8 WATER

8.1 INTRODUCTION

This chapter describes the existing hydrological and hydrogeological characteristics at the development lands associated with the proposed development and associated project components including grid connection and replacement forestry lands, as detailed in Chapter 2. The surface water features and characteristics are described, as well as the site drainage and groundwater. An impact assessment was carried out to determine whether the project is likely to have a significant adverse effect on the hydrology and hydrogeological aspects of the environment and to propose mitigation measures to reduce any potential negative impact of the proposed wind farm.

8.1.1 Scope of Assessment

1. Establish the baseline conditions on site;
2. Identify the likely significant adverse effects on surface and groundwater of the proposed development during construction and operation;
3. Identify and develop mitigation measures to avoid, reduce or eliminate likely significant adverse effects;
4. Identify any significant residual impacts, effects and possible cumulative impacts after mitigation measures are implemented.

8.1.2 Methodology

An examination of the existing hydrological regime and an assessment of the potential impact of the proposed wind farm development on the hydrological regime has been undertaken through a combination of a desktop study of hydrological resources followed by a site walkover and field work.

8.1.2.1 Desk Study

A desktop study involving a review of all available information, datasets and documentation sources pertaining to the site's natural environment was completed. The study involved the following:

- Examination of maps and aerial photography to identify any hydrological features, and site topography and slope;
- Determination of the catchments and drainage regime on the site and downstream from the site;
- Review of legislation including the Water Framework Directive and all previous water quality legislation along with the River Basin Management Plan for Ireland 2018 - 2021;
- Review of existing water quality data available from the EPA;
- Review of rainfall data for the site catchment;
- Review of Water Framework Directive datasets, reports and maps;
- Examination of the Geological Survey of Ireland (GSI) online datasets pertaining to hydro-geology features such as aquifers, wells, groundwater bodies and groundwater protection schemes;
- Examination of National Parks and Wildlife Service (NPWS) nature conservation designations; and
- Preparation of catchment and other site maps.

8.1.2.2 Field Work

Field work involved the following:

- A walkover survey of the site to identify hydrological features on site, wet ground, drainage patterns and distribution, exposures, and drains;
- Measurement of slope inclination and mapping of significant features;
- Confirmation of the site catchments and drainage regime, and any hydrological buffers to be implemented.

8.1.3 Assessment Criteria

8.1.3.1 Impact Assessment Methodology

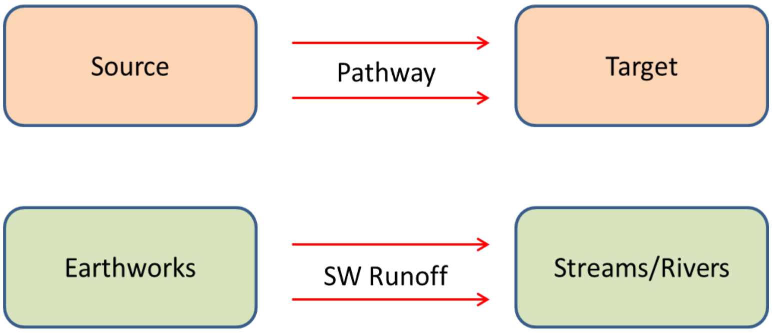
Please refer to **Chapter 1** of the EIAR for details on the impact assessment methodology (EPA, 2002, 2003, 2015 and 2017). In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in **Table 8-1** are then used to assess the potential effect that the Project may have on them.

Table 8-1: Receptor Sensitivities (adapted from www.sepa.org.uk)

Sensitivity of Receptor	
Not sensitive	Receptor is of low environmental importance (e.g. surface water quality classified by EPA as A3 waters or seriously polluted, fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability “Low” to “Medium” classification and “Poor” aquifer importance.
Sensitive	Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability “High” classification and “Locally” important aquifer.
Very sensitive	Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability “Extreme” classification and “Regionally” important aquifer.

8.1.3.2 Overview of Impact Assessment Process

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



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

- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2017);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003); and,
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, draft 2015).

The description process clearly and consistently identifies the key aspects of any potential 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 (Section 8.3.2 and 8.3.3), 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, operation, and decommissioning activities which have the potential to generate a source of significant negative impact on the geological and hydrological/ 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 potential 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 potential 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 negative effects. 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.

8.1.3.3 Relevant Legislation

The EIAR is 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 Acts 2000-2020;
- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (transposes the provisions of Directive 2014/52/EU into Irish Law);
- European Communities (Birds and Natural Habitats) Regulations 2011-2015, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Council Directive 2009/147/EC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293 of 1988: Quality of Salmon Water Regulations, resulting from EU Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life;
- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722 of 2003 European Communities (Water Policy) Regulations, as amended, 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). 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.

- S.I. No. 122/2014 - European Union (Drinking Water) Regulations 2014 and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 684 of 2007: Waste Water Discharge (Authorisation) Regulations 2017, 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. 106 of 2007: European Communities (Drinking Water) Regulations 2007 and S.I. No. 122 of 2014: European Communities (Drinking Water) Regulations 2014, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the "Drinking Water Directive") and EU Directive 2000/60/EC;
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

The existing EPA water quality data are compared to Environmental Water Quality Standards as set out in the European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I. No. 272 of 2009). Baseline sampling and analysis will be carried out prior to construction. It must be noted that these standards are used for comparative purposes only as the surface water is not for human consumption. The results have also been assessed against the surface water limits as outlined in S.I. No. 293/1988 European Communities (Quality of Salmonid Waters) Regulations, 1988. All water quality analysis must be considered in the wider context of the Water Framework Directive.

8.1.3.4 Relevant Guidance

- Environmental Protection Agency (2017): Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Environmental Protection Agency (September 2015): Draft - Advice Notes on Current Practice (in the preparation of Environmental Impact Statements);
- Environmental Protection Agency (2003): Advice Notes on Current Practice (in the preparation of Environmental Impact Statements);
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2005): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Wind Farm Development Guidelines for Planning Authorities (2006);
- Irish Wind Energy Industry Best Practice Guidelines (IWEA, 2012);
- The Code of Best Forest Practice and the Forestry and Water Quality guidelines[1];
- Control of water pollution from linear construction projects. Technical guidance (C648) 234pp. CIRIA, UK (Murnane *et al.* 2006);
- '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes'* (NRA, 2008);
- Good Practice During Wind Farm Construction. Scottish Renewables 2019;

[1] The Code of Best Forest Practice is a listing of all forestry operations and the manner in which they should be carried out to ensure the implementation of sustainable forest management in Ireland, as agreed at the Third Ministerial Conference on the Protection of Forests in Europe, Lisbon, 1998.

https://www.agriculture.gov.ie/media/migration/forestry/publications/codeofbestforestpractice/Code%20of%20Best%20Forest%20Prac%20Part%201.pdf

- Developments on Peat Land - Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste'. Scottish Renewables (2012);
- '*Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters*' (IFI, 2016);
- *'CIRIA B14 Design of Flood Storage Reservoirs'* (Hall *et al*. 1993);
- '*River Crossings and Migratory Fish: Design Guidance*' (Scottish Executive, 2012).

8.1.3.5 Surface water quality

The Quality Rating (Q) System is the standard biotic index which is used by the EPA. The Q-index is a quality measurement ranging from Q1 to Q5 with Q1 being of the poorest quality and Q5 being pristine/unpolluted. The Quality Rating System has been shown to be a robust and sensitive measure of riverine water quality and has been linked with both chemical status and land-use pressures in catchments. The system facilitates rapid and effective assessment of the water quality of rivers and streams. There are nine Q-value scores, ranging from 1 to 5 (including intermediate scores such as Q4–5). High ecological quality is indicated by Q5 or Q4–5 while Q1 indicates bad quality.

