Cush Wind Farm

Environmental Impact Assessment Report

Chapter 7: Water

Cush Wind Limited

Galetech Energy Services

Clondargan, Stradone, Co. Cavan Ireland

Telephone +353 49 555 5050

www.galetechenergy.com

Contents

7.1 Introduction

7.1.1 Background & Objectives

This chapter provides an assessment of the likely and significant effects of the proposed project 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 project;
- Identify likely positive and negative impacts of the project on surface and groundwater during the construction, operational and decommissioning phases of the project;
- Identify mitigation measures to avoid, remediate or reduce likely or significant negative effects; and,
- Assess likely or significant cumulative effects of the project because of other developments.

7.1.2 Description of the Project

In summary, the project comprises the following main components as described in **Chapter 3**:-

- 8 no. wind turbines with an overall tip height of 200m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including provision of site drainage infrastructure and forestry felling.
- Temporary alterations to the turbine component haul route; and,
- Construction of an electricity substation, Battery Electricity Storage System and installation of 5.6km of underground grid connection to facilitate connection of the proposed electricity substation to the existing 110kV substation at Clondallow, County Offaly;

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, County Offaly. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route and associated temporary alteration works are located within counties Galway, Roscommon, Westmeath, and Offaly. It is envisaged that the turbines will be transported from the Port of Galway, through the counties of Galway, Roscommon, Westmeath and Offaly, to the project site. As the route follows motorway and national roads through these counties, it is assessed that there is no likelihood of effects on water and, therefore, these areas have been screened out from further assessment.

A full description of the project is presented in **Chapter 3**.

7.1.3 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, 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 P.Geo (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 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 EIS/EIAR for Oweninny WF, Cloncreen WF, Derrinlough WF, and over 100 no. other wind farm related projects.

David Broderick P.Geo (BSc, H.Dip Env Eng, MSc.) is a Hydrogeologist with over 17 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 has worked on the EIS/EIAR for Oweninny WF, Cloghan WF, Drumlins Park WF, Arderroo WF and Yellow River WF, and over 80 other wind farm related projects across the country.

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 296/2018: 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. 94/1997: 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. 293/1988: 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. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 and S.I. No. 722/2003 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. 41/1999: 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. 249/1989: 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. 439/2000: Quality of Water intended for Human Consumption Regulations and S.I. No. 278/2007 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.106/2007: European Communities (Drinking Water) Regulations and S.I. No. 122/2014: European Union (Drinking Water) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption and WFD 2000/60/EC;
- 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 (2022) *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports*;
- 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*;
- DOE/NIEA (2015) *Wind Farms and Groundwater Impacts – A guide to EIA and Planning Considerations*;

- Department of the Environment, Heritage, and Local Government (2006) *Wind Energy Development Guidelines for Planning Authorities 2006*;
- Department of the Housing, Planning, and Local Government (2019) *Draft Revised Wind Energy Development Guidelines;*
- 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*; and,
- *Offaly County Development Plan 2021-2027.*

7.2 Methodology

7.2.1 Desk Study

A desk study of the overall project and receiving environment (described below) 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 project and surrounding area. The desk study included consultation and review 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 Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Galway - Offaly). Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland (2004); Groundwater Body Initial Characterization Reports;
- OPW Past Flood Event Mapping (www.floodinfo.ie);
- OPW Flood Mapping (www.floodinfo.ie);
- Ordnance Survey Ireland (OSI) – 6 inch and 1;5000 scale basemaps; and,

- Offaly County Development Plan (2021 – 2027) Strategic Flood mapping;
- Aerial photography (www.bing.com/maps, www.geohive.ie, www.google.com/maps).

7.2.2 Site Investigations

Detailed drainage mapping, hydrological constraints mapping, and baseline monitoring was initially undertaken by HES on 21 October 2022. Further site investigations including trial pits and gouge cores were undertaken on 5 December 2022 and 23 January 2023. Surface water sampling and water quality baseline monitoring were completed on 25 January and 26 March 2023.

A Stage 3 Flood Risk Assessment including flood modelling was completed by HES in July 2021 (see **Annex 7.1**).

A geotechnical assessment used to inform the assessment contained within this chapter was carried out by Fehily Timoney & Company (FT) and is enclosed at **Annex 6.1**. Separately, a Planning-Stage Spoil & Peat Management Plan has been prepared (see **Annex 3.4**) which details the treatment and management of material excavated during the construction phase of the project.

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

- Walkover surveys and hydrological mapping of the project site and the surrounding area were undertaken whereby water flow directions and drainage patterns were recorded;
- A trial pit investigation to determine subsoil depth and lithology along with groundwater conditions (i.e. potential groundwater inflows). 7 no. trial pits in total and 5 no. soil cores were completed;
- 170 no. soil probe locations along with slope angle measurements were carried out by FT as part of the geotechnical assessment;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken to determine the origin and nature of surface water flows;
- Surface water sampling (2 no. rounds) was undertaken to determine the baseline water quality of the primary surface waters originating from the project site and grid connection route;
- Stage 3 Site Specific Flood Risk Assessment (**Annex 7.1**); and,
- WFD Compliance Assessment Report (**Annex 7.3**)

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 project 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 Attribute	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, matters 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 1.8.**

Consultee	Summary of Consultee Response	Issue(s) Addressed in Section(s)
Irish Water (IW)	• Where the development proposal has the potential to impact an Irish Water Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Irish Waters Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant' site and receiving waters should be identified as part of the report.	7.3.15

OPW	• The proposed site is located in lands that benefit from the Boolinaraig Drainage District. There may be a risk of flooding at this location. The Local Authority and the developers should satisfy themselves that there is adequate level of protection against flooding at this location. • Datasets prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage. • The channel in question [at the Project Site] is not an OPW maintainable channel; however, it is good practise that a 10-metre wide strip be retained adjacent to the channel to permit access to the local authority for maintenance. Ideally, the strip should not be fenced, paved or landscaped in a manner that would prevent access by maintenance plant. • Further to this, please note that for the construction, replacement or alteration of any bridge or culvert over any channel which appears on a 6-inch to 1 mile map, Prior Section 50 consent must be sought under Section 50 of the Arterial Drainage Act, 1945.	7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.3.16. 7.4.3.8, 7.5.1.7 & Annex 7.1
Department of Agriculture, Food and the Marine (Forest Division)	• 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)	7.3.14, 7.4.3.9 & 7.5.1.8
Geological Survey of Ireland (GSI)	• The Groundwater Data Viewer indicates aquifers classed as a 'Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones', a 'Locally important gravel aquifer 'and a 'Regionally Important Aquifer - Karstified (diffuse)' underlie the proposed wind farm development. The Groundwater Vulnerability map indicates the area covered is variable. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your assessments • Our karst data viewer indicates that there is a karst spring (Tobernapoula), in the vicinity of the wind farm development at Ballynaguilsha townland.	7.3.9, 7.3.10 & 7.3.12

Table 7.6: Summary of Scoping Responses

7.3 Description of the Existing Environment

7.3.1 Site Location & Description

The project site, which has an area of approximately 290ha, is located c. 4km north of Birr, Co. Offaly. The N62 dissects the project site into an eastern portion and western portion. The project site setting is basin peat bogs fringed by other bogs, agricultural and forestry lands.

The western portion is mainly bordered by forestry with some agricultural land and cutover peat bog while the eastern portion its mainly agricultural land with some cutaway peat bog. Access to the proposed project site from the N62 is at various forestry/bog entrances and via private farm entrances off surrounding local roads.

Current land use within the project site is made up predominantly of peat bogs, agricultural pasture/grassland, and forestry, including commercial and woodland planting (of various species) and scrub.

2 no. turbines (T1 and T3) located towards the north of the project site are located on cutover bog and cutover bog mixed with scrub growth. The main proposed spoil deposition area (SDA1) along with the main construction compound (CC1) are also located on this type of landcover. T2 is located in an area of bog woodland (non-Annex I).

3 no. turbines (T4, T5 and T6) are located in mixed woodland/forestry which are also largely underlain by peat deposits at the proposed development areas. Turbines T5 and T6 are located in areas of commercial forestry (conifer plantation). There are also proposed spoil deposition areas around turbines T5 and T6.

The remaining 2 no. turbines (T7 and T8), substation, BESS, windfarm control building, met mast and construction compound no. 2 (CC2) are located on agricultural grassland.

The proposed project site is low lying with topography being slightly undulating to flat and with ground elevations ranging between 47 and 63m OD (Ordnance Datum). The overall slope is to the west.

The most elevated section of the proposed project site is found along the eastern fringes where agricultural grassland rises up to 63m OD (met mast location). The ground slopes in a general westerly direction from this eastern section to the lowest point on the far west of the project site which follows the valley of the Rapemills River.

The underground grid connection (5.6km) follows public roads for 4.7km with an off-road section through private lands for 0.65km. Approximately 200m of the route is in the project site itself. The off-road section of the grid connection is through rough grassland. The existing ESB owned Clondallow 110kV substation is located 1.7km to the southwest of the proposed project site.

The haul route works are predominately located within motorway and national roads. The majority of the works comprise the temporary removal of street furniture to accommodate the delivery of turbine components.

The junction works at the N52/N62, located 1.7km to the southeast of the project site, will involve the temporary removal and replacement of a small section of tree lined hedgerow on the eastern side of the junction to make room for a temporary turning area for the construction phase which is on a grassland area to the east of the N52.

The forestry replant lands in County Monaghan are mainly agricultural pasture, with fields bounded by hedgerows and treelines.

7.3.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year annual average rainfall recorded at the Birr rainfall station, located c. 4km southwest of the project site are presented in **Table 7.7** below.

Birr, Co. Offaly												
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
80.4	56.7	66.7	56.4	59	66.9	63	80.2	67.1	94	79.3	80	849.7

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

The closest synoptic[1] weather station where the average potential evapotranspiration (PE) is recorded is also at Birr. The long-term average PE for this station is 445mm/yr. This value is used as a best estimate of the project site's PE. Actual Evaporation (AE) at the site is estimated as 422mm/year (calculated as 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

= 850mm/year – 422mm/year

ER = 428mm/year

Based on recharge coefficient estimates from the GSI (www.gsi.ie), an estimate of 18mm/year average annual recharge is given for basin peat in this area (recharge coefficient of ~4%). This means that the hydrology of the project site is characterised by very high surface water runoff rates and very low groundwater recharge rates.

Therefore, conservative annual recharge and runoff rates for the site are estimated to be 18mm/year and 410mm/year respectively.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. A summary of various return periods and duration rainfall depths for the project site are presented in **Table 7.8.**

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 (10-year, 50-year, 100-year). These extreme rainfall depths have been incorporated into the proposed wind farm drainage design.

Return Period (Years)				
Storm Duration	**1**	**5**	**30**	**100**
5 mins	3.8	6.6	13.9	17.1
15 mins	6.2	10.9	19.5	28.0
30 mins	7.8	12.3	22.9	32.0
1 hour	10	16.2	26.8	36.5
6 hours	18.6	27.2	40.4	51.5
12 hours	23.6	33.3	47.3	58.9
24 hours	30	40.6	55.5	67.3
2 days	37.1	48.6	63.9	75.8

Table 7.8: Return Period Rainfall Depths for Project Site

[1] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

7.3.3 Local & Regional Hydrology

On a regional scale, the proposed project site is located within Hydrometric Area 25 (Lower Shannon Catchment) and mainly situated inside the Shannon[lower]_SC_040 sub-catchment (i.e. Rapemills River). The grid connection route extends into the Shannon[lower]_SC_060 (Little Brosna River) sub-catchment.On a local scale, the Rapemills River (Rapemills_010) rises approximately 8km to the east of the project site and then flows in westerly direction through the project site itself. The Rapemills River then flows into the River Shannon approximately 10.5km downstream of the project site.

Approximately 2.7km of the grid connection is located in the Rapemills River catchment while the other 2.9km is located in the Little Brosna River catchment. The Little Brosna River flows approximately 1km to the southwest of the existing Dallow substation, at Clondallow, before joining the River Shannon a further 12km downstream.

