MWP

Chapter 08 Water

Ballycar Wind Farm Project

8. Water

8.1 Introduction

This chapter describes the existing hydrological and hydrogeological characteristics in the EIAR study area and considers the potential effects on the existing aquatic environment associated with the proposed development. The surface water features, and characteristics of the receiving environment are described, as well as the site drainage and groundwater attributes.

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 effect of the proposed wind farm. Refer to **Chapter 2 Description of the Proposed Development** for a full description of the overall proposed development.

8.1.1 Competency of Assessor

This Water Chapter has been prepared by Christopher Ahern and reviewed by Micheál Fenton of MWP. Christopher Ahern holds a BSc in Earth Science and a MSc in Applied Environmental Geoscience from University College Cork. His expertise includes hydrology, 1D and 2D hydraulic modelling, flood analysis, and the preparation of flood risk assessment reports.

Micheál Fenton has 15 years' experience in the areas of hydrology, hydraulic analysis, flood risk assessments, strategic drainage studies as well as completing drainage and civil design for numerous wind farm projects. He has also worked as a researcher in the Centre for Hydrology, Micrometeorology and Climate Change in UCC in the area of hydrology and flood event analysis and part of his work was published in the OPW FSU packages. Micheál has a strong understanding of the first principals of hydrology and has extensive knowledge of frequently used flood estimation methods such as those presented in the FSU, FSR and FEH. In addition to this, he has a strong competence in 1D/2D hydraulic modelling.

8.1.2 Scope of Assessment

The scope of the chapter and assessment includes the following:

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; and
4. Identify any significant residual impacts, effects and possible cumulative effects after mitigation measures are implemented.

8.1.3 Methodology

A comprehensive assessment of the potential effect of the proposed development on the hydrological and hydrogeological regime has been undertaken through a combination of a desktop study of resources, followed by a site walkover and field survey work.

8.1.1.1 Desk Study

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

- Examination of maps and aerial photography to identify any hydrological features, 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 (WFD) and all previous water quality legislation along with the River Basin Management Plan (RBMP) for Ireland 2022 - 2027;
- Review of existing water quality data available from the Environmental Protection Agency (EPA);
- Review of WFD and its 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;
- Preparation of catchment and other site maps; and
- Examination of information on private wells or water supply available from the GSI online datasets and the EPA Water Abstraction Register.

8.1.1.2 Field Work

Field work involved the following:

- Site walkover surveys in 2021, 2022 and 2023 were undertaken to identify hydrological features on site, wet ground, drainage patterns and distribution, exposures, and drains;
- Surveys at proposed watercourse crossings were undertaken on 24th June 2021 and 26th June 2023, these were completed in conjunction with field hydrochemistry surveys;
- Measurement of slope inclination and mapping of significant features;
- Confirmation of the site catchments and drainage regime, and any hydrological buffers to be implemented;
- Field hydrochemistry measurements were done in-situ, using the Aquaread multi-parameter probe, to determine pH, Total Dissolved Solids, Electrical Conductivity, Dissolved Oxygen, Temperature, Turbidity;
- The collection of water samples for laboratory analysis for select quality parameters [Ammonium, Total Ammonia, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate, Nitrite, Orthophosphate, Suspended Solids, Total Phosphorus, Total Hardness, Total Dissolved Solids, and Total Organic Carbon (TOC)];

- Consultation was undertaken with Inland Fisheries Ireland (IFI), Waterways Ireland and GSI amongst others. Of those mentioned, only IFI responded. Consultation with IFI is included in **Appendix 1B**.

8.1.4 Assessment Criteria

8.1.1.3 Impact Assessment Methodology

On completion of the desk study and baseline field study, the sensitivity of the water environment receptors were assessed. Levels of sensitivity which are defined in **Table 8-1** were then used to assess the potential effect that the proposed development may have on them.

Table 8-1: Receptor Sensitivities (Adapted from: www.sepra.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.

8.1.1.4 Overview of Impact Assessment Process

The conventional source-pathway-target model was applied to assess potential effects of the proposed development on hydrological and hydrogeological receptors (see **Figure 8-1**, as an example).

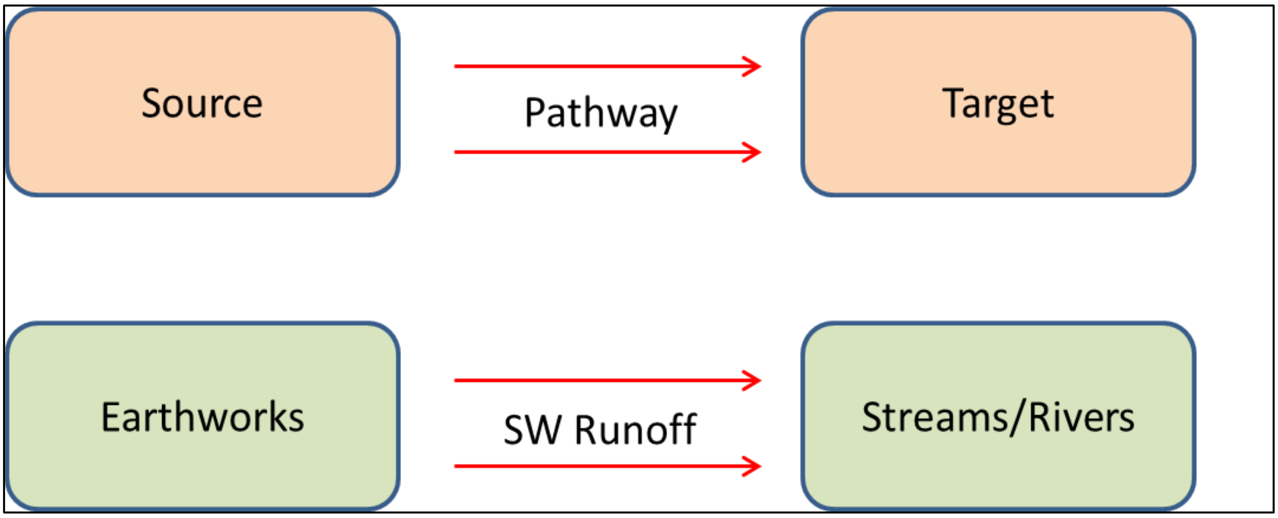

Figure 8-1: Source-pathway Target Model

Where potential effects are identified, the classification of these 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):

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

The application of the Impact Assessment methodology identifies the key aspects of any potential impact source, namely its character, magnitude, duration, likelihood and whether it is of a direct or indirect effect.

In order to provide an understanding of the stepwise impact assessment process applied (see **Section 8.3.2** and **8.3.3**),**Table 8-2** presents 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 effect descriptors are combined.

Using this defined approach, the impact assessment process is then applied to all wind farm construction, operation, and decommissioning activities which have the potential to generate negative effects on the geological and hydrological/ hydrogeological (including water quality) environments.

Table 8-2: Summary of Impact Assessment Process

Step	Impact Assessment	Description
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

Step	Impact Assessment	Description
		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 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.

8.1.1.5 Relevant Legislation

This chapter has considered legislation specifically relating to water including:

The Water Framework Directive (WFD) (2000/60/EC)

The Water Framework Directive (WFD) (2000/60/EC) (WFD) establishes an integrated and coordinated framework for the sustainable management of water. Under the WFD[1], the island of Ireland has been divided into a number of River Basin Districts (RBD) in order to facilitate the effective implementation of the WFD objectives. The proposed development site is located within the Shannon International River Basin District. The WFD Catchment is the Lower Shannon (ID:25D) and the Shannon Estuary North (ID: 27).

The strategies and objectives of the WFD in Ireland have influenced a range of national legislation and regulations, since its inception in the year 2000.

The WFD (1st Cycle) was transposed into national legislation in 2003, with the aims to:

- Prevent deterioration of status for surface and groundwaters and the protection, enhancement and restoration of all water bodies;
- Achieve good ecological status and good chemical status for surface waters and good chemical and good quantitative status for groundwaters;
- Progressively reduce pollution of priority substances and phase-out of priority hazardous substances in surface waters and prevention and limitation of input of pollutants in groundwater;
- Reverse any significant, upward trend of pollutants in groundwaters; and
- Achieve standards and objectives set for protected areas in Community legislation.

The objective for each surface water and groundwater body is to prevent deterioration, maintain high and good status waters, restore waters to at least good status where necessary, and ensure that the requirements of

[1] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

associated protected areas are met. The River Basin Management Plan for Ireland 2022 - 2027 (RBMP), the third-cycle of river basin management planning under the WFD, provides for the targeted implementation of the two principle objectives of the WFD, namely;

1. To prevent the deterioration of water bodies and to protect, enhance and restore them with the aim of achieving at least good status; and
2. To achieve compliance with the requirements for designated protected areas.

Five key 'evidence-based' priorities form the pillar of this iteration of the RBMP and are outlined as follows:

1. Ensure full compliance with relevant EU legislation;
2. Prevent deterioration;
3. Meet the objectives for designated protected areas;
4. Protect high-status waters; and
5. Implement targeted actions and pilot schemes in focused sub-catchments aimed at:
    a) targeting water bodies close to meeting their objective; and
    b) addressing more complex issues that will build knowledge for the third cycle.

The assessment will determine the impact in accordance with the following regulations which give effect to the WFD:

- S.I No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010 (as amended);
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Water Regulations) 2009 (as amended);
- S.I. No. 99/2023 - European Union (Drinking Water) Regulations 2023;
- S.I. No. 293 of 1988: Quality of Salmonid Water Regulations;
- European Communities Environmental Objectives (Freshwater Pearl Mussel Regulations) 2009 to 2018 (as amended); and
- Urban Waste Water Treatment Regulations (SI No. 254 of 2001 as amended) (UWW Regulations).

These Regulations have been devised to implement the requirements of the WFD and establish Environmental Quality Standards for the purpose of assessing the status of surface waters and groundwaters. The Surface Waters Regulations apply to all surface waters including lakes, rivers, canals, transitional waters, and coastal waters and supersede all previous water quality regulations.

<u>Water Framework Directive - Protected Areas:</u>

The WFD requires a register of protected areas. These are protected for their use (such as fisheries or drinking water) or because they have important habitat and/or species that directly depend on water. The register includes areas identified by the WFD itself or other European Directives. These may include:

- Areas used for water abstraction - European Union (Water Policy) (Abstractions Registration) Regulations 2018 (S.I. No. 261 of 2018);

- Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality (repealing Directive 76/160/EEC); Nutrient Sensitive Areas (Nitrates Directive 91/676/EEC; Wastewater Treatment Directive 91/271/EEC);
- Areas of protected species or habitats where water quality is an important factor in their protection (Natura 2000 sites under Conservation of wild birds 2009/147/EC and Habitats Directive 92/43/EEC); and
- Surface waters (The European Communities Environmental Objectives (Surface Waters) Regulations [S.I. No 272 of 2009], and amendment regulations 2012 [S.I. 327 of 2012]), 2015 (S.I. 386/2015), 2019 (S.I. 77/2019), 2021 (S.I.659/2021), 2022 (S.I.288/2022), and 2023 (S.I. 410/2023).

Potential impacts of the proposed development on Special Areas of Conservation (SAC) and Special Protection Areas (SPA) are addressed in **Chapter 6 Biodiversity**, **Chapter 7 Ornithology** and in the **Natura Impact Statement (NIS)** submitted with the planning application.

8.1.1.6 Relevant Guidance

Relevant guidelines have been used to inform the preparation and assessment of impacts from the proposed development on surface water and groundwater, including:

- Environmental Protection Agency (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- 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);
- Clare County Development Plan 2023-2029;
- The Code of Best Forest Practice and the Forestry and Water Quality guidelines[2];
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- 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;
- The SuDS Manual (C753) - Construction Industry Research and Information Association (CIRIA), 2015;
- Developments on Peat Land - Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste'. Scottish Renewables (2012);

[2] 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.

- 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); and
- River Crossings and Migratory Fish: Design Guidance (Scottish Executive, 2012).

8.1.1.7 Surface Water Quality

The Quality Rating (Q) System is the standard biotic index which is used by the EPA. This system was developed to determine the status of organic pollution in Irish rivers by assessing the occurrence of macro-invertebrate taxa of varying sensitivity to pollution[3]. Biological Water Quality data was examined as part of this assessment (see **Section 8.1.1.14**). 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. Biological Water Quality data was examined as part of this assessment (See **Section 8.1.1.14**).

8.1.1.8 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 outlined in **Table 8-3** and **Figure 8-9**.

Table 8-3: Summary of Impact Assessment Process (Source: GSI)

Vulnerability Mapping Guidelines					
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:					

[3]http://www.epa.ie/QValue/webusers/

https://gis.epa.ie/EPAMaps/

(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.