8.1.3.6 Groundwater vulnerability

Groundwater Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability maps are based on the type and thicknesses of subsoils (sands, gravels, glacial tills (or boulder clays), peat, lake and alluvial silts and clays), and the presence of karst features. Groundwater is most at risk where the subsoils are absent or thin and, in areas of karstic limestone, where surface streams sink underground at swallow holes. All land area is assigned one of the following groundwater vulnerability categories, as presented in the GSI vulnerability mapping guidelines and shown in **Table 8-2** below.

Table 8-2: Vulnerability Mapping Guidelines (Adapted from GSI)

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (sand/gravel)	Moderate Permeability (e.g. Sandy subsoil)	Low Permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	
Extreme (E)	0-3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	30m radius
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A
Notes: (1) N/A = not applicable (2) Precise permeability values cannot be given at present (3) Release point of contaminants is assumed to be 1-2 m below ground surface.					

8.1.3.7 Sensitivity, Impact Assessment and Significance

An impact rating has been developed with reference to 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' (NRA, 2005). This document deals with major infrastructure developments and the assessment guidance is therefore deemed appropriate to the current project. The sensitivity of the receiving hydrological environment was identified. The sensitivity of an environmental receptor is based on its ability to absorb an impact without perceptible change. Then the magnitude of the potential hydrological impact was estimated. The sensitivity rating, together with the magnitude of the potential impact, provides an overall rating of the significance of the impact prior to application of mitigation measures.

The assessment of the magnitude of an impact incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for hydrological impacts are defined as set out in **Table 8-3** below.

Table 8-3: Assessment of Magnitude of Hydrological Impact (Adapted from NRA, 2005)

Magnitude	Criterion	Description and Example
Major	Loss of attribute	Long term changes to the geology, hydrology, water quality and hydrogeology, e.g., loss of EU-designated salmonid fishery: change in water quality status of river reach, loss of flood storage/increased flood risk, pollution of potable source of abstraction
Moderate	Impact on integrity of attribute or loss of part of attribute	Short to medium term changes to the geology, hydrology, water quality and hydrogeology: loss in productivity of a fishery, contribution of significant sediment and nutrient quantities in the receiving water, but insufficient to change its water quality status
Minor	Minor impact on attribute	Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology - measurable change in attribute, but of limited size and/or proportion
Negligible	Impact on attribute but of insufficient magnitude to affect the use/integrity	No perceptible changes to the geology, hydrology, water quality and hydrogeology: discharges to watercourse but no loss in quality, fishery productivity or biodiversity, no increase in flood risk

Potential impacts are assessed as being of major, moderate, minor or negligible significance as shown in **Table 8-4** below.

Table 8-4: Significance of Criteria

Magnitude	Sensitivity			
	Very High	High	Medium	Low
Major	major	major	moderate	minor
Moderate	moderate	moderate	moderate	minor
Minor	minor	minor	minor	negligible
Negligible	negligible	negligible	negligible	negligible

8.1.4 Statement on Limitations and Difficulties Encountered

No difficulties were encountered in the preparation of this assessment.

8.1.5 Competency of Assessor

This Water Chapter has been prepared by Sean Doyle BE CEng MIEI of Malachy Walsh and Partners. Sean Doyle has twenty years' experience in 1D and 2D hydraulic modelling, flood analysis, drainage design, and the preparation of flood risk assessment reports and hydrology/water chapters of EIARs.

8.2 EXISTING RECEIVING ENVIRONMENT

8.2.1 Site and project context

The proposed development is located mainly within and adjacent to an area that has been and continues to be used for peat harvesting. Part of the site periphery is outside the peat area and is used as agricultural grassland.

8.2.2 Surface Hydrology

8.2.2.1 Surface water features

The proposed development site is located a short distance to the north of the Galey River which flows from east to west and outfalls to the Cashen River and ultimately to the Mouth of the Shannon. The Tarmon Stream, which is a tributary of the Galey River, flows south near the eastern extremity of the site. The Ballyline River and a network of its tributaries extend from north of the site and outfall to the River Shannon downstream of Ballylongford. The Coolkeragh stream, a tributary of the Ballyline, traverses the western part of the site for a short distance.

The Galey River is part of the Lower River Shannon Special Area of Conservation (SAC) (Site Code 002165). The Ballyline River is not within the SAC but there is a potential hydrological connection to the SAC and the River Shannon and River Fergus Estuaries SPA (Site Code 004077) via Ballylongford Bay.

The proposed turbine location T2 is illustrated in **Figure 8-1** below. The scale of the map suggests that the turbine location intersects the Coolkeragh stream. Ground truthing undertaken during site walkovers indicated that this is not the case in reality. The proposed turbine is located >50m away from the stream.

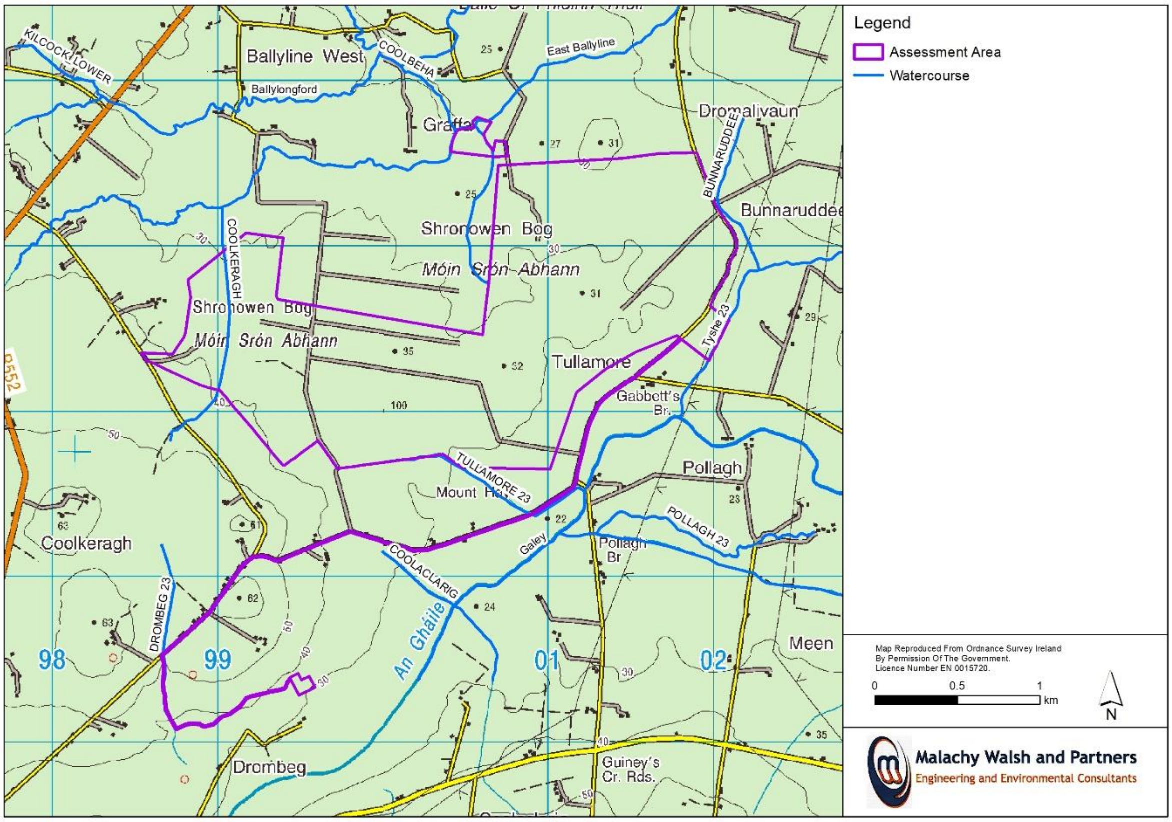


Figure 8-1: Watercourses

The site is on the boundary of two catchments. The southeast part of the site, which includes turbines T6, T9, T10 and T12, and the electrical sub-station, is in the catchment of the Galey River. The remainder of the development drains to the north to the Ballyline River.