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

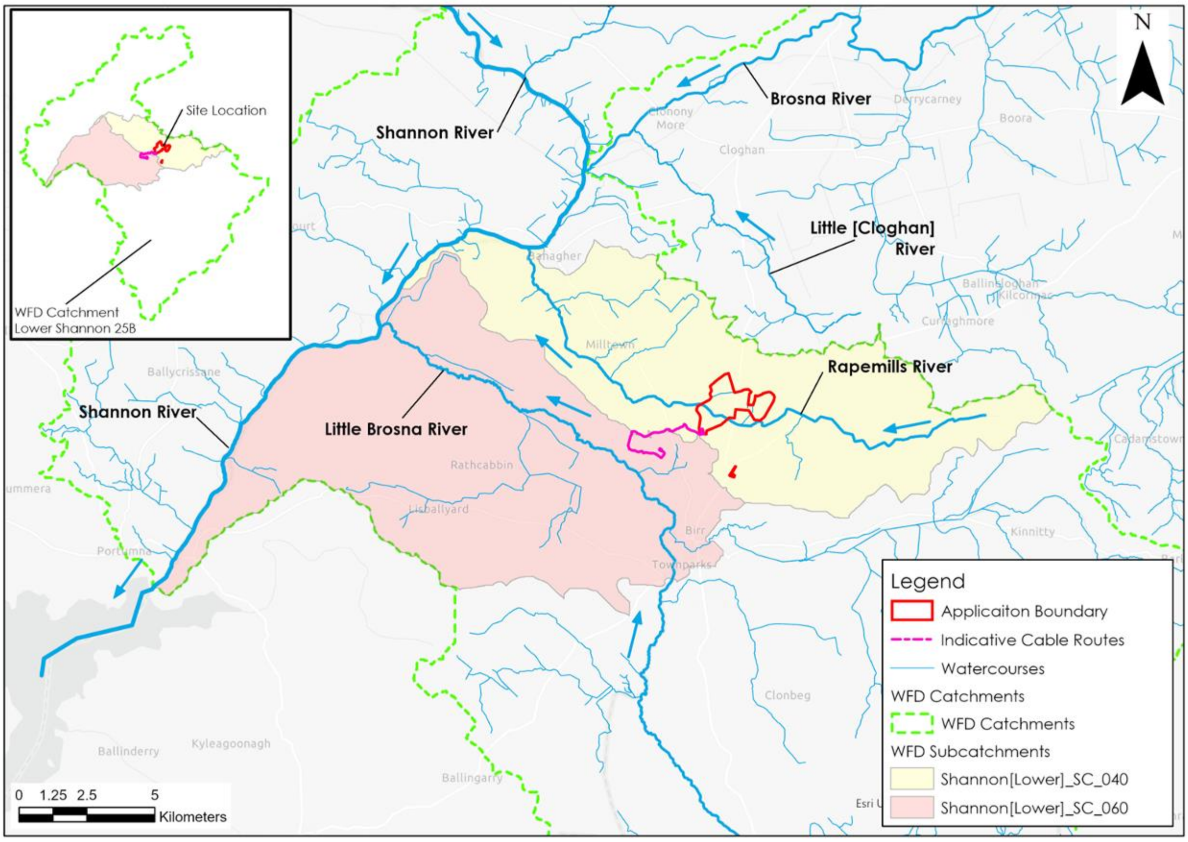


Figure 7.1: Local Hydrology Mapping

7.3.4 Existing Drainage Regime

The primary drainage feature within the project site is the Rapemills River which flows westerly through the southwestern section of the site for 1.2km. The Rapemills River is deep (2m) with steep banks and up to 5m in width.

A tributary stream of Rapemills River, referred to as the West Galros Stream by the EPA emerges from forestry on the eastern portion of the project site, crosses the N62 and then merges with the Rapemills River close to the western boundary of the project site.

The West Galros Stream has a modified channel appearance, up to 3m wide, c.1m deep with a high water level that's close to ground level. The stream is also heavily vegetated.

The northern half of the project site, including the cutaway/cutover private bogs on the northwest of the project site initially drain to the West Galros Stream.

The private cutaway bogs on the northwest of the project site (including turbines T1 and T3 along with the spoil deposition area and the main construction compound – SC1) drain directly into the West Galros Stream via several bog drains with outfalls into the Galros Stream west of the N62.

The forestry on the east of the project site (including turbines T5 and T6) also drain to the West Galros Stream. On the western portion of the project site, the cutaway peat bog at the proposed turbine T1 and T3 locations drain southerly into the West Galros Stream via several north/south drainage channels.

The majority of the southern half of the project site drains directly into the Rapemills River, including the substation, control building and turbines T2, T4, T7 and T8.

Turbine T2 and the substation are located to the south of the Rapemills River. Drainage in this area is northwards towards the Rapemills River channel. The agricultural land to the south of the Rapemills River, referred to as callows locally are generally wet and boggy and highly susceptible to winter flooding and surface water ponding. The forestry in the area of proposed turbine T4 also drains southerly towards the Rapemills River.

The fringing grasslands on the east of the project site (including turbines T7 and T8 along with the met mast) slope westerly towards the bog. Drainage from the grasslands flows into a watercourse which flows southerly along the edge of the bog. This drain has an outfall on the Rapemills River which flows to the south of the bog in question.

Within the project site there are 3 no. proposed (new) watercourse crossings (1 no. on Rapemills, 1 no. on West Galros and 1 no. on minor watercourse west of T7/T8). There is 1 no. existing crossing proposed for upgrade on the West Galros Stream just southeast of the main construction compound.

There are no EPA mapped watercourse crossings along the proposed grid connection route. The closest EPA mapped watercourse, which is a headwater stream of the Little Brosna River, is located approximately 500m to the east of the Dallow substation.

The haul route works at the N62/N52 junction is intercepted by a small watercourse that drains westerly into a wetland area located immediately to the northwest of the road junction.

Within the forested areas of the project site, there are also numerous manmade drains that are in place to drain the forestry plantations. The current internal forestry drainage pattern is influenced by the topography, subsoils, layout of the forest plantation, and by the existing forest road network. The forest plantations are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the plantation and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation.

Mound drains and ploughed ribbon drains are generally spaced approximately every 15m and 2m respectively. As illustrated at **Figure 7.2** below, interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access roads and watercourses.

A schematic of a typical standard forestry drainage network is illustrated at **Figure 7.2.** This schematic is representative of the drainage network at the forestry plantations at the project site and that which will be implemented at the proposed forestry re-plant lands.

The integration of the existing project site drainage with the proposed project drainage is a key component of the drainage design and is discussed further at **Section 7.3.16** and **Section 7.4.3.2** below.

The existing drainage regime at the project site is illustrated at **Figure 7.3**.

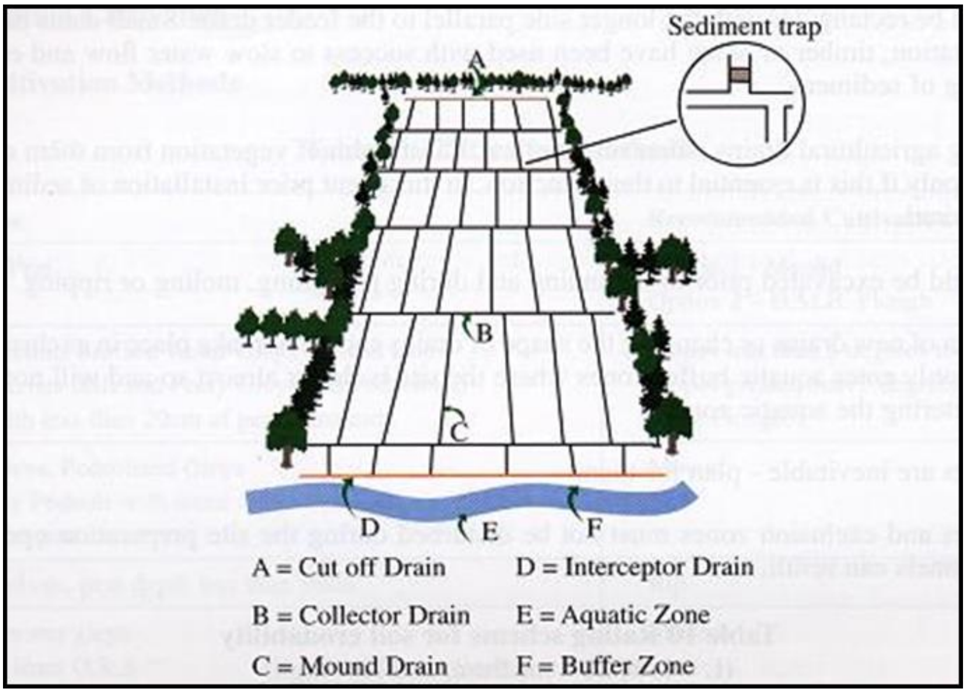


Figure 7.2: Schematic of Existing Forestry Drainage

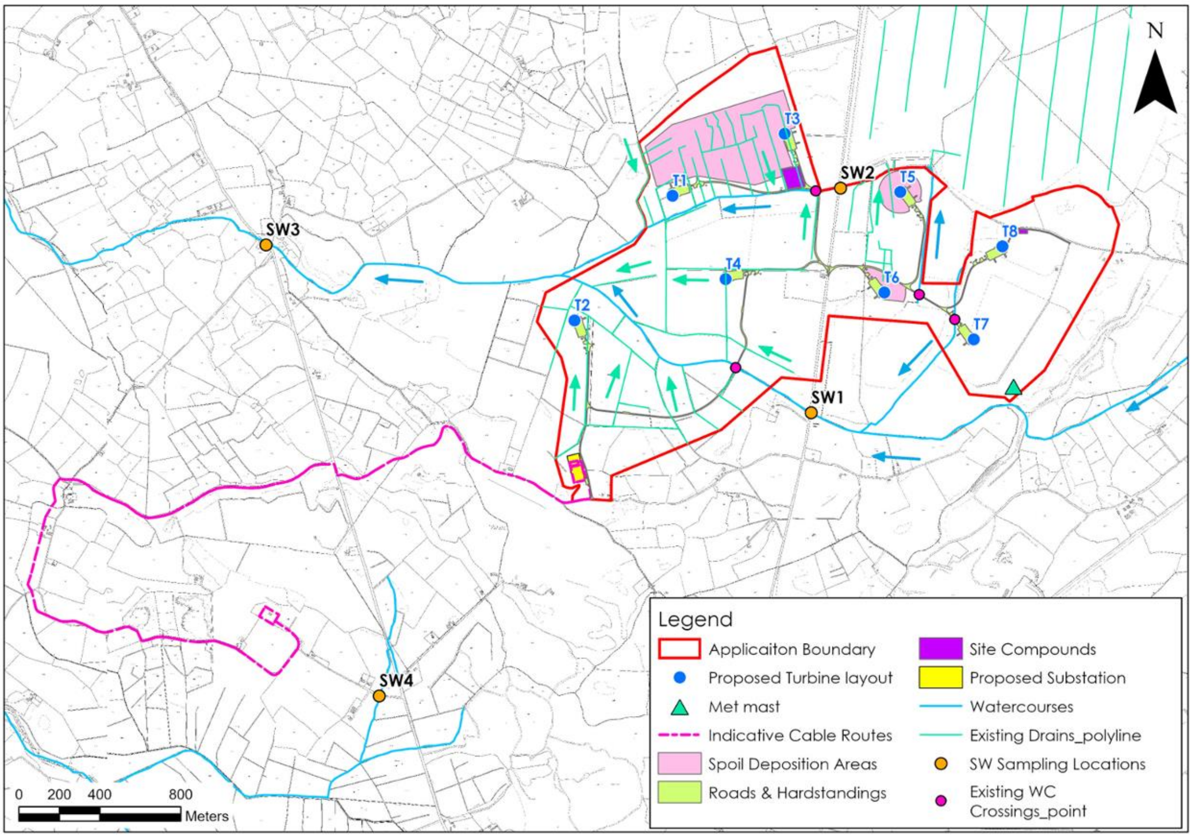


Figure 7.3: Wind Farm Site Drainage Map

7.3.5 Baseline Runoff

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 soil/subsoil type and thickness (**Table 7.9**). It represents, therefore, the average wettest monthly scenario in terms of volumes of surface water runoff from the project site 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 project. As outlined in **Section 7.3.16** below, a '1-in-100 year return' period has been used for design purposes.

The surface water runoff co-efficient for the project site is estimated to be 96% due to the extensive basin peat coverage.

The highest long-term average monthly rainfall recorded at Birr over the period 1981 – 2010 occurred in October, at 94mm.

The average monthly evapotranspiration for the synoptic station at Birr over the same period in October was 16.2mm. The calculation is carried out for the project site area (c. 290ha). The balance indicates that a conservative estimate of surface water runoff for the site during the highest rainfall month is 218,822m^3/month, which equates to an average of 7,059m^3/day, as outlined in **Table 7.10.**

Water Balance Component	Depth (m)
Average October Rainfall (R)	0.094
Average October Potential Evapotranspiration (PE)	0.0162
Average October Actual Evapotranspiration (AE = PE x 0.95)	0.0154
Effective Rainfall October (ER = R - AE)	0.0786
Recharge (4% of ER)	0.0031
Runoff (96% of ER)	0.0755

Table 7.9: Water Balance & Baseline Runoff Estimates for Wettest Month (October)

Landholding Area (ha)	Baseline Runoff per month (m^3)	Baseline Runoff per day (m^3)
290	218,822	7,059

Table 7.10: Baseline Runoff for the Project Site

7.3.6 Published Flood Mapping

OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/) and historical mapping (i.e. 6" & 25" base maps) were consulted to identify those areas of the project site which are at risk of fluvial flooding.

Datasets prepared by the OPW identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) indicate areas of the project site are prone to flooding or poor drainage.

No recurring flood incidents within the proposed project site boundary or along the grid connection were identified from OPW's Past Flood Event Mapping. OPW's Past Flood Event Mapping (refer to **Figure 7.4**).

The closest mapped recurring flooding event to the overall proposed project is on the Little Brosna approximately 5km downstream of the proposed grid connection.

The closest mapped recurring flooding event to the proposed project site itself is on the Lower Shannon approximately 10.5km downstream of the project site.

There is no text on local available historical 6" or 25" mapping for the proposed project site or grid connection that identify areas that are "prone to flooding".

OPW's River Flood Extents Mapping is currently the most accurate available flood mapping for the country, however this is currently not available for the area of the proposed project site.

OPW National Indicative Fluvial Mapping is available for the area of the proposed project site which shows the estimated 100-year and 1000-year flood zones (refer to **Figure 7.5** below. The National Indicative Fluvial Mapping is not as accurate as the Flood Extents Mapping and is also not intended to replace site specific flood risk assessments (discussed in **Section 7.3.7** below).