8.1.1.9 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 and hydrogeological environment was identified for the proposed development. 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 determined. The sensitivity rating, together with the magnitude of the potential impact, provides an overall rating of the significance of the effect prior to application of mitigation measures.

The assessment of the magnitude of an effect incorporates the timing, scale, size and duration of the potential impact. The magnitude criteria for hydrological effects are defined as set out in Table 8-4.

Table 8-4: 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 effects are assessed as being of major, moderate, minor or negligible significance as shown in **Table 8-5**.

Table 8-5: 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

8.1.5 Statement on Limitations and Difficulties Encountered

No difficulties were encountered in the preparation of this assessment.

8.2 Existing Receiving Environment

8.2.1 Site and Project Context

8.1.1.10 Proposed Development Site

The proposed development is situated in a rural area of south County Clare in the Electoral Divisions of Cloontra and Ballycannon. The site is within the townlands of Glennagross, Cappateemore East, Ballycannan West, Ballycannan East, Ballycar North and Ballycar South and consists of coniferous forestry, transitional woodland scrub, agricultural land and a small localized area of peat located to the north-western corner of the site. When designing the layout for the proposed wind farm, the peat area was avoided. The proposed development is located south of the R471 Regional Road. Refer to **Figure 8-2** below.

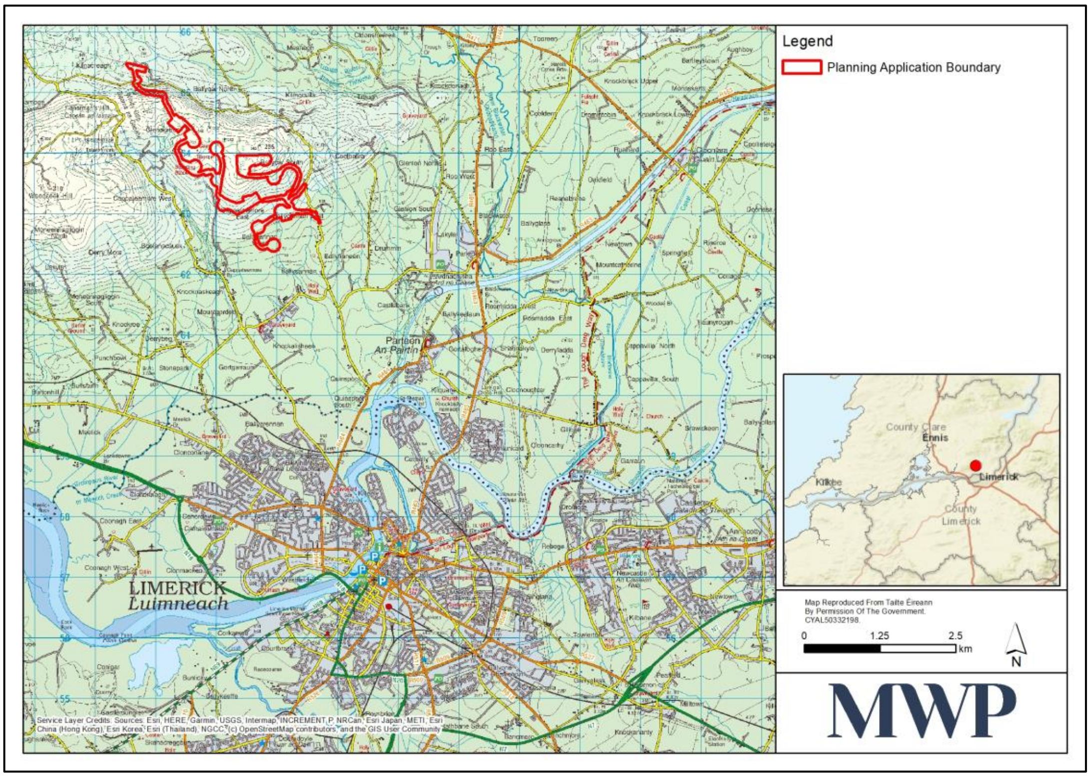

Figure 8-2: Site Location

8.1.1.11 Grid Route and Substation

In addition to the proposed development as described, there is a proposed underground connection between T1 and the proposed 110kV substation which will be located northwest of T1. The underground connection from T1 is routed along existing forestry tracks and through conifer forestry to the north west of the wind farm site and connects to the proposed 110kV substation. From the proposed 110kV substation, an underground cable is routed in a north west direction where it connects to the existing 110 kV overhead line. The proposed 110kV grid route is approximately 1.5km in length. 1.0km of the 110kV grid route is proposed within existing forestry tracks, the remaining 0.5km is routed through conifer forestry. It also crosses a 3m wide local public road. A new unbound stone access track will be constructed over the 110kV grid route on private lands to allow access for future maintenance. Refer to **Figure 8-3** which depicts this detail.

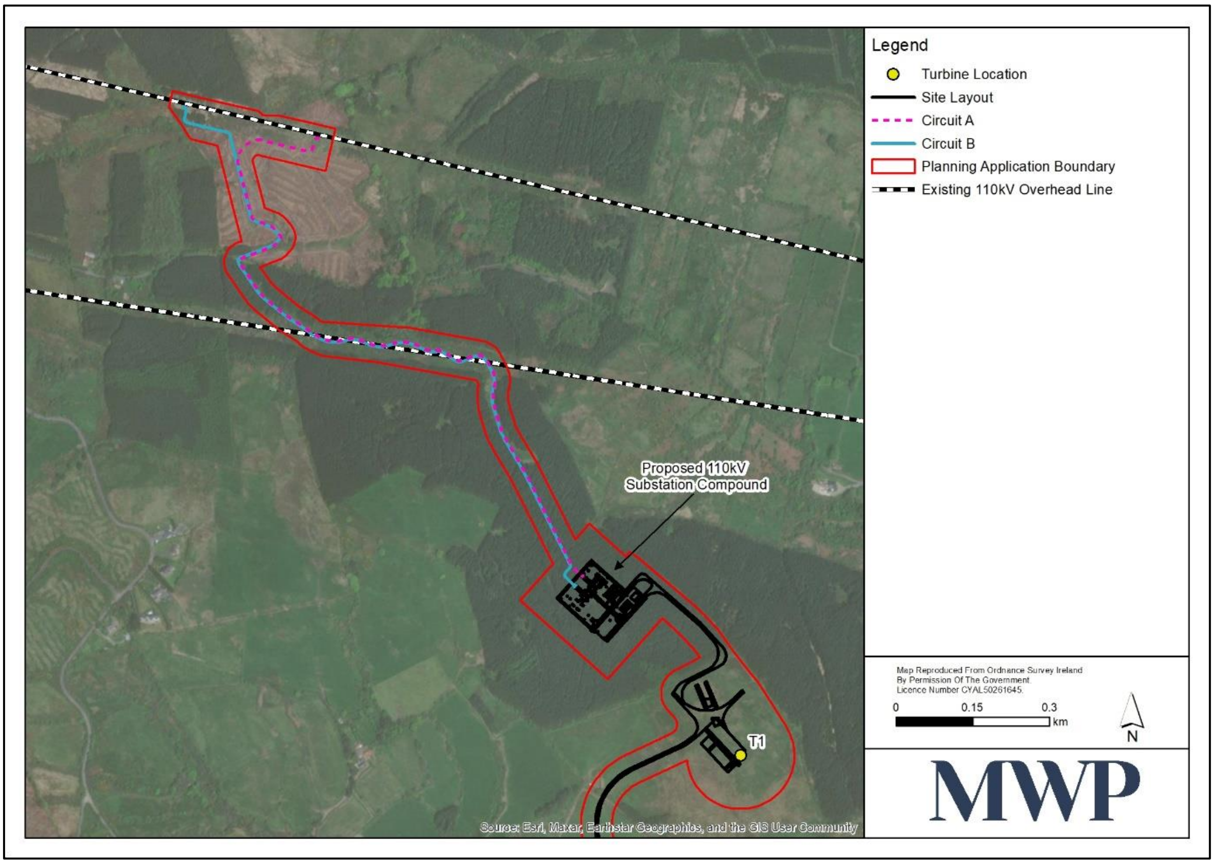

Figure 8-3: Grid Connection Route

8.2.2 Surface Hydrology

8.1.1.12 Surface Water Features

The proposed development site and grid route is located within the Shannon International River Basin District. The WFD Catchment is the Lower Shannon (ID:25D) and the Shannon Estuary North (ID: 27). The WFD sub-catchment is Shannon [Lower]_SC_100 and Owenogarney_SC_020. There are five EPA mapped watercourses that flow from north to south within the landownership boundaries of the proposed site, these are:

- Cappateemore East;
- West Ballycannan;

- East Ballycannan;
- North Ballycannan; and
- Unnamed.

One EPA mapped watercourse flows across the proposed grid connection route:

- Kilnacreagh. Refer to **Figure 8-4** below.

The Cappateemore East stream and the unnamed stream are tributaries to the Crompaun East stream which flows along the western perimeter of the proposed development site. The West and East Ballycannan streams are tributaries which flow into the North Ballycannan stream, which flows through the eastern section of the proposed site. These watercourses and their network of tributaries extend from the northern extremities of the site and outfall to the River Shannon which is located approximately 3km south of the site. The South Ballycar stream and its tributaries flow south immediately east of the site boundary and outfall into the Shannon south east of the site.

The downstream areas (located outside of the development's site boundary) of the North and West Ballycannan streams are part of the Lower River Shannon Special Area of Conservation (SAC) (Site Code 002165). The downstream areas of the Crompaun East stream (located outside of the development's site boundary) are also within the SAC and the River Shannon and River Fergus Estuaries SPA (Site Code 004077). The Lower River Shannon SAC is located approximately 1km south of T12.

During the site walkover, an additional stream/brook (unmapped watercourse) which flows through the site was identified. This unmapped watercourse flows from north to south between T2 and T3 and outfalls into the Cappateemore East stream, approximately 220m southwest of T4. This stream is visible on historic 6 inch mapping where it is indicated that this stream is the original course of the Cappateemore East stream.

The proposed grid connection route and substation location to the north of the proposed wind farm site occur within the Blackwater (Clare) River catchment. The nearest watercourse to the proposed connection to the overhead line is the 1st order Kilnacreagh Stream (EPA segment code 25_3206) which flows into the Blackwater River (also known as the Trough River). The grid connection route crosses the 1st order Kilnacreagh Stream (EPA segment code 25_3206) which flows from west to east approximately 50m to the south of the nearest proposed tower to be erected to connect to the existing overhead line. The Kilnacreagh Stream joins the 1st order Trough River (EPA code 25B06, also known as the Blackwater River) which flows in a westerly direction for ca. 5.2 km until it is fed by the 3rd order Derryvinnann River. There is an unmapped watercourse near the northern extent of the proposed development site that flows into the Kilnacreagh Stream. This unmapped watercourse corresponds to an eroding / upland river.