The site is located within two River Basin Districts: the Shannon Estuary South RBD to the northeast and the Tralee Bay-Feale RBD to the southeast. The River Basin catchments are shown in **Figure 8-2**.

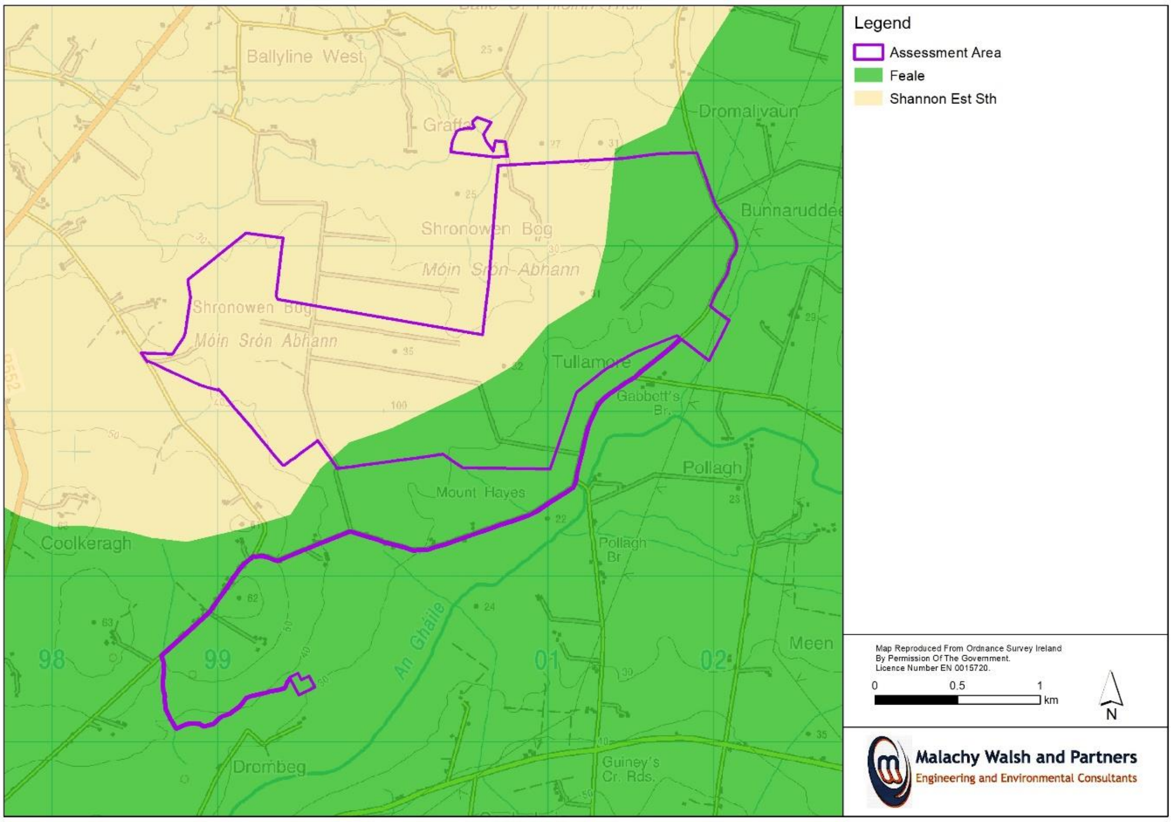


Figure 8-2 River Basin Catchments

8.2.2.2 Drainage

Most of the site and adjacent peatland has been extensively modified to facilitate peat extraction. A network of artificial drains has been created within Shronowen Bog to lower the water table. These drains outfall to the Galey River to the south and to a series of tributaries of the Ballyline River to the north.

8.2.2.3 Biological Water Quality

The EPA has monitoring stations on the rivers to which the drainage system for the proposed development outfall. There are two on the Galey River and one on the Tarmon Stream a relatively short distance from the site. Two more stations are located on the Ballyline River further north. The latest water quality data for each of these stations is shown in **Table 8-1**.

Table 8-1 River Water Quality at Nearby EPA Monitoring Stations 2017

River	Station Name/Location	Station ID	Q-rating	Corresponding WFD status
Galey	Shrone Bridge	RS23G010500	Q4	Good
Galey	Galey Bridge	RS23G010400	Q3-4	Moderate
Tarmon Stream	Gabbett's Bridge	RS23T030500	Q3-4	Moderate

River	Station Name/Location	Station ID	Q-rating	Corresponding WFD status
Ballylongford_020	Gortanacooka Bridge	RS24B030700	Q4	Good
Ballylongford_010	Bridge SW of Shrone	RS24B030400	Q4	Good

8.2.2.4 Physico-chemical water quality

Field sampling of the physicochemical properties of streams adjacent to the site was carried out in 2020. The locations of the sampling points are illustrated in **Figure 8-3** below.