According to the National Indicative Fluvial Mapping, 1 no. turbine (T2) is located in a 100-year flood zone along with approximately 350m of its proposed connecting spur road from the south. The southern section of the main construction compound (SC1) is also in a mapped 100-year flood zone.

In addition, approximately 370m of the proposed access road between turbines T2 and T4 is also in a mapped 100-year flood zone along with approximately 120m of the proposed access road leading to turbine T1.

All other proposed project infrastructure is mapped above the mapped 1000-year flood level and therefore all infrastructure is located in Flood Zone C (Low Risk).

It is a key design feature of the project 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 project, is prevented and controlled is through avoidance by design.

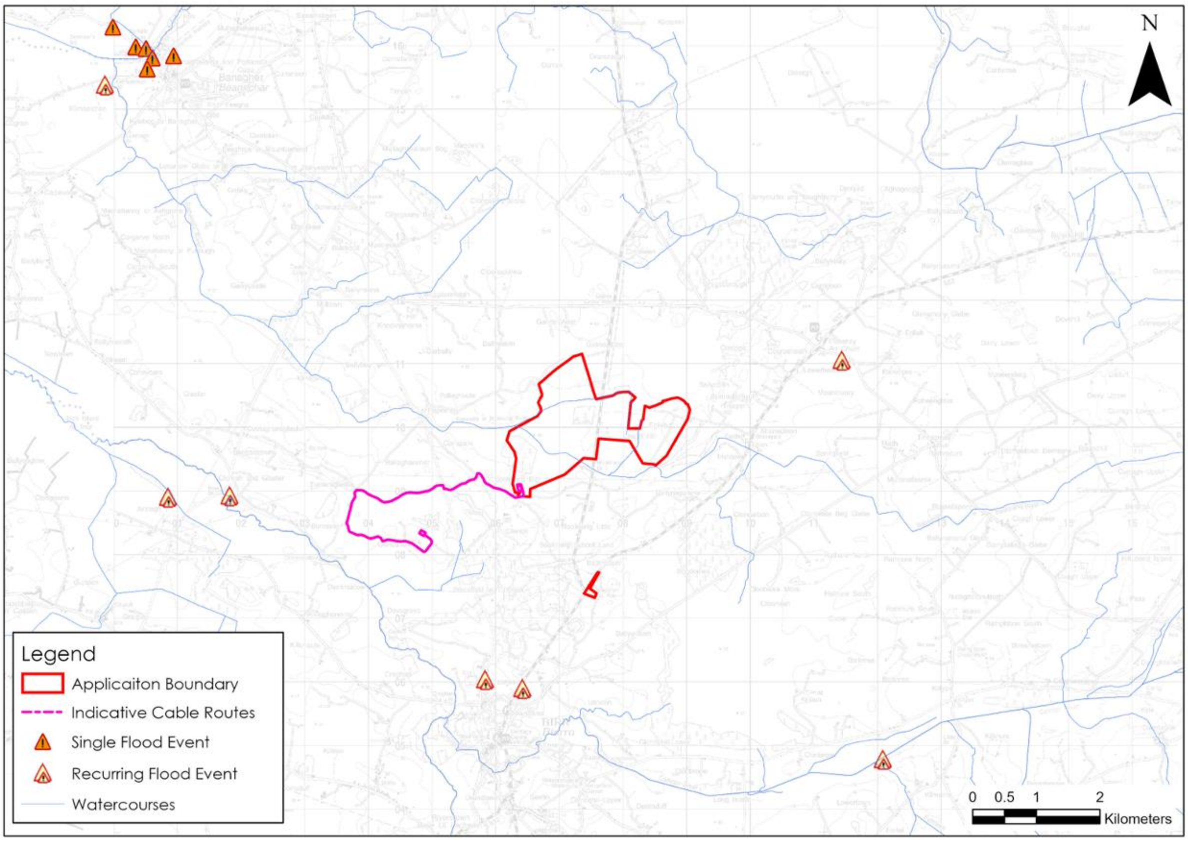


Figure 7.4: OPW Flood Hazard Mapping

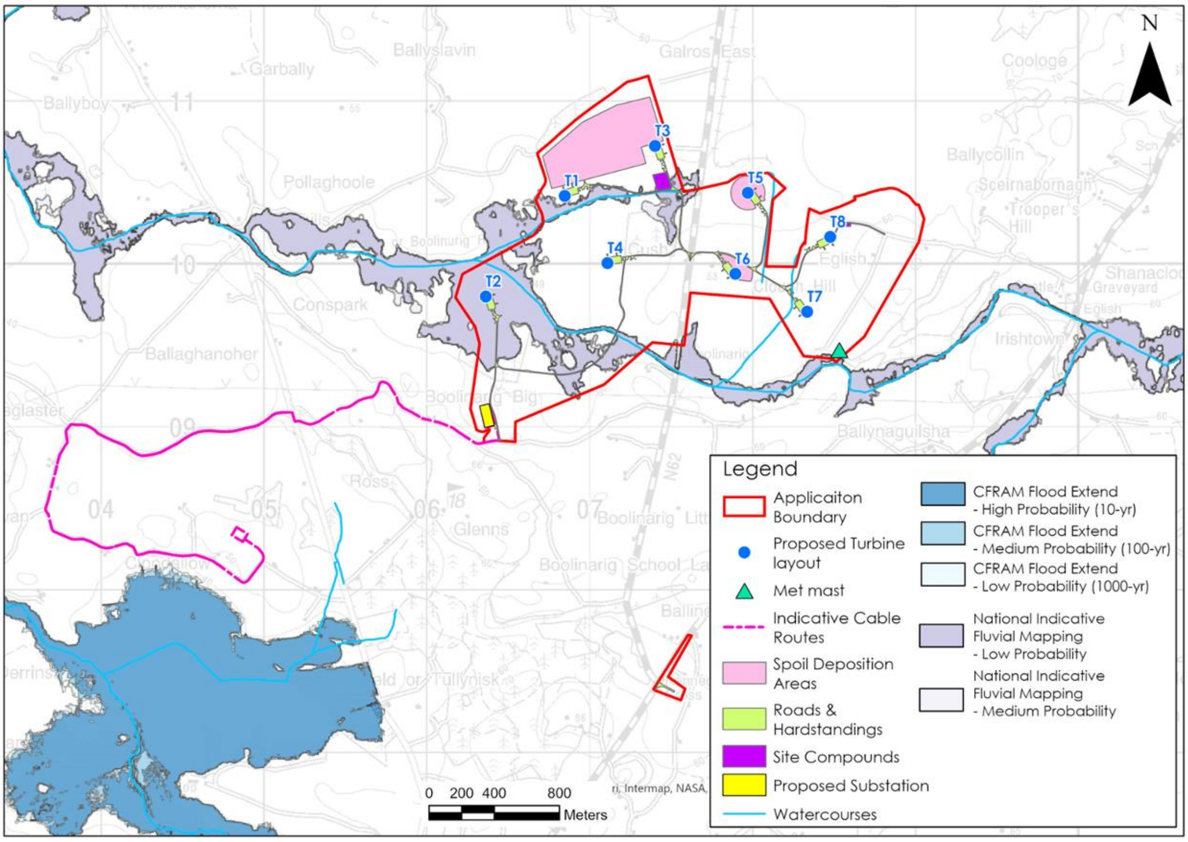


Figure 7.5: National Indicative Fluvial Mapping

7.3.7 Site Specific Flood Risk Assessment

A Stage 3 Site Specific Flood Risk Assessment (FRA) including flood modelling was completed by HES for the proposed project site in July 2021(refer to **Annex 7.1**). This was done at the time to assess the accuracy of the Preliminary Flood Risk Assessment (PFRA) mapping which was the only available published flood mapping for the area at the time.

The PFRA mapping, which is no longer used, was a national screening exercise, based on preliminary analysis, to identify areas where there may be a significant risk associated with flooding. The mapping was not site specific and had inherited inaccuracies.

Please note that the Site Specific Flood Risk Assessment also overrides the National Indicative Fluvial Mapping in terms of its flood zone mapping accuracy at the project site.

The Stage 3 Site Specific Flood Risk Assessment involved detailed site topographic surveys, use of Lidar data and flood flow modelling of the Rapemills River and floodplain.

The site specific modelled 100-year and 1000-year flood zones for the proposed project site are shown on **Figure 7.6** below. A 20% increase in flows is allowed for climate change.

The site specific flood zone modelling shows that proposed turbine location T2 is just outside the 100-year and 1000-year flood zones. Two sections of access road at watercourse crossing locations between turbine locations T2 and T4 (which amounts to approximately 100m of access road) are located within the 100-year and 1000-year flood zone.

Therefore, with the exception of the 100m of this proposed access road, the project site and grid connection are located in Flood Zone C (Low Risk).

Refer to **Annex 7.1** for Stage 3 Site Specific Flood Risk Assessment report.

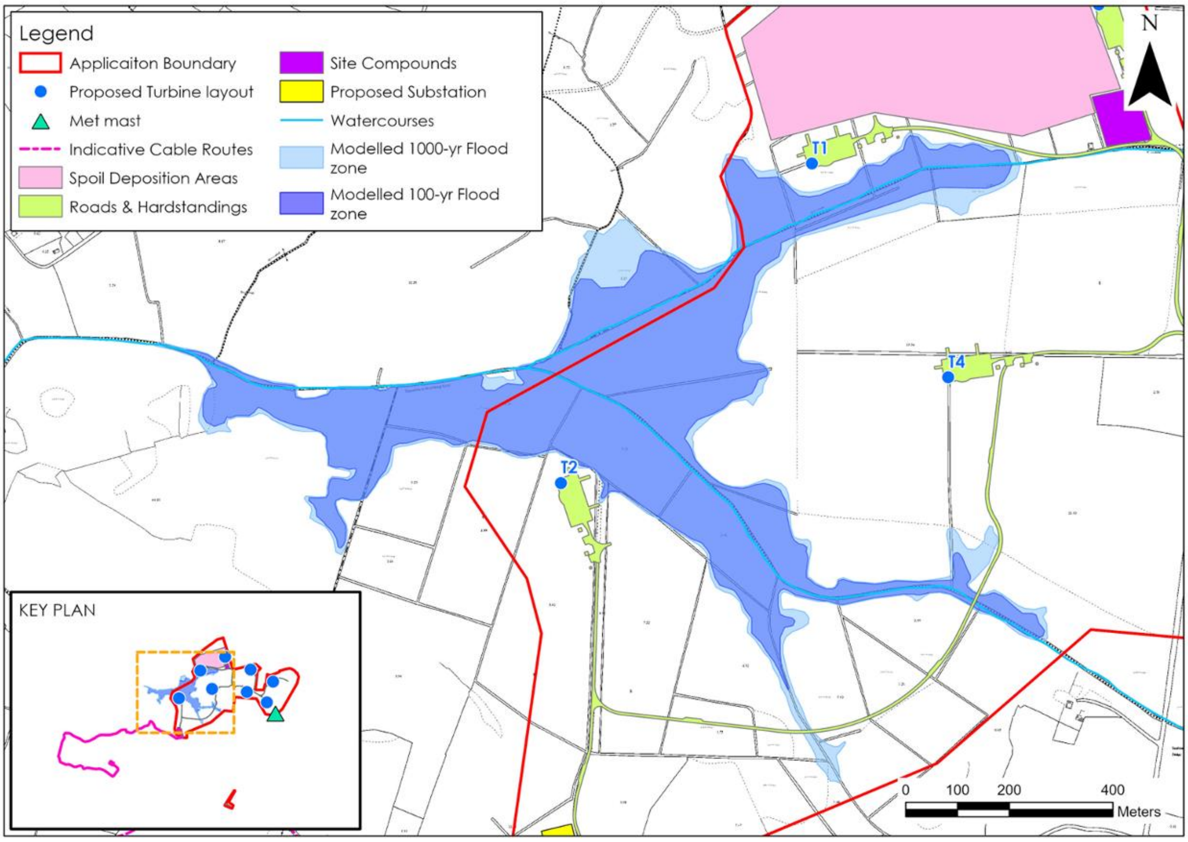


Figure 7.6: Modelled Flood Zones

7.3.8 Surface Water Quality/Hydrochemistry

Biological Q-rating[2] data for EPA monitoring points on nearby river waterbodies are shown in **Table 7.11** below. Most recent data available (2017-2022) show that the Q-ratings for the Rapemills River range from Moderate to High with the closest downstream monitoring point (Bridge at Rapemills) having a Moderate status.

The Q ratings for the Little Brosna range from Good to High downstream of the grid connection route.

The closest downstream monitoring point in the Little (Cloghan) River catchment is 6km downstream and has a Poor rating but improves to High ~3km further downstream.

[2] The Q-Rating scheme method is used whereby a Quality-index is assigned to a river or stream based on macroinvertebrate data.

Station Name/Code	River Waterbody	Q-Value Score	Status
Br near Eglish Castle	Rapemills_010	4	Good
Boolinarig Bridge	Rapemills_010	4	Good
Br at Rapemills	Rapemills_010	3 - 4	Moderate
Br SW of Taylors X Rds	Rapemills_020	4 - 5	High
Derrinsallow Bridge	Little Brosna_060	5	High
New Br	Little Brosna_060	4	Good
Crancreagh Br	Little_Cloghan_020	2 - 3	Poor
Br 2km SW of Cloghan	Little_Cloghan_020	4 - 5	High

Table 7.11: Latest EPA Q-Rating

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units), temperature (˚C) and dissolved oxygen (DO-%) were taken at surface water sampling location (SW1–SW4) downstream of the project site and grid connection on 25th January 2023 and again on 26th March 2023 and the results are listed in **Table 7.12** below. Refer to **Figure 7.3** for sample locations.