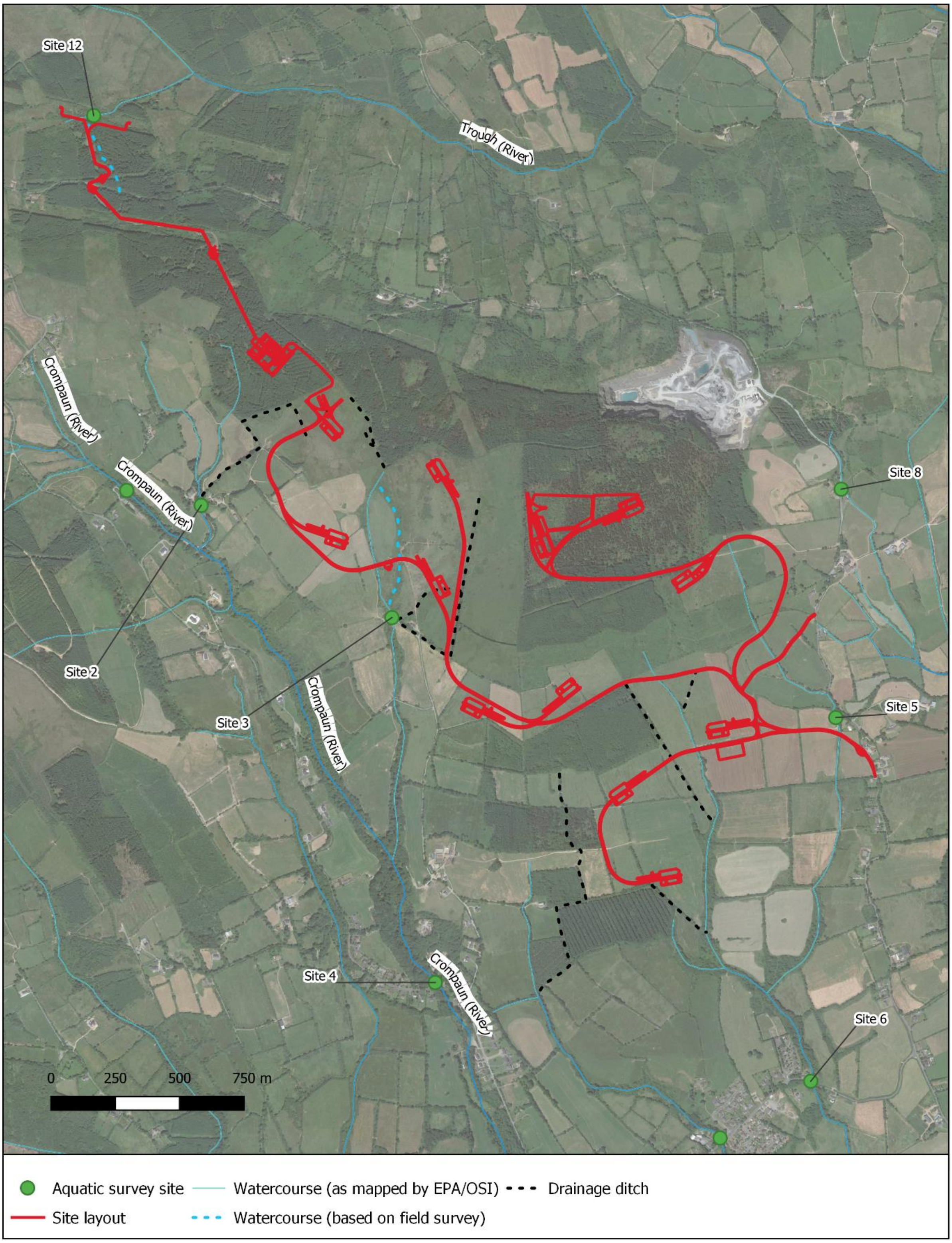

Figure 8-4: Surface Water Hydrology Map

8.1.1.13 Drainage

Drainage in the northwestern section of the site has a network of small artificially dug drains and in some areas, underground drains to improve the drainage in this area. It appears that these drains have been unsuccessful in lowering the water level by any noticeable degree as the area was still very waterlogged during the site visit. This ponding was, however, restricted to this area. The on-site assessments noted waterlogging at the initial T1 proposed location. However, following a process of constraints led design, T1 was moved as far as possible north west, approximately 100m, to avoid this area of degraded upland bog, which is subject to waterlogging. Refer to **Chapter 6 Biodiversity** for a detailed description of the habitats in this area and the siting of T1 in relation to this area of degraded upland bog. These drains outfall to the upstream extent of the Cappateemore East stream.

There is no existing drainage system onsite except for small-scale historic agricultural land drains (indicated on 6-inch historic mapping) that outfall into the various streams that flow through the site.

According to the 6 inch historic mapping, there are numerous historic land drains within the proposed site boundary.

8.1.1.14 Biological Water Quality

The EPA has monitoring stations on the rivers to which the watercourses within the proposed development outfall. There are four on the Crompaun East stream, with two located a relatively short distance downstream of the site and two located further downstream. There is one monitoring station on the North Ballycannan Stream, a relatively short distance from the proposed development. The closest monitoring station on the Blackwater River is located 3 km to the northeast of the site. Refer to **Figure 8-5** below.

The latest water quality data for each of these stations is shown in **Table 8-6**. The most recent Q5 ratings obtained at two stations date from 1991 & 1988. It is unlikely that these remain valid. The other stations also had a Q5 rating in 1991 and have since regressed to ratings of Q3 & Q3-4 in 2022.

Table 8-6: River Water Quality at relevant EPA Stations in proximity to the proposed development site

River	Station Name/Location	Station ID	Q-rating	Corresponding WFD status*	Latest Rating (Year)	River Waterbodies Risk
Crompaun (East)	CROMPAUN (EAST) - Cappateemore Bridge	RS27C090300	Q3-4	Moderate	2022	At Risk
Crompaun (East)	CROMPAUN (EAST) - Br W of Knockalisheen	RS27C090400	Q5	High	1991	At Risk
Crompaun (East)	CROMPAUN (EAST) - Bridge S.W. of Knockalisheen	RS27C090500	Q5	High	1988	At Risk
Crompaun (East)	Meelick Bridge	RS27C090600	Q3	Moderate	2022	At Risk
North Ballycannan	NORTH BALLYCANNAN - Interstitual, Br u/s from Quinspool North R Confl	RS25N170970	N/A	Unassigned	N/A	At Risk
Blackwater	BLACKWATER (CLARE) - Br SE of Cappanagh	RS25B060030	Q4	Good	2006	At Risk

** WFD Status in relation to ecological status or potential*

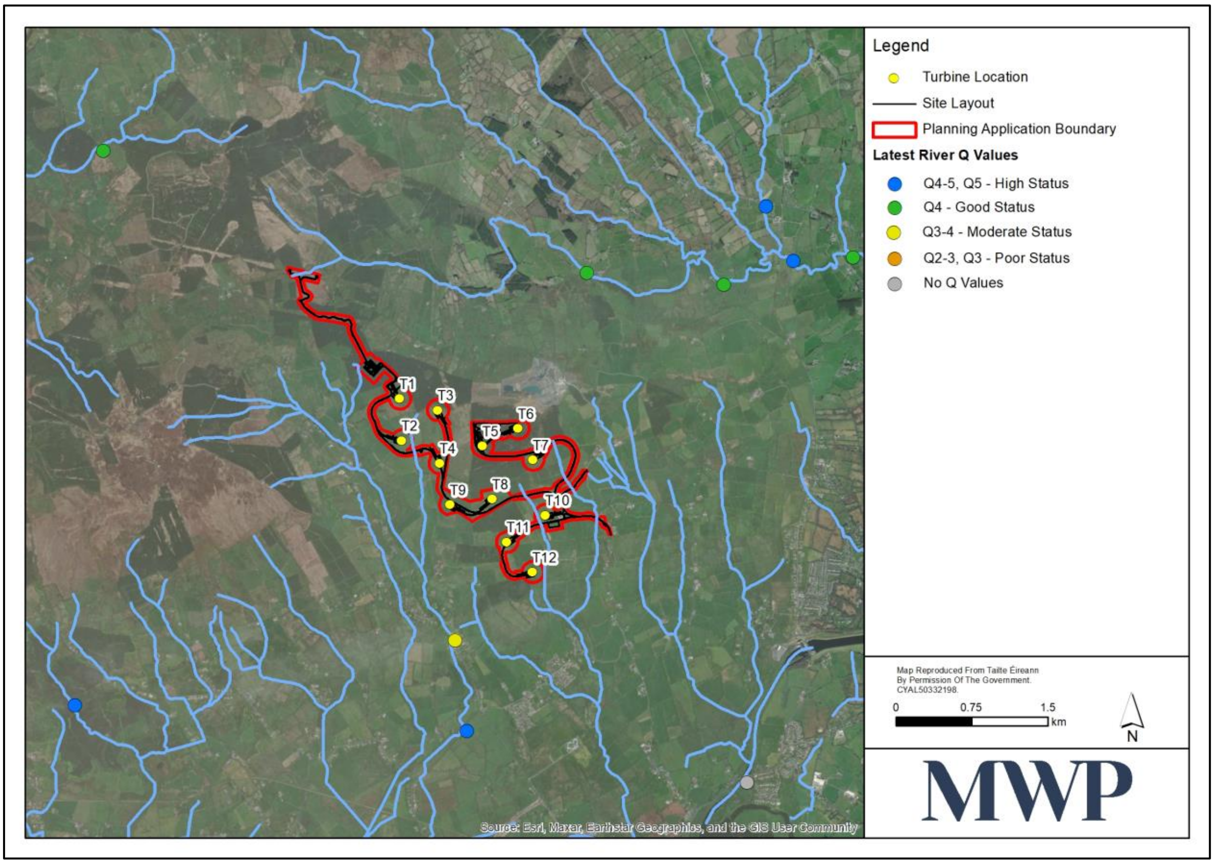

Figure 8-5: Latest River Q Values Map

As part of the current assessment, a biological water quality assessment was carried out at 10 locations in 2021 (Sites 1 – 10). Relevant data from an 11th site (Site 11) is also included in this assessment, based on surveys carried out by MWP in 2018 at this location (**Figure 8-6**) (Refer also to **Aquatic Ecology Report**, **6A**). Further assessments were carried out in 2023, including aquatic habitat surveying at an additional site (Site 12). The assessment sites (1 to 11) are shown in **Table 8-7**. Site 12 was unsuitable for assigning a Q-rating, or any other biotic index due to its small size, marginal habitat and difficult access. Biological water quality was determined as follows:

- **Site 1 and Site 4** were rated 'Slightly polluted (Q3-4)', equivalent to Water Framework Directive (WFD) 'Moderate status' due the paucity of pollution sensitive taxa;
- **Site 3 and Site 10** were rated 'Unpolluted Q4' equivalent to WFD 'good status'; and
- **Site 2, 4, 9 and 11** were rated 'Unpolluted Q4-5' equivalent to WFD 'high status'.

Based on Biological Monitoring Working Party (BMWP) scores, biological water quality was rated moderate to very good based on the diversity of macroinvertebrate assemblages recorded. The Average Score per Taxon (ASPT) scores ranged from 4.6 (Site 5) to 8.1 (Site 2). The values at all sampling locations except Site 5 were indicative of good water quality, where a value of > 5.5 is deemed to signify good water quality. The EPT[4]

[4] The EPT Index is the total number of distinct taxa within the groups, Trichoptera, Ephemeroptera, and Plecoptera. For example, if five species of Ephemeroptera (mayflies), five Plecoptera (stoneflies), and two Trichoptera (caddisflies) are found at a site, the total number of EPT taxa and Index would equal 12.

(Ephemeroptera, Plecoptera, Trichoptera) index of water quality varied between 0 (Site 5) to 11 (Site 9 and Site 11). Based on the EPT index therefore, macroinvertebrate richness is highly variable.

Table 8-7: Biological Water Quality at Aquatic Sites within and downstream of the Proposed Development

Site	Watercourse	Q-rating	Quality Status	Correspond-ing WFD Status	BMWP Score	BMWP Cate-gory	BMWP Interpretation	ASPT	EPT
1	Crompaun	3-4	Slightly polluted	Moderate	96.7	Good	Clean but slightly impacted	7.4	8
2	Glennagross	4-5	Unpolluted	High	105	Very good	Unpolluted, unimpacted	8.1	10
3	Cappateemore east	4	Unpolluted	Good	91.8	Good	Clean but slightly impacted	6.6	8
4	Crompaun East	3-4	Slightly polluted	Moderate	94.2	Good	Clean but slightly impacted	6.7	7
5	North Ballycannan	3	Moderately Polluted	Moderate	9.2	Very poor	Heavily polluted	4.6	0
6	North Ballycannan	3	Moderately Polluted	Moderate	46.8	Moderate	Moderately impacted	5.9	3
7	West Ballycannan	3	Moderately Polluted	Moderate	69.4	Moderate	Moderately impacted	6.3	4
8	South Ballycar	3	Moderately Polluted	Moderate	78.5	Good	Clean but slightly impacted	6.5	6
9	South Ballycar	4-5	Unpolluted	High	133	Very good	Unpolluted, unimpacted	7.4	11
10	West Roo	4	Unpolluted	Good	124.6	Very good	Unpolluted, unimpacted	6.9	10
11	Blackwater	4-5	Unpolluted	High	149.1	Very good	Unpolluted, unimpacted	6.8	11