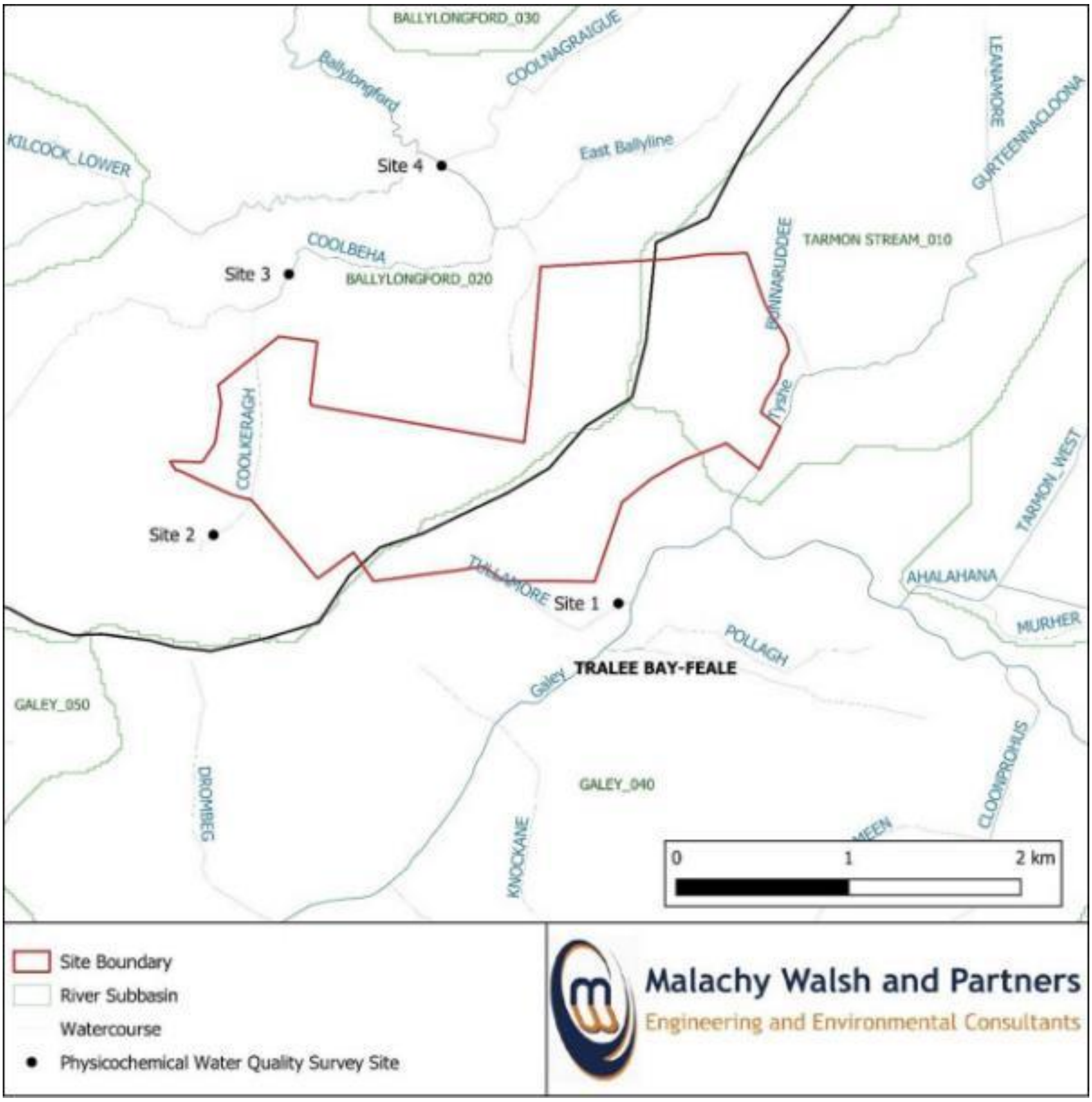


Figure 8-3: Surface Water Sampling Locations

The results are listed in **Table 8-6**. Field parameters were measured on-site by a MWP technician using a calibrated Aquaread AP-5000 Portable multi-parameter water quality probe.

Conductivity values ranged from 215 µS/cm to 437 µS/cm. These values reflect the peaty nature of the study area, with the lower values at Site 1 and Site 2 likely brought about by greater proportions of peat in the respective catchments. All Dissolved Oxygen concentrations were within the 80% - 120%

range expected of water of good quality with respect to oxygenation. The range of pH suitable for fisheries is considered to be 5.0 - 9.0, though 6.5 - 8.5 is preferable (EPA, 2001). As the pH of the watercourses draining the proposed development site pH ranged from 7.24 to 8.03, they are considered suitable for aquatic life.

Table 8-6: Physico-chemical water quality results

	Site 1 R01159 39554	Site 2 R98796 39925	Site 3 R99231 41445	Site 4 R00119 42065
Conductivity (µS/cm)	215	271	437	387
Temperature (°C)	8.28	8.7	8.8	8.2
Total dissolved solids (mg/L)	150	176	284	252
Dissolved oxygen (%)	96.7	95.3	94.6	96.2
Dissolved oxygen (ppm)	11.4	11.35	11.25	11.62
pH	8.03	7.41	7.24	7.36
Time	15:50	16:05	16:23	16:38

Sampling and analysis will also be carried out prior to construction to establish baseline conditions at that time.

8.2.2.5 Surface water sensitivity

Watercourse sensitivity has been derived from the biological ratings obtained from the EPA biological water quality results. It is considered that all surface waters within and near the site are of moderate sensitivity as indicated by the Biotic Indices of Q4 and Q3-4 at the monitored sites.

8.2.3 Groundwater

8.2.3.1 Groundwater body

The proposed wind farm is located within two groundwater bodies as shown in **Figure 8-4**. These are the Ballylongford Groundwater Body (GWB) at the northwest part of the site and the Abbeyfeale GWB at the southeast part. The Abbeyfeale GWB lies adjacent to the northeast boundary of the site.

The bedrock geology is described as mudstone, siltstone and sandstone of the Shannon Group, Code CNSHG with sandstone depth of about 700 metres. The sub-soil is described as cutover peat.

Groundwater vulnerability is low throughout the site.

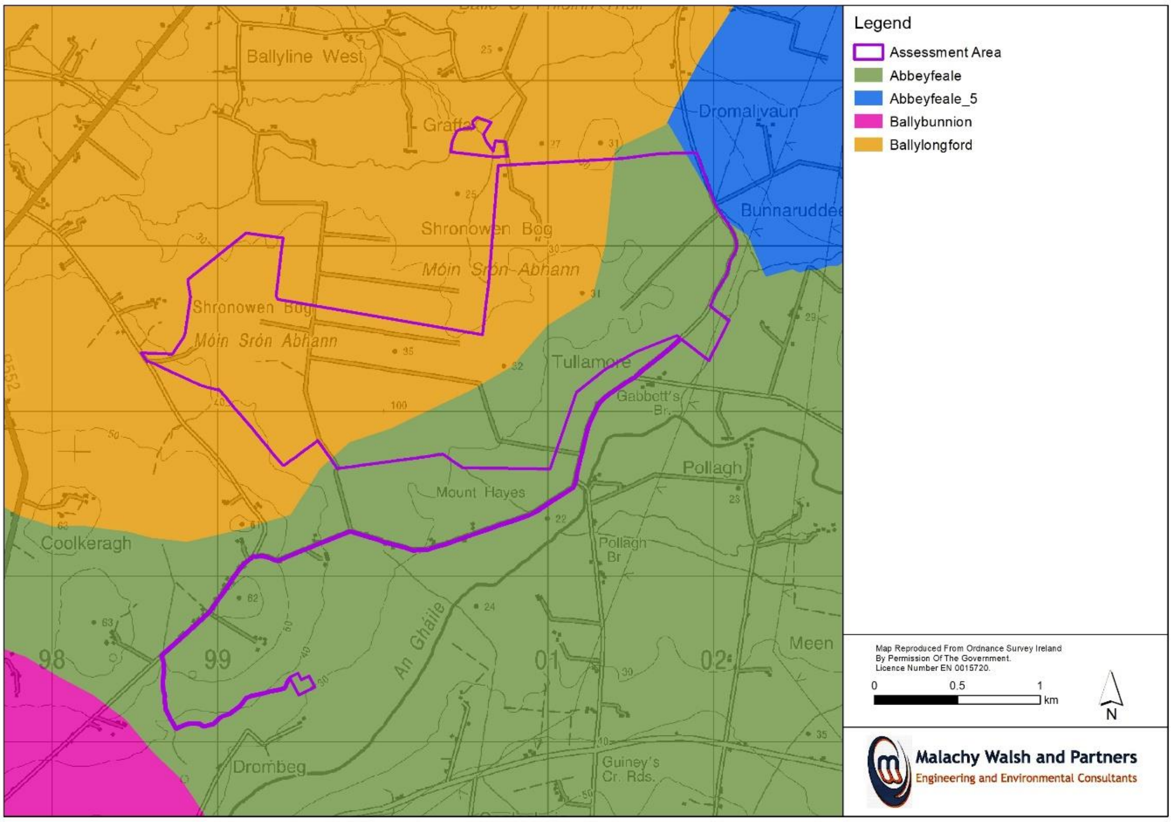


Figure 8-4: Groundwater Bodies

8.2.3.2 Aquifer classification

An aquifer is defined as a geological formation that is capable of yielding quantities of water. While most rock types are aquifers, their supply varies. Geological strata are categorised for hydrogeological purposes as Major Aquifers (Regionally Important), Minor Aquifers (Locally Important) or Unproductive Rocks (Poor Aquifers/Aquitards).

