructed of aggregates which will facilitate the permeation of rainfall. The increase in runoff from most of the development catchment will therefore be negligible even in the absence of surface water control measures. Therefore, it is assessed that there will be no risk of exacerbated flooding down-gradient of the site.

7.3.15 Development Interaction with the Existing Manmade Drainage Network

In relation to hydrological constraints, a self-imposed buffer zone of 50m has been put in place for on-site streams where feasible. Manmade drainage ditches at the site are not considered a hydrological constraint however a 10m buffer has been applied as a surface water quality protection measure for the downstream watercourses (i.e. streams/rivers).

The general design approach for wind farm developments is to utilise and integrate the project with the existing land infrastructure where possible whether it be existing access tracks or the existing land drainage network. Utilising the existing infrastructure means that there will be less of a requirement for new construction/excavations which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing land drains have no notable hydrological value and can be readily integrated into the proposed drainage scheme using the methods outlined below (**Sections 7.3.16** and **Section 7.4.4.1**).

7.3.16 Proposed Drainage Management

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, construction areas and temporary storage 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 stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters. During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated, through various attenuation methods, to a high quality prior to being released. Examples of attenuation methods include interceptor drains, collector drains, check dams, settlement/stilling/silt ponds and buffered outfalls.

A schematic of the proposed site drainage management is shown as **Figure 7.8** below. A detailed drainage design will be prepared, post consent, as part of the detailed design process (as is the normal course) demonstrating the implementation of the drainage design and attenuation infrastructure.

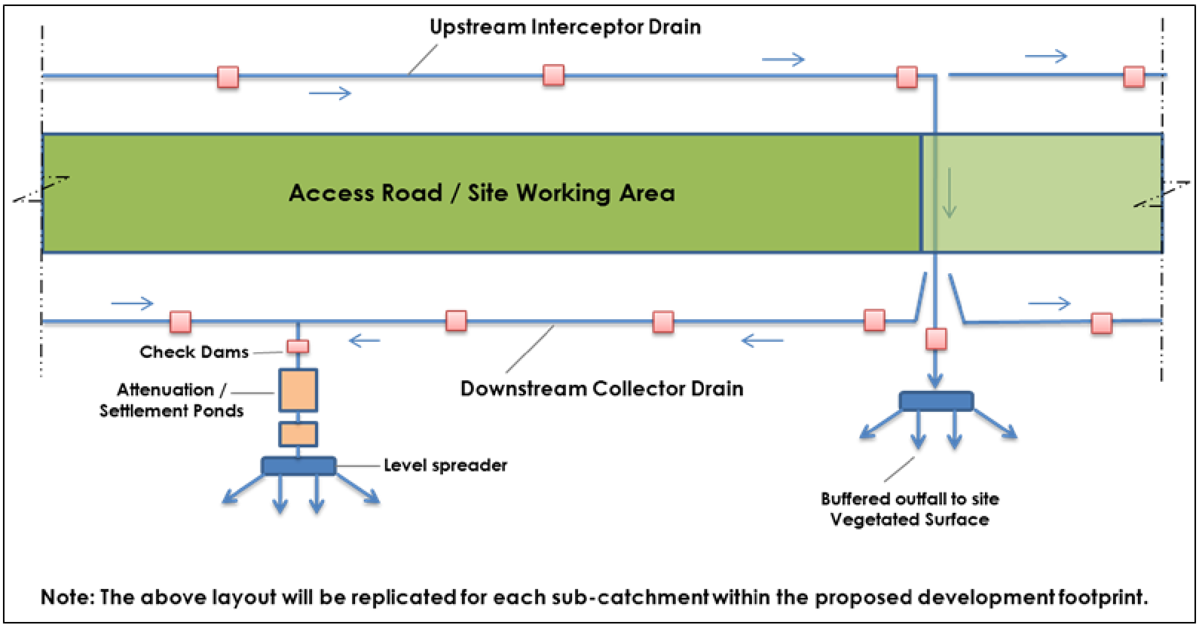


Figure 7.8: Schematic of Proposed Site Drainage Management

7.3.17 Receptor Sensitivity

Due to the nature of wind farm developments, being near surface construction activities, effects on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during environmental impact assessment reporting. The primary risk to groundwater at the site would be from cementitious materials, hydrocarbon spillage and leakages. These are common potential impacts on all construction sites (such as road works and industrial sites). All potential contamination sources are to be carefully managed at the site during the construction, operational and decommissioning phases of the development and mitigation measures are proposed below to deal with these potential minor impacts.