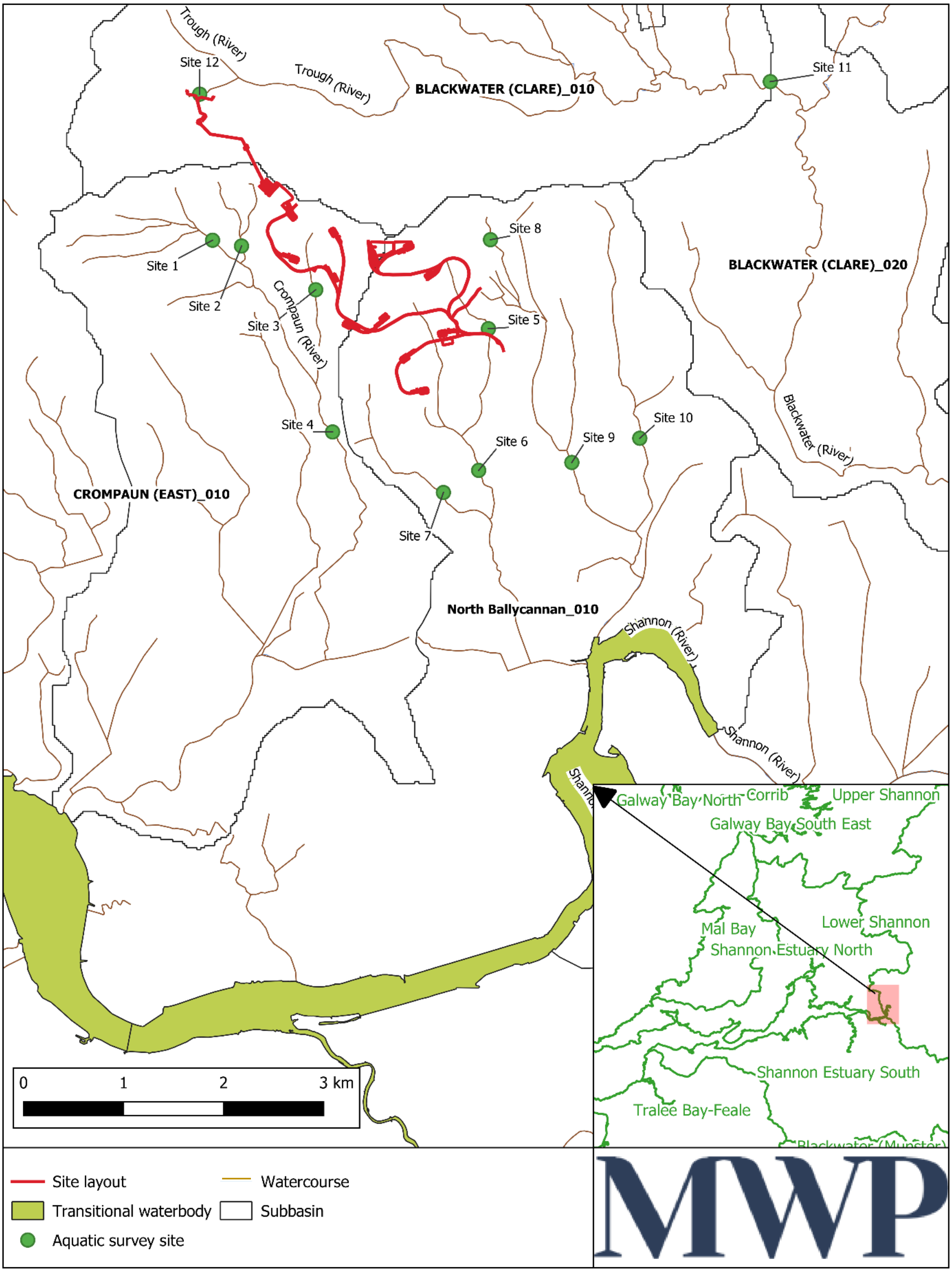

Figure 8-6: Aquatic Survey Site Locations

8.1.1.15 Physico-Chemical Water Quality

Results of the on-site physico-chemical measurements at the survey sites in 2021 are presented in **Table 8-8**.

It should be noted that the baseline results in the following tables will not be solely relied upon pre construction. While the results in the following tables reflect current water quality, further baseline water quality monitoring will be undertaken prior to commencement of the development. See **Section 8.4.6.21** for more detail.

Field parameters were measured on-site by MWP using a calibrated Aquaread AP-5000 Portable multi-parameter water quality probe (**Table 8-8**).

Physico-chemical laboratory analysis results for 2021 and 2023 are presented in **Table 8-9** and **Table 8-10** , respectively. The results are discussed below.

Table 8-8: Physico-chemical water quality results from on-site measurements taken on 24th June 2021.

Parameter	Site									
	1	2	3	4	5	6	7	8	9	10
Dissolved Oxygen (%)	82.1	78.6	77.4	100.9	43.7	64.6	56.4	37.9	76.4	82.1
Dissolved Oxygen (ppm)	8.85	8.38	8.28	11.23	4.62	6.49	6.05	4.01	8.29	8.86
Time	9.47	13.23	12.20	15.08	15.54	16.33	14.23	15.23	10.54	11.20
Conductivity (µS/cm)	269	321	291	334	302	495	399	558	444	470
Temp (°C)	10.8	12.05	11.1	11.25	12.58	16.2	12.48	12.4	12.63	13.15
pH	6.77	7.43	7.34	7.35	7.42	7.32	7.42	7.25	7.36	7.56
Turbidity (NTU - 1st)	1.35	1.8	7.32	0.81	1.02	0.99	3.17	9.16	2.05	1.31
Turbidity (NTU - 2nd)	2.22	1.53	7.09	0.94	0.82	0.86	3.82	9.07	1.36	1.06
Turbidity (NTU - 3rd)	1.04	1.5	7.28	0.95	0.85	0.71	3.56	8.62	1.48	0.71
Turbidity (NTU - average)	1.54	1.61	7.23	0.90	0.90	0.85	3.52	8.95	1.63	1.03

Table 8-9: Physico-chemical water quality results from laboratory analysis (samples taken on 24th June 2021).

Parameter	Unit	Site									
		1	2	3	4	5	6	7	8	9	10
Biochemical Oxygen Demand (BOD)	mg/L	2.3	1	0.7	0.4	0.6	0.5	0.9	0.3	0.2	<0.1
Total Ammonia	mg/L N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Unit	Site									
		1	2	3	4	5	6	7	8	9	10
Total Dissolved Solids	mg/L	128	216	122	192	148	280	200	336	224	242
Total Hardness	mg/L $CaCO_3$	82	123	75	111	75	191	147	201	129	149
Total Organic Carbon	mg/L	4.2	<2	2.8	2	3	3.1	6	3.3	4.6	5.2
Total Phosphorus (as P)	mg/L P	<0.1	0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Suspended Solids	mg/L	<5	<5	<10	<10	<10	<10	<10	<10	<10	<10
Nitrate (as NO_3)	mg/L NO_3	1.5	5.6	3.9	2.3	1.3	2.3	0.57	3.3	2	2.9
Nitrite (as NO_2)	mg/L NO_2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate (as P)	mg/L P	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Table 8-10: Physico-chemical water quality results from laboratory analysis (samples taken on 26th June 2023).

Parameter	Unit	Site									
		1	2	3	4	5	6	7	8	9	10
Conductivity	µS/cm	66	62	61	66	15	62	63	62	64	74
B.O.D	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Suspended Solids	mg/L	<4	<4	<4	<4	<4	<4	6	<4	<4	<4
Total Ammonia	mg/L N	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate (as NO3)	mg/L NO3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Nitrite (as NO2)	mg/L NO2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ortho-Phosphate (as P)	mg/L P	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Hardness	mg/L CaCO3	16	16	16	17	29	16	16	16	18	22

Parameter	Unit	Site									
		1	2	3	4	5	6	7	8	9	10
Chemical Oxygen Demand (COD)	mg/l	<10	<10	10	<10	<10	11	<10	13	13	12
Total Phosphorus (as P)	mg/L P	0.08	0.06	0.07	0.04	0.08	0.06	0.06	0.04	0.05	0.06
Total Organic Carbon (TOC)	mg/L	4.6	4.9	5.3	5.4	5	6	6	5.9	6.8	8.4
Total Dissolved Solids	mg/L	47	35	34	37	54	35	35	35	36	42

Total Ammonia concentrations sampled were <0.1 mg/l at all sites in both the 2021 and 2023 sampling periods. In relation to the 'Quality of Salmonid Waters Regulations 1988' this parameter has an Environmental Quality Standard (EQS) of ≤1mg/L NH_4, subject to conforming to the standard for non-ionized ammonia. The mandatory value for Ammonium in the 'Quality of Salmonid Waters (293/1988)' is <0.1 mg/L NH_4^+. This parameter should be measured for its quality of salmonid waters by using 95% of the results collected over a 12-month period for it to be considered an appropriate reading (Flynn, 1988). The result in **Table 8-8** is for a single reading only, which is deemed appropriate for purposes of the current baseline assessment.

Dissolved Oxygen ranged from 37.9% (4.01 mg/L) at Site 8 to 100.9% (11.23 mg/L) at Site 4 in the 2021 round of sampling. In relation to the 'Quality of Salmonid Waters Regulations (SWR) 1988' this parameter has an EQS >6 mg/L and ≤9 mg/L. Oxygenation conditions at Site 5 (43.7%) and Site 8 were therefore below the minimum stipulated in the SWR, while Site 4 exceeded the maximum in the 2021 round of sampling. An excess of DO is not a problem in itself but it indicates that the daytime conditions may be mirrored by an equally large undersaturation of oxygen at night-time when photosynthesis ceases and plant respiration supervenes with the consumption of oxygen (EPA, 2001).

According to EPA (2001), salmonid fish will begin to be affected as DO levels drop to around 50% saturation, and in many instances of fish kills, the mortality is directly due to asphyxiation as the DO levels fall massively because of organic pollution. The effects of eutrophication are closely related to the DO regime in both rivers and lakes. Where there are dense growths of phytoplankton, photosynthesis will take place during the extended daylight periods of summertime, resulting in the production of oxygen which may lead to water DO levels far in excess of 100% saturation. Biochemical Oxygen Demand (BOD) serves as an indicator of the presence of organic matter in a watercourse (eutrophication) and is a useful measure of water quality. BOD results were within the range <0.1 mg/l (Site 10) to 2.3 mg/l (Site 1). The results at all locations coincided with WFD high status with respect to this parameter, with the exception of Site 1 in the 2021 round of sampling. At Site 1, the result corresponded with WFD 'good status' (95% ile). The results at all locations adhered to the 'Quality of Salmonid Waters (293/1988)' guidance of 3 mg/L O_2 for salmonid waters and are within the recommended tolerance of 5 mg/L O_2 in the SWR.

The results for orthophosphate across all sites was <0.02 mg/l in both the 2021 and 2023 sampling. The orthophosphate levels for the surveyed sites met the 'high' quality status requirements (mean value).

In the Quality of Salmonid Waters (293/1988), a Total Phosphorus concentration of 0.2 mg/l for salmonids is regarded as indicative in order to reduce eutrophication. The total phosphorus result for each site was <0.02 mg/l, therefore are below the 0.2 mg/l target.

There are no Environment Quality Standards (EQSs) for nitrate, however average nitrate concentration values less than 4 mg/l NO_3 (0.9mg/l N) and less than 8 mg/l NO_3 (1.8mg/l N) are considered by the EPA to be indicative of high and good quality respectively (EPA, 2017). The results for all sites were below 4 mg/l NO_3 which means these sites are considered to be of high quality, in accordance with EPA (2001) guidance. The concentration of nitrite was <0.02 mg/L, which is below the SWR threshold of 0.05 mg/L in both 2021 and 2023 sampling.

All sites had a result for suspended solids of <10 mg/L which is much less than the mandatory value of ≤25mg/L, stated in the 'Salmonid Water Regulations (1988)'.

Total dissolved solids (TDS) were between 122 mg/L (Site 3) and 336 mg/l (Site 8). There are no specified parametric limits for TDS but the result at Site 8 was considered elevated.

Total Hardness values in the range of 75 mg/L (Site 3 and 5) to 201 mg/L (Site 8) $CaCO_3$ were recorded. Water that has a hardness less than 61 mg/L is considered soft; 61-120 mg/L, moderately hard; 121-180 mg/L, hard; and more than 180 mg/L, very hard (Heath, 1983). Water in the study area is classified as mostly moderately hard but very hard in parts of the north Ballycannan catchment (Site 6 and Site 8 >180 mg/L). Harder water can reduce the effect of toxicity of some metals including zinc, copper and lead (EPA, 2019).

TOC values varied from <2 mg/L at Site 2 to 5.2 mg/l at Site 10. This parameter has no limit target specified in legislation.

8.1.1.16 Surface Water Sensitivity

Watercourse sensitivity has been derived from the biological ratings in the EPA water quality results and from the biological water quality assessment that was carried out as part of the current assessment for the proposed development. Based on the findings, it is considered that all surface waters within and near the proposed development site are of moderate to high sensitivity as indicated by the Biotic Indices of Q3 – Q4-5 at the sampling sites.

8.1.1.17 Flood Risk Identification

A review of the available sources of flooding on the OPW flood information portal (www.floodinfo.ie) indicates that there are no instances of historic flooding within the proposed development site or along the grid route. There is no available Catchment Flood Risk Assessment and Management (CFRAM)[5] or National Indicative Fluvial Mapping (NIFM) fluvial flood maps[5] available for this site. Pluvial flooding is unlikely due to the terrain.

It is anticipated that the relatively minor increase in impermeable areas due to the proposed development may increase the risk of flooding downgradient of the site due to the increase in the rate of runoff.