The proposed development is situated over an aquifer that is described by Geological Survey Ireland (GSI) as a Locally Important Aquifer which is Moderately Productive only in Local Zones (Category LI) (**Figure 8-5**).

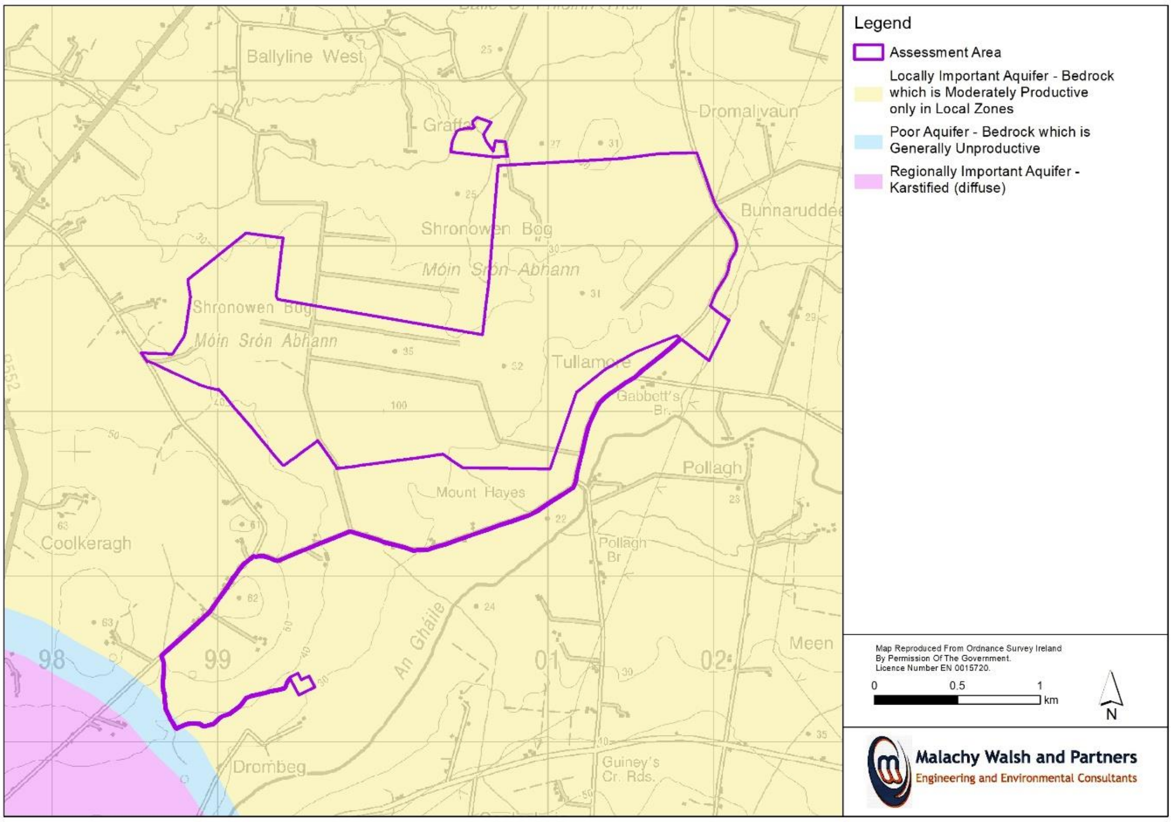


Figure 8-5: Groundwater aquifer map

8.2.3.3 Abstraction

The GSI database lists eight boreholes to the north of the site for agricultural and domestic use. A dug well and a borehole are located to the south of the site, also for agricultural and domestic use. The Yield Class is described as Poor in all cases.

8.2.3.4 Groundwater sensitivity

The overburden deposits of peat in the study area have generally low permeability and therefore act as a confining layer, preventing the free movement of surface water to the underlying aquifer within the bedrock. The groundwater recharge is 18 mm/year which is within the lowest category of National Groundwater Recharge Ireland values (1-50 mm/year).

According to the GSI maps the groundwater vulnerability class is Low throughout the site except for a small area at the southeast boundary that is Medium (**Figure 8-6**).

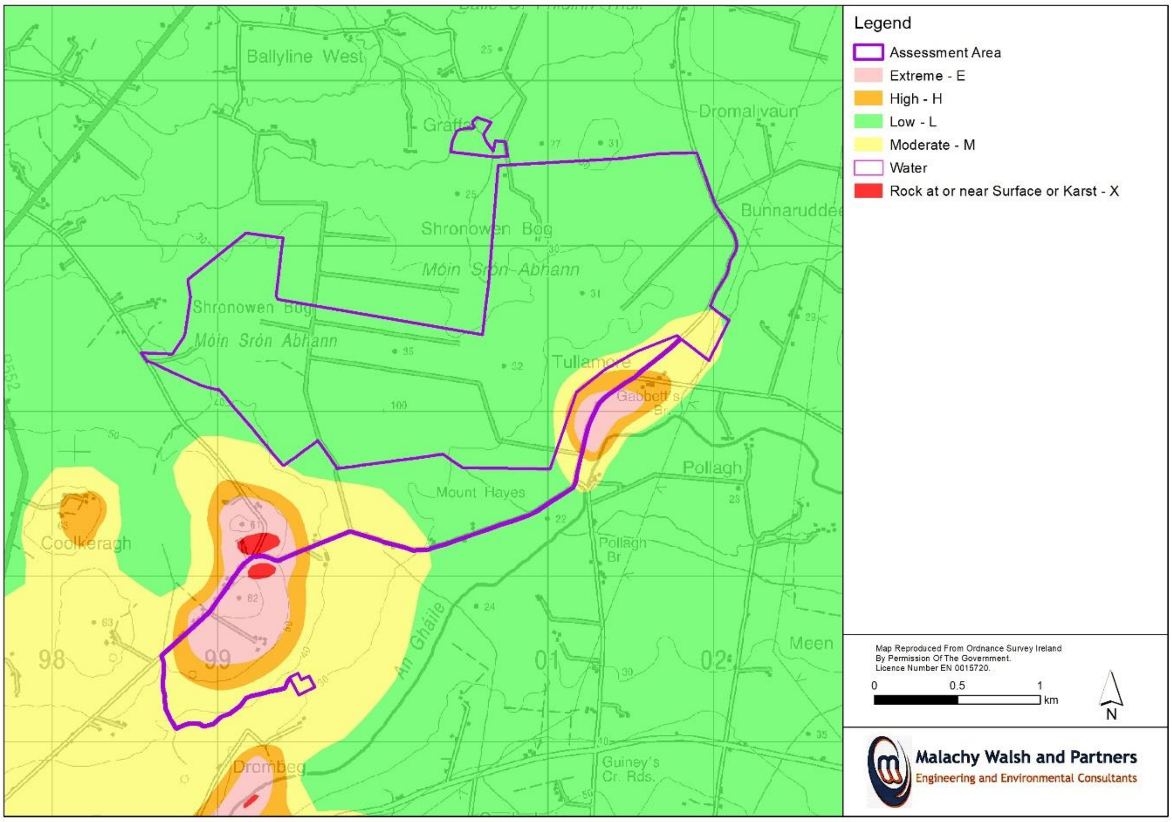


Figure 8-6: Groundwater vulnerability map

8.2.4 Do-Nothing Scenario

The wind farm site consists predominantly of active and cutover bog (at turbines T3 to T12) with the remainder being used as agricultural grassland (T1 to T2).

If the wind energy development for which this document has been prepared does not go ahead, it is assumed that the current peat extraction activities will continue until the peat is exhausted or until the practice is phased out as part of national climate action policy.