Based on criteria set out in **Table 7.2**, groundwater at the site can be classed as Medium Importance in terms sensitivity to pollution because the bedrock is generally unproductive and classified as a locally important aquifer. Any contaminants which may be accidentally released on-site are more likely to travel to nearby streams within surface runoff.

Surface waters such as the Stonyford River, River Deel and the River Boyne are classed as High to Very High Importance and are very sensitive to potential contamination. These rivers and associated lakes are known to be of trout potential and are important locally for fishing.

The designated sites that are hydraulically connected (surface water flow paths only) to the proposed development include the River Boyne and Blackwater SAC and therefore have Extremely High Importance. These designated sites can be considered very sensitive in terms of potential impacts.

Comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters. Mitigation measures will ensure that surface runoff from the developed areas of the site will be of a high quality and will therefore not 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.

Local domestic wells can be considered to have Low Importance.

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible by using a 50m buffer. From the constraints map (**Annex 7.2**), it can be seen that apart from some sections of access road, the T7 hardstand, a section of the construction compound and the watercourse crossing locations, the majority of the proposed development (including all turbine locations) is located outside of areas that have been assessed to be hydrologically sensitive.

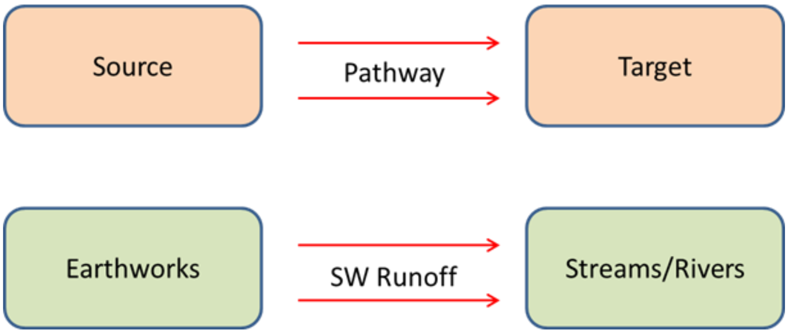
The hydrological buffer will ensure that the proposed drainage mitigation measures (discussed below) can be installed up-gradient of primary drainage features within sub-catchments to facilitate appropriate, efficient and effective attenuation of surface water runoff.

7.4 Description of Likely Effects

The likely effects of the proposed development are set out below, with mitigation measures that will be put in place to eliminate or reduce them are providing in following sections.

7.4.1 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess likely impacts on downstream environmental receptors (see below, bottom as an example) as a result of the proposed development.



Where likely impacts are identified, the classification of impacts in the assessment follows the descriptors provided in the glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):-

- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2017);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003); and,
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002).

The description process clearly and consistently identifies the key aspects of any likely impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect nature.

In order to provide an understanding of the stepwise impact assessment process applied below (**Sections 7.4.3 and 7.4.4**), we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all wind farm construction and operation activities which have the potential to generate a source of significant adverse impact on the hydrological and hydrogeological (including water quality) environments.

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the likely impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a likely impact is generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.
Step 6	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

7.4.2 Do Nothing Scenario

In the do nothing scenario, there would be no alteration to the hydrological environment. The hydrological regime, including runoff rates, would remain unchanged and current land use practices would continue. Existing land drainage arrangements would continue to function in their current manner.

7.4.3 Construction Phase

7.4.3.1 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

Construction phase activities that will require earthworks resulting in removal of vegetation cover and excavation of soil and mineral subsoil (where present) are detailed in **Chapter 3**. Potential sources of sediment laden water include:-

- Drainage and seepage water resulting from infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;

- Construction of the grid connection including cable trench 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 of downstream water bodies. The likely effects are assessed to be significant if in the absence of mitigation.

Attribute	Description
Receptor	Down-gradient streams, rivers and dependant ecosystems
Pathway/Mechanism	Drainage and surface water discharge routes
Pre-Mitigation Effect	Indirect, negative, moderate, temporary, likely effect

Table 7.14: Earthworks

7.4.3.2 Groundwater Levels and Local Well Supplies During Excavation works

Dewatering of deep excavations (such turbine foundations) have the potential to impact on local groundwater levels and nearby wells (if present). However, groundwater level effects are assessed to be minimal (if any) due to the existing local hydrogeological regime as outlined above and further discussed below.

No groundwater level effects are anticipated from the construction of the grid connection, including underground cabling, due to the shallow nature of the excavations (i.e. ~1-2m). The haul route upgrade works do not present a risk either as all works are at existing ground level and do not require excavations at depth.