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[5] https://www.floodinfo.ie/map/floodmaps/

8.1.1.18 Groundwater Body

The proposed development site and grid connection route are situated within two groundwater bodies (GWBs). These are the Tulla-Newmarket on Fergus GWB (European Code: IE_SH_G_229) and the Lough Graney GWB (European Code: IE_SH_G_157). Both of these have a poorly productive bedrock flow regime. The bedrock lithology in this area is mainly comprised of Old Red Sandstone (ORS). The southern areas of the proposed development site are comprised of Lower Limestone Shale (LLS) and the Ballysteen Formation. The thickness in the ORS is generally more than several hundreds of meters thick at its maximum. However, permeability tends to decrease rapidly with depth. Most flow occurs in the upper 15m, in the zone that comprises a weathered layer and a connected fracture zone below this, although deeper flows may occur along faults or significant fractures. The maximum thickness of the LLS is generally less than 100m, with the Ballysteen formation comprising of a thickness of 100m – 200m. Similar to the ORS, the groundwater flow is generally confined to the upper 15m, although deeper inflows from along fault zones or connected fractures may be encountered.

8.1.1.19 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 majority of the proposed development site and grid connection are situated within 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 8-8**). Parts of the northwest and southern areas of the site, are situated within an aquifer which is described as a Poor Aquifer, which comprises of bedrock which is generally unproductive except for local zones (Category PI).

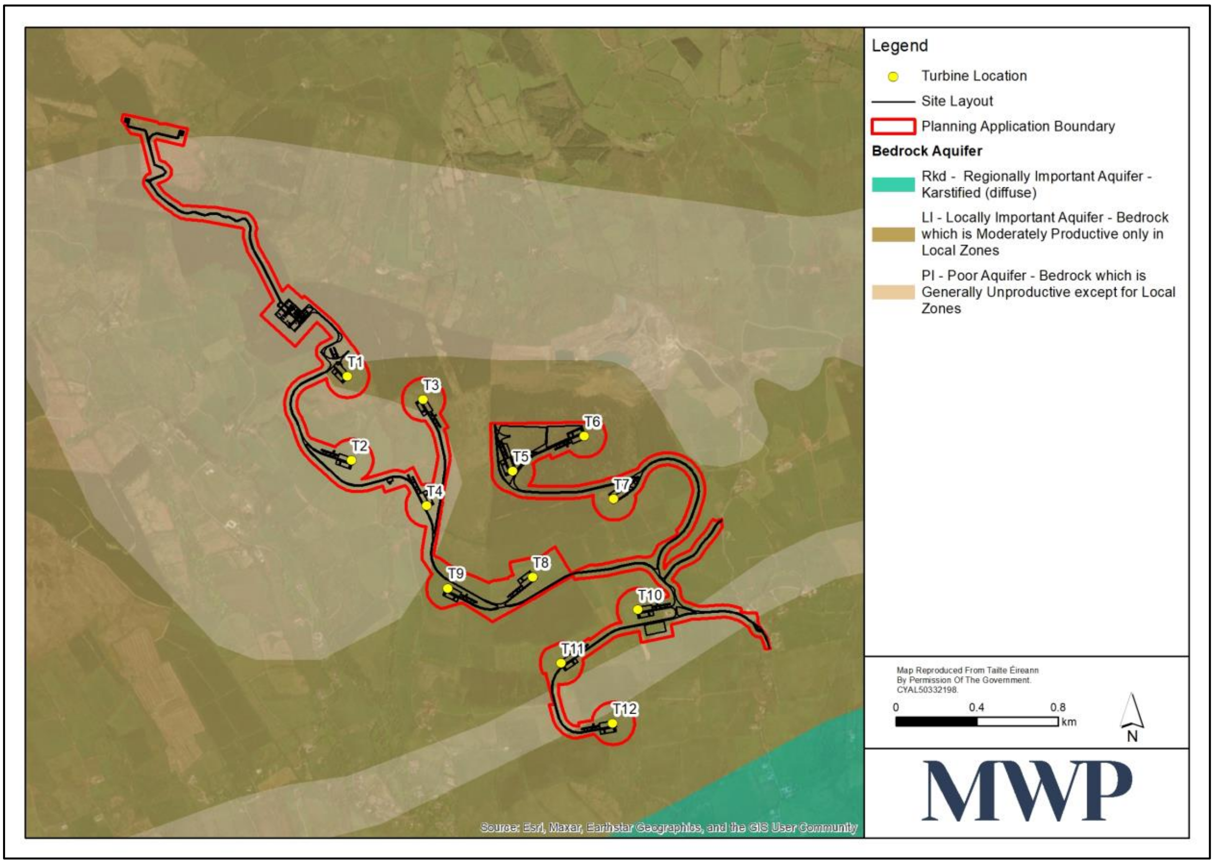

Figure 8-8: Groundwater Resources (Aquifer) Map

8.1.1.20 Abstraction

The GSI database lists six boreholes and two dug wells in proximity to the southeast of the proposed development site, which are labelled for agricultural and domestic use (**Table 8-11** and **Figure 8-9**). The Yield Class is described as Poor for all of these, with the exception of one dug well and one borehole which has not been assigned a yield class. Details of these boreholes/dug wells are provided in **Table 8-11**. There are two Group Water Schemes located approximately 20km to the north (Bodyke and Raheen Rd). These have 55 and 20 connections respectively and are groundwater sourced schemes. However, there is no hydrological link between these and the proposed development site and therefore, these schemes will be unaffected by any activity associated with the proposed site development. There may be other unmapped local wells for domestic or farming use and therefore, for the purpose of this EIAR, it will be assumed and assessed that all residential properties downgradient of the proposed development have private water abstraction for drinking water use.

No groundwater will be abstracted as part of the proposed development. However, should any groundwater be intercepted during construction (e.g., by excavation works) and need to be removed to facilitate the works, the amount of water would not be of such a quantity as to exceed the recharge capacity of the groundwater body.

Table 8-11: Groundwater Wells Properties & Description

GSI Name	Well Type	Drill Date	Depth (m)	Well Use	Yield Class	Yield m^3/d	Easting	Northing
1415NEW006	Borehole	May 16, 1969	20.7	Agri & Domestic Use	Poor	10.9	157,050.00	162,450.00

GSI Name	Well Type	Drill Date	Depth (m)	Well Use	Yield Class	Yield m^3/d	Easting	Northing
1415NEW023	Borehole	February 15, 1973	1.5	Agri & Domestic Use	Poor	13.1	157,150.00	162,390.00
1415NEW024	Dug Well	May 16, 1969	80.5	Agri & Domestic Use	Poor	16.4	157,130.00	162,340.00
1415NEW035	Borehole	July 15, 1972	N/A	Agri & Domestic Use	Poor	N/A	157,570.00	162,740.00
1415NEW036	Borehole	Mar 15, 1973	N/A	Agri & Domestic Use	Poor	N/A	157,560.00	162,690.00
1415NEW037	Borehole	Jan 1, 1966	99.1	Agri & Domestic Use	Poor	27.3	157,560.00	162,640.00
1415NEW038	Dug Well	Dec 29, 1899	N/A	Agri & Domestic Use	N/A	N/A	157,560.00	162,590.00
1415NEW005	Borehole	Nov 1, 1929	15.2	Agri & Domestic Use	N/A	6.5	158,200.00	161,650.00

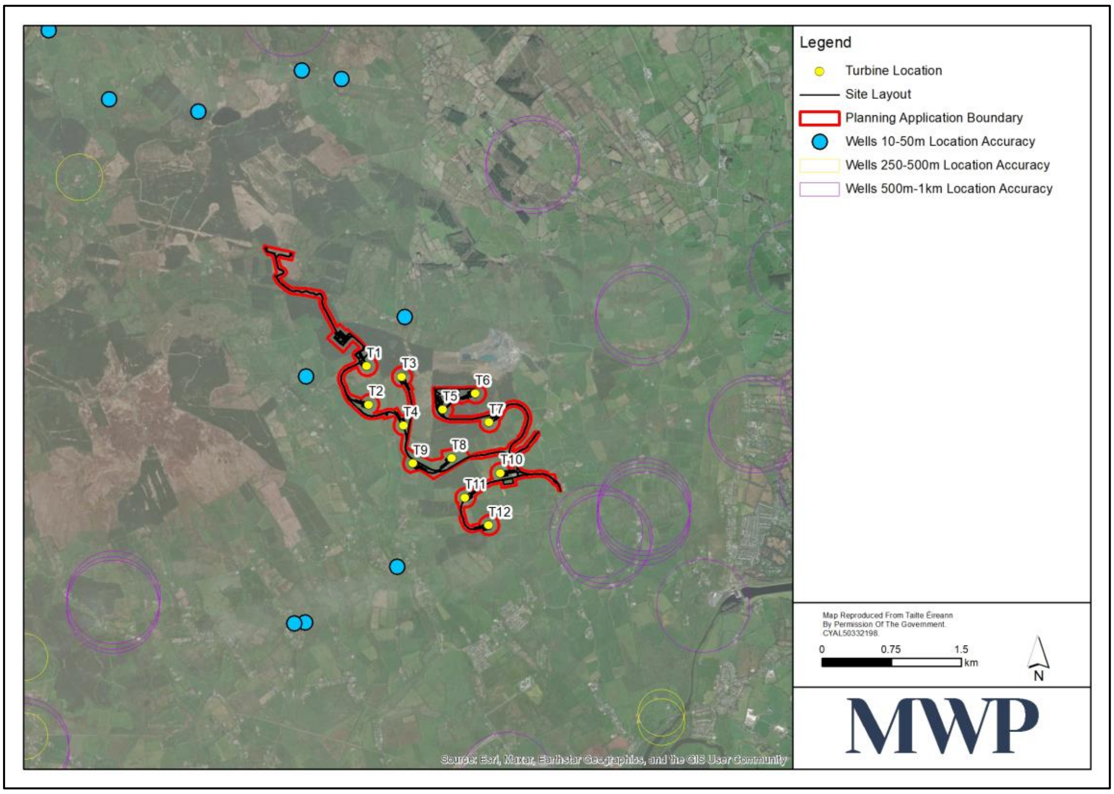

Figure 8-9: Groundwater Wells & Springs Map

8.1.1.21 Groundwater Sensitivity

Large areas of the development site contain areas in which the bedrock is at or near the surface (groundwater vulnerability: ‘Rock at or near surface’, ‘Extreme’). The remainder of the site has varying degrees of groundwater vulnerability ranging from moderate to high as illustrated in **Figure 8-10.**

The groundwater recharge rate was obtained from GSI and provides an estimate of the average amount of rainwater that percolates down through the subsoils to the water table over a year. The groundwater recharge rate within the development site is relatively low and ranges from 100 mm/yr to 200 mm/yr.

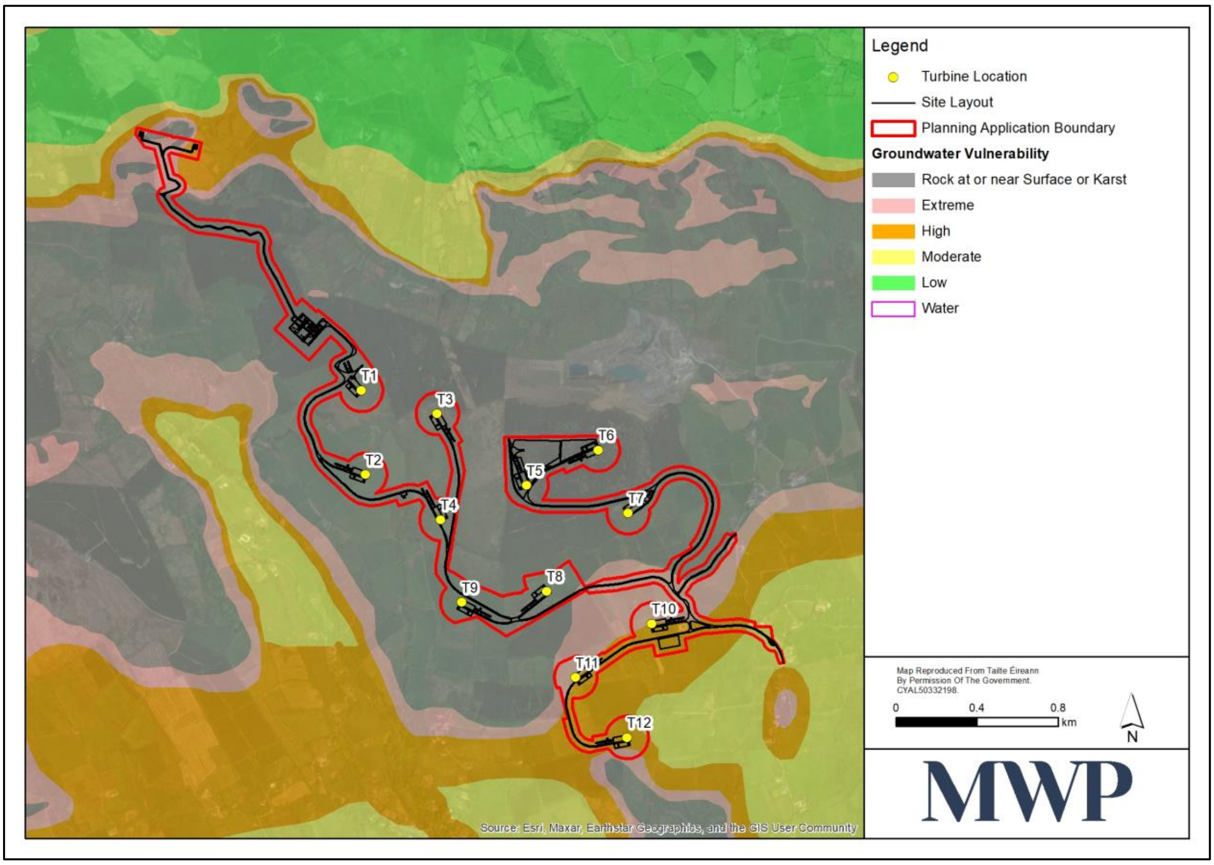

Figure 8-10: Groundwater Vulnerability

8.3 Likely Significant Effects

8.3.1 Do-Nothing Scenario

If the proposed wind energy development for which this document has been prepared does not go ahead, it is assumed that the landuse will remain unchanged without the construction of the wind farm. Agricultural practices will remain the same, with tree felling of the commercial conifer plantation occurring, which will be subject to felling licences and application of Forestry Guidelines as per the felling programme. There will be no alteration of the existing hydrological or hydrogeological regime.