It is assumed that the use of the agricultural grassland will remain unchanged with or without the construction of the wind farm. Both peat extraction and agricultural activities can adversely impact water quality if not managed correctly.

8.3 LIKELY SIGNIFICANT EFFECTS

8.3.1 Construction Phase

During the construction period, the development has the potential to lead to temporary impacts on hydrology and water quality unless appropriate mitigation is applied. The site has already been extensively drained by manmade drainage channels created to facilitate peat harvesting. New internal road construction will be required to provide access to seven of the 12 turbine locations and to the met mast site. The remaining turbine locations (T3, T5, T8, T9 and T12) will be accessed directly from the existing internal road network which already has a drainage system. The construction of new access roads will require some additional drains and removal of linear areas of the peat soil which will affect groundwater flow by localised lowering of the water table and diverting near-surface groundwater flow into the drains and channels.

The main risk to water quality results from the potential for ingress of sediment or accidental fuel or oil spillages discharging to either the Galey or Ballyline Rivers. Any pollutants entering the Galey could then be transferred to downstream fresh and marine waters. A Natura Impact Statement (NIS) has been prepared to assess the impacts on the relevant Natura 200 sites (Lower Shannon SAC and River Shannon/Fergus Estuaries SPA) and propose suitable mitigation measures (Refer to NIS submitted with the planning application).

The depth of groundwater drawdown will generally be no deeper than the access road drainage level. As the depth of excavation for drains is generally less than 1 metre, this is considered to be a relatively minor impact. Temporary drawdown of the water table will also occur as a result of excavation for the turbine foundations.

The subsoil has low permeability, and the groundwater vulnerability is low to moderate, resulting in a low risk of groundwater contamination. Notwithstanding this, mitigation measures will be put in place to maintain a low level of groundwater vulnerability.

The following are the potential impacts on hydrology due to wind farm construction activities:

- Excavation of peat could lead to an increase in suspended solids in the surface water run-off and from minor quantities of exposed mineral soils. The removal of the vegetated material could also lead to an increase in the rate of run-off along the route of the site access roads and hard-standing areas. This could present a risk of minor downstream flooding.
- The increase in the rate of surface water run-off due to the increase in hard surface areas as a result of the development could lead to a very minor cumulative risk of flooding downstream.
- Inappropriate site management of excavations and of excavated peat could lead to loss of suspended solids to surface waters.
- Inappropriate management of the drainage of peat storage areas could lead to loss of suspended solids to surface waters.
- Excavations for drainage systems could disturb underlying silt below the peat.
- Cable trenches could act as a conduit for surface water flows.
- Flows from the new drainage system could be impeded, should blockages occur in the existing drains adjacent to access tracks.
- The construction of new infrastructure has the potential to obstruct existing overland flow.

- Inappropriate management of spoil heaps could result in accidental break-out of silt on site leading to the loss of suspended solids to surface waters.
- Use of machinery during construction could result in spillage of fuel, oils, lubricants, or other hydrocarbons to surface waters, with potentially adverse impacts on local groundwater quality and surface water quality in downstream areas. A film of oil on a waterbody can prevent gaseous exchange and prevent re-oxygenation, with deleterious effects on aquatic ecology.

8.3.2 Operational Phase

The main potential hydrological impact of the development is a slight increase in run-off from a storm event to the Galey and Ballyline Rivers due to a decrease in ground permeability at the turbine hardstands and substation. The duration for concentration of surface water flows will decrease as a result of the additional hard-surfaced areas resulting in additional flows being discharged to the drains adjacent to access tracks during rainfall events. However, the potential increase in runoff rate is likely to be negligible because of the low permeability of the existing surface.

During the operational phase, oil will be used in cooling the transformers. There is therefore a potential for oil spills at the substation; however, the transformer will be located in a concrete bund which will prevent loss of oil to the external environment in the event of a spill. It is not envisaged that the maintenance activities taking place on the wind farm, involving general maintenance of the wind turbines, maintenance of the drainage system, material storage areas and reinstated areas, will give rise to any significant impacts on the hydrological regime of the area.

8.3.3 Decommissioning Phase

If it is decided to decommission the wind farm at the end of its 30-year operational life, rather than apply for permission to repower the wind farm, a comprehensive reinstatement proposal, including the implementation of a program that details the removal of all structures, will be submitted to Kerry County Council for approval prior to the decommissioning work. Turbine components will be removed however it is envisaged that access roads will remain in place An environmental assessment will be undertaken at that time to ascertain whether or not it would be more or less environmentally damaging to remove or keep in place the underground cables and access tracks. If the access tracks are removed the associated artificial drains will be infilled. All elements of the decommissioning works will be agreed with the council beforehand and there will be a consent requirement for the timing of decommissioning works.

The turbines, transformers, substation and met mast will be dismantled and removed from the site following a method statement agreed with Kerry County Council. All associated hardstand areas will be remediated to match the surrounding land-cover at the time. All materials removed from the site will be treated in accordance with best practice waste management procedures and any requirements specified by the council.

In the event that decommissioning of the grid connection is required, it is likely that the underground cables will be cut back and left *in situ*. If the cables are left *in situ* then no reinstatement works will be required and the associated environmental impact of project decommissioning would be minimal.

8.3.4 Summary of unmitigated impacts on sensitive receptors

A summary of unmitigated potential impacts on surface waters due to the development of the proposed wind farm is provided below in **Table 8-7**. This indicates that some activities during the construction of the wind farm, if unmitigated, could have a significant effect on receiving watercourses, particularly the risk of sedimentation of sensitive catchments. Operation and maintenance activities are not expected to have a significant effect on the receiving watercourses.

Table 8-7: Summary of potential hydrological impact significance on sensitive receptors

Activity		Potential Impact	Receptor	Sensitivity	Prior to mitigation	
					Magnitude	Significance
Site Preparations	Tree felling near turbine T1 and on the new road between T4 and T6 in advance of construction	Increase in rate of run-off and increased level of phosphates in the run-off	Galey and Ballyline Rivers	Moderate	Minor	Minor
Site Preparations	Excavation for drainage system	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor
Construction	Contractor's compound, site roads, cable trenching, turbine foundation construction, crane hardstand construction, sub-station.	Increase in rate of run-off from hard surfaces	Galey and Ballyline Rivers	Moderate	Minor	Minor
Construction	Contractor's compound, site roads, cable trenching, turbine foundation construction, crane hardstand construction, sub-station, crane pad construction, sub-station, and peat management	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor
Construction	Spillages of fuels, oils, and other hydrocarbons	Hydrocarbon pollution	Galey and Ballyline Rivers	Moderate	Moderate	Moderate

	during construction					
O & M	Site access tracks, berms, and reinstated peat storage area.	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor
	Site roads and sub-station	Increase in rate of run-off	Galey and Ballyline Rivers	Moderate	Minor	Minor

8.3.5 Risk of major accidents and disasters

No risk of major accidents or disasters has been identified as part of the preparation of this chapter. The southern part of the site drains to the Galey River which flows into the tidal reach of the Cashen River about 13 kilometres downstream. The Galey River in the vicinity of the site has a catchment area of 170 km^2 that extends more than 20 kilometres to the east. The median annual flood flow at this location is 92 m^3/second. Any increased flow due to the presence of the wind farm would not have a measurable effect on the flow rate in the river and does not increase flood risk along the river reach. The northern part of the site drains to the Ballyline River via a network of small tributaries. The Ballyline River flows into the Shannon Estuary via Ballylongford Creek, five kilometres to the north of the site. The wind farm catchment contributing to this river system is very flat and not subject to sudden increases in flow rate.