Attribute	Description
Receptor	Groundwater levels / flow paths
Pathway/Mechanism	Groundwater flowpaths
Pre-Mitigation Effect	Indirect, slight, short term, unlikely impact

Table 7.15: Groundwater levels & Local Wells

The deepest excavation works will be centred around the turbine foundations. The turbine foundations will be gravity design, with the exception of T10 which will require a piled foundation. Foundation depths are expected to be to a depth of ~3m.

Based on the trial pit investigation, the groundwater table in the area covered by limestone tills is more than 2.5 – 3m below ground level. However, in areas of cutover bog, the underlying silts/clays were generally found to be saturated. Groundwater levels in areas of cutover bog will be between 1 and 1.5m below ground level. Groundwater inflows were typically found to be low to moderate.

The hydrogeological setting below some of the proposed turbine locations (saturated silts/clays) means groundwater dewatering will likely be required but pumping volumes will not be significant.

In terms of local well supplies, the assessment undertaken at **Section 7.3.13** above identified no potential wells down-gradient of turbine locations. Based on the well impact assessment and the nature of the local hydrogeological regime, impacts on local well supplies are not anticipated and, therefore, no specific mitigation or monitoring measures, other than best practice construction methodologies, are proposed.

7.4.3.3 Excavation Dewatering and Likely Impacts on Surface Water Quality

Some minor surface water/shallow groundwater seepages and direct rainfall input will likely occur in excavations which will create additional volumes of water to be treated by the runoff/surface water management system. Inflows will require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore pollution issues are not assessed as likely to occur.

Attribute	Description
Receptor	Down-gradient surface water bodies
Pathway/Mechanism	Overland flow and site drainage network
Pre-Mitigation Effect	Indirect, negative, moderate, temporary, unlikely effect on surface water quality

Table 7.16: Excavation Dewatering

7.4.3.4 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.

Attribute	Description
Receptor	Groundwater and surface water
Pathway/Mechanism	Groundwater flowpaths and site drainage network
Pre-Mitigation Effect	Indirect, negative, slight, short term, unlikely effect on local groundwater quality. Given the nature of the groundwater environment, discussed at **Sections 7.3.7**, **7.3.8**, **7.3.9** and **7.3.10** above, adverse effects on groundwater quality are assessed to be unlikely. Indirect, negative, significant, short term, likely effect to surface water quality

Table 7.17: Release of Hydrocarbons

7.4.3.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from site welfare wastewater treatment systems has the potential to impact on groundwater and surface waters.

Attribute	Description
Receptor	Groundwater quality and surface water quality
Pathway/Mechanism	Groundwater flowpaths and site drainage network

Pre-Mitigation Effect	Indirect, negative, significant, temporary, unlikely effect on surface water quality. Indirect, negative, slight, temporary, unlikely effect on local groundwater.

Table 7.18: Contamination from Wastewater

7.4.3.6 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant adverse 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 ≥6 to ≤ 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. Freshwater ecosystems are dependent on stable near neutral pH hydrochemistry. They are extremely sensitive to the introduction of high pH alkaline waters into the system. The batching of wet concrete on site and washing out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution.

Attribute	Description
Receptor	Surface water hydrochemistry and ecosystems
Pathway/Mechanism	Site drainage network
Pre-Mitigation Effect	Indirect, negative, moderate, brief, likely effect on surface water

Table 7.19: Release of Cement-Based Products

7.4.3.7 Morphological Changes to Surface Water Courses & Drainage Patterns

Diversion, culverting and bridge crossing of surface watercourses can result in morphological changes, changes to drainage patterns and alteration of aquatic habitats. The construction of structures over water courses also has the potential to significantly interfere with water quality and flows during the construction phase.

6 no. watercourse crossings will be required within the wind farm site and 3 no. along the grid connection route within the wind farm site also. The watercourses proposed for crossing are either 1st or 2nd order streams.

Within the wind farm site the grid cable will be placed within the proposed wind farm access roads at 3 no. proposed crossing locations (i.e. no separate crossing will be required for the grid cable).

Attribute	Description
Receptor	Surface water flows, stream morphology and water quality.
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Negative, direct, slight, long term, likely impact.

Table 7.20: Morphological Impacts

7.4.3.8 Potential Hydrological Impacts on Designated Sites

The closest designated site to the proposed development is the River Boyne and River Blackwater SAC. The River Deel, to which a small section of the western section of the proposed development site drains, is within the River Boyne and River Blackwater SAC. The Stonyford River, albeit not designated itself (at the location of the site), drains to the River Boyne and River Blackwater SAC, some 7km downstream of the wind farm site. Therefore, the proposed development is hydrologically connected to the River Boyne and River Blackwater SAC.