8.3.2 Construction Phase

The construction of the proposed development will require excavation/filling and has the potential to lead to effects on hydrology, hydrogeology and water quality unless appropriate mitigation is applied. New internal access track construction will be required to provide access to all 12 turbine locations and the substation location. The construction of new access tracks will require some additional drains and the removal of soil, diverting near-surface groundwater flow into the drains and channels. Mitigation measures are outlined in **Section 8.4** below and within the **Surface Water Management Plan** (**SWMP**) (**Appendix 2B**).

The main risk to water quality results from the potential for ingress of sediment or accidental fuel or oil spillages discharging to any of the streams which flow through the development site. Any pollutants entering these watercourses could then be transferred to downstream fresh and estuarine waters. A Natura Impact Statement (NIS) has been prepared to assess the impacts on the relevant Natura 2000 sites (Lower Shannon SAC and River Shannon/Fergus Estuaries SPA) and proposes suitable mitigation measures (Refer to the **NIS**). Mitigation measures are also outlined in **Section 8.4** below.

It is not anticipated that large volumes of groundwater will be encountered within the borrow pit or other excavations. The bedrock in this area is largely comprised of sandstone bedrock which typically yields flow paths which are short, localised, and shallow. This is combined with the fact that there is no regional groundwater flow regime influencing groundwater inflows at the elevation of the borrow pit. Groundwater inflows will be influenced by recent rainfall and limited groundwater storage. The borrow pit location at the top of a ridge and in the vicinity of a watershed divide also ensures groundwater inflow will be restricted to recent recharge.

Large volumes of groundwater are not anticipated within the borrow pit. The proposed borrow pit is at a high point within the site with ground falling away to the west. A high groundwater table is not anticipated at the location due to the elevated position, with a fall in ground adjacent. The proposed base level of the borrow pit is 240mAOD. The base level of the existing Ballycar Quarry, to the north of the site is approximately 165mAOD. The existing quarry is likely to have already depressed the ground water table in the area to a level less than the proposed borrow pit base level.

The subsoil has moderate permeability, and the groundwater vulnerability is moderate to extreme with large areas of bedrock at or near the surface. This results in a moderate to high risk of groundwater contamination. A review of the neighbouring quarry expansion EIA indicated that a pumping test undertaken at the quarry floor showed poor permeability of the rock formation. The local bedrock comprises sandstone and siltstone bedrock layers. In this type of hydrogeology, the flow paths will be short, localised and shallow (c. 15m). This will result in very small groundwater flows and reduced risk of groundwater contamination.

Mitigation measures will be put in place to eliminate the risk of groundwater contamination during the construction phase. The following sections outline the potential effects on hydrology due to wind farm construction activities, prior to mitigation measures being applied.

8.3.2.1 Increase in Surface Runoff

Progressive replacement of the vegetated surface with impermeable surfaces could potentially result in an increase in the proportion and speed of surface water runoff reaching the surface water drainage network. The proposed wind farm footprint comprises turbine hardstanding, access tracks, an electrical sub-station and a construction compound. Temporary works include local road widening. During storm rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems, or increase the flood risk downgradient.

The infrastructure footprint for the proposed development is relatively small. The increase in runoff from the proposed development will, therefore, be negligible compared to the flows of the receiving waters. This is even before proposed mitigation measures will be implemented.

Pathway/Mechanism: Surface water features, site drainage network, hardstand areas, substation and access tracks.

Receptor: Surface waterbodies within and downgradient of the proposed development site.

Pre Mitigation Effect: ***Slight, Negative, Indirect, Permanent, Likely***

8.3.2.2 Increase in Suspended Solids

Activities that result in the release of suspended solids to surface watercourses, could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects are significant if not mitigated against. There are a number of associated activities which could lead to an increase in total suspended solids in water. These include;

- Earthworks resulting in the removal of vegetated material within the site development area.
- Cut and fill activities.
- Excavation of soil within the site development area.
- Inappropriate site management of excavations and of excavated soil within the site development area.
- Inappropriate management of the drainage of spoil storage areas.
- Cable trenches could act as a conduit for surface water flows.

Pathway/Mechanism: Surface water and drainage discharge routes.

Receptor: Surface waterbodies within and downgradient of the proposed development site.

Pre Mitigation Effect: ***Significant, Negative, Indirect, Short Term, Likely.***

8.3.2.3 Potential Release of Hydrocarbons

Use of machinery during construction could result in spillage of fuel, oils, lubricants, or other hydrocarbons to surface waters and groundwater, with potentially adverse effects on local groundwater quality and surface water quality in downstream areas. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway/Mechanism: Surface/ground water flow paths and site drainage.

Receptor: Surface waters and groundwater.

Pre Mitigation Effect: ***Significant, Negative, Indirect, Short Term, Unlikely.***

8.3.2.4 Release of Cement Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative effects on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of $\pm$ 0.5 of a pH unit. Entry of cement-based products into the proposed development site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses, represents a risk to the aquatic environment. Batching of wet concrete will not occur onsite, therefore washing out of transport and the placement of machinery are the activities most likely to generate a risk of cement-based pollution.

Pathway/Mechanism: Surface water features and drainage.

Receptor: Surface water bodies.

Pre Mitigation Effect: ***Moderate, Negative, Indirect, Temporary, Likely.***

8.1.1.22 Morphological Changes to Surface Water Courses & Drainage Patterns

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

Pathway: Site drainage network.

Receptor: Surface water flows, stream morphology and surface water quality.

Pre Mitigation Effect: ***Negative, Direct, Slight, Long Term, Unlikely.***

8.3.2.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Biological contamination from leaking sanitary waste could lead to contamination of receiving waters. Release of effluent from domestic wastewater treatment systems has the potential to effect groundwater and surface waters.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Down-gradient well supplies, groundwater quality and surface water quality.

Pre Mitigation Effect: ***Negative, Indirect, Significant, Temporary, Unlikely.***

8.1.1.23 Potential Effects on Groundwater Levels and Local Well Supplies During Excavation Works & from Proposed Borrow Pit

Groundwater levels may be lowered as a result of dewatering due to excavation works and dewatering of the proposed borrow pit. This has the potential to effect local well supplies in close proximity of the site. As previously discussed, it is not anticipated that large volumes of groundwater will be encountered within the borrow pits. The bedrock in this area is comprised of sandstone bedrock which typically yields flow paths which are short, localised, and shallow. Therefore, it is unlikely that there will be any impact on neighbouring wells as a result of the proposed development.

Pathway: Groundwater flow paths.

Receptor: Down-gradient water supplies (springs and groundwater wells).

Pre-Mitigation Effect: ***Negative, Indirect, Slight, Short Term, Unlikely.***

8.1.1.24 Conifer Tree Felling

The felling of carboniferous trees to accommodate turbines, substation, grid connection and access tracks as part of the proposed development can lead to exposure of soils and subsoils, entrainment of suspended sediment in watercourses, release of sediment attached to timber in stacking areas, and nutrient release.

Felling of conifer forestry is required within and around wind farm infrastructure to accommodate the construction of foundations, hardstands and access tracks, as well as to facilitate assembly of turbines. It is proposed to fell to a distance of up to 95m around turbines.

Pathways: Drainage network and surface water bodies.

Receptors: Surface water bodies.

Pre Mitigation Effect: ***Negative, Indirect, Moderate, Short Term, Likely***.

8.3.3 Operational Phase

The main potential operational phase hydrological impact of the development is a slight increase in run-off from a storm event to the streams within the site due to a minor decrease in ground permeability at the turbine hardstands, grid connection 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, especially when mitigation measures are implemented as outlined in Section 8.4.

Pathways: Surface water features, site drainage network, hardstand areas and access tracks.

Receptor: Surface waterbodies within and downgradient of the proposed development site.

Pre Mitigation Effect: ***Slight, Negative, Direct, Reversible, Likely.***

During the operational phase, oil will be used in cooling the transformers. As a result, there is 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 effects on the hydrological regime of the area.

Pathways: Surface water features and site drainage network.

Receptor: Surface waterbodies within and downgradient of the proposed development site.

Pre Mitigation Effect: ***Not Significant, Negative, Indirect, Short Term, Unlikely.***

8.3.4 Decommissioning Phase

The potential effects associated with decommissioning of the proposed development will be similar to those associated with construction, however of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works.

If it is decided to decommission the wind farm at the end of its 35-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 the relevant planning authority for approval prior to the decommissioning work. Access tracks and associated drainage will remain in place during the decommissioning phase. An environmental assessment will be undertaken at that time to ascertain whether or not it would be more or less environmentally impactful 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 planning authority and there will be a consent requirement for the timing of decommissioning works.

The substation will likely remain in place as part of the permanent electrical infrastructure.

The turbines, transformers, and meteorological mast will be dismantled and removed from the site following a method statement agreed with the planning authority. 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.

The grid connection cable will remain a permanent part of the national grid and therefore decommissioning is not foreseen. In the event of decommissioning, it will involve removing the cable from the ducting but leaving the ducting and associated supporting structure in place. The ducting will not be removed if the environmental assessment of the decommissioning operation demonstrates that this would likely do more harm than leaving them in situ. The assessment will be carried out closer to the time to take into account environmental changes over the project life. No significant effects on the hydrological and hydrogeological environment are expected to occur during the decommissioning stage of the proposed development.

8.3.5 Risk of Major Accidents and Disasters

No risk of major accidents or disasters has been identified as part of this assessment. The potential for a landslide within the site is negligible, as the primary risk factor, specifically deep peat on sloped ground does not exist within the development footprint. Refer to Chapter 9 Land and Soils for further details.

8.3.6 Cumulative Effects

A cumulative effect 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 assessment with the proposed development is provided in Chapter 2. The developments considered, and the extent to which there may be a cumulative effect, are dependent on the individual EIAR topic area.

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

- O’Connell’s Quarry Expansion (planning reference 18/818):

  It is proposed that the quarry will undergo an expansion of 10 hectares. Due to the proposed implementation of good construction practice and mitigation measures for the quarry expansion no significant cumulative hydrological or hydrogeological effects are anticipated as a result of the proposed quarry expansion.

- Felling of Commercial Forestry:

  It is proposed that all on-site forestry activities will cease for the duration of the wind farm construction and commissioning phase. Forestry operations, outside of the proposed development site, will resume again post commissioning of the wind farm. As such there will be no cumulative effects with forestry operations at the proposed development site.

- Fahy Beg Wind Farm Development (planning reference ABP: PL03.317227):

  It is proposed to construct of a wind farm in the townlands of Fahy Beg, Fahy More North, Ballymoloney, Ballyknavin (Ed O'Briensbridge), Ballyquin More, Woodpark and Leitrim, Co Clare together with the development of an underground grid connection cable to the national grid.

- Drummin Solar Farm Development (planning reference: Local Authority: 2357)

  A 10-year planning permission for development is sought at land to the west/north west of Ardnacrusha within the townlands of Castlebank, Glenlon North, Glenlon South, Drummin and Ballykeelaun, for the development of a solar farm on a site of approximately 70 hectares

There are no other operational, permitted, or proposed wind farm developments which may impact cumulatively with the proposed development. The nearest wind turbines are the single turbine at Limerick Blow Moulding Ltd. at Parteen which is approximately 3.8 kilometres from the proposed development, and the Johnson and Johnson wind turbine in the University of Limerick campus which is approximately 8.5 km from the proposed development. The permitted 19 turbine Carrownagowan wind farm (currently under Judicial Review) is approximately 12 kilometres northeast of the proposed development. The proposed Fahy Beg Development approximately 8.5 km northeast of the proposed development is currently under consideration by An Bord Pleanála, following planning refusal by Clare County Council. This assessment has shown no significant water effects to receptors closest to the proposed wind farm. Given the significant separation distances of the proposed development to other farms and geographical positioning there will be no cumulative water effects, therefore there will be no significant effect.