The OPW flood hazard maps indicate flooding incidents at Pollagh Bridge and Gabbetts Bridge which are on local roads over the Galey River and the Tarmon Stream, respectively. Both of these incidents were part of the same flood event that occurred on the 8th of January 2005. These locations are several metres lower in elevation than the lowest part of the wind farm site. The site will therefore not be adversely affected by any future flood event at these locations.

The development proposals, during both the construction and operational phases will not incur an increased risk of accidents or disasters within or outside the confines of the site.

8.3.6 Cumulative effects

A cumulative impact arises from incremental changes caused by other past, present, or reasonably foreseeable actions together with the proposed development. Any cumulative effect with existing developments is incorporated in the impact assessments sections of the individual topic areas/chapters. A list of planned and approved/permitted developments assessed in the EIAR for cumulative impact with the proposed development is provided in **Chapter 2 - Project Description**. The developments considered, and the extent to which there may be a cumulative impact, are dependent on the individual topic area.

The projects considered in relation to the potential for cumulative effects pertaining to water include:

- Tullahennel Wind Farm – Operational
- Leanamore Wind Farm - Operational
- Curraderrig Wind Farm - Operational
- Beale Wind Farm - Operational

Evaluation of the cumulative impacts must also assess the potential linkage pathways with nearby permitted/operational developments and activities relative to their shared receptors.

The Curraderrig and Beale wind farms are remote from Shronowen and in a different catchment. Part of the Tullahennel wind farm, which is to the west of the Shronowen, and Leanamore wind farm, which is to the east, drain to tributaries of the Ballyline River. However, since each of these individual wind farms have insignificant effects on the downstream flood risk, it is not envisaged that the addition of the Shronowen wind farm would incur any significant cumulative flood risk downstream. Overall, the likelihood of significant cumulative adverse effects on geology and hydrogeology arising from the proposed development and other existing and permitted wind farms in the region is considered to be negligible.

8.4 MITIGATION

The following elements of mitigation have been incorporated into the design of the project which has been outlined in detail in **Chapter 2** of this EIAR. A Preliminary Construction Environmental Management Plan (CEMP) has been prepared for the project and is included as **Appendix 2-1**. A construction stage CEMP will be prepared to collate and manage the proposed and agreed mitigation measures, monitoring and follow-up arrangements and management of impacts. A CEMP provides a commitment to mitigation and follow-up monitoring, reduces the risk of pollution, and improves the sustainable management of resources. Environmental protection measures will include:

- Siltation and erosion control
- Management of excavated soils and excavated materials
- Fuel management
- Invasive species management

Best practice approaches will be deployed with regard to all activities including the following:

- Drainage
- Peat management
- Dewatering
- Cement Bound Granular Mixtures (CBGM)
- Accidental spillages

The proposed development will be constructed with cognisance of the guidelines listed in Section 8.1.3.3 to achieve the above. The design of drainage for the proposed development aims to maintain a continuity of existing flows and to manage the discharges at source where possible. A 50m buffer was applied to streams and lakes shown on the 1:50,000 scale OSI maps at the design phase, and used as a constraint for turbine placement.

Mitigation measures for surface water are proposed below. Given that surface and groundwater hydrology is inextricably linked, protection of surface waters in the affected catchments will also help protect groundwater bodies in the study area.

8.4.1 Construction Phase

8.4.1.1 Site clearance

Some local felling of commercial forestry will be required at turbine T1 and some scrub clearance along part of the route of the new road between turbines T2 and T4. The new roads within the wind farm will be constructed over the existing peat layer using a floating construction method and will not require site clearance. However, all structures including wind turbine foundations, met mast and electrical substation will require removal of the topsoil and peat layers. The excavated peat will be moved to the designated peat storage areas within the site.

These activities incur a risk of contamination of surface water. Mitigation measures to prevent such contamination will be implemented in accordance with the Forestry and Water Quality Guidelines (DMNR, 2000). It is anticipated that these measures will prevent run-off erosion and consequent sediment release into the nearby watercourses. The measures are outlined in the following sections.

8.4.1.2 Sediment control

The runoff from the existing and new internal roads will be collected in open drains on both sides of the road. These drains will outfall directly to the adjacent land, most of which is peat. Each outfall will have a silt fence to collect the sediment in the runoff. Any residual sediment downstream of the silt fences will be trapped in the surface vegetation so that it does not contaminate the downstream watercourses. The runoff from each of the turbine and crane hardstand sites will be collected separately from the road runoff and directed to settlement ponds. The ponds will allow any silt in the runoff to settle out before discharge to the adjacent vegetated surface. Details of the settlement ponds including calculation of the required size are included in **Chapter 3 – Civil Engineering** of the EIAR.

Where the roads have a gradient greater than 2%, check dams will be installed in the drains. The check dams will be constructed with filter stone and will be placed at a spacing that is dependent on the drain gradient with shorter spacing used on steeper sections. The bottom of the upper check dam will be at same height as top of lower check dam.

8.4.1.3 Concrete Control

During the pouring of concrete, effective containment measures will be implemented to avoid spilling concrete outside construction areas and to prevent concrete entering any part of the drainage system. To reduce the potential for cementitious material entering watercourses, concrete pours will be supervised by the Construction Manager. The construction manager will ensure that the area of the pour is completely drained of water before a pour commences. Pours will not take place during heavy rainfall.

There will be a dedicated concrete chute washout area on site. Concrete trucks will be washed out off site at the source quarry. Wet concrete operations are not envisaged for this site within or adjacent to watercourses or aquatic zones. However, if wet concrete operations are required in such locations, a suitable risk assessment will be completed prior to works being carried out.

For the cable trench construction, temporary storage of Cement Bound Granular Mixtures will be on areas where there is no direct drainage to surface waters and where the area has been appropriately isolated with bunds.

8.4.1.4 Storage areas

Cement products are hazardous and should always be stored in a COSHH store or similar (such as a shipping container), and only be in the open when in use. If cement products are temporarily located in the open, then they will be located within an impermeable bunded area and covered to prevent contact with rainwater. This will prevent direct drainage of cement storage areas to surface waters. Bunding will be in the form of sandbags or silt fencing.

Excavated peat or mineral soil will be removed to the designated material storage areas. The main peat deposition area is near the southern boundary of the site near turbine T6, with additional smaller areas near T1, T11 and T12. The Peat Stability Risk Assessment Report (**Volume 3, Appendix 9-1**), addresses the risk of peat slippage and how excavated peat should be managed on site, stored temporarily and re-used in landscaping. Details of how materials will be managed on-site during construction are set out in the Peat and Spoil Management Plan (**Volume 3, Appendix 9-2**).

To facilitate both construction of the internal roads and disposal of excavated peat and to avoid double handling and unnecessary transportation, excavated peat will, where possible, be placed during construction directly into material storage areas.

Mineral and peat soils will be placed separately in order to prevent mixing of materials. As excavation and construction will take place on a phased basis, the peat that is excavated during construction will be reused in the reinstatement of turbine bases, borrow pits and material storage areas. Temporary stockpiles of peat and mineral soils will not be permitted within 50m of any watercourse.

The drainage of the material storage areas will include the provision of settlement ponds to reduce the concentration of suspended solids in the run-off from these areas, and the addition of silt fencing where deemed necessary. Overland flows will be diverted around these areas. Material storage areas will be monitored to manage any potential loss of suspended solids to surface waters.

Any diesel or fuel oils stored on site will be protected by a bund with 110 % of the capacity of the storage tank.

8.4.1.5 Road construction

To mitigate against siltation of storm water runoff, road construction material will consist of crushed aggregate with low fines content. The use of quarry dust will not be permitted.