Any likely surface water effects are unlikely to be significant due to dilution/assimilation capacity effects over such distances. Notwithstanding this, surface water management and mitigation is proposed to protect local surface water and avoid adverse downstream surface water quality effects.

Attribute	Description
Receptor	Down-gradient water quality and designated sites
Pathway/Mechanism	Surface water flowpaths
Pre-Mitigation Effect	Indirect, negative, slight, short term, likely effect

Table 7.21: Designated Site Effects

7.4.4 Operational Phase

Activities during the operational phase of the proposed development will be significantly reduced compared to the construction phase, with extremely limited sources for likely adverse hydrological effects.

7.4.4.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. The permanent development footprint comprises turbine hardstands, access tracks, substation and compound amongst others. During rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

Attribute	Description
Receptor	Surface waters and dependant ecosystems.
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Direct, negative, moderate, permanent, likely impact.

Table 7.22: Operational Phase Effects

As determined in **Section 7.3.14** above, a potential increase of 0.33% increase in the average daily/monthly volume of runoff from the site in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from a relatively small area of the overall study area being developed. Specifically, the proposed permanent development footprint is approximately 8.09ha, representing 2.9% of the total study area of 275ha.

The increase in runoff from the developed site will therefore be negligible which, even in the absence of mitigation measures, confirms that there will be no risk of exacerbated flooding down-gradient of the site.

7.4.5 Decommissioning Phase

Decommissioning phase effects are likely to be very similar to construction phase impacts but the overall likelihood for adverse effects will be much lower due to reduced groundworks and excavations taking place. Some of the effects will be reduced or avoided by retaining some elements of the proposed development where appropriate; for example, access tracks within the site are likely to be retained for agricultural uses.

7.4.6 'Worst-Case' Scenario

The 'worst-case' for hydrological effects is assessed to comprise the contamination of surface water features during the construction, operational and decommissioning phases, which in turn could affect the ecology and quality of the downstream surface water bodies. Also, it is assessed that localised groundwater contamination from spillages or hydrocarbons and other pollutants could occur. However, best practice construction methodologies and dedicated mitigation measures will be put in place to prevent this 'worst-case' scenario from arising.

7.4.7 Cumulative Effects

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the hydrogeological setting of the site (i.e. low permeability peat, silts and clays overlying a poor bedrock aquifer) and the near surface nature of construction activities, cumulative impacts with regard groundwater quality or quantity arising from the proposed development are assessed as not likely.

In terms of cumulative hydrological impacts arising only from elements of the proposed development (wind farm infrastructure, grid connection and haul route works), no likely significant effects are expected for the reasons described below.

Due to the construction methodologies, construction programme (i.e. the grid trench will be excavated in stages) and the transient nature of the works within the catchment over several kilometres, significant surface water quality impacts are not anticipated. Similarly, significant surface water quality impacts arising from the 110kV substation are not assessed as likely to occur as a result of the construction methodologies to be implemented, the surface water control measures to be put in place and the adherence to the 50m hydrological buffer where possible. Additional drainage control measures are outlined below, where works or infrastructure is located inside a 50m buffer zone.

A hydrological cumulative impact assessment of the proposed development has been undertaken with regards in-combination effects with other projects and plans, including wind energy developments, located in the regional River Boyne catchment within a 20km radius of the proposed development site.

A number of developments, identified at **Chapter 1**, also have the potential to result in cumulative hydrological effects; however, the mitigation measures outlined below will ensure that the proposed development will not result in any likely significant effects and it is assessed that there is no potential for interaction with other developments or for in-combination effects to occur.

There are only 2 no. other permitted and proposed wind farms within a 20km radius of the proposed development. This includes the permitted Yellow River Wind Farm (29 no. permitted turbines) and the proposed Ballivor Wind Farm comprising up to 26 no. turbines. It should be noted that a planning application for the Ballivor Wind Farm has not yet progressed; however, according to www.ballivorwindfarm.ie, a planning application will be lodged in the future and the precise number of turbines may change.

With regard to the Yellow River Wind Farm, the permitted development is located approximately 17km to the southwest of the proposed development site and 11 no. of the permitted 29 no. turbines are located in the River Boyne catchment.

The proposed Ballivor Wind Farm site is located immediately to the east/southeast of the subject proposed development site. All 26 no. currently proposed turbines are located in the River Boyne catchment (9 no. in the River Deel sub-catchment,14 no. in the Stonyford River sub-catchment and 3 no. in the main River Boyne catchment). As discussed in **Section 7.3.3** above, all of the proposed Bracklyn Wind Farm infrastructure is located in the Stonyford River sub-catchment.