Monitoring point SW1 – SW3 are at locations both upstream and downstream of the project site and SW4 is located downstream of the grid connection.

Electrical conductivity (EC) values for main river waterbodies at the proposed project site ranged between 290 and 580µS/cm which would be typical for an area underlain by limestone bedrock. The flow in the rivers has a high groundwater component.

The pH values, which ranged between 6.9 and 7.3, were generally near neutral, would be typical of catchments a mixture of peat and mineral soil coverage. The dissolved oxygen concentrations are within the normal range for a 'Good' to 'High' status watercourses.

Surface water samples (2 no. rounds) were also taken at the 4 no. sampling locations for laboratory analysis. Results of the laboratory analysis are shown alongside relevant surface water quality regulations (EQS) in **Table 7.13** (Round No. 1/R1) and **Table 7.14** (Round No. 2/R2) below. Original laboratory reports are attached as **Annex 7.2**.

Location	EC (µS/cm)		pH		Dissolved Oxygen (%)	
	25/01/23	26/03/23	25/01/23	26/03/23	25/01/23	26/03/23
SW1	560	580	7.1	7.2	92	95
SW2	290	310	6.9	7.0	89	91
SW3	550	535	7.3	7.2	96	98
SW4	565	560	7.1	7.2	98	97

Table 7.12: Summary of Field Hydrochemistry Results

Parameter	EQS	Sample ID			
		SW1	SW2	SW3	SW4
Total	25(+)	<5	<5	<5	<5

Parameter	EQS	Sample ID			
		SW1	SW2	SW3	SW4
Suspended Solids (mg/L)					
Ammonia N (mg/L)	≤0.065 to ≤ 0.04(*)	0.04	0.21	0.06	<0.02
Nitrite NO_2 (mg/L)	-	<0.05	0.07	0.06	<0.05
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	26.8	18.2	23.3	<5
Nitrogen (mg/L)	-	5.6	4.7	5.2	<1.0
Phosphorus (mg/L)	-	<0.10	0.10	<0.10	<0.10
Chloride (mg/L)	-	23.3	23.5	23.3	20.6
BOD	≤ 1.3 to ≤ 1.5(*)	<1	1	<1	<1

(+) S.I. No. 293/1988: Quality of Salmon Water Regulations.
(*) S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009.

Table 7.13: Analytical Results of Surface Water Sampling (R1, 25/01/2023)

Parameter	EQS	Sample ID			
		SW1	SW2	SW3	SW4
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5
Ammonia N (mg/L)	≤0.065 to ≤ 0.04(*)	0.04	0.14	0.05	0.03
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	27.1	16.3	20.6	<5
Nitrogen (mg/L)	-	6.2	4.2	4.8	<1.0
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10
Chloride (mg/L)	-	23.6	22.2	22.5	23.3
BOD	≤ 1.3 to ≤ 1.5(*)	2	2	2	<2

(+) S.I. No. 293/1988: Quality of Salmon Water Regulations.
(*) S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009.

Table 7.14: Analytical Results of Surface Water Sampling (R2, 26/03/2023)

Total suspended solids were <5mg/L in all 8 no. samples during both sampling rounds (R1/R2) which is below the S.I. No. 293/1988 Maximum Acceptable Concentration (MAC) of 25mg/L.

Ortho-phosphate results were below the High Status threshold with regard (S.I. 272/2009) in both sampling rounds (R1 & R2).

Results for ammonia N ranged between Good to High Status with the exception of SW2 when the Good Status threshold was exceeded on both occasions.

BOD results were below the High Status threshold in R1 but all results exceeded the Good Status threshold in R2.

Nitrate values were in the 15 – 30mgL range for sample location SW1 – SW3 and were notably lower at SW4 (<5mgL) over the two rounds.

Phosphorus and nitrite levels were consistently low in all samples over both rounds. Levels of chloride are typical of surface waters in an inland setting.

7.3.9 Hydrogeology

Based on the GSI bedrock mapping (www.gsi.ie), Dinantian Pure Unbedded Limestones (Waulsortion Limestone) underlie the middle section of the proposed project site, Dinantian Lower Impure Limestones (Ballysteen Formation) are mapped on the west, while Dinantian Pure Bedded Limestones (Visean Limestones) are mapped on the east of the proposed project site.

The Dinantian Lower Impure Limestones and Dinantian Pure Unbedded Limestones which underlie the project are classified by the GSI (www.gsi.ie) as a Locally Important Aquifer, having bedrock which is moderately productive only in local zones (LI). All proposed infrastructure relating to the project is underlain by a Locally Important Aquifer with the exception of the met mast which is underlain by Dinantian Pure Bedded Limestones on the far east of the project site.

Dinantian Pure Bedded Limestones (Visean Limestones) are classified as a Regionally Important Karstified Aquifer with diffuse flow (Rkd).

The limestone bedrock in the area of the proposed project site is typically covered by a substantial thickness of peat, marl, lacustrine clay and glacial deposits (typical descending order from ground level to bedrock). Please refer to the Land, Soils and Geology Chapter (**Chapter 6**).

The glacial deposits will likely provide the dominant potential pathway for groundwater movement at the project site especially where permeable tills or sands and gravels are present under peat, marl and lacustrine deposits. The peat, marl and lacustrine clay deposits have very low permeability and significantly limit groundwater recharge at the project site.

Due to the presence of the overlying peat (which results in minimal recharge) and the low permeability of the underlying marl and lacustrine deposits, groundwater movement through the underlying glacial deposits will be relatively slow unless higher permeability sands and gravels horizons are present. Recharge is likely to be limited to the perimeter of the development site where the peat is thin or absent (the presence of peat will prevent rapid recharge to underlying regional groundwater systems). Based on topography and regional surface water drainage regime, the groundwater flow direction is likely to be westerly towards the Shannon River. A low groundwater gradient is expected.

There is a shallow water table in the peat layer across the site which comprises mainly rainwater. This is perched and largely isolated from the underlying regional groundwater system (which occurs in underlying till and bedrock).

Sand and gravels are mapped to overlie the bedrock along the majority of the grid connection route (i.e. Birr Gravels GWB). These gravels deposits are classified as a Locally Important Gravel Aquifer (Lg) by the GSI.

In terms of local Groundwater Bodies (GWBs), the proposed project site and grid connection straddles the Banagher GWB (IE_SH_G_040), Birr GWB (IE_SH_G_041)and the Birr Gravels GWB (IE_SH_G_244). The majority of the project site is located in the Banagher GWB.

The Banagher GWB is described as being Poorly Productive as it comprises mainly Dinantian Lower Impure Limestones and Dinantian Pure Unbedded Limestones. The Birr GWB is described as karstic as it comprises Dinantian Pure Bedded Limestones.

The Dinantian Lower Impure Limestones and Dinantian Pure Unbedded Limestones do not typically dispose themselves to significant karstification as they are generally impure.

The GSI do not map any karst features within the proposed project site, however a karst spring (Tobernapoula Spring) is mapped close to the south-eastern site boundary where the underlying geology is mapped as Dinantian Pure Unbedded Limestones. Tobernapoula Spring discharges into the Rapemills River upstream of the project site.

Based on criteria shown in the **Table 7.1** above, the Locally Important aquifers have a Low to Medium Importance. The Regionally Important aquifer at the eastern side end of the project site has a High Importance.

A local bedrock aquifer map is shown as **Figure 7.7** below.

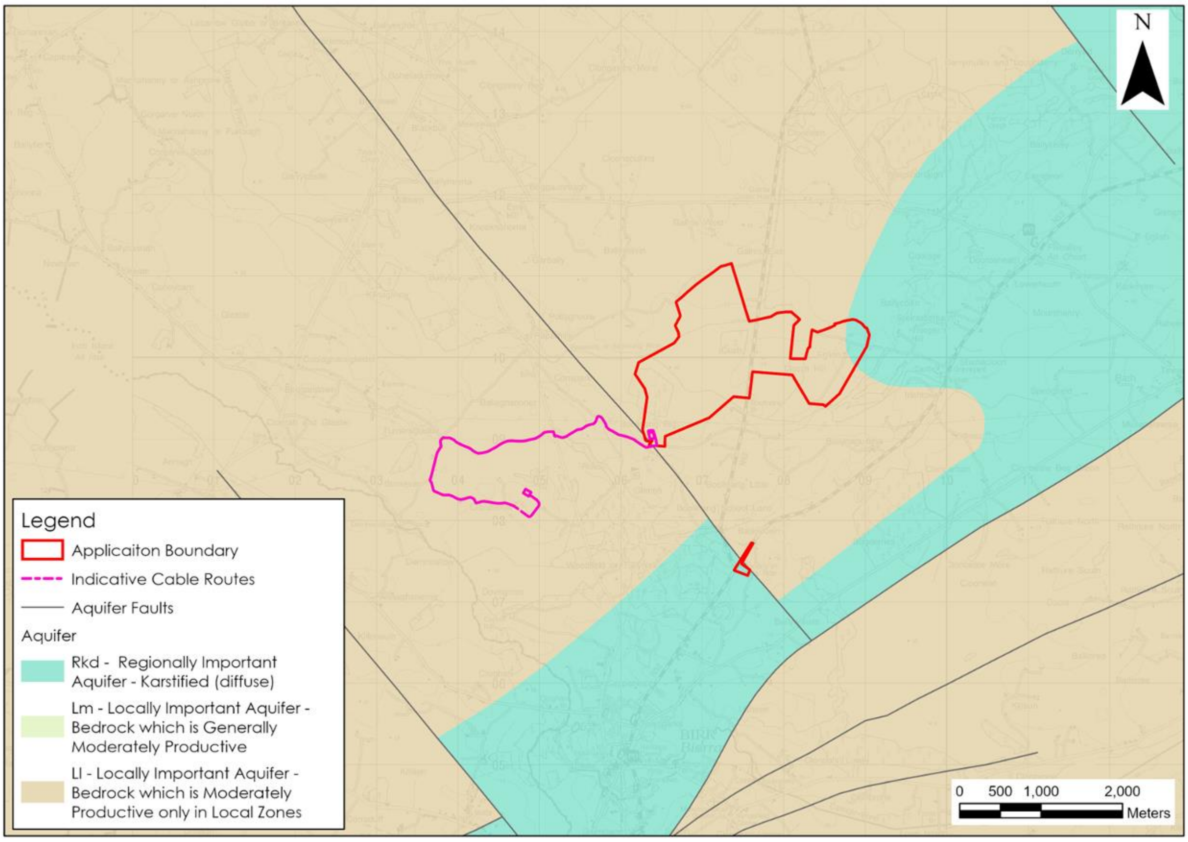


Figure 7.7: Bedrock Aquifer Mapping

7.3.10 Groundwater Vulnerability

The mapped groundwater vulnerability rating of the bedrock aquifer beneath the project site is mainly Moderate. This is consistent with the presence of basin peat itself underlain by a substantial depth of marl and lacustrine clays and glacial deposits over the majority of the project site.

A high vulnerability rating is mapped in the area of the agricultural lands on the east of the project site and also in the area underlain by gravels such as along the grid connection.

Due to the low permeability nature of the basin peat which covers the majority of the project site there is a very low potential for groundwater recharge, dispersion and movement within the underlying bedrock aquifer; therefore, surface water bodies such as drains and streams/rivers are more vulnerable (to contamination from project activities) than groundwater at this general location.

7.3.11 Groundwater Hydrochemistry

Based on data from the GSI publication on the Banagher GWB and Birr Gravels GWB, groundwaters in this area are typically very hard with a calcium-bicarbonate signature. Hardness generally ranges from 380 – 450 mg/l as CaCO3, with high electrical conductivities (650 – 800 µS/cm).

7.3.12 Groundwater Body Status

Local Groundwater Body (GWB) status information is available from www.catchments.ie.

In terms of local Groundwater Bodies (GWBs), the proposed project site and grid connection straddles the Banagher GWB (IE_SH_G_040), Birr GWB (IE_SH_G_041) and the Birr Gravels GWB (IE_SH_G_244). The majority of the project site is located in the Banagher GWB.

All GWBs in the area of the project as assigned 'Good Status', which is defined based on the quantitative status and chemistry. No groundwater pressures are reported for these groundwater bodies.

7.3.13 Surface Water Body Status

This section is a summary of the WFD Compliance Assessment undertaken for the proposed project site and grid connection. The full WFD Assessment report is attached **Annex 7.3.**

Table 7.15 below summaries the WFD information for river waterbodies immediately downstream of the project site and grid connection. Refer to **Annex 7.3** for a review of all waterbodies downstream of the project site.

The Rapemills River has been assigned an overall 'Moderate Status' along with a risk result of "At Risk". The Little Brosna_060 is assigned a 'Good Status' along with a risk result of "Not At Risk".

The Little (Cloghan)_010 is assigned 'Poor Status' and the risk status in under review.

Refer to **Table 7.15** below for additional information such Risk Result and Pressure Category.

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 Importance.

Regional Catchment	Water Body	Overall WFD Status (2016-2021)	Risk result (3rd Cycle)	Pressures & Activities
Shannon	Rapemills_010	Moderate	At Risk	Agriculture
	Rapemills_020	Moderate	At Risk	Agriculture & Extractive Industry
	Little Brosna_060	Good	Not At Risk	n/a
	Little (Cloghan)_010	Poor	Under review	n/a

Table 7.15: WFD Status & Risk Result

7.3.14 Designated Sites & Habitats

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

Local designated sites in the area and downstream of the proposed project site, grid connection and haul route works are shown on **Figure 7.8** below. The project is not located within any designated conservation site.