In terms of cumulative hydrological effects arising from elements of the proposed development, the potential for effects on water quality or flood flows is low as they are all contained within the proposed development site. Therefore, they will be within the wind farm drainage catchment where all construction water will be attenuated and treated as described.

The projects outlined above have or will be put through a rigorous design process for obtaining planning permission. Where relevant, these projects/plans have incorporated Construction Environmental Management Plans and Appropriate Assessments to ensure that there will be no adverse effects on hydrology or hydrogeology.

Given the geographical distance between the Fahy beg wind farm and the Drummin solar farm construction works areas and the proposed development, the potential for significant cumulative effects is negligible.

Having considered the implementation of good construction practice and design for the proposed quarry expansion and felling of commercial forestry in the surrounding area, no significant cumulative hydrological or hydrogeological effects are anticipated.

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 and Chapter 3 of this EIAR. A Construction Environmental Management Plan (CEMP) has been prepared for the project and is included as Appendix 2A. This CEMP will be updated by the appointed contractor to incorporate any planning conditions, monitoring and follow-up management of impacts. A CEMP provides a commitment to implementation of mitigation measures and follow-up monitoring, thereby reducing the risk of pollution, and improving the sustainable management of resources. A site-specific Surface Water Management Plan (SWMP) (Appendix 2B) has also been prepared for the proposed development and details of this are summarised below. Details of the proposed site drainage system are given in Planning Drawing 22156-MWP-00-00-DR-C-5006 and associated drawing sheets.

Environmental protection measures will include:

- Diversion of short sections of drains;
- Siltation and erosion control;
- Management of excavated soils and excavated materials;
- Fuel/hydrocarbon management; and

- Invasive species management.

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

- Drainage (see **Section 8.4.1**);
- Spoil management;
- Dewatering;
- Cement Bound Granular Mixtures (CBGM);
- Accidental spillages;
- Vehicle Washing.

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 the 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 EPA mapped watercourses 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 Proposed Drainage Management

A site drainage system will be constructed on the proposed development site so as to attenuate run-off, guard against soil erosion and safeguard downstream water quality. The drainage system will be implemented along all internal site access tracks, storage areas, crane hardstand areas, site construction temporary compound, the met mast location and the proposed substation site. Details of the proposed site drainage system are given in the **Planning Drawings** referenced earlier.

The drainage system will be excavated and constructed in conjunction with access track construction.

The concepts and details pertaining to the drainage philosophy are described in **Chapter 3 Civil Engineering** (**Section 3.13**) of this EIAR.

The following gives an outline of drainage management arrangements (further details and relevant figures available in **Chapter 3 Civil Engineering**):

- The surface water run-off drainage system will be implemented along all internal access tracks, to separate and collect 'dirty water' run-off from the tracks and to intercept clean over land surface water flows from crossing internal trackss;
- To achieve separation, clean water drains will be positioned on the upslope and dirty water drains positioned on the downslope of track sides, with track surfaces sloped towards dirty drains;
- Clean water will be piped under both the access tracks and downslope collection drains to avoid contamination. Piping the clean water under the access tracks allows the clean water to follow the course it would have taken before construction, thus mimicking the existing surface water over land flow pattern of the proposed development site and also not altering the natural/existing hydrological regime

on site. It is noted that the natural hydrology of the wind farm site is already altered by the imposition of the current forestry drainage regime;

- Measures addressed in the drainage design include:
    - Check dams will be placed at regular intervals, based on slope gradient, along all drains to slow down runoff and to encourage settlement and to reduce scour and ditch erosion;
    - Check dams will be constructed in accordance with best practice utilising clean stone at points along the drainage channel during the construction phase to further mitigate against any sediment escaping to nearby watercourses; and
    - Low gradient drains will be provided. These reduce the velocity of flow in the drains, thus reducing soil and subsoil erosion and reducing hydraulic loading to watercourses.
- Where possible existing drains will remain untouched. There will be a short section of an existing drain diverted in the vicinity of T4 to eliminate the risk of sediment release during construction;
- Regular buffered outfalls will be utilised that consist of numerous small drains off the main drain which end by fanning out into the surrounding vegetation by tapering drains. The drain will contain hard-core material to entrap suspended sediment;
- Drains carrying construction site runoff will be diverted into settlement ponds, which will promote sediment deposition and reduce hydraulic loading by slowing flow velocities allowing sediment to settle. Settlement ponds have been designed in the form of a three stage tiered pond system. The design of the settling pond system for the proposed development site is detailed in the Planning Drawings;
- These will be maintained by the contractor to the satisfaction of the client's engineers and IFI for the entire construction period;
- Flow from the settlement ponds will enter the sediment traps where runoff will be cleaned further by a series of graded gravel filters. Silt traps will require regular inspection and cleaning, and material removed will be disposed at an appropriate location such as an on-site borrow pit/deposition areas;
- Drainage ditch outfalls from silt traps will discharge at regular intervals to mimic the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points. The drainage ditches will flow onto the existing ground by fanning out onto the surrounding vegetation via tapering drains;
- The access tracks will be graded so that all runoff is directed to the dirty water drains. A low mound will be constructed between the track and the clean water drain to ensure that runoff from the track cannot flow into the clean water system;
- No disturbance will be permitted to the natural vegetative buffer. They will be fenced where necessary; and
- Best practice and practical experience on other similar projects suggests that in addition to the above outlined drainage plans, there are additional site based decisions and plans that can only be made in the field through interaction between the Site Construction Manager, the Project Hydrologist and the Project Geotechnical Engineers. In relation to decisions that are made on site, it is important to stress that these will be implemented in line with the associated drainage controls and mitigation measures outlined above and to ensure protection of all watercourses. These details are included in the **CEMP** and **SWMP** for the project (See **Chapter 3 Civil Engineering** and **Appendix 2A** and **2B**).

8.3.2 Construction Phase

8.1.1.25 Site Clearance

Felling of coniferous trees is required as part of the proposed development. Mitigation measures will be implemented in accordance with the Forestry and Water Quality Guidelines (DMNR, 2000) and Coillte (2009): Forest Operations & Water Protection Guidelines. These measures will prevent run-off erosion and consequent sediment release into the nearby watercourses.

8.1.1.26 River Crossings

No work will take place within 50m buffer zones of EPA mapped watercourses except for construction works identified in Planning Drawing No. 22156-MWP-DR-C-5006 at the following locations:

- Temporary Construction Site Entrance;
- Grid Connection to OHL;
- Met Mast works.

Any works taking place in the vicinity of unmapped watercourses or land drains will be undertaken in accordance with the mitigation measures set out in this Chapter and in the CEMP and Surface Water Management Plan contained in Appendix 2A and 2B respectively. Working near watercourses during or after intense or prolonged rainfall events will be avoided and work will cease entirely near watercourses when it is evident that there is a risk that pollution could occur. All construction method statements will be developed in consultation with Inland Fisheries Ireland and in accordance with the details in the CEMP accompanying this application. The selection criteria and other details of the proposed crossings can be found in Chapter 3 Civil Engineering. These crossings will be subject to a Section 50 application to ensure flood risk upstream and downstream of the crossing is not increased.

8.1.1.27 Drains

A robust drainage system will be put in place including maintenance and enhancement of existing drainage, as well as new systems, to minimise sediment release during construction. The existing drainage system will be retained and improved where required. Along new access tracks, interceptor drains and silt traps will be put in place simultaneously with the construction of site access tracks and turbine base construction, such that excavation works and any constructed hard surface or mineral soils storage areas will have a functioning drainage system in place in advance of the main construction activity. Drains adjacent to access tracks and cable trenches, will be excavated as outlined in the Forest Road Manual (Ryan et al., 2004). The increase in the rate of run-off along the route of the site access tracks and hard-standing areas will be mitigated by the proposed drainage system which includes 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.

Disturbance to the soil layer adjacent to these tracks will be minimised and thus there will be a low potential for an increase in suspended solids in the surface water run-off. Silt traps will be provided at regular intervals in the existing drains along the tracks to mitigate any increase in suspended solids in the surface water run-off due to trafficking these access tracks from the construction areas.

Where the tracks have a gradient greater than 2%, check dams will be installed in the drains. The check dams will be constructed with stone of minimum size 37.5mm and will be laid at a spacing of between 9m and 30m dependent on the site slope. The bottom of the upper check dam will be at same height as the top of lower check dam.

8.1.1.28 Sediment Control

The runoff from the existing and new internal access tracks will be collected in open drains on both sides of the track. These drains will outfall directly to the adjacent land. 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 access track 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 access tracks 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.

8.1.1.29 Settlement Ponds

Dedicated settlement ponds will be provided adjacent to access tracks, hardstands, substation, and storage areas. The criteria for settling efficiency will be in accordance with that set down in CIRIA B14 Design of Flood Storage Reservoirs (Hall et al. 1993), for the efficient removal of suspended solids. Settlement ponds will be put in place prior to excavation for turbines or construction of site access tracks.

All drains adjacent to access tracks will discharge to settlement ponds which will reduce the flow velocity and allow the suspended solids to settle. There may be a requirement for a series of settlement ponds where storage volumes are insufficient to allow settlement. Drainage stone will be placed at the inlet and outlet to the ponds to filter the flows before they enter the ponds. The ponds will have a modular surface area of 24 m^2 to cater for a runoff area of 1,200 m^2. Where larger areas have to be catered for, the pond area will increase pro rata. The settlement capacity is independent of depth; however, a nominal depth of 1.00 metres will be used to allow for storage of settled material. The length to width ratio will be at least 5:1 to encourage uniform flow across the cross-section of the pond and to avoid short-circuiting of the flow.

In the event of an emergency, the settlement ponds will provide a temporary holding area for any accidental spills on site as it will be possible to block off the outflow for a limited period. The settlement ponds will be fenced off for safety.

The outfall detail from the ponds will include a shallow trough of 300mm depth, lined with an impermeable liner and filled with stone. This trough will be 2 metres in length and will encourage the diffuse spread of flow back into the downstream watercourses. This will also help to mitigate the effect of flows above the design flow rate.

8.1.1.30 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, who will ensure 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 the proposed development within or adjacent to watercourses or aquatic zones. No batching will take place on site. 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 in areas where there is no direct drainage to surface waters and where the area has been appropriately isolated with bunds.

8.1.1.31 Borrow Pit

There is one borrow pit proposed as part of the development. The borrow pit proposed within the site will be used to obtain approximately 30,000m^3 of subsoil and 165,000m^3 of site won stone aggregate for use in the construction of the wind farm. The borrow pit is located within the northern area of the site where it will be used as a source of hardcore for the construction of access tracks, crane hardstands and construction compound.

Prior to felling of trees over the area of the proposed borrow pit; an interceptor drain will first be excavated upslope to intercept existing overland flows and divert them around the borrow pit prior to discharge via a buffer zone on the downslope side.

Standing water, any surface water runoff or water pumped from within the borrow pit is likely to contain an increased concentration of suspended solids. Runoff or pumped water from the borrow pit will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the area. These drains will contain check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events. The settlement ponds have been designed to a modular size where if larger areas of runoff must be catered for at a single discharge point the size of the settlement pond will be increased pro rata.

It is not anticipated that large volumes of groundwater will be encountered within the borrow pit. The bedrock in this area is comprised of sandstone bedrock which typically yields flow paths which are short, localised, and shallow. This is combined with the fact that there is no regional groundwater flow regime influencing groundwater inflows at the elevation of the borrow pit. Groundwater inflows will be influenced by recent rainfall and limited groundwater storage. Its location at the top of a ridge and alongside a watershed divide also ensures groundwater inflow will be restricted to recent recharge.

8.1.1.32 Storage Areas and Material Deposition Areas

Cement products are hazardous and will always be stored in a Control of Substances Hazardous to Health (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.

Spoil will also be stored around the turbines to a maximum height of 1m. The felled areas around the turbines have been identified as a potential additional area that will be used to store material; however, priority will be given to restoration of the borrow pit and the dedicated material deposition areas.

No permanent stockpiles will be left on site after the completion of the construction phase works. After completion of the turbine base reinstatement, works will commence and all remaining stockpiles will be removed for permanent disposal at the proposed deposition areas within the site. Excavated soil will be removed to the designated material storage areas. Details of how materials will be managed on-site during construction are set out in Chapter 3 Civil Engineering.

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

Temporary stockpiles of spoil 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.