In terms of the likely effects of wind farm developments on downstream surface water bodies, the greatest risk is during the construction phase as this is the phase when earthworks and excavations will be undertaken at the sites.

All turbine locations (9 no.) at the proposed development are located within the Boyne River catchment. The total number of turbines that could potentially be operating inside a 20km radius of the proposed development site within the Boyne River catchment is 46 no. (9 no. from the proposed development, 11 no. from the Yellow River Wind Farm and 26 no. from the proposed Ballivor Wind Farm).

The total area of the Boyne River catchment (inside a 20km radius) is c. 600km^2 which equates to 1 no. turbine per 13km^2 which is considered not significant in terms of likely cumulative hydrological effects on the River Boyne. This turbine density calculation is also conservative as it does not include the area of the remainder of the Boyne catchment outside the 20km radius.

The likelihood of cumulative effects on the Stonyford River sub-catchment is more pronounced given the relatively small catchment area upstream of the Bracklyn Wind Farm and Ballivor Wind Farm; however, the likelihood of cumulative effects remains low and will be further mitigated through the measures described at **Section 7.5** below.

The flood risk assessment, undertaken at **Section 7.3.14**, demonstrates that even in the absence of mitigation, the likelihood of increased runoff from the proposed development is negligible. Therefore, the implementation of the proposed drainage control, which will release stormwater from the proposed development at greenfied rates, will ensure cumulative effects with regard flood risk will be neutral.

With regard likely cumulative surface water quality effects, it is assessed in **Section 7.6.1.1** that any residual effects will be imperceptible and short term following the implementation of measures described in the Surface Water Management Plan (outlined below) and proposed hydrological mitigation measures. This will ensure there will be no likely significant cumulative adverse effects on the water quality environment from the proposed development and therefore the likelihood for hydrological cumulative impacts is assessed to be negligible.

7.5 Mitigation & Monitoring Measures

The overarching objective of the proposed mitigation measures is to ensure that all surface water runoff is comprehensively treated and attenuated such that no silt or sediment laden waters or deleterious material is discharged into the local drainage system. A preliminary/outline Surface Water Management Plan (SWMP), incorporating the surface water drainage design has been prepared, see **Annex 3.8** (**Volume II**), and incorporates the principles of Sustainable Drainage Systems (SuDS) through an arrangement of surface water drainage infrastructure. The SWMP has had regard to greenfield runoff rates and has been designed to mimic same and is sufficient to accommodate a 1-in-100 year rainfall event.

While the SuDS, overall, is an amalgamation of a suite of drainage infrastructure; the overall philosophy is straightforward. In summary:-

- All surface water runoff will be directed to specially constructed swales surrounding all areas of ground proposed to be disturbed (including the area for the temporary storage of material);
- The swales will direct runoff into settlement ponds/silt traps where silt/sediment will be allowed to settle; and
- Following the settlement of silt/sediment, clean water will be discharged indirectly to the local drainage network via buffered outfalls thus ensuring that no scouring occurs.

The suite of surface water drainage infrastructure will include interception drains, collector drains swales, sedimats, flow attenuation and filtration check dams, settlement ponds/silt traps, and buffered outfalls.

The design criteria implemented as part of the SuDS are as follows:-

- To minimise alterations to the ambient site hydrology and hydrogeology;
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site;
- To minimise sediment loads resulting from the development run-off during the construction phase;
- To preserve greenfield runoff rates and volumes;
- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed;
- To provide settlement ponds to encourage sedimentation and storm water runoff settlement;
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally;
- To manage erosion and allow for the effective revegetation of bare surfaces; and
- To manage and control water within the site and allow for the discharge of runoff from the site below the MAC of the relevant surface water regulation value.

It should be noted that the measures set out below refer to the overall mitigation framework within which the SWMP has been prepared; while further measures are also proposed.

7.5.1 Construction Phase

7.5.1.1 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

Mitigation by Avoidance

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible by using a 50m buffer. From the constraints map (**Annex 7.2**), it can be seen that apart from some sections of access track, the T7 hardstand, a section of the construction compound along, the north-western corner of the substation along with the watercourse crossing locations, the majority of the proposed development areas (including all turbine locations) are located outside of areas that have been assessed to be hydrologically sensitive.

As described in **Chapter 3**, specific mitigation measures, incorporated into the design of the development and through implementation of best practice methodologies (discussed below) will be employed where work inside buffer zones is proposed.

The generally large setback distance from sensitive hydrological features means that sufficient space is provided for the installation of proposed drainage mitigation measures (discussed below) and to ensure their effective operation. The proposed buffer zone will ensure:-

- Avoidance of physical damage to watercourses, and associated release of sediment;
- Avoidance of excavations within close proximity to surface water courses;
- Avoidance of the entry of suspended sediment from earthworks into watercourses; and,
- Avoidance of 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.