Designated sites in close proximity to the proposed project site and grid connection include Woodville Woods pNHA (Site Code: 000927), Ross and Glens Eskers pNHA and Ridge Road, SW of Rapemills SAC/pNHA (Site Code: 000919). The junction works at the N52/N62 drains into Woodville Woods pNHA.

The proposed grid connection runs adjacent to Ross and Glens Eskers pNHA.

The abovementioned close proximity designated sites are not water dependant.

The closest SPA to the site is Dovegrove Callows SPA (Site Code: 004137) is adjacent to part of the grid connection on the public road to the south of Dallow substation.

The project site drains to the northwest via the Rapemills River, which passes the All Saints Bog and Esker SAC and pNHA (Site Code: 000566) and the All Saints Bog SPA (Site Code:004103) approximately 3.5km from the project site.

However, there is no surface water connection between the project site and All Saints Bog and Esker SAC as All Saints Bog discharges into Rapemills River and not vice versa.

Groundwater flow in the area of the project site is likely to be westerly towards All Saints Bog and Esker SAC. However, groundwater flow below All Saints Bog will be limited to the deeper glacial deposits which are separated from the overlying bog by very low permeability marl and lacustrine clay deposits which underlies the basin peat in this area.

The Rapemills River ultimately drains into the River Shannon and flows through the River Shannon Calllows SAC (Site Code: 00216) and the Middle Shannon Callows SPA (Site Code:004096), which lie approximately 6.8km northwest of the project site.

Local designated sites in the area, and downstream, of the project are shown at **Figure 7.8** below.

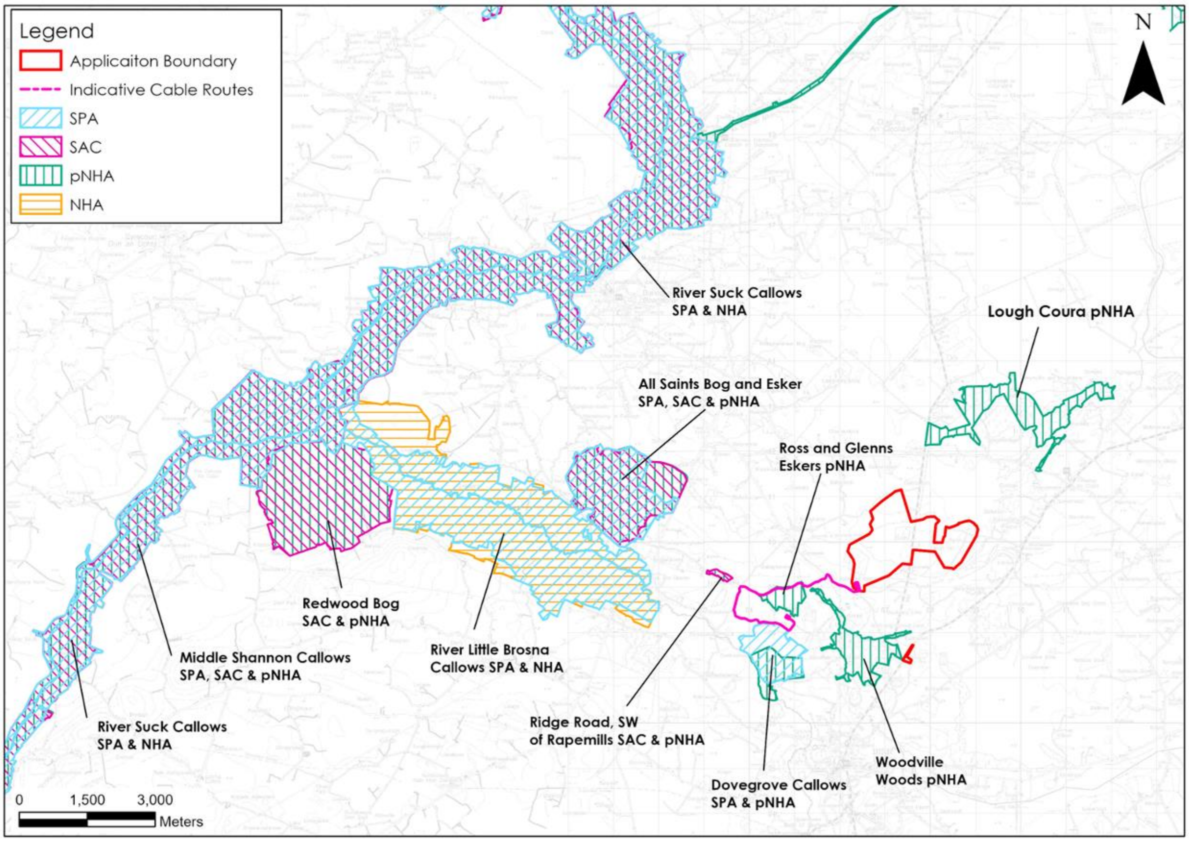


Figure 7.8: Designated Sites

7.3.15 Water Resources

According to the GSI online mapping there are no groundwater source protection areas in the immediate area of the project site or grid connection. The closest source protection area to the project site, which is associated with the Rath Public Water Supply, is located nearly 3km to the east of the site.

Private well locations (accuracy of <50m only) were reviewed using GSI well database (www.gsi.ie). There are no GSI wells mapped with 1km of the project site.

Wells along the grid connection route, haul route works areas, and forestry re-plant lands were not identified as no effects on groundwater are expected due to the shallow nature of the 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 of the wind farm has a well supply and this impact assessment approach is described further below. Private dwellings (i.e. potential wells) along the grid connection route, at the haul route works areas, and at the forestry re-plant lands were not identified due to the very low risk posed to any potential well.

Please note wells may or may not exist at each property, but our conservative rationale here is that it is better to assume a well may exist at each downgradient property and assess the potential impacts from the project on such assumed wells, rather than make no assessment and find out later that groundwater wells do actually exist.

The private well assessment undertaken below in **Section 7.4.3.10** assumes the groundwater flow direction is reflective of the topography and overall surface drainage and is therefore likely to follow a general westerly pattern towards the River Shannon.

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

This assessment focused on the wind turbine locations as these are the locations where the deepest excavations will be undertaken. All excavations required for site entrances, access tracks, crane hardstands, compounds, and the electricity substation will be shallow and therefore there is no likelihood of significant effects on groundwater supplies.

Based on the above approach, there is only 1 no. turbine (T1) within 1km of potentially down-gradient wells. Potentially down-gradient wells are located in the Pollaghoola and Rapemills townland area to the west of the project site. The closest down-gradient dwelling to a turbine is 830m away.

All other turbines are in excess of 1.3km from a potentially down-gradient well.

7.3.16 Development Interaction with the Watercourses & 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 (i.e. Rapemills River, West Galros Stream etc). Manmade forestry and bog drainage ditches at the project site are not considered a hydrological constraint.

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 bog/forestry drains have no notable hydrological value and can be readily integrated into the proposed drainage scheme using the methods outlined below (see **Section 7.5.12**).

7.3.17 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 project. 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 project site which may 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, stilling/silt/sediment ponds, settlement lagoons, and buffered outfalls.

A schematic of the site drainage management is shown as **Figure 7.9** below. A Planning-Stage Surface Water Management Plan (SWMP) has been prepared and is enclosed at **Annex 3.4**. The SWMP, prepared by GES on the basis of a drainage design by Jennings O'Donovan & Partners, incorporates drainage design features to ensure the appropriate management of surface waters at the project site.

A detailed SWMP, incorporating a further-developed drainage design, will be prepared, post consent, as part of the detailed design process prior to construction (as is the normal course) demonstrating the implementation of the drainage design and attenuation infrastructure.

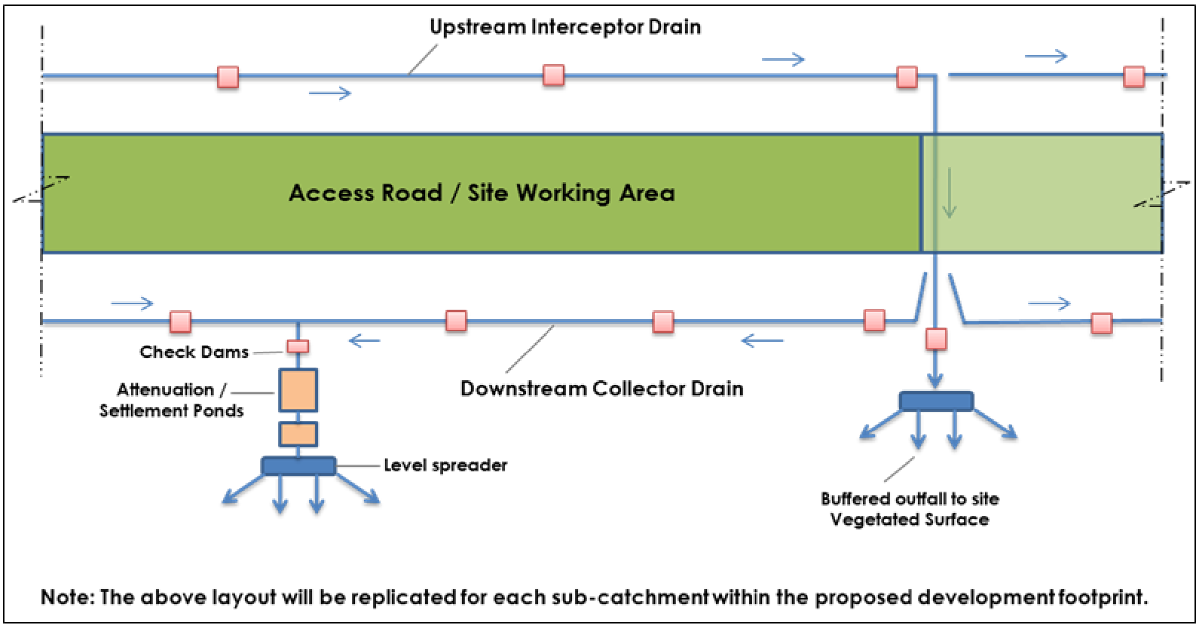


Figure 7.9: Schematic of Proposed Primary Site Drainage Management

7.3.18 Receptor Sensitivity

Due to the nature of wind farm developments and grid connections, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risks to groundwater at the site would be from cementitious materials, hydrocarbon spillage and leakages and potential piling works at turbine bases.

These potential significant effects are assessed in **Section 7.4** below. Some of 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 project site and grid connection during the construction and operational phases of the development and mitigation measures are proposed below (**Section 7.5**) to deal with these potential impacts.

The bedrock aquifers are not likely to be sensitive to pollution. This is because the majority of the project site, is covered in basin peat which in turn is underlain by marl, clays and glacial tills and these layers act as a protective cover to the underlying bedrock aquifer.

The underlying glacial deposits are not mapped as an aquifer, but they are likely to be used locally as a water supply and therefore they can also be classed as Sensitive to pollution.

The grid connection passes over locally important sand and aquifers which lack the protective layers of peat, clays and glacial tills. These aquifers are sensitive to pollution.

However, at the project site in particular, 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 Rapemills River and West Galros Stream are classed as High to Very High Importance and are very sensitive to potential contamination. These watercourses also provide drainage pathways to downstream designated sites.

The designated sites that are hydraulically connected (surface water flow paths only) to the project include the River Shannon Calllows SAC, Middle Shannon Callows SPA, Little River Brosna Callows SPA and River Suck Callows SPA and therefore have Extremely High Importance. These designated sites can be considered very sensitive in terms of potential impacts. The junction works at the N52/N62 drains into Woodville Woods pNHA which however is not a water dependant designated site.

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

The key design approach has been the avoidance of sensitive aquatic areas, where possible, by implementing a 50m buffer. From the constraints map (**Figure 7.10**), it is evident that; other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations) is located outside of areas that have been assessed to be hydrologically sensitive.

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

Due to the remoteness of the forestry replanting lands from sensitive receptors and the absence of any potential for significant effects, replanting works/activities have been scoped out of further assessment.