8.4.1.6 Plant and refuelling

Only qualified persons shall operate machinery or equipment. Machinery and equipment shall be checked on a regular basis to ensure they are working properly (no oil/fuel leaks etc.). No refuelling shall take place within 50m of any watercourse. Fuel will be stored in doubly-bunded bowsers or in bunded areas at the site compound. Plant nappies and spill kits will be readily available on plant equipment or when working with fuel operated heavy tools. To mitigate against sources of contamination, refuelling of plant and vehicles will only take place within designated areas of the site compound or in other areas specifically designated for this purpose. Only emergency breakdown maintenance will be carried out on site. Appropriate containment facilities will be provided to ensure that any spills from breakdown maintenance vehicles are contained and removed off site.

A suitable permanent fuel and oil interceptor shall be installed to deal with all substation surface water drainage. Temporary petrol and oil interceptors will be installed at the site compound for plant repairs/storage of fuel/temporary generator installation.

8.4.1.7 Waste

A dedicated storage area will be provided at the site compound for building materials such as cables, geotextile membranes, blocks, tools and equipment, fence posts and wire, booms, pipes etc. A Waste Management Plan will be prepared by the Appointed Project Contractor for the construction phase. This will be prepared with reference to 'Best Practice Guidelines on the Preparation of Waste Management Plans for Construction and Demolition Projects' (DoEHLG, 2006).

Any material deemed unsuitable for re-use in the works will be transported off site in trucks and disposed of under license from Kerry County Council. This will prevent any contaminated run-off to drains adjacent to access tracks during heavy rainfall.

All personnel working on site will be trained in pollution incident control response, and an emergency response plan will be prepared as part of the CEMP.

8.4.1.8 Monitoring

During the construction phase of the project, a surface water monitoring schedule, drawn up prior to construction, will be followed. Suspended solids monitoring will be undertaken on a weekly basis and ad-hoc if required (rainfall event for example), while monthly monitoring of pH, metals, nitrates, and phosphates will also take place. This will be compared with the baseline data obtained prior to construction from the EPA and from sampling. If the measured value exceed the baseline values, the cause will be determined and remedial measures put in place as necessary.

8.4.1.9 Environmental Manager

A Construction Environmental Management Plan (CEMP) will be developed and will be implemented during construction works providing a commitment to water quality mitigation and follow-up monitoring, reducing the risk of pollution, and improving the sustainable management of resources.

The implementation of the proposed environmental control measures, proposed and agreed mitigation measures, monitoring, and follow-up arrangements and management of impacts will be managed through the CEMP. The waste management plan provides for systematic waste management identifying types and quantities of wastes arising, their management, documentation, treatment or disposal, and the parties responsible, at all stages of the project. The CEMP provides the client and main project contractor with a practical guide to ensuring compliance with Planning and Environmental requirements by all parties.

An Environmental Manager with appropriate experience and expertise will be employed by the appointed Principal Contractor for the duration of the construction phase to ensure that all the environmental design, control and mitigation measures outlined in the EIAR and supporting planning documentation in relation to the water environment are implemented. The Environmental Manager together with an environmental team will deal with drainage maintenance, mitigation measures and monitoring. The Environmental Manager will have the authority to stop construction activity if there is potential for adverse environmental effects to occur.

8.4.2 Operational Phase

Potential impact on water quality due to the operation and maintenance of the wind farm is principally related to the minor risk of oil spillages. This will have been mitigated by design through the provision of adequate bunding and implemented in the construction stage.

All vehicular movement during operation and maintenance will be restricted to the internal access roads and hardstands.

8.4.3 Decommissioning Phase

If it is decided to decommission the wind farm at the end of its 30-year life, it is envisaged this will involve removal of the turbines, covering of the concrete foundations and hardstands with soil or peat, removal of the electrical substation, met mast, and associated equipment and possibly removal of the underground cables.

There is the potential for surface water run-off from exposed soil surfaces, such as those that will initially cover over the decommissioned turbine foundations, to result in slight negative effects on water quality in local surface waters. However, in the case of the proposed development, the site drainage and sediment control measures will still be in place which will prevent any silt-laden run-off due to temporary disturbance and movement of soil from entering the local surface water network. Therefore, no negative effect on surface water or ground water quality is envisaged during decommissioning.

8.5 RESIDUAL IMPACTS

On implementing the above mitigation measures, the significance of the residual impact on the water environment during the construction and operational phase of the development is assessed as being negligible negative to minor negative. Mitigation by design has been implemented in the first to prevent adverse impacts. Other mitigation measures will be implemented and monitored throughout the construction and operation phases. It is considered that the proposed project design including control measures together with mitigation measures will ensure that there will be no significant adverse effect on surface water quality, surface water flows or groundwater resources.

Mitigation measures will, where required, be put in place before development work commences. As a result of the retention and treatment measures to be applied, the wind farm is expected to have a low impact on the receiving environment. Consequently, the proposed development is not expected to contribute to any cumulative adverse effects of other existing or proposed developments in the vicinity. When the mitigation measures are implemented in full, a high degree of confidence can be assured that any adverse effects on the receiving environment will be minor. In particular, the development and operation of the wind farm, if undertaken as proposed, is not expected to have a significant adverse effect on the groundwater regime. The risks associated with sedimentation and contamination of the aquifers due to erosion and runoff will be reduced to minimal levels as areas are re-vegetated and construction traffic is no longer present. Hydrological conditions would not be altered to a degree that would affect the local or wider area.

Table 8-8: Residual Hydrological Impact Significance on Sensitive Receptors

Activity		Potential Impact	Receptor	Sensitivity	Prior to mitigation		After mitigation	
					Magnitude	Significance	Magnitude	Significance
Site Preparations	Tree felling near turbine T1 and on the new road between T4 and T6 in advance of construction	Increase in rate of run-off and increased level of phosphates in the run-off	Galey and Ballyline Rivers	Moderate	Minor	Minor	Negligible	Negligible
	Excavation for drainage system	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor	Negligible	Negligible
Construction	Contractor's compound, site roads, cable trenching, turbine foundation construction, crane hardstand construction, sub-station.	Increase in rate of run-off from hard surfaces	Galey and Ballyline Rivers	Moderate	Minor	Minor	Negligible	Negligible
	Contractor's compound, site roads, cable trenching, turbine foundation construction, crane hardstand construction, sub-station, crane pad construction, sub-station, and peat management	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor	Minor	Negligible
	Spillages of fuels, oils, and other hydrocarbons during construction	Hydrocarbon pollution	Galey and Ballyline Rivers	Moderate	Moderate	Moderate	Minor	Minor
O & M	Site access tracks, berms, and reinstated peat storage area.	Erosion and sedimentation	Galey and Ballyline Rivers	Moderate	Moderate	Minor	Minor	Negligible
	Site roads and sub-station	Increase in rate of run-off	Galey and Ballyline Rivers	Moderate	Minor	Minor	Negligible	Negligible

8.6 CONCLUSION

During construction and operation/maintenance phases of the proposed development, a number of activities will take place on site, some of which will have the potential to affect the hydrological regime or water quality at the site or its vicinity.

Pollution control and other preventative measures have been incorporated into the project design to minimise adverse impacts on water quality. Mitigation by design will be the principal means for reducing suspended sediment run-off arising from construction activities. Preventative measures also include fuel, concrete, and waste management, which will be incorporated into the project Construction Environmental Management Plan (CEMP).

The construction of the wind farm with implementation of the proposed mitigation measures will nothave asignificant adverse effect on the hydrology and hydrogeology of the site and surrounding area.