Mitigation by Prevention

The following section details the measures which will be put in place during the construction phase to ensure that surface water features are protected from the release of silt or sediment and to ensure that all surface water runoff is fully attenuated to avoid the discharge of dirty water.

- Source controls to limit the likelihood for 'dirty water' to occur:-
  - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with clean washed gravel, filter fabrics, and other similar/equivalent or appropriate systems;
  - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas or other similar/equivalent or appropriate measures.
- In-Line controls to ensure appropriate management of silt laden water:-
  - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

- Treatment systems to fully attenuate silt laden waters prior to discharge:-
  - Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

It should be noted for this site that an extensive network of land drains already exists, and these will be integrated and enhanced as required and used within the wind farm development drainage system. The integration of the existing land drainage network and the proposed wind farm network is common practice in wind energy developments and will also result in benefits to surrounding agricultural lands.

The main elements of interaction with existing drains will be as follows:-

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the likelihood for any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- During the operational phase of the wind farm, runoff from individual turbine hardstanding areas will be not discharged into the existing drain network but discharged locally at each turbine location through stilling ponds and buffered outfalls onto vegetated surfaces;
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site;
- Drains running parallel to the existing roads that requiring widening will be upgraded. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles and silt fences will be used during the upgrade works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

Water Treatment Train

A final line of defence can be provided by a water treatment train such as a “Siltbuster”, if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a ‘Siltbuster’ 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 water treatment train will apply for the entirety of the construction phase.

Silt Fences

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses 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 of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the hydrological buffer zones to provide an additional layer of protection in these areas.

Silt Bags

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats (sediment entrapment mats, consisting of coir or jute matting) placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Management of Runoff from Soil Deposition Areas

It is proposed that excavated soil and peat will be used for reinstatement and landscaping throughout the site and any excess material will be placed in 2 no. deposition areas at the wind farm site, 1 no. soil deposition area and 1 no. peat deposition area.

Excavated peat from grid connection to be used as backfill and landscaping/reinstatement. Excavated soil from grid on public road (as well as road surfacing) to be removed to licenced facility.

Both proposed spoil deposition areas are located outside the 50m stream buffer zone (refer to **Annex 7.2**).

The proposed deposition areas are natural depressions in the ground and therefore there might be a requirement to de-water prior to infilling (please refer to Section 7.5.1.2 for mitigation measures relating to dewatering.

During the initial placement of spoil in the deposition areas, silt fences, straw bales and biodegradable matting will be used to control surface water runoff. Drainage from overburden deposition areas will ultimately be routed to an oversized swale and a number of settlement ponds and a 'Siltbuster' with appropriate storage and settlement capacity, designed for a '1-in-100 year 6-hour return' period, before being discharged to the on-site drains.

Spoil deposition areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, soil/peat deposition areas will no longer be a likely source of silt laden runoff. Settlement ponds will be left in place until the areas have stabilised.

Grid Connection Installation Works

Temporary silt fencing/silt trap arrangements will be placed within existing roadside/field drainage features along the grid connection to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed at an appropriate licenced facility. The bare ground re-seeded/reinstated immediately and silt fencing temporally left in place if necessary.

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 soil/subsoil or vegetation stripping will be suspended or scaled back if prolonged or intense 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;
- Meteo Alarm: 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 an impending high rainfall intensity event.

Works will 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 will 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

The construction of the site drainage system will be carried out, at the respective location, prior to other activities being commenced. The construction of the 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 functional for all subsequent construction works.

Monitoring

Prior to the commencement of development, a detailed Site Drainage Plan and Surface Water Management Plan (SWMP) will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of the detailed Construction Environmental Management Plan (CEMP), will be agreed in writing with the Planning Authority.

The SWMP will also include a programme for the monitoring of surface waters in the vicinity of the construction site by a designated Environmental Manager. The monitoring programme will comprise field testing and laboratory analysis of a range of agreed parameters. The civil works contractor, who will be responsible for the construction of the site drainage system, and Environmental Manager will undertake regular inspections of the drainage system to ensure that all measures are functioning effectively. 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.

Any excess build-up of silt levels that may decrease the effectiveness of the drainage feature, will be removed and disposed of in an appropriate manner.

7.5.1.2 Excavation Dewatering and Potential Impacts on Surface Water Quality

The management of excavation dewatering (pumping), particularly in relation to any accumulation of water in foundations or electricity line trenches, and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:-

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations, will be put in place;
- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters to ensure that Greenfield runoff rates are mimicked;
- If required, pumping of excavation inflows will prevent build up of water in the excavation;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of wind farm excavations by the Environmental Manager will occur during the construction phase. If high levels of seepage inflow occur, excavation work at this location will cease immediately and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies. 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. They will be used as final line of defence if needed.

7.5.1.3 Potential Release of Hydrocarbons during Construction and Storage

Mitigation measures proposed to avoid release of hydrocarbons at the site are as follows:-

- The volume of fuels or oils stored on site will be minimised. All fuel and oil will be stored in an appropriately bunded area within the temporary construction compound. Only an appropriate volume of fuel will be stored at any given time. The bunded area will be roofed to avoid the ingress of rainfall and will be fitted with a storm drainage system and an appropriate oil interceptor;
- All bunded areas will have 110% capacity of the volume to be stored;

- On site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled at the temporary compound and will be towed around the site by a 4x4 jeep to where plant and machinery is located. No refuelling will be permitted at works locations within the 50m hydrological buffer. The 4x4 jeep will also be fully stocked with fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations to avoid any accidental leakages;
- All plant and machinery used during construction will be regularly inspected for leaks and fitness for purpose;
- Spill kits will be readily available to deal with any accidental spillage;
- All waste tar material arising from road cuttings (from trenching or other works in public roads) will be removed off-site and taken to a licensed waste facility. Due to the potential for contamination of soils and subsoils, it is not proposed to utilise this material for any reinstatement works; and
- An outline emergency plan for the construction phase to deal with accidental spillages is contained within the Outline Construction and Environmental Management Plan (**Annex 3.8**). This emergency plan will be further developed prior to the commencement of development, and will be agreed with the Planning Authority as part of the detailed CEMP.

7.5.1.4 Groundwater and Surface Water Contamination from Wastewater Disposal

Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-

- Measures to avoid contamination of ground and surface waters by wastewaters will comprise:-The provision of self contained port-a-loos (chemical toilets) with an integrated waste holding tank will be installed at the site compound, maintained by the providing contractor, and removed from site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the site, nor will any wastewater be discharged to the site.

7.5.1.5 Release of Cement-Based Products

The following mitigation measures are proposed to ensure that the release of cement-based products is avoided:-

- No batching of wet-cement products will occur on site. Ready-mixed concrete will be brought to site as required and, where possible, emplacement of pre-cast products, will take utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided insofar as possible;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. Chute cleaning will be undertaken at lined cement washout ponds with waters being tankered and stored in the

temporary construction compound, removed off site and disposed of at an approved licensed facility. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed;

- Weather forecasting will be used to ensure that prolonged or intense rainfall is not predicted during concrete pouring activities; and,
- The pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

7.5.1.6 Morphological Changes to Surface Water Courses & Drainage Patterns

The following mitigation measures are proposed:-

- Where possible, all proposed new stream crossings will be clear span bridges (bottomless culverts) and the stream beds will remain undisturbed. No in-stream excavation works at the crossing locations are proposed and therefore there will be no impact on the stream at the proposed crossing location;
- Where internal wind farm electrical cabling of grid connection cabling will pass above or below the existing culvert and will not directly interfere with the culvert;
- At the time of construction, all guidance/best practice requirements of the Office of Public Works (OPW) or Inland Fisheries Ireland will be incorporated into the design/construction of the proposed watercourse/culvert crossings;
- As a further precaution, in-stream construction work (if/where required) 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", i.e., 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 (any deviation from this will be done in discussion with the IFI);
- During the near stream construction works (i.e. within the 50m buffer zone), double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase; and
- All new or revised watercourse crossings (watercourses mapped on OSI mapping) will require a Section 50 license application to the OPW in accordance with the Arterial Drainage Act 1945. The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

The proposed development will not alter the hydrology or water balance of the catchments/watercourses downstream of the proposed site, therefore the proposed development will not affect any proposed bog rehabilitation plans which may be carried out in the future on any adjoining boglands. Any such rehabilitation plans will be required to be completed in a manner which does not affect upstream drainage patters and, therefore, no effects on the proposed development site are anticipated.

7.5.1.7 Potential Hydrological Impacts on Designated Sites

The proposed mitigation measures for protection of surface water quality, which will include buffer zones and robust drainage control measures (i.e. interceptor drains, swales, settlement ponds), will ensure that the quality of runoff from proposed development areas will be very high.

As stated in **Section 7.6.1.1** below, there could potentially be an "imperceptible, temporary impact" on local streams and rivers which, if occurs, would be extremely localised and of a very short duration (i.e. hours). Therefore, significant indirect hydrological or water quality effects on the downstream River Boyne and River Blackwater SAC will not occur.