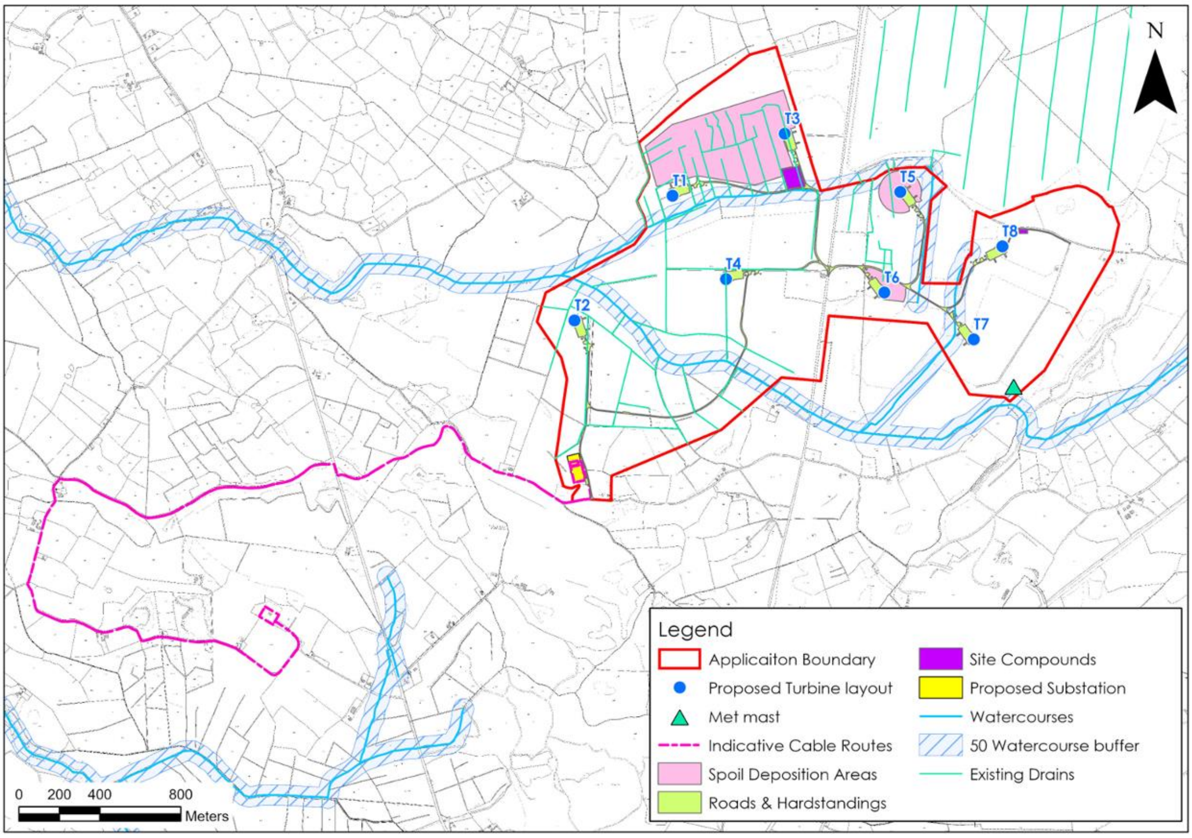


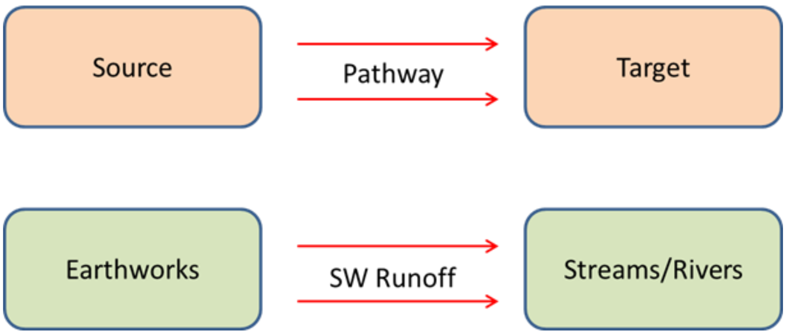
Figure 7.10: Hydrological Constraints Map

7.4 Description of Likely Effects

The likely effects of the project are set out below, with mitigation measures that will be put in place to eliminate or reduce like significant adverse effects are provided 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 project.



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 EPA:-

- *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, 2022);

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 to 7.6**), 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 negative 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 and hydrogeological 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 Clear Felling & Surface Water Quality Effects

A total of c. 23 hectares (ha) of forestry, accounting for 17% of the existing forestry coverage at the project site (c. 135ha), will be permanently felled to accommodate the construction and operation of the wind farm.

The tree felling activities will be the subject of a Felling Licence application to the Forest Service, in accordance with the Forestry Act 2014 and the Forestry Regulations 2017 (SI. 191/2017) and as per the Forest Service's policy on granting felling licenses for wind farm developments.

Likely effects during tree felling activities occur mainly from:-

- Exposure of soil and subsoils due to vehicle tracking and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter watercourses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads/tracks resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface water courses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

Attribute	Description
Receptor	Down-gradient streams and rivers (Rapemills River, West Galros Stream and River Shannon) and dependant ecosystems
Pathway/Mechanism	Drainage and surface water discharge routes
Pre-Mitigation Effect	Indirect, negative, slight, temporary, likely effect on surface water quality.

Table 7.16: Clear Felling and Surface Water Quality Effects

7.4.3.2 Earthworks (Removal of Vegetation Cover, Excavations, Piling & 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 excavations;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the grid connection including cable trench and haul route works 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 ecosystems of downstream river waterbodies. The likely effects are assessed to be significant if in the absence of mitigation.

Attribute	Description
Receptor	Down-gradient streams and rivers (Rapemills River, West Galros Stream and River Shannon) and dependant ecosystems
Pathway/Mechanism	Drainage and surface water discharge routes
Pre-Mitigation Effect	Indirect, negative, significant, short term, likely effect on surface water quality

Table 7.17: Earthworks

7.4.3.3 Groundwater Level Drawdown Effects During Excavation Works

No borrow pits are proposed at the project site, so no associated active dewatering works are proposed. Smaller scale temporary dewatering may occur at some excavations (i.e. turbine bases) and these have the potential to affect local groundwater levels. However, temporary reductions in groundwater levels by temporary dewatering will be very localised and of small magnitude due to the nature and permeability of the local peat and subsoil geology, which comprises moderate to very low permeability lacustrine along with some glacial deposits.

The installation of gravity foundation turbine bases in the underlying glacial deposits in particular is likely to require some temporary dewatering arrangements, where excavations are typically up to 5m deep (refer to **Chapter 3** for preliminary foundation detail).

However, due to the dominance of moderate to low permeability glacial till subsoils and lacustrine deposits below the bogs, the impacts on groundwater levels will be localised to the excavation and only for a temporary basis during the construction work. Water level impacts are unlikely to be significant beyond 50m from any excavation.

Subject to detailed site investigation works at proposed turbine positions, piled foundations may be required. Piling (if required), will require less excavation of material and will avoid the requirement for deep, open excavations thus active dewatering is typically not required. There will be some minor displacement of groundwater volumes during drilling and pile column emplacement, but volumes will be very small (<10m^3).

No groundwater level effects are anticipated from the construction of the haul route and grid connection works (including underground cabling) due to the shallow nature of the excavations (i.e. c.1-2m).

Attribute	Description
Receptor	Groundwater levels / flow paths /local GWBs (Banagher GWB, Birr gravels GWB and Birr GWB).
Pathway/Mechanism	Groundwater flowpaths
Pre-Mitigation Effect	Direct, negative, slight, brief, unlikely effect on groundwater levels.

Table 7.18: Groundwater Levels

7.4.3.4 Excavation Dewatering & Likely Effects 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 project site and therefore pollution issues are not assessed as likely to occur.

Attribute	Description
Receptor	Down-gradient surface water bodies (Rapemills River, West Galros Stream and River Shannon)
Pathway/Mechanism	Overland flow and site drainage network
Pre-Mitigation Effect	Indirect, negative, moderate, short term, likely effect on surface water quality

Table 7.19: Excavation Dewatering Discharges

7.4.3.5 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 (Banagher GWB, Birr gravels GWB and Birr GWB) and surface water (Rapemills River, West Galros Stream and River Shannon)
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 7.3.9**, **7.3.10** and **7.3.12** above, negative effects on groundwater quality are assessed to be unlikely. Indirect, negative, moderate, short term, likely effect to surface water quality

Table 7.20: Release of Hydrocarbons

7.4.3.6 Groundwater & Surface Water Contamination from Wastewater Disposal

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

Attribute	Description
Receptor	Groundwater (Banagher GWB, Birr gravels GWB and Birr GWB) and surface water (Rapemills River, West Galros Stream and River Shannon)
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 7.21: Contamination from Wastewater

7.4.3.7 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥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 (Rapemills River, West Galros Stream and River Shannon) and ecosystems.
Pathway/Mechanism	Site drainage network
Pre-Mitigation Effect	Indirect, negative, moderate, short term, likely effect on surface water

Table 7.22: Release of Cement-Based Products

7.4.3.8 Hydromorphological 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.

Within the project site there are 3 no. proposed (new) watercourse crossings (1 no. on Rapemills, 1 no. on West Galros and 1 no. on minor watercourse west of T7/T8). There is 1 no. existing crossing proposed for upgrade on the West Galros Stream just southeast of the main construction compound.

There is no requirement for natural watercourse crossing works along the grid connection route, only drains.

Attribute	Description
Receptor	Surface water flows, stream morphology and water quality in the Rapemills River and West Galros Stream
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Direct, negative, slight, long term, likely impact on watercourse morphology and water quality

Table 7.23: Hydromorphological Effects

7.4.3.9 Hydrological Effects on Designated Sites

The project site drains to the northwest via the Rapemills River, which passes the All Saints Bog and Esker SAC and pNHA (Site Code: 000566) and the All Saints Bog SPA (Site Code:004103) ~3.5km from the project site.

However, there is no surface water connection between the project site and All Saints Bog and Esker SAC as All Saints Bog discharges into Rapemills River and not vice versa.

Groundwater flow in the area of the project site is likely to be westerly towards All Saints Bog and Esker SAC. However, groundwater flow below Saints Bog will be limited to the deeper glacial deposits which are separated from the bog by very low permeability marl and lacustrine clay deposits which underlies the basin peat in this area.

The Rapemills River and Little Brosna River ultimately drains into the River Shannon which flows through the River Shannon Calllows SAC (Site Code: 00216) and the Middle Shannon Callows SPA (Site Code:004096). The Little Brosna River also flows through the River Little Brosna Callows SPA (Site Code:004086).

Downstream, surface water quality effects are unlikely to be significant at the location of the SACs due to dilution/assimilation capacity effects over such distances, particularly in the River Shannon itself. Notwithstanding this, surface water management and mitigation is proposed to protect local surface water and avoid significant negative downstream surface water quality effects.

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

Table 7.24: Effects on Designated Sites

7.4.3.10 Effects on Local Private Wells

Based on the assessment approach described in **Section 7.3.15** above there is only 1 no. turbine (T1) within 1km of potentially down-gradient wells. Potentially down-gradient wells are located in the Pollaghoola and Rapemills townland area to the west of the project site. All other turbines are in excess of 1.3km from a potentially down-gradient well.

Due to the requirement for foundation excavations and the use of cement, the potential impacts on closet down-gradient dwellings (and potential well) from proposed turbine T1 is assessed further below.

Attribute	Description
Receptor	Down-gradient groundwater quality and private well drinking water sources
Pathway/Mechanism	Groundwater and surface water flowpaths
Pre-Mitigation Effect	Indirect, negative, imperceptible, short term, unlikely effect

Table 7.25: Private Drinking Water Supplies

7.4.3.11 Effects on the WFD Status and Objectives

This section is a summary of the WFD Assessment undertaken for the proposed project site and grid connection. The full WFD Assessment report is attached **Annex 7.3.**

Table 7.15 above summaries the WFD information for river waterbodies immediately downstream of the project site and grid connection. Refer to **Annex 7.3** for a review of all waterbodies downstream of the project site.

In terms of local Groundwater Bodies (GWBs), the proposed project site and grid connection straddles the Banagher GWB (IE_SH_G_040), Birr GWB (IE_SH_G_041) and the Birr Gravels GWB (IE_SH_G_244). The majority of the project site is located in the Banagher GWB.

Effects on surface water and groundwater quality as a result of the project may negatively affect the WFD status in the absence of appropriate mitigation.

Attribute	Description
Receptor	Down-gradient groundwater and surface water bodies status
Pathway/Mechanism	Groundwater and Surface water flowpaths
Pre-Mitigation Effect	Indirect, negative, slight, short term, unlikely effect on WFD status

Table 7.26: WFD Status Effects

A full WFD assessment has been undertaken and is provided at **Annex 7.3**

7.4.3.12 Effects on the Haul Route N52/N62 Junction Works

The requirement of a reverse manoeuvre at the junction will result in the temporary removal of road signs and street lighting, along with the removal and replacement of a small section of tree lined hedgerow on the eastern side of the junction.

There will be a requirement for only very minor earthworks and therefore has a low potential to effect surface water quality.

Attribute	Description
Receptor	Surface water flows, stream morphology and water quality in the Rapemills River
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Direct, negative, imperceptible, brief, likely effect on water quality

Table 7.28: Water Quality Effects of the Haul Route Junction Works

7.4.4 Operational Phase

Activities during the operational phase of the project will be significantly reduced compared to the construction phase, with extremely limited sources for likely significant negative hydrological and hydrogeological effects.

7.4.4.1 Increased Runoff due to Progressive Replacement of Natural Surface with Lower Permeability Surfaces

The progressive replacement of the vegetated surface with impermeable surfaces could 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 and electrical substation amongst others. During rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading to local drains and streams, resulting in erosion of watercourses and impact on downstream aquatic ecosystems.

The permanent development footprint of the wind farm infrastructure including the tracks associated with the amount to approximately 8.65ha (86,500m^2).

The spoil storage area has not been included in this assessment as there is no hardstand placement. The spoil storage areas will essentially involve placement of spoil and peat on an already existing peat surface and therefore there will be no significant change in ground conditions affecting runoff.

Attribute	Description
Receptor	Surface waters (Rapemills River, West Galros Stream and River Shannon) and dependant ecosystems.
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Direct, negative, imperceptible, permanent, likely effect on existing drainage / runoff volumes

Table 7.29: Increased Runoff Effects

The emplacement of the proposed project footprint, as described in **Chapter 3**, (assuming emplacement of impermeable materials) could result in an average total site increase in surface water runoff of 272m^3/month, for the month of highest average recorded rainfall. This equates to an average increase of 8.8m^3/day (**Table 7.31**). This represents a 0.12% increase in the average daily/monthly volume of runoff from the project 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 project site being developed. Specifically, the proposed permanent development hardstand area is approximately 8.65ha, representing 3% of the total project site area of 290ha.