8.1.1.33 Access Track and Temporary Road Widening Construction

To mitigate against siltation of storm water runoff, access track and temporary road widening construction material will consist of crushed aggregate with low fines content. The use of quarry dust will not be permitted. Silt fencing will be erected around the perimeter of the temporary road widening area to minimise siltation.

8.1.1.34 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. There will be no discharge of any priority or hazardous substances to groundwater and surface waters.

A suitable permanent fuel and oil interceptor will 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.

8.1.1.35 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 Clare 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.

A NIS was completed for the proposed development and determined that there will be no adverse effects on any qualifying interests of protected Natura 2000 sites hydrologically linked and downstream of the proposed site or temporary works. Additionally, associated mitigation measures as outlined will be implemented as part of this EIAR and the CEMP during the construction and operational phases to ensure that there will be no significant adverse effects on the hydrological or hydrogeological regime pertaining to the development site.

8.1.1.36 Monitoring

The Surface Water Management Plan (SWMP) (Appendix 2B) sets out the proposed surface water quality monitoring programme during pre-construction, the construction phase and operational phase which will be agreed and amended as required with Clare County Council and IFI. A summary of the proposed monitoring is outlined below. See Appendix 2 in the SWMP for the Scheduling of Works Operating Record Example (SOWOR).

Pre- Construction Monitoring

Baseline water quality monitoring will be updated prior to commencement of the proposed development. Water quality field testing and laboratory analysis will be undertaken prior to commencement of felling and construction at the site. Clare County Council will be notified of the monitoring programme and it will be based on the planning stage programme already outlined in the EIAR and CEMP and presented herein.

In order to ensure a comprehensive understanding of baseline water quality conditions including during low and high flow water conditions, upstream and downstream of the proposed development site, baseline water quality measurements will be undertaken monthly for a period of 6 months prior to commencement of construction at the 12 suggested locations identified (See Figure 8-5 in Section 8.2.2.14). However, additional locations can be included at any time as deemed necessary. These locations will be agreed with Clare County Council.

Analysis will be for a range of parameters with relevant regulatory limits along with EQSs.

Construction Monitoring

During the construction phase of the project, a surface water monitoring schedule, finalised prior to construction, will be followed. In summary, it is proposed that weekly field surface water quality chemistry monitoring will be taken at the identified 12 surface water quality monitoring locations mentioned above, or others as required. The following parameters will be measured:

- pH (field measured);
- Electrical Conductivity (field measured);
- Temperature (field measured);
- Dissolved Oxygen (field measured);
- Total Dissolved Solids (TDS) (field measured);
- Turbidity (field measured).

Each month, the ECoW will take samples from each location and bring to the laboratory for analysis on a range of parameters with relevant regulatory limits and EQSs. This will be compared with the baseline data obtained prior to construction from the EPA and from sampling outlined in this EIAR. If the measured value exceeds the baseline values, the cause will be determined, and remedial measures put in place as necessary.

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 to 2018. The likely suite of determinants will include:

- pH;
- Total Petroleum Hydrocarbons (TPH);
- Temperature;
- Total Phosphorus;
- Chloride;
- Nitrate;
- Nitrite;

- Total Nitrogen;
- Orthophosphate;
- Ammonia N;
- Biochemical Oxygen Demand;
- Total Suspended Solids.

Continuous, in-situ, monitoring equipment will be installed at selected locations. The monitoring equipment will provide continuous readings for turbidity levels, flow rate and water depth in the watercourses.

8.1.1.37 Environmental Manager

The CEMP is a living document, it will be revised and 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 environmental control measures, mitigation measures, monitoring, and follow-up arrangements and management of effects 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.

8.4.7 Operational Phase

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 an increase in flood risk downgradient of the site. The runoff control measures for the proposed development have been designed in the context of storm events of varying duration and intensity. The settlement ponds have been designed to cater for a maximum continuous flow rate associated with a medium-intensity rainfall event. Higher intensity runoff will be attenuated by the open drain collection system which provides temporary storage and limits the rate at which it enters the settlement ponds. Further details of the measures proposed can be found in the Surface Water Management Plan (See Appendix 2B).

Potential effects 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 tracks and hardstands.

8.4.8 Decommissioning Phase

The potential effects on the water environment during the decommissioning stage will be similar to those during the construction phase, and as such the proposed mitigation for the Decommissioning Phase are similar to those outlined previously. Moreover, due to the relative long life of the wind farm infrastructure, it is likely that a revised/updated environmental assessment will be required at the time of decommissioning to account for any changes in baseline conditions at the proposed development site, and potential changes is assessment guidelines and legislation.

If it is decided to decommission the wind farm at the end of its 35-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 the relevant planning authority for approval prior to the decommissioning work. Turbine components will be removed, however it is envisaged that access tracks and associated drainage 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 impactful 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 planning authority and there will be a consent requirement for the timing of decommissioning works.

The substation will likely remain in place as part of the permanent electrical infrastructure.

The turbines, transformers, and met mast will be dismantled and removed from the site following a method statement agreed with planning authority. 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 and circular economy management procedures.

The grid connection cable will likely remain a permanent part of the national grid and therefore, decommissioning is not foreseen. In the event of decommissioning, it will involve removing the cable from the ducting but leaving the ducting and associated supporting structure in place. The ducting will not be removed if the environmental assessment of the decommissioning operation demonstrates that this would do more harm than leaving them in situ. The assessment will be carried out closer to the time to take into account environmental changes over the project life. 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 Effects

By implementing the above mitigation measures, the significance of the residual effects on the water environment during the construction and operational phase of the development is assessed as being imperceptible to not significant. Mitigation by design has been implemented from the early concept and design stage to prevent adverse effects. 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 negative effect on surface water quality, surface water flows or groundwater resources. Refer to Table 8-12 below.

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 proposed development is expected to have a low impact on the receiving environment. Consequently, the proposed development is not expected to contribute to any cumulative negative effects with 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 negative effects on the receiving environment will be imperceptible/not significant. In particular, the development and operation of the wind farm, when undertaken as proposed, is not expected to have a significant negative 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 or hydrogeological conditions would not be altered to a degree that would affect the local or wider area.

Additionally, as previously mentioned, a Natura Impact Statement (NIS) has been completed for the proposed development and determined that there will be no adverse effects on any qualifying interests of protected Natura 2000 sites hydrologically linked and downstream of the proposed site. Therefore, there will be no significant adverse effects on the hydrological or hydrogeological regime pertaining to the development site.

Table 8-12: Residual Hydrological and Hydrogeological Effect Significance on Sensitive Receptors

Activity		Potential Impact	Receptor	Pre Mitigation			Post Mitigation		
				Significance	Probability	Duration	Significance	Probability	Duration
Construction	Removal of vegetated surface leading to increase in impermeable areas for turbine hardstands, access tracks, met mast hard stand, substation and associated compound.	Increase in Surface Runoff	Surface Waterbodies	Slight	Likely	Permanent	Imperceptible	Unlikely	Long Term
	Earthworks such as removal of vegetation, excavation of soil and rock, inappropriate excavated material/spoil management.	Increase in Suspended Solids	Surface Waterbodies and Groundwater	Significant	Likely	Short Term	Imperceptible	Unlikely	Short Term
	Spillage of fuel, oil, lubricants, or other hydrocarbons during construction.	Potential Release of Hydrocarbons	Surface Waterbodies and Groundwater	Significant	Likely	Short Term	Imperceptible	Unlikely	Short Term
	Spillage of cement-based products.	Release of Cement Based Products	Surface Waterbodies and Groundwater	Moderate	Likely	Temporary	Imperceptible	Unlikely	Short Term
	Diversion, culverting and bridge crossing of surface watercourses.	Morphological Changes to Surface Watercourses & Drainage Patterns	Surface Waterbodies	Slight	Unlikely	Long Term	Imperceptible	Unlikely	Long Term
	Leaking sanitary waste or release of effluent from domestic wastewater treatment systems.	Groundwater and Surface Water Contamination from Wastewater Disposal	Surface Waterbodies & Groundwater	Significant	Unlikely	Temporary	Imperceptible	Unlikely	Short Term

Activity		Potential Impact	Receptor	Pre Mitigation			Post Mitigation		
				Significance	Probability	Duration	Significance	Probability	Duration
	Dewatering due to excavation works and dewatering of the proposed borrow pit.	Increase in Suspended Solids	Down Gradient Water Supplies	Slight	Unlikely	Short Term	Imperceptible	Unlikely	Short Term
	Felling of carboniferous trees to accommodate development.	Increase in Suspended Solids	Surface Waterbodies	Moderate	Likely	Short Term	Imperceptible	Unlikely	Short Term
Operational	Decrease in permeability due to hardstand areas, access tracks, substation and associated compound.	Increase in Surface Runoff	Surface Waterbodies	Slight	Likely	Permanent	Imperceptible	Unlikely	Long Term
Operational	Spillage of fuel, oil, lubricants, or other hydrocarbons during operation and maintenance.	Potential Release of Hydrocarbons	Surface Waterbodies and Groundwater	Not Significant	Unlikely	Short Term	Imperceptible	Unlikely	Short Term

8.6 Compliance with the Water Framework Directive

In line with the requirements of the EU Water Framework Directive (WFD) (2000/60/EC) (WFD), all Member States are required to protect and improve water quality in all waters so that good ecological status is achieved by 2027 at the latest and establishes an integrated and coordinated framework for the sustainable management of water.

Developments that have the potential to effect ‘water bodies’ as designated by the WFD are required to demonstrate that actions would not result in a deterioration in ‘Good’ status. This chapter of the EIAR speaks directly to the potential effect of the proposed development on the water resources located within the vicinity of the development. The chapter also details the mitigation measures that will be implemented during the construction, operation and decommissioning phases of the development to ensure that the risk to any water resources is significantly reduced.

The mitigation measures proposed in **Section 8.4** to ensure compliance with the WFD are summarised below;

- Site Clearance – Mitigation measures will be implemented in accordance with the Forestry and Water Quality Guidelines (DMNR, 2000).
- River Crossings – All construction method statements will be developed in consultation with Inland Fisheries Ireland and in accordance with the details in the CEMP accompanying this application.
- Drains – A robust drainage system will be put in place including maintenance and enhancement of existing drainage, as well as new systems, to minimise sediment release during construction. Settlement ponds, check dams, silt fencing, interceptor drains and silt traps will also be implemented.
- Sediment Control – The runoff from the existing and new internal access tracks will be collected in open drains on both sides of the track. Each outfall will have a silt fence to collect the sediment in the runoff. The runoff from each of the turbine and crane hardstand sites will be collected separately from the access track runoff and directed to settlement ponds.
- Settlement Ponds – Dedicated settlement ponds will be provided adjacent to access tracks, hardstands, substation, and storage areas. The criteria for settling efficiency will be in accordance with that set down in CIRIA B14 Design of Flood Storage Reservoirs.
- 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.
- Borrow Pit – Runoff or pumped water from the borrow pit will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the area. These drains will be of check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events.
- Storage Areas & Deposition Areas – Materials will be stored as described in **Section 8.4.**
- Access Track/Temporary Road Widening Construction – To mitigate against siltation of storm water runoff, access track construction material will consist of crushed aggregate with low fines content. Silt fencing will erected.
- Plant and Refuelling – Appropriate plant and refuelling measures outlined previously will ensure no contamination to hydrological or hydrogeological receptors occur.
- 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.
- Monitoring - During the construction phase of the project, a surface water monitoring schedule, finalised prior to construction, will be followed.

- Environmental Management – The **CEMP** will be updated and 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.

8.7 Conclusion

During the construction and operation/maintenance phases of the proposed development, a number of activities will take place, some of which will have the potential to affect the hydrological and hydrogeological 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 effects on water quality. Mitigation by design has been the principal means which will reduce suspended sediment run-off arising from construction activities. Preventative measures also include fuel, concrete, and waste management, which are incorporated into the project **CEMP** (**Appendix 2A**).

The implementation of the proposed mitigation measures will;

- Prevent a deterioration in status of bodies of surface and groundwater;
- Not jeopardise the attainment of good surface water chemical status;
- Not permanently exclude or compromise the achievement of the objectives of the WFD in other bodies of water within the same river basin district; and
- Is consistent with other Community Environmental legislation.

Due to the design of the project, and the mitigation and monitoring measures described which will be adopted, it is not likely that there will be an unsustainable drawdown of groundwater likely to exceed its recharge capacity, or that there will be a discharge of priority substances or priority hazardous substances from the proposed development. The proposed development alone or in combination with other developments is not likely not cause a deterioration in the quality of any body of surface water or groundwater, is not likely to alter the chemical status of any waters, is not likely to have a significant effect on any European site and is not likely to compromise the ability of any waters to meet the objectives of the Water Framework Directive and transposing legislation.

With implementation of the proposed mitigation measures, the construction of the wind farm and associated activities alone or in combination with other projects will not have a significant adverse effect on the hydrology and hydrogeology of the site and surrounding area.

8.8 References

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