7.5.2 Operational Phase

7.5.2.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

The operational phase drainage system of the proposed development are described below:-

- Interceptor drains will be installed up-gradient of all infrastructure to collect clean 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 by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access tracks, turbine hardstanding areas and substation compound areas which may contain entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- Transverse drains ('grips') will be constructed, where appropriate, in the surface layer of access tracks to divert any runoff into swales/track side drains;
- Check dams will be used along sections of access tracks drains to intercept silts at source. Check dams will be constructed from a 40mm non-friable crushed rock or similar;
- Settlement ponds, emplaced downstream of track swale sections, turbine locations and the selected substation option, 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; and,
- Settlement ponds will be designed in accordance the greenfield runoff rate requirements; and,
- Imported rock for construction purposes and road surfacing will be strong, well-graded limestone which will be resistant to erosion and have a low likelihood to generate fines in hardstand runoff.

The operation of the underground grid connection will not result in any likely hydrological or water quality effects and therefore do not require mitigation measures.

7.5.3 Decommissioning Phase

As in the construction phase, temporary surface runoff control measures will again be put in place during decommissioning works. The drainage system will remain operational during the decommissioning phase and will serve to treat any sediment laden surface water run-off due to a renewed disturbance of soils. Following decommissioning, re-vegetation will be implemented as soon as practicable and monitored to ensure vegetation is established.

7.6 Residual Effects

7.6.1 Construction Phase

7.6.1.1 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Water

Following the implementation of appropriate mitigation measures, as outlined above, the residual effect is assessed to be a negative, indirect, imperceptible, short term, likely impact and no significant effects on water quality are assessed as likely.

7.6.1.2 Likely Impacts on Groundwater Levels and Local Well Supplies During Excavation works

Significant effects on groundwater levels/flows or groundwater supplies are not anticipated as a result of the proposed development. It is concluded, therefore, that likely significant effects will not arise.

7.6.1.3 Excavation Dewatering and Likely Impacts on Surface Water Quality

Residual effects, following the implementation of mitigation measures, are assessed to be indirect, imperceptible, short term and no likely significant effects on surface water quality are anticipated.

7.6.1.4 Likely Release of Hydrocarbons during Construction and Storage

Following the implementation of appropriate mitigation measures, as outlined above, the residual effect is assessed to be indirect, negative, imperceptible, short term and unlikely.

No significant effects on surface water or groundwater quality are assessed as likely.

7.6.1.5 Groundwater and Surface Water Contamination from Wastewater Disposal

No significant residual effects are assessed as likely to occur.

7.6.1.6 Release of Cement-Based Products

Residual effects, following the implementation of mitigation measures, are assessed to be negative, indirect, imperceptible, short term and unlikely.

No significant effects on surface water quality are assessed as likely to occur.

7.6.1.7 Morphological Changes to Surface Water Courses & Drainage Patterns

Significant effects due to morphological changes, occurring as a result of watercourse crossings or drain diversions, are not assessed to result in significant residual effects. Residual effects are anticipated to be negative, direct, imperceptible, short term and likely.

7.6.1.8 Likely Hydrological Impacts on Designated Sites

No significant residual effects are assessed as likely to occur.

7.6.2 Operational Phase

7.6.2.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Following the implementation of appropriate mitigation measures, as outlined above, the residual effect is assessed to be direct, neutral, long term and likely; however, significant effects are not likely.

7.6.3 Decommissioning Phase

No likely significant residual effects on the hydrological environment or on water quality are envisaged during the decommissioning stage of the proposed development.

7.7 Summary

During each phase of the proposed development (construction, operation and decommissioning) a number of activities will take place on the site of the proposed development, some of which will have the potential to significantly affect the hydrological regime or water quality at the site or its vicinity. These significant potential effects generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement based compounds, with the former having the most potential for impact.

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise any likely adverse impacts on water quality and downstream designated sites. A self imposed 50m stream buffer and 10m drain buffer was used during the layout of the proposed development, thereby avoiding sensitive hydrological features insofar as possible.

The management of surface water is the principal means of significantly reducing sediment runoff arising from construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of wind farm runoff into local watercourses. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water treatment measures).

Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the detailed CEMP to be prepared prior to the commencement of development.

Overall, the proposed development presents no likelihood for significant effects on surface or groundwater quality following the implementation of the proposed mitigation measures. Additionally, this assessment has determined that there is no likelihood for significant cumulative effects to arise due to the construction, operation or decommissioning of the proposed development.