The additional runoff volume is low due to the fact that the runoff potential from the site is naturally very high (96% runoff coefficient) due to the prevailing baseline hydrogeological conditions at the project site (i.e. peat surfaces, lacustrine clays etc). 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/recharge of rainfall. A water balance assessment is provided below.

Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Footprint Area (m^2)	Footprint Area 100% Runoff (m3) (m^3)	Footprint Area 96% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
218,822	7,059	86,500	6,799	6,527	272	8.8	0.12

Table 7.30: Baseline Runoff for the Wind Farm Site

7.4.4.2 Hydrocarbons Spillages/Leakages

During operational maintenance works, there is a small risk associated with release of hydrocarbons from site vehicles, although it is not envisaged that any significant refuelling works will be undertaken on site during the operational phase.

Oil used in transformers (at the substation and within each turbine) and storage of oils at the substation could leak during the operational phase and result in effects on water quality.

Attribute	Description
Receptor	Surface waters, groundwater and dependant ecosystems.
Pathway/Mechanism	Site drainage network.
Pre-Mitigation Effect	Direct, negative, slight, long-term, unlikely impact.

Table 7.31: Hydrocarbons Spillages Leakages during the Operational Phase

7.4.4.3 Increased Flood Risk due to Development in Fluvial Flood Zones

The main purpose of the Stage 3 FRA for the project site was to inform the wind farm layout design at an early stage and to keep as much of the proposed high infrastructure outside of fluvial flood zones as possible. Therefore, the potential for significant effects on flood risk have been removed.

Therefore, most of the proposed infrastructure with the exception of short sections of proposed access roads at 2 no. watercourse crossing locations (which are unavoidable) are located in Flood Zone C. Mitigation is provided below for these elements of the infrastructure.

Attribute	Description
Receptor	Proposed infrastructure and downstream receptors (i.e. property and people)
Pathway/Mechanism	Site drainage network and Rapemills River
Pre-Mitigation Effect	Indirect, negative, imperceptible, long term, likely effect on flood risk

Table 7.32: Flood Risk

7.4.4.4 Potential Hydrogeological Effects with Piled Turbine Foundations

Due to the possibility of deep peat, lacustrine clays and glacial tills at turbine locations T1 – T6, piled foundations may be required. The following potential scenarios arise in respect of proposed piling works:

- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as lacustrine clay), to allow downward flow into the underlying aquifer;
- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as lacustrine clay), to allow upward migration alkaline groundwater to the acidic bog surface, thus potentially altering local hydrochemistry and therefore vegetation at the bog surface; and,
- Creation of a blockage to regional groundwater flow within the underlying aquifer due to placement of pile clusters.

These pathways are analogous to pathways described for piling works associated with contaminated land sites, as detailed in Environment Agency (2001).

Attribute	Description
Receptor	Groundwater flowpaths (upward and/or downward pathways, and regional groundwater flows).
Pathway/Mechanism	Groundwater quality in the underlying Banagher and Birr GWBs and groundwater hydrochemistry at the surface and within the peat bog.
Pre-Mitigation Effect	Negative, moderate, direct, short term, likely effect on groundwater quality/hydrochemistry.

Table 7.33: Turbine Foundation Piling and Hydrogeological Effects

7.4.5 Decommissioning Phase

Decommissioning phase effects are likely to be very similar to construction phase impacts but the overall likelihood for significant negative 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 project 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 and hydrogeological effects are 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 Hydrological 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 project site (i.e. low permeability peat, silts and clays overlying a locally bedrock aquifer) and the near surface nature of construction activities, cumulative impacts with regard groundwater quality or quantity arising from the proposed project are assessed as being unlikely to occur.

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

Due to the construction methodologies, construction programme (i.e. the grid connection trench will be excavated in stages) and the transient nature of the works over several kilometres, significant surface water quality effects are not anticipated as a result of the construction methodologies to be implemented, the surface water control measures to be put in place and the general adherence to the 50m hydrological buffer. Additional drainage control measures are outlined in this chapter, where works or infrastructure is located inside a 50m buffer zone.

Also, the majority of the grid connection is located in the Little Brosna River catchment (2.9km) while the wind farm infrastructure/turbines etc is located in the Rapemills River catchment. The distribution of proposed infrastructure in separate catchments significantly reduces the potential for cumulative effects.

A hydrological cumulative impact assessment of the project has been undertaken below with regards cumulative effects with other projects and plans, including wind energy developments, located in the Rapemills River catchment (the proposed wind farm site itself and all turbines etc. are situated in the Rapemills River catchment). Cumulative effects outside the Rapemills River catchment are unlikely for the reasons outlined above.

Also, downstream of the Rapemills River catchment (i.e. the River Shannon itself) no cumulative hydrological effects are likely due to large upstream catchment area of the River Shannon (i.e. ~6,700km^2) and the very high dilution effects afforded by such a large regional catchment and subsequent large surface water flows. In comparison, the Rapemills River catchment (~95km^2) only accounts for 1.4% of the River Shannon catchment upstream of the Rapemills/Shannon confluence. The potential for dilution is very high.

All turbine locations (8 no.) at the project site are located within the Rapemills River catchment. Also, there are two other wind farms locally that have either turbines operating or proposed in the Rapemills River catchment. These are Derrinlough Wind Farm which is currently under construction and Meanwaun Wind Farm which is constructed and operational.

The total number of wind turbines that could potentially be operating in the Rapemills River catchment is 18 no. (8 no. from the project site and 10 no. turbines from the other wind farms (i.e. Derrinlough – 6 no. and Meanwaun – 4 no.)

The total area of the Rapemills catchment is c. 95km^2 which equates to 1 no. turbine per 5.3km^2 which is considered not significant in terms of likely cumulative hydrological effects on the Rapemills River.

Also, 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. If the project is granted permission, both the Derrinlough Wind Farm and Meanwaun Wind Farm will be operational by the time construction commences and therefore construction phase effects cannot overlap.

The water balance assessment, undertaken at **Section 7.4.4.1** above, demonstrates that even in the absence of mitigation, the likelihood of increased runoff from the proposed project site during the operational phase is imperceptible. Therefore, the implementation of the proposed drainage control, which will release stormwater from the project site at greenfield rates, will ensure cumulative effects during the operational phase with regard flood risk and hydromorphology will be neutral.

In relation to non-wind farm, smaller commercial and private development in the Rapemills catchment, the majority of the local developments relate to the provision and/or alteration of one-off housing and agricultural developments.

These developments are typically small scale and localised in nature and impacts on water quality or flows (surface water or groundwater) are not expected. Therefore, any likely significant hydrological cumulative impacts with respect to the project will not occur.

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 Planning-Stage SWMP, incorporating the surface water drainage design has been prepared, see **Annex 3.4**, and incorporates the principles of Sustainable Drainage Systems (SuDS) through an arrangement of surface water drainage infrastructure. The SWMP has regard to greenfield runoff rates and is designed to mimic same and is sufficient to accommodate a 1-in-100 year rainfall event.

While the SuDS 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 treatment, 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;
- 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; and,
- The high sensitivity of downstream receptors along with WFD status

7.5.1 Construction Phase

7.5.1.1 Clear Felling & Surface Water Quality Effects

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:-

- Department of Agricultural, Food and the Marine (2019) *Standards for Felling and Reforestation*;
- Forestry Commission (2004) *Forests and Water Guidelines, Fourth Edition*. Publ. Forestry Commission, Edinburgh;
- Coillte (2009) *Forest Operations and Water Protection Guidelines*;
- Coillte (2009) *Methodology for Clear Felling Harvesting Operations*; and,
- Forest Service (2000: *Forestry and Water Quality Guidelines*. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

<u>Mitigation by Avoidance</u>

There is a requirement in the *Forest Service Code of Practice* and in the *FSC Certification Standard* for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document *Forestry and Water Quality Guidelines* are detailed at **Table 7.34**.

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

Table 7.34: Minimum Buffer Zone Widths (Forest Service, 2000)

During the construction phase, a self-imposed conservative buffer zone of 50m will be maintained for all Rapemills River and West Galros Stream where possible. These buffer zones are illustrated at **Figure 7.10**.

Of the 23ha proposed for felling, only ~2.5ha are located inside the 50m buffer zone.

The large distance between the majority of the felling areas and sensitive aquatic zones means that any poor quality runoff arising from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the additional mitigation measures outlined below will be employed.

<u>Mitigation by Design</u>

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods, as follows:-

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of tracks and culverts will be ongoing through any felling operation. No tracking of vehicles through watercourses will occur. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the areas to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and avoid being placed at right angles to the contour;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil disposal areas. All new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion or where felling inside the 50m buffer is required, it will be necessary to install double or triple sediment traps;
- All drainage channels will taper out before entering the 50m buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;

- Brash or bog mats will be used to support vehicles on soft ground, reducing topsoil and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place before they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside the 50m watercourse buffer. Straw bales and check dams will be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low, rainfall in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads/tracks and culverts will be ongoing through the felling operation;
- Refuelling or maintenance of machinery will not occur within 50m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted:
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Trees will be cut manually from along streams and using machinery to extract whole trees; and
- Travel will only be permitted perpendicular to and away from surface water features.

Silt Traps

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, increase residence time and allow settling of silt in a controlled manner.

Drain Inspection and Maintenance

The following items will be carried out during pre-felling inspections and regularly thereafter:-

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual waterlogging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections, the main drainage ditches will be identified. Where possible, the pre-felling inspection will be carried out during rainfall;
- Following tree felling, all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site, if impeded by silt or debris, will be unblocked; and
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure

that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4-weeks of the felling activity commencing, preferably in medium-to-high water flow conditions. The 'during' sampling will be undertaken once a week or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Details of the proposed surface water quality monitoring programme are outlined in the Water Quality Monitoring Plan (refer to **Annex 3.4**).

The surface water sampling locations used in this EIAR for the project site and grid connection (i.e. SW1 – SW4) will also be used as sampling locations during felling activities.

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

7.5.1.2 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 by using a 50m buffer. From the constraints map (**Figure 7.10**) it is evident that; other than some sections of access tracks, watercourse crossings (4 no.), part of the crane hardstanding of turbine T7, the southern end of the main construction compound and the northern end of the spoil deposition area at turbine T5; the majority of the proposed wind farm infrastructure (including all turbine locations and the spoil deposition areas) is located outside of areas that have been assessed to be hydrologically sensitive. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

As described above and at **Chapter 3**, specific mitigation measures, incorporated into the design of the project (embedded mitigation) 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 ensures that sufficient space is provided for the installation of 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 treated and 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, sandbags, 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 bog and forestry drains already exists, and these will be integrated and enhanced as required and used within the wind farm 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 wind farm drainage into the existing site drainage network. This will reduce the likelihood of 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; and
- 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.

Water Treatment Train

While the silt/sediment ponds and lagoons are assessed as providing a sufficient level of protection to avoid any deterioration in downstream water quality; 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 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 50m 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 the Spoil Deposition Areas

It is proposed that excavated overburden/spoil will be utilised for reinstatement of excavated areas etc. and for landscaping purposes. Excess material, or material which is unsuitable for this purpose, will be stored, permanently, at the dedicated spoil deposition areas.

The main spoil deposition area is located outside the 50m stream buffer zone (refer to **Figure 7.10).** A small section of the spoil deposition area at turbine T5 encroaches the 50m buffer zone. Additional mitigation in the form of double silt fencing will be placed around all infrastructure that encroaches the 50m buffer zone.

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. Double silt fencing will be placed along the edge of the bog drain that intercepts the deposition areas.

Drainage from the overburden deposition areas will ultimately be into to the existing bog drain network where it is proposed that check dams will be installed every 20m or so to create a series of settlement ponds, before being discharged.

Spoil deposition areas will be sealed with a digger bucket and allowed to revegetate as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised, spoil deposition areas will no longer be a likely source of silt laden runoff. Surface water protection infrastructure 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 route to remove any suspended sediments from the works area. The trapped sediment will be removed and disposed of at an appropriate licenced facility. Any bare-ground will be 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 locations, prior to other activities being commenced. The construction of the drainage system will only be carried out during periods of, where possible, no rainfall, therefore avoiding runoff. This will avoid 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 SWMP will be prepared to detail the siting and composition of the surface water management measures. The respective plans, which will form part of a detailed Construction Environmental Management Plan (CEMP), will be prepared prior to the commencement of development.

The CEMP will also include a detailed Water Quality Monitoring Plan 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. The surface water sampling locations used in this EIAR (i.e. SW1 – SW4) will be used during construction activities. 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.

7.5.1.3 Excavation Dewatering and Effects 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 silt/sediment ponds and settlement lagoons 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.

7.5.1.4 Release of Hydrocarbons during Construction & 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 refuelling 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 and accidental spillages;
- 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 Planning-Stage CEMP (**Annex 3.4**). 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.

7.5.1.5 Groundwater & Surface Water Contamination from Wastewater Disposal

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

- 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.

7.5.1.6 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 be utilised;
- All watercourse crossings will utilise pre-cast products and the use of wet-cement products within the hydrological buffer will be avoided;
- 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 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 concrete pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

7.5.1.7 Morphological Changes to Surface Water Courses & Drainage Patterns

The following mitigation measures are proposed:-

- 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;
- All internal wind farm electrical cabling or 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 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 *Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters* (2016) (i.e., July 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;
- The new watercourse crossings at the wind farm site 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; and,
- No instream works are proposed at the grid connection watercourse crossings.

7.5.1.8 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, silt/settlement ponds, settlement lagoons), will ensure that the quality of runoff from development areas will be very high.

As stated in **Section 7.6.1.2** below, an "*imperceptible, temporary effect*" on local streams and rivers would, if it occurs, be extremely localised and of a very short duration (i.e. hours). Therefore, considering the imperceptible effects on local surface water quality along increased dilution capacity of downstream river waterbodies, significant indirect hydrological or water quality effects on the downstream designated sites will not occur.

7.5.1.9 Effects on the Private Well Water Supplies

Potentially down-gradient wells are located in the Pollaghoola and Rapemills townland area to the west of the project site. The closest down-gradient dwelling to a turbine (T1) is approximately 830m away.

The risk to any potential well source down-gradient of a turbine location from potential contaminant release (i.e. sediment, hydrocarbons, and cement-based compounds) within any excavation at this separation distance is very low (i.e. 830m). Due to the relatively low bulk permeability of mineral soils beneath the peat (i.e. predominately silts and clays with some interbedded gravels), the low recharge characteristics (due to the overlying peat) and the low groundwater gradients (flat topography), groundwater travel times are expected to be slow. The relatively low permeability and the diffuse nature of groundwater flow in the mineral soils would mean that a pollutant would take months to travel this distance as demonstrated below by means of the Darcy mean velocity equation:

$$q = k.i$$

$$v = q/ ne$$

$$T = L / v$$

where:

q = specific discharge (m/day)

k = permeability m/day (a value of 20m/day for moderate to low permeability subsoils is used).

ne = porosity (a value of 0.025 is used for silts/clays).

i =slope of the water table in the subsoil can be estimated from on topography (a value of 0.005 is used down-gradient of the turbine (52mOD - 48mOD)/850m = 0.005).

v = Darcy velocity (m/day).

L = Distance (metres).

T = Time of travel (days)

Based on a groundwater flow velocity of 4m/day (4.6×10^{-5} m/s), conservative worst-case estimate), the time of travel (ToT) for a potential pollutant to flow from the development location to the closest dwelling house (i.e. 850m) would be in the order of 212 days. During this time any discharge would be assimilated and attenuated by natural groundwater flow and diluted by rainfall recharge. Also, any entrained sediment would be filtered within the low permeability subsoils. Therefore, the risk posed to potential well sources at this distance from potential spills and leaks from excavations is negligible.

In addition, there are proposed mitigation measures (outlined above) that will minimise and prevent potential groundwater contamination from hydrocarbons and other chemicals (refer to **Sections 7.5.1.4** and **7.5.1.6**).

7.5.1.10 Effects on the WFD Status

No additional targeted measures are required or proposed in respect of the WFD assessment. The strict implementation of the measures set out in the preceding sections will ensure that the status of both surface water and groundwater bodies in the vicinity of the site will be maintained.

With regard to treatment standards, the drainage system has been designed to achieve compliance with surface water Environmental Quality Standards (EQS) in the downstream receiving waters. Details of monitoring proposals, to ensure this compliance, is described in the Planning-Stage SWMP (**Annex 3.4**).

The application of the drainage management as outlined will ensure compliance with EU Surface Water Regulations and WFD requirements while also maintaining the baseline hydrology of the site.

As such, the project is compliant with the requirements of the Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC).

7.5.1.11 Effects of the Haul Route Junction Works

Detailed mitigation measures for sediment control are outlined in **Section 7.5.1.2**. and, detailed mitigation measures for control of hydrocarbons during construction works are outlined in **Section 7.5.1.4.**

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 project is 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;
- Swales and check dams 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.

7.5.2.2 Hydrocarbons Spillages/Leakages

Mitigation measures relating to oils and fuels are as follows:-

- Fuels stored on site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume for the time period of the construction;
- The substation transformer and oil storage tanks will be located in a concrete bund, impervious to rainwater ingress, capable of holding 110% of the stored oil volume;
- Turbine transformers will be located within the turbines, and any leaks will be fully contained within the turbine thus eliminating any pathway for leakages to affect land and soil;
- Maintenance vehicles will be regularly inspected for leaks and fitness for purpose; and
- An emergency plan for the operational phase to deal with accidental spillages will be contained within an Environmental Management Plan. Spill kits will be available to deal with accidental spillages.

7.5.2.3 Increased Flood Risk due to Development in Fluvial Flood Zones

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;
- 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; and,
- The high sensitivity of downstream receptors along with WFD status.

Flood Resilience Measures

The site-specific flood zone modelling shows that only short sections of proposed access road at 2 no. watercourse crossing locations will potentially be affect by fluvial flooding. One crossing is on the Rapemills River itself and the second is a large land drain on the south of the site which drains into the Rapemills River.

For these new crossing works a consent will be sought under Section 50 of the Arterial Drainage Act, 1945 to install a new culvert/bridge with the hydraulic capacity to accommodate a 100-year flood flows while maintaining at least a 300mm freeboard above the flood level.

The proposed access road surface level will be close or at the existing ground level to prevent obstruction of surface water flow paths.

7.5.2.4 Turbine Foundation Piling & Hydrogeological Effects

The proposed mitigation measures designed for the protection of downstream surface water quality and groundwater quality within the peat bog will be implemented at all construction work areas.

- Mitigation measures for sediment control are detailed in **Section 7.6.1**;
- Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 7.6.1.5** and **7.6.2.2**; and,
- Mitigation measures for the control of cement-based products during construction works are detailed in **Section 7.6.1.7**.

Proposed mitigation measures relative to piling works will comprise:

- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

Impact Assessment

Proposed piles will penetrate through peat deposits, marl and lacustrine clay deposits (where they occur), and then into underlying glacial tills or bedrock. Where present the marl and clay layer is likely to act as an aquitard/low permeability layer, through which only very small amounts of water can flow.

Peat water is perched above the regional groundwater table. Peat water occurs in the bog basins, while regional groundwater flow will occur in the underlying bedrock aquifer. Glacial tills that occur between the base of the peat/lacustrine clays may be permeable in local zones, but in general will have a moderate to low permeability. Therefore, the two main groundwater systems are the upper acidic peat water, and the lower regional bedrock groundwater water. As the underlying bedrock is mainly limestone, the groundwater occurring within this aquifer will be alkaline.

For the driven piles the marl and clay and also the glacial tills are likely to 'self-seal' around the piles, meaning that a long term pathway between the upper peat/bog water and the lower bedrock aquifer will not be sustained.

Research indicates that provided the aquitard layer is of a reasonable thickness and the piles driven through have a cross section without re-entrant angles, the likelihood of creating preferential flow paths for downward migration of leachate (i.e. peat water) is very low. This hypothesis is consistent with the results obtained by Hayman et al (1993) and Boutwell et al (2000).

For bored piles, as the temporary steel casing is removed, a steel reinforcement cage is added to the pile column and then concrete is added to the toe of the pile using a tremie pipe. Vermiculite is used to create a plug between the concrete and the displaced water, therefore the concrete seals the entire pile column and pushes the vermiculite plug to the surface as concrete is added. The temporary steel casing is removed carefully as the concreting works are being completed. This concreting process is similar to that used when grouting a water supply production well (IGI (2007), and EPA (2013)). This means that a long term pathway between the upper peat/bog water and the lower bedrock aquifer will not be sustained.

Scenario 1: Creating a Pathway for Downward Flow

To ensure downward flow of peat water and/or pollutants from the piling works does not occur, a bentonite seal will be used in a starter pit for each driven pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for either piling work option to create pathways for downward flow of peat water or pollutants that could affect groundwater quality in the underlying aquifer is imperceptible.

Scenario 2: Creating a Pathway for Upward Flow

No upwelling of groundwater to the peat surface water recorded in any of the site investigation locations recorded across the proposed site. Notwithstanding this, to ensure upward flow of underlying groundwater via potential pathways created by piling works does not occur, a bentonite seal will be used in a starter pit for each driven pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for piling works to create pathways for upward flow of alkaline groundwater to the bog surface is imperceptible.

Scenario 3: Blocking Regional Groundwater Flow

For example, if a piling array of 50 no. 300mm piles is applied at each of the 6 no. turbine base locations underlain by peat and lacustrine clays (as piling Option 1), this combined area of piling footprint amounts to ~21.2m^2, or 3.53m^2 per turbine base.

Each turbine base is 500m – 800m apart. The area of the piles driven into the ground is distributed over a very large area, and that area only amounts to 0.024% of the development footprint, or 0.00073% of the proposed project site area.

Also, none of the proposed piles would penetrate any great distance into the underlying bedrock aquifer, as they will find sufficient resistance, either in the over lying glacial tills/mineral subsoils or upon reaching the top of bedrock. At such wide separation distance, the ability of clusters of piles, with a plan area of ~3.53m^2 per turbine, to alter or affect regional groundwater flow is imperceptible.

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.

Likely effects would be similar to the construction phase but to a lesser degree. There would be increased trafficking and an increased risk of disturbance to underlying soils at the project site. Any such effects would be less than during the construction phase as the drainage system would be fully mature and would provide additional filtration of runoff. Any diesel or fuel oils stored on site would be bunded.

Following decommissioning, turbine foundations, hardstanding areas and access tracks will be rehabilitated in accordance with the methods outlined at **Chapter 3**. The access tracks may be left in place, subject to agreement with the Planning Authority and the landowner. It is considered that this approach will result in lesser effects that would their removal.

7.6 Residual Effects

7.6.1 Construction Phase

7.6.1.1 Clear Felling and Surface Water Quality Effects

Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be negative, imperceptible, indirect, temporary, and likely effect on downstream water quality and aquatic habitats.

7.6.1.2 Earthworks (Removal of Vegetation Cover, Excavations & 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 to occur.

7.6.1.3 Groundwater Level Effects

Significant effects on groundwater levels/flows will not occur as a result of the project. It is concluded, therefore, that likely significant effects will not arise.

7.6.1.4 Excavation Dewatering & 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 will occur.

7.6.1.5 Release of Hydrocarbons during Construction & 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 likely significant effects on surface water or groundwater quality will occur.

7.6.1.6 Groundwater and Surface Water Contamination from Wastewater Disposal

No likely significant residual effects will occur.

7.6.1.7 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 likely significant effects on surface water quality will occur.

7.6.1.8 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 assessed to not result in significant residual effects. Residual effects will be negative, direct, imperceptible, short term and likely.

7.6.1.9 Hydrological Effects on Designated Sites

No significant residual effects are assessed as likely to occur.

Due to the knowledge of the ground conditions (subsoil types) groundwater levels, gradients and flow directions as well as the mitigation measures provided to ensure the protection of water quality and water quantity (recharge), no residual effects on designated sites will occur.

7.6.1.10 Effects on local Groundwater Well Supplies

Due to the setback distance from potential downstream wells, the shallow nature of the earthworks, the low groundwater recharge characteristics of the project site, along with the slow and diffuse nature of groundwater flow, no effects on local wells will occur.

7.6.1.11 Effects on WFD Status

No effects on WFD status of surface water or groundwater bodies will occur.

7.6.1.12 Effects of the Haul Route Junction Works

No residual effects.

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.

7.6.2.2 Hydrocarbons Spillages Leakages during the Operational Phase

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

7.6.2.3 Increased Flood risk due to Development in Fluvial Flood Zones

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

7.6.2.4 Turbine Foundation Piling & Hydrological Effects

Residual effects, following the implementation of mitigation measures and design measures, are assessed to be negative, indirect, likely, long term imperceptible effect.

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 project.

7.7 Summary

During each phase of the project (construction, operation and decommissioning) a number of activities will take place 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 was used to inform the layout of the wind farm, thereby avoiding sensitive hydrological features.

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 – settlement pond and tertiary lagoons).

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 project presents no likelihood for significant effects on surface or groundwater quality following the implementation of the proposed mitigation measures; while the project can be constructed, operated and decommissioned without affecting the WFD status of any waterbody or adversely affecting the achievement of WFD status. 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 project.

Bibliography

CIRIA, 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.

DoHLG, 2006: Wind Farm Development Guidelines for Planning Authorities.

DOE/NIEA (2015): Wind Farms and Groundwater Impacts – A guide to EIA and Planning Considerations.

EPA (2022) Guidelines on the Information to be contained in Environmental Impact Assessment Reports.

EPA, 2003: Advice Notes on Current Practice (in the preparation of Environmental Impact Statements).

EPA (2021): 3rd Cycle Lower Shannon Catchment Report (HA 25B).

EPA (2021): 3rd Cycle Lower Shannon (Brosna) Catchment Report (HA 25A).

Environment Agency (2001) National Groundwater and Contaminated Land Centre – Piling into Contaminated Sites.

GSI (2004): Banagher GWB: Summary of Initial Characteristics.

GSI (2004): Birr GWB: Summary of Initial Characteristics.

IFI, 2016: Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters, Inland Fisheries Ireland (2016).

IGI, 2013: Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements, (Institute of Geologists Ireland, 2013).

NRA, 2008: Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, (National Roads Authority, NRA, 2008).

PPG1 - General Guide to Prevention of Pollution (UK Guidance Note).

PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note).

SNH, 2010: Scottish Natural Heritage report (SNH): Good Practice During Wind Farm Construction.

SNH, 2013: Scottish Natural Heritage report (SNH): Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms.