7.0 Hydrology, Hydrogeology and Water Quality

7.1 Introduction

7.1.1 Background and Objectives

Hydro Environmental Services (HES) was engaged by ABO Energy Ireland Ltd (ABO) to undertake an assessment of the potential likely and significant effects of the proposed Keerglen wind farm development (*i.e.* the Proposed Development) on the hydrology, hydrogeology and water quality aspects of the receiving environment.

A full description of the Proposed Development is provided in Chapter 3.

This chapter provides a baseline assessment of the environmental setting of the Proposed Development, as described in Chapter 3, in hydrology, hydrogeology and water quality and discusses the potential likely significant effects that the construction, operation and decommissioning of the Proposed Development will have. Where required, appropriate mitigation measures to avoid any identified significant effects to hydrology, hydrogeology and water quality are recommended and the residual effects of the Proposed Development post-mitigation are assessed. This chapter also identifies and assesses any likely cumulative effects which may result from the Proposed Development.

As detailed in Section 1.1.1 of Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Development', 'Wind Farm Site', 'Underground Electricity Export Connection' and 'Turbine Delivery Route' (TDR). The Proposed Development site includes the Wind Farm Site, with both the Underground Electricity Export Connection Route and TDR screened (as defined by the EIAR Study Boundary) for the purposes of the EIA Directive.

7.1.2 Statement of Authority

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

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessments for land, soils, hydrology and hydrogeology for a large variety of project types. This chapter of the EIAR was prepared by Michael Gill and Conor McGettigan.

Michael Gill (BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 3 years' experience in the environmental sector in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016) from University College Dublin. Conor routinely prepares the land, soils, geology, hydrology and hydrogeology sections of environmental impact assessment reports for wind farm development on peatlands.

7.1.3 Relevant Legislation

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

The following legislation has been complied with in the preparation of the hydrology, hydrogeology and water quality assessment of this EIAR:

- Planning and Development Acts, 2000-2023;
- Planning and Development Regulations, 2001 (as amended);
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 4/1995: The Heritage Act 1995 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 477/2011: European Communities (Birds and Natural Habitats) Regulations, implementing EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD").
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC).
- European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003);
- S.I. No: 122/2010: European Communities (Assessment and Management of Flood Risks) Regulations, resulting from EU Directive 2007/60/EC;
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,

- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

7.1.4 Relevant Guidance

The hydrology, hydrogeology and water quality chapter of this EIAR has been prepared in accordance with, where relevant, to guidance contained in the following documents:

- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018);
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Commission 2017);
- Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);
- Environmental Protection Agency (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations";
- OPW (2009) The Planning System and Flood Risk Management;
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Wind Farm Development Guidelines for Planning Authorities (2006);
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses;
- Good Practice During Wind farm Construction (Scottish Natural Heritage, 2010);
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001;
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);

- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018).

7.2 Assessment Methodology

7.2.1 Desk Study

A desk study of the Proposed Development site and the study area was initially completed in the Summer of 2021 to collect all relevant meteorological, hydrological and hydrogeological data. The desk study was completed to supplement site walkover surveys, drainage mapping and site investigations. The desk study information has been checked and updated, where necessary, in March and April 2024.

The desk study involved consultation with the following sources (note that all data sources were last accessed between 25th March and 19th April 2024):

- Historical OSI mapping, 6" and 25" basemaps (www.geohive.ie);
- Environmental Protection Agency soils databases (www.epa.ie);
- Geological Survey of Ireland groundwater and geological databases (www.gsi.ie);
- Geological Survey of Ireland geological heritage site mapping (www.gsi.ie):
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 6 – Bedrock Geology of North Mayo (GSI, 2003);
- Environmental Protection Agency Water Databases (www.catchments.ie);
- Environmental Protection Agency Hydrotool Database (www.catchments.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks and Wildlife Service Public Map Viewer (www.catchments.ie);
- Geological Survey of Ireland – Groundwater Body Characterisation Reports; and,
- OPW Flood Mapping Databases (www.floodinfo.ie).

7.2.2 Baseline Monitoring and Site Investigations

Detailed site walkover surveys, including geological and hydrological mapping of the Proposed Development site was undertaken by Michael Gill and Conor McGettigan of HES (refer to Section 7.1.2 above for qualifications and experience) between 2nd March 2022 and 19th April 2023. During these site visits, in terms of the water environment, hydrological monitoring on these dates included drainage mapping, surface water flow monitoring, field hydrochemistry, grab sampling, piezometer installation and groundwater level monitoring.

The combined hydrological and hydrogeological dataset collated by HES has been used in the preparation of this EIAR chapter.

For completeness, the site investigations to address the hydrological and hydrogeological aspects of this EIAR chapter are as follows:

- HES completed site walkover surveys including drainage mapping at the Proposed Development Site on 2nd and 3rd March 2022, 13th May 2022, 21st September 2022, 29th November 2022, 29th March 2023, 19th April 2023, and 5th October 2023;
- Field hydrochemistry measurements (4 no. rounds) were taken at the main watercourses draining the Wind Farm Site and along Underground Electricity Export Connection to determine the nature and origin of flows;
- 4 no. rounds of surface water flow monitoring was undertaken in the mains streams draining the Wind farm Site;
- A total of 12 no. surface water grab samples were undertaken across 2 no. sampling rounds to determine the baseline water of the primary surface waters originating from the Wind Farm Site and along the Underground Electricity Export Connection;
- HES installed 2 no. piezometer transects, comprising a total of 6 no. piezometers couples, at the Wind Farm Site on 3rd March 2022 to facilitate groundwater monitoring in order to aid the understanding of the local hydrogeological regime. These piezometers were dipped a total of 6 no. occasions between 13th May 2022 and 19th April 2023 to determine the local hydrogeological regime.

7.2.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the list of Consultees is outlined in Chapter 2 of this EIAR. Matters raised by Consultees in their responses with respect to the hydrological, hydrogeological and water quality environment are summarised in Table 7.1 below.

Table 7.1 Summary of Relevant Scoping Responses

Consultee	Description	Addressed in Section
GSI	**Geological Heritage**: The GSI Scoping response acknowledges that there are no County Geological Sites (CGS) in the vicinity of the Keerglen landholding however the Killala Area CGS is in the vicinity of the cable route. GSI state that there are no envisaged impacts on the integrity of the current CGS by the Proposed Development. **Groundwater**: Th GSI recommend using the Groundwater Viewer to identify areas of High to Extreme Vulnerability, as any groundwater-surface water interactions that might occur would be greatest in these areas. **Geohazards**: Landslides are common in areas of peat, rock near the surface and in fine to coarse range materials, areas which are found within the proposed areas of the wind farm development. Records show that there has been a landslide event occurring in the 1950s within the Keerglen landholding.	The potential effect of the Proposed Development on the Killala Area CGS is addressed in Section **Error! Reference source not found.**. Groundwater vulnerability at the Proposed Development Site is detailed in Section 7.3.10

Table 7.1 Summary of Relevant Scoping Responses		
Irish Water	No project specific scoping responses were provided by Irish Water.	N/A

7.2.4 Impact Assessment Methodology

The guideline criteria (EPA, May 2022) require that the baseline environment is described in terms of the context, character, significance and sensitivity of the existing environment. The description of the baseline environment is Step 5 of the information which must be included in an EIAR as per the guideline criteria (2022).

The assessment of effects follows the description of the baseline environment and is Step 6 of the information which must be included in an EIAR. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique of being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR.

In addition to the above methodology, the importance of the receiving environment receptors was assessed on completion of the desk study and baseline study. Levels of importance which are defined in **Error! Reference source not found.**2 for hydrology. The levels of importance are used to assess the potential effects that the Proposed Development may have on these receptors.

Table 7.2: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)		
Importance	**Criteria**	**Typical Example**
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes.

7.2.5 Study Areas

The water study area for the hydrological and hydrogeological impact assessment is defined by the regional surface water catchments and groundwater bodies within which the Proposed Development is located. The Water Study Area for the Wind Farm Site is defined by the Keerglen and Ballinglen rivers while the study area for the Underground Electricity Export Connection extends into the Cloonaghmore River catchment. The hydrological setting of the Proposed Development site is detailed in full in Section 7.3.4.

7.2.6 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the hydrology, hydrogeology and water quality chapter of this EIAR.

7.3 Description of the Baseline Environment

7.3.1 Site Description and Topography

7.3.1.1 Wind Farm Site

The Wind Farm Site is located approximately 5.5km southwest of the village of Ballycastle and approximately 15km northwest of Crossmolina town in north Co. Mayo. The Wind Farm Site has a total area of c.81.88ha and is located in an area of upland blanket bog, in the townlands Keerglen, Ballinglen and Ballkinlettragh in north Co. Mayo.

The Wind Farm Site can be accessed via local roads which extend to the west from the R315. This regional road connects the R310 at Pontoon to the R314 at Ballycastle. A network of local access roads and forestry tracks extend from this national road into the Wind Farm Site. These tracks have facilitated previous peat cutting at Keerglen. Site walkover surveys have revealed that the peat harvesting methodology used at Keerglen has been sausage peat cutting. As part of the Proposed Development, it is proposed to access the main Wind Farm Site via the L51723 through the upgrade of this existing local road and the provision of new sections of site access tracks and a temporary access junction and roadway connecting the R315 to the L51723 in the townland of Ballinglen.

The Wind Farm Site is dissected by the Keerglen River which flows to the west and north, before veering to the east. The Keerglen River has eroded a deeply incised valley and exposes subsoils and bedrock along its course. Several smaller natural watercourses and manmade drains also drain the Wind Farm Site and discharge into the Keerglen River, a tributary of the Ballinglen River. The proposed temporary access junction and roadway between the R315 and the L51723 and located to the east of the Ballinglen River.

The main area of the Wind Farm Site is characterised by upland sloping ground with elevations ranging from ~200mOD (metres above Ordnance Datum) to 100mOD. The topography slopes towards the Keerglen River valley. Topography falls steeply to the northeast, whereby the temporary access junction and roadway between the R315 and the L51723 are located at elevations of ~30 to 40mOD in the vicinity of Ballinglen River.

7.3.1.2 Underground Electricity Export Connection

The proposed Underground Electricity Export Connection will connect to the existing Tawnaghmore ESB Substation or a Large Energy User at Killala Business Park and will be c.22.8km in length. The Underground Electricity Export Connection will originate from the proposed onsite 38kV electrical substation in the townland of Keerglen. Within the Wind Farm Site the Underground Electricity Export Connection will travel along Wind Farm Site access roads and will cross the Keerglen and Ballinglen rivers. To the east of the Wind Farm Site, the Underground Electricity Export Connection will travel to the south along the R315 as far as the townland of Creevagh More. From here the Underground Electricity Export Connection will travel to the east along local roads, crossing the Cloonaghmore River at Tonrehown Bridge. The Underground Electricity Export Connection will then continue along local roads as far the Killala Business Park in the townland of Tawnaghmore.

Ground elevations along the Underground Electricity Export Connection (outside of the Wind Farm Site) are typically between 30 and 50mOD.

7.3.2 Land (Land-Take)

7.3.2.1 Wind Farm Site

Corine land cover maps (2018) show that the majority of the Wind Farm Site is located on 'peat bogs' with some areas of 'transitional woodland scrub' located along the Keerglen River. Agricultural pastures are mapped in the eastern section of the Wind Farm Site in the vicinity of the Ballinglen River and at the location of the proposed temporary access junction and roadway between the R315 and the L51723.

Land use surrounding the Wind Farm Site comprises predominantly of peat bogs with some coniferous forestry plantations further to the north, south and west. Further to the east, along the R315, agricultural grasslands with rural settlements and farmyards are mapped along the valley of the Ballinglen River.

Site walkover surveys and the inspection of recent aerial photographs have verified landuse at the Wind Farm Site. These surveys confirmed that the Wind Farm Site is located in an upland area which is dominated by cutover peat, with HES noting the occurrence of turbary peat cutting. The main area of the Wind Farm Site is also used for cattle grazing. Some areas of coniferous forestry were recorded in the vicinity of the new proposed access tracks in the northeast of the Wind Farm Site.

7.3.2.2 Underground Electricity Export Connection

As stated above, the Underground Electricity Export Connection will be predominantly located in the carriageway of the existing public road network to existing Tawnaghmore ESB Substation or a Large Energy User at Killala Business Park. Within the Wind Farm Site, the Underground Electricity Export Connection will be located within the carriageway of existing tracks and roads which are proposed for upgrade or along new proposed access tracks. Landcover in the lands surrounding the Underground Electricity Export Connection is predominantly comprised of agricultural pastures, with peat bogs mapped by Corine in the area of the Wind Farm Site.

7.3.2.3 Hydrological Considerations

The hydrological factors with regard peat stability were assessed using a combination of desk study data, aerial photography (historical and contemporary), topographic lidar data flow path drainage analysis, site walkovers, field drainage mapping and gouge coring. Detailed drainage maps were prepared along with hydrological constraints mapping for on-site drainage features and wet areas.

Many of the Pre-conditions as described by PLHRAG are hydrological in nature and are listed in the guidance as follows:

- Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity, especially an iron pan at the base of the peat deposit);
- A convex slope or a slope with a break of slope at its head (concentration of subsurface flow);
- Proximity to local drainage, either from flushes, pipes or streams (supply of water); and,
- Connectivity between surface drainage and the peat/impervious interface (mechanism for generation of excess pore pressures).

Identifying the above Pre-conditions at the Proposed Development Site was a key part of the hydrological constraints assessment carried out in conjunction with project design team.

7.3.3 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The 30-year annual average (1981 – 2010) rainfall (AAR) recorded at Bellacorick (Lacktanvack), ~8.3km southwest of the Wind Farm Site are presented in 7.3. The long-term average annual rainfall data for this rainfall station is ~1,564mm/yr.

However, the rainfall data from Bellacorrick is likely to underestimate the actual average annual rainfall at the Wind Farm Site due to the elevation difference between the Wind Farm Site and this weather station. Bellacorrick rainfall station stands at an elevation of ~95mOD (metres above Ordnance Datum) whilst the topography at the Wind Farm Site reach up to 179mOD.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Wind Farm Site is ~1,714mm/yr. This is considered to be the most accurate estimate of average annual rainfall from the available sources.

Table 7.3: Long Term Rainfall Data

Station		X-Coord		Y-Coord		Ht(mOD)		Opened		Closed		
Bellacorick (Lacktanvack)		**100400**		**325000**		**95**		**1968**		**N/A**		**Total**
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
170.6	123.5	131.6	97.2	89.8	86.6	97.2	118.2	131.3	179.6	165	173.7	1,564.3

In addition, HES installed a rain gauge at the Wind Farm Site on 15th March 2022. The daily rainfall volumes were recorded for a period of 25 months and the data is presented in Figure 7.1 below. During this period the greatest daily rainfall volume was recorded on the 7th September 2022 with 53.4mm of rainfall.

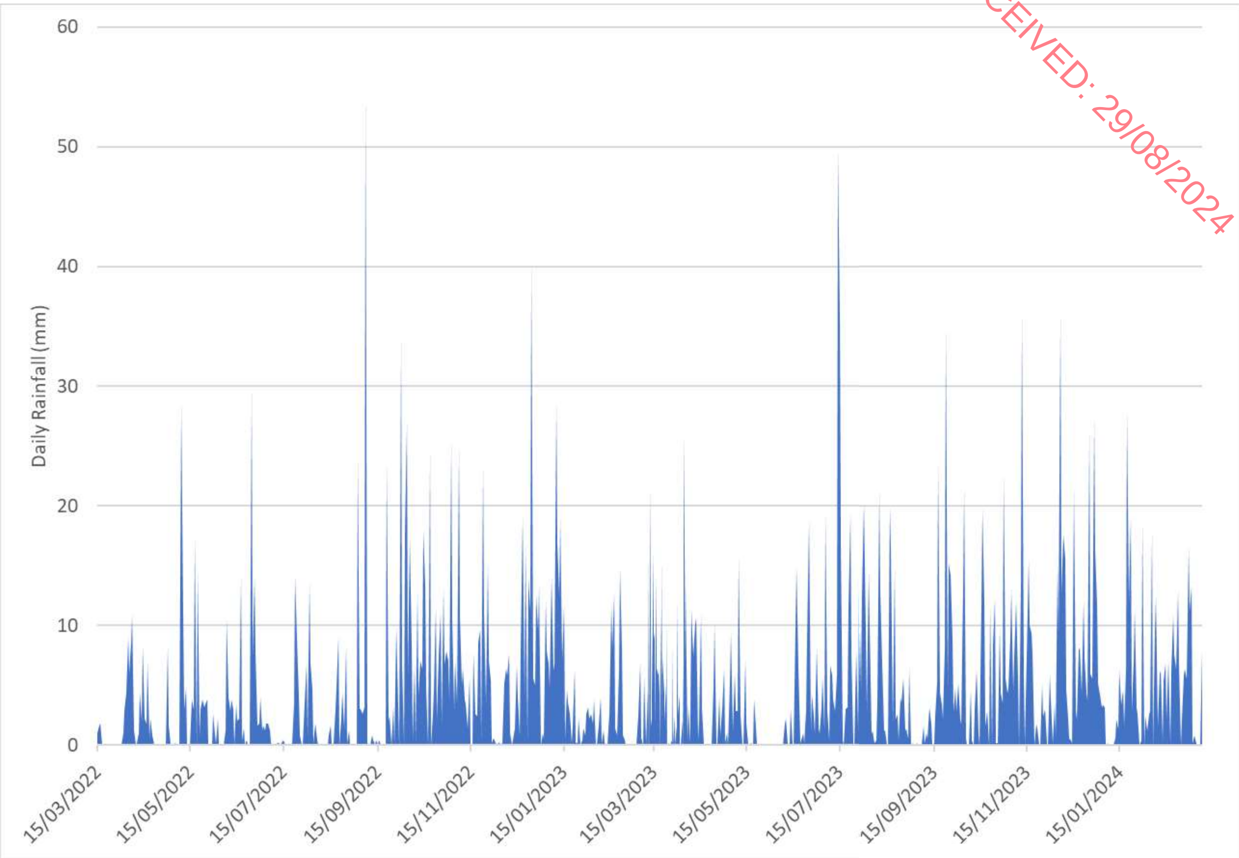

Figure 7.1: Daily Rainfall Data at Wind Farm Site (March 2022 to April 2024).

The closest synoptic station where the average potential evapotranspiration (PE) is recorded is at Belmullet, located ~36km west of the Wind Farm Site. The long-term average PE for this station is 527.1mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Wind Farm Site is estimated as 500.7mm/yr (which is 0.95 x PE). The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,714mm/yr – 501mm/yr

ER = 1,213mm/yr

Groundwater recharge coefficient estimates are available from the GSI (www.gsi.ie). Within the Wind Farm Site recharge coefficients range from 10% in areas of peat to 22.5% in areas mapped as being underlain by till.

An estimate of ~121mm/year average annual recharge is given for the Wind Farm Site. This calculation is based on a recharge coefficient of 10%. A recharge coefficient at the lower end of the GSI scale (10-22.5% was chosen due to the coverage of peat, the sloping nature of the local topography and the low permeability of the underlying bedrock aquifer. This means that the hydrology of the Wind Farm Site is characterised by high surface water runoff rates and relatively low groundwater recharge rates. This is supported by on-site observations made during the site walkover surveys whereby a high density of headwater streams were recorded within the Wind Farm Site.

Therefore, conservative annual recharge and runoff rates for areas of the Wind Farm Site which are covered in peat are estimated to be ~121mm/yr and ~1,092mm/yr respectively.

Climate change will likely result in precipitation changes from the baseline scenario outlined above over the lifetime of the project. Climate change projections for Ireland are provided by Regional Climate Models (RCM's) downscaled from larger Global Climate Models (GCM's). Projections for the period 2041-2060 (mid-century) are available from Met Eireann (www.met.ie). The data indicates a projected decrease in summer rainfall from 0 to 13% under the medium-low emission range scenario and an increase in the frequency of heavy precipitation events of ~20%. In total the projected annual reduction in rainfall near the Wind Farm Site ~4 to 8% under the medium-low emission scenario and ~4 to 6% under the high emissions scenario. Local average long term rainfall data for the Wind Farm Site is 1,714mm/yr. Under the medium-low emissions scenario this may reduce to ~1,668 – 1,577mm/yr, while under the high emissions scenario this figure may reduce to 1,688 – 1,611mm/yr.

The Climate Change rainfall projections discussed previously are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the proposed development, as the turbines have a life span of ~30 years. It is likely that the long-term effects of climate change on rainfall patterns will not be observed during the lifetime of the proposed wind farm. The drainage design for the proposed development accounts for any potential short-term climate change rainfall events which may relate to the increased frequency of high intensity precipitation events.

In addition to the average rainfall data, extreme value rainfall depths are available for Met Eireann. A summary of various return periods and duration rainfall depths for the Keerglen Wind Farm site are presented in 7.4 below.

Table 7.4: Keerglen Return Period Rainfall Depths (mm)

Storm Duration	Return Period Years			
	1	5	30	100
5 mins	4.2	7.1	12.3	17.3
15 mins	6.8	11.6	20.2	28.4
30 mins	8.9	14.9	25.3	35.1
1 hour	11.6	19.0	31.6	43.4
6 hours	23.0	35.9	56.6	75.0
12 hours	30.1	45.9	70.9	92.8
24 hours	39.2	58.7	88.7	114.7
2 days	51.2	73.5	106.4	133.8

7.3.4 Regional and Local Hydrology

7.3.4.1 Wind Farm Site

On a regional scale, the Wind Farm Site is located in the Blacksod-Broadhaven surface water catchment within Hydrometric Area 33 of the Western River Basin District (WRBD). This catchment includes the area drained by all streams entering the tidal water between Corraun Point and Benwee Head, Co. Mayo. The catchment has a total area of 1,302km^2.

On a more local scale, the Wind Farm Site is located in the Glencullin River sub-catchment (Glencullin[NorthMayo]_SC_010) and 3 no. WFD river sub-basins.

- The vast majority of the Wind Farm Site, including all proposed turbines, construction compound, the on-site substation and the proposed borrow pit, is mapped in the Keerglen_010 WFD river sub-basin.
- The majority of the access road along the L51723 is mapped in the Ballinglen_010 WFD river sub-basin.
- The temporary access junction and roadway is mapped at the boundary between the Ballinglen_010 and Ballinglen_020 WFD river sub-basins.

Within the Keerglen_010 river sub-basin, a small stream, referred to as the Fiddauncushaneen stream, originates to the southwest of the Wind Farm Site and flows to the north before it merges with another stream, which flows from the southwest, to form the Keerglen River. The Keerglen River then flows to the north along the eastern boundary of Ummerantarry Bog National Heritage Area (NHA), before it veers to the east. Several small 1st order streams, most of which are unnamed, originate in the vicinity of the Wind Farm Site and flow downslope and discharge into the Keerglen River. These watercourses are largely unnamed with the exception of the Fiddaunboy stream in the east. The Keerglen River then continues flowing to the northeast before it discharges into the Ballinglen River. The Ballinglen River flows northwards before discharging into Bunatrahir Bay ~6.5km northeast of the Wind Farm Site.

A regional hydrology map is shown in Figure 7.2.

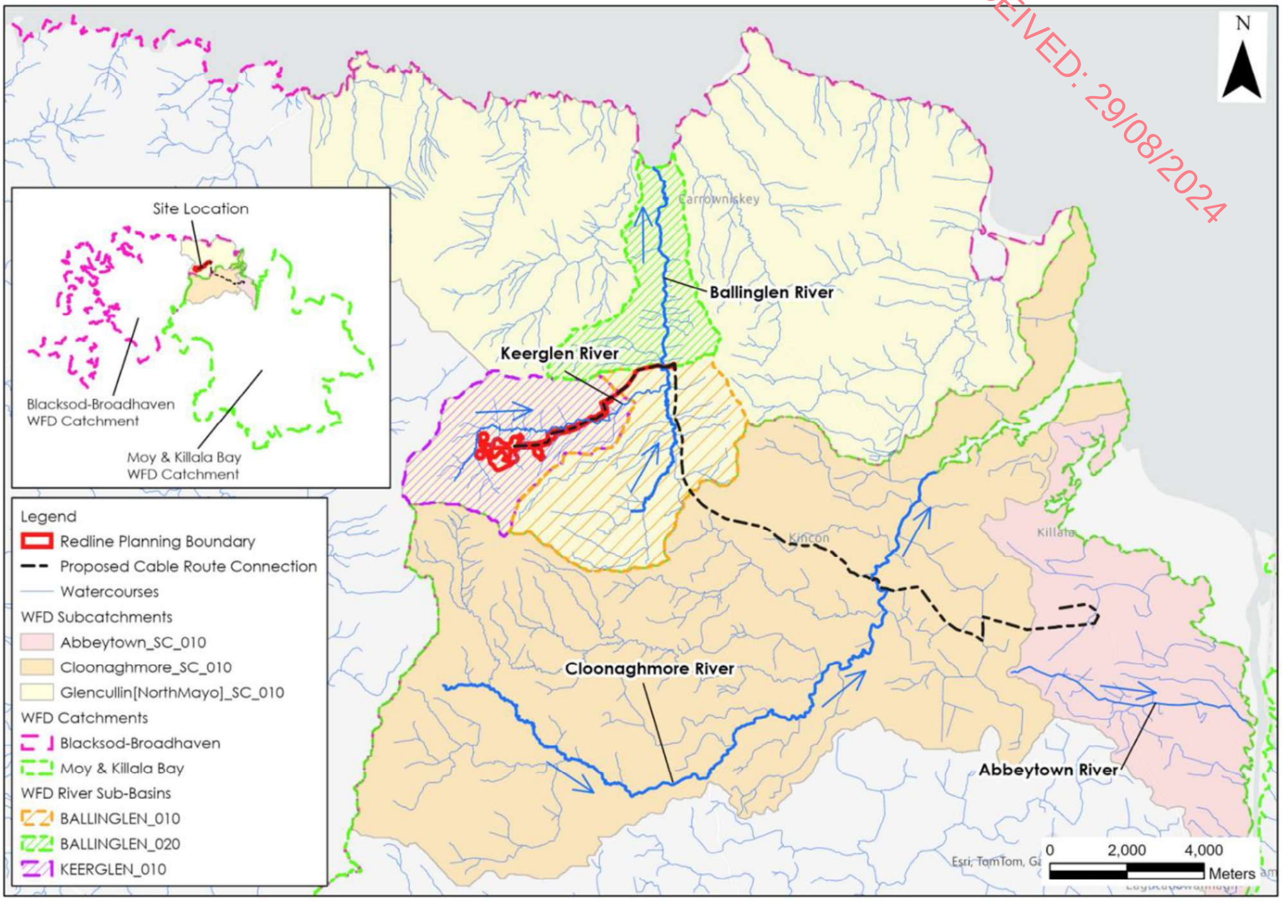

Figure 7.2: Regional Hydrology Map

7.3.4.2 Surface Water Flows

There are no OPW gauging stations located downstream of the Wind Farm Site for which flow data is available (www.waterlevel.ie). Therefore the EPA's hydrotool, available on www.catchments.ie, was consulted in order to estimate baseline flow volumes in the vicinity and downstream of the Wind Farm Site. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several Hydrotool nodes were consulted in the vicinity and downstream of the Wind Farm Site and Figure 7.3 below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes.

A 95%ile flow relates to the flow which will be exceeded within the river, 95% of the time. For example, the 95%ile flow at Node 33_1806 on the Keerglen River, to the northwest of the Wind Farm Site, is estimated to be 0.026m^3/s (26l/s). This indicates that 95% of the time, the flow at this location is estimated to be at or above 0.026m^3/s. Due to the increased catchment size, the 95%ile flow at Node 33_1738 on the Keerglen River, upstream of its confluence with the Ballinglen River, increases to 0.056m^3/s. The greatest flow volumes downstream of the Wind Farm Site will occur in the Ballinglen River, upstream of where it discharges into Bunatrahir Bay. At Node 33_2092, the 95%ile flow is estimated to be 0.135m^3/s. The progressively increasing flow volumes downstream of the Wind Farm Site are associated with the increased upstream catchment of the respective waterbodies.

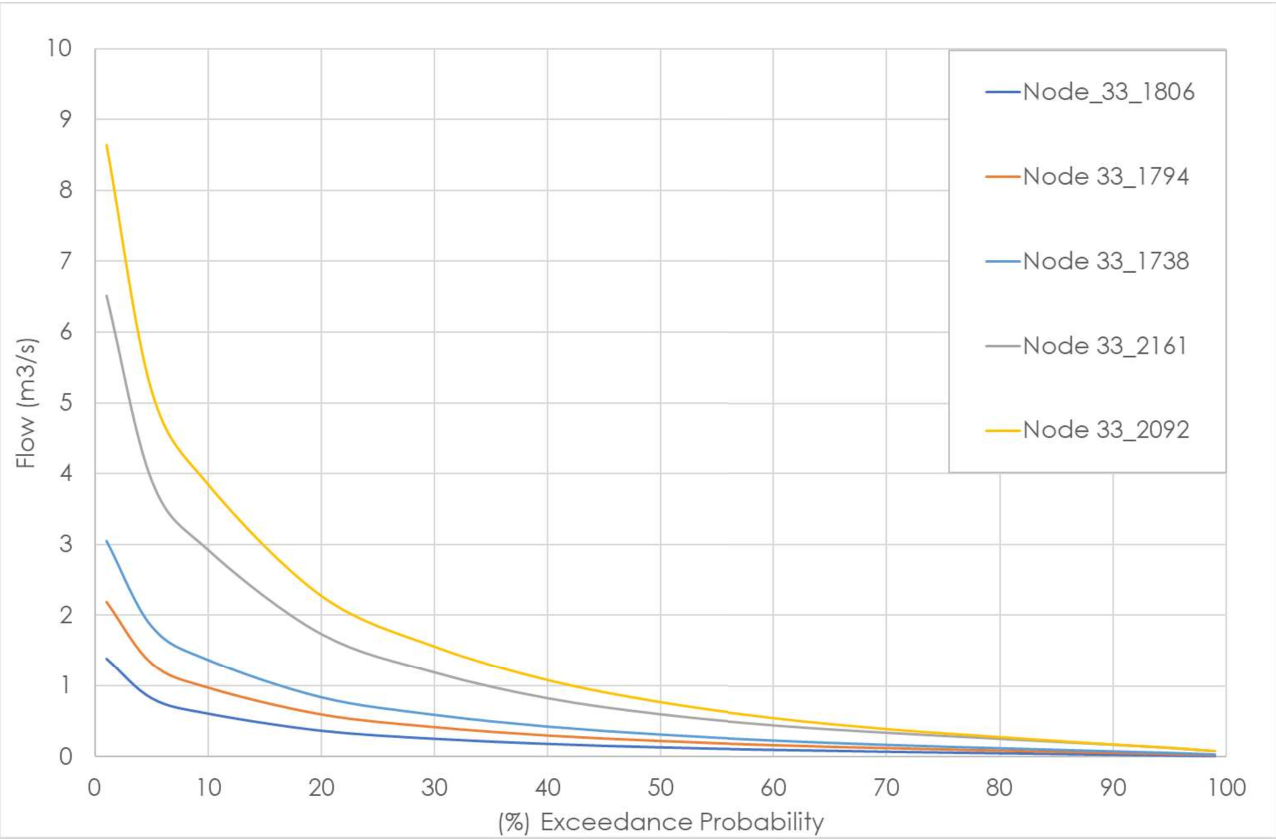

Figure 7.3: EPA Hydrotool – Flow Duration Curves (www.epa.ie)

7.3.4.3 Underground Electricity Export Connection

The Underground Electricity Export Connection is located in 2 no. WFD surface water catchments. The western section, in the vicinity of the Wind Farm Site, is located in the Blacksod-Broadhaven surface water catchment (Hydrometric Area 33). Meanwhile, the eastern section of the Underground Electricity Export Connection is located in the Moy and Killala Bay surface water catchment within Hydrometric Area 34.

Within the Blacksod-Broadhaven surface water catchment, there are a total of 5 no. watercourse crossings over EPA mapped rivers and streams. These crossings are located over the Ballinglen River to the east of the Wind Farm Site and along 5 no. tributaries of the Ballinglen River along the R315.

Meanwhile, within the Moy and Killala Bay surface water catchment, there are a total of 6 no. watercourse crossings over EPA mapped rivers and streams. These crossings are located over the Cloonaghmore River and 3 of its tributaries. In addition, the Underground Electricity Export Connection is proposed to cross a small watercourse at 2 no. locations in the vicinity of Killala Business Park.

The WFD river sub-basin through which the Underground Electricity Export Connection passes are detailed in Table 7.5.

Table 7.5: Proposed Development and WFD Regions

Proposed Development Infrastructure	WFD River Sub-Basin	WFD Sub-catchment	WFD Regional Surface Water Catchment
8 no. turbines, construction compound, borrow pit, onsite substation, upgrades to existing roads and new proposed roads	Keerglen_010	Glencullin[NorthMayo]_SC_010	Blacksod-Broadhaven
Underground Electricity Export Connection (including 4 no. crossings) and the temporary access junction and roadway	Ballinglen_010		
Temporary access junction and roadway	Ballinglen_020		
Underground Electricity Export Connection	Breaghwy_010	Cloonaghmore_SC_010	Moy & Killala Bay
Underground Electricity Export Connection	Cloonaghmore_040		
Underground Electricity Export Connection (including 3 no. crossings)	Cloonaghmore_050		
Underground Electricity Export Connection (including 3 no. crossings)	Moyne_010	Abbeytown_SC_010	

7.3.5 Wind Farm Site Drainage

As discussed above, the Wind Farm Site is drained by the Keerglen River and several of its tributaries.

The Keerglen River has eroded a deep valley into the subsoil peat, exposing the underlying glacial tills, and occasionally the bedrock geology at the surface. In the vicinity of the Wind Farm Site, the Keerglen River meanders in a broad valley. The riverbed is comprised of gravels and cobbles which are often coated in moss.

Several unnamed 1st and 2nd order streams flow from the high ground surrounding the river valley and discharge into Keerglen River. Some of these streams have themselves eroded out relatively deep valleys.

Drainage of the Wind Farm Site is further facilitated by a network of drainage ditches which have been constructed locally to facilitate turbary peat cutting activities. The drains have a relatively low density and are generally present every 40m. These features direct water downslope towards the Keerglen River and its tributaries.

4 no. rounds of surface water flow monitoring were carried out at the main streams draining the Wind Farm Site and the results are shown in Table 7.6 below. As expected, the greatest flows were recorded on the Keerglen River downstream of the majority of the Wind Farm Site (SW3) while the smallest flows were recorded further upstream along a tributary of the Keerglen River (SW1).

A map of the existing Wind Farm Site drainage is shown as Figure 7.4.

Table 7.6: Surface Water Flow Monitoring

Location	Round 1 (L/s) 02/03/2022	Round 2 (L/s) 21/09/2022	Round 3 (L/s) 29/11/2022	Round 4 (L/s) 19/04/2023
SW1	~4	~2	~6	~5
SW2	~50	~30	~50	~25
SW3	~120	~90	~120	~60
SW4	~16	~12	~15	~20

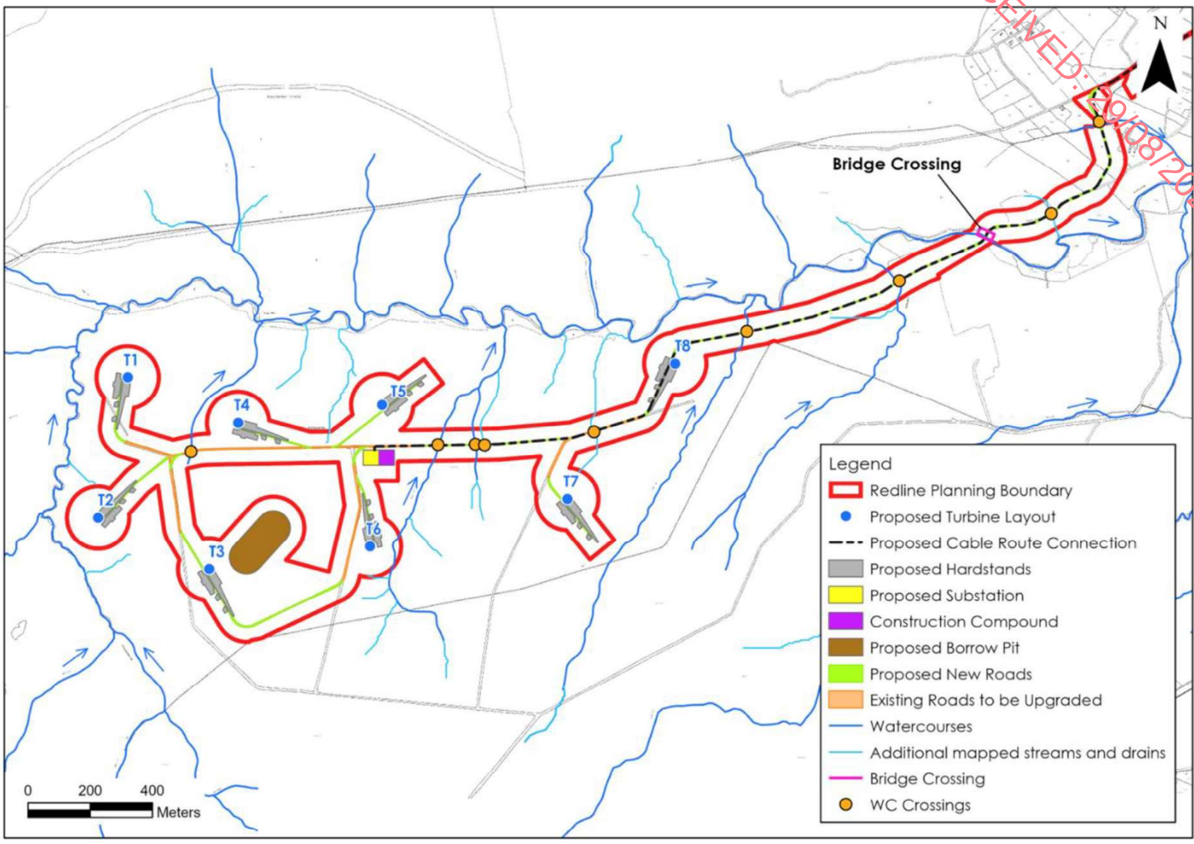

Figure 7.4: Existing Drainage Map for the Wind Farm Site

7.3.6 Summary Flood Risk Assessment

A Flood Risk Assessment (FRA) of the Proposed Development site has been carried out by HES, the findings of which are presented in full in Appendix 7.2 and are summarised below.

To identify those areas as being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping, CFRAM River Flood Extents, historical mapping (i.e. 6" and 25" base maps) and the GSI Groundwater Flood Maps were consulted. These flood maps are available to view at Flood Maps – www.floodinfo.ie.

There is no text on local available historical 6" or 25" mapping for the Wind Farm Site that identify areas that are "prone to flooding" within the site.

The OPW Past Flood Events Maps have no records or recurring or historic flood instances within the Wind Farm Site. The closest mapped flood event is located ~10km to the northeast and is associated with coastal flooding at Lacken Strand. Meanwhile, along the Underground Electricity Export Connection, a recurring flood event is mapped on the Cloonaghmore River at Tonrehown. With regard to this flood event, the local area engineers report states that "*road and property flooding at junction in Tonrehown area from the river Cloonaghmore once or twice a year*". There are no additional historic flood events mapped along the Underground Electricity Export Connection.

The GSI Winter 2015/2016 Surface Water Flood Map shows surface water flood extents for this winter flood event. This flood event is recognised as being the largest flood event on record in many areas. The flood map for this event does not record any flood zones within the Wind Farm Site or along the Underground Electricity Export Connection.

No CFRAM mapping has been completed for the area of the Wind Farm Site or along the Underground Electricity Export Connection.

The National Indicative Fluvial Flood Map for the Present Day Scenario shows flooding along the Keerglen and Ballinglen rivers in the vicinity of the Wind Farm Site. However, these flood zones do not extend any significant distance from the river channels due to the deeply incised nature of the valleys. No flood zones are mapped along any of the smaller streams which drain the Wind Farm Site. With respect to the Underground Electricity Export Connection, fluvial flood zones are mapped along the Ballinglen and Cloonaghmore Rivers. These mapped flood zones are at existing watercourse crossings.

Furthermore, the Wind Farm Site and the Underground Electricity Export Connection are not mapped within any historic or modelled groundwater flood zones.

Despite the presence of low permeability peat soils at the Wind Farm Site, the risk of pluvial flooding is low due to the sloping nature of the local topography.

In general, the risk of flooding at the Wind Farm Site is very low due to the elevated and sloping nature of the site and the high density of mountain streams which flow rapidly downslope.

It is a key design of the Proposed Development to ensure all surface water runoff is treated (water quality control) and attenuated (water quantity control) prior to diffuse discharge at pre-existing greenfield rates. As such the mechanism by which downstream flooding is prevented and controlled is through avoidance by design. These proposed drainage attenuation measures are outlined in the impact assessment section below.

7.3.7 Surface Water Quality

7.3.7.1 Wind Farm Site

Biological Q-rating data for EPA monitoring points on the Keerglen and Ballinglen Rivers downstream of the Wind Farm Site are shown on Table 7.7 below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High).

Downstream of the Wind Farm Site, the Keerglen River achieved a Q-rating of Q4-5 (i.e. High status) in 2020 at a bridge northeast of Doondragon (RS33k010200). Further downstream, the Ballinglen River also achieved a Q-rating of Q4-5 at Ballinglen Bridge (RS33B010100).

Table 7.7: Latest EPA Water Quality Monitoring Q-Rating Values

Station Code	Watercourse	Year	Easting	Northing	EPA Q-Rating Status
RS33K010200	Keerglen	2020	109378	333311	High (Q4-5)

RS33B010100	Ballinglen	2020	110241	334195	High (Q4-5)
RS34C030200	Cloonaghmore	2022	115710	328677	Moderate (Q3-4)
RS34C030270	Cloonaghmore	2022	116677	330545	Good (Q4)

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) were taken at 4 no. surface water sampling locations (SW1-SW4) in the vicinity and downstream of the Wind Farm Site on 4 no. occasions between 2nd March 2022 and 19th April 2023. Field hydrochemistry was also completed at an additional 2 no. locations (SW5 and SW6) downstream of the Underground Electricity Export Connection (refer to Section **Error! Reference source not found.** below). The location of these sampling points are shown on Figure 7.5 and the results are summarised in Table 7.8 below.

Electrical conductivity values at the sampling locations downstream of the Wind Farm Site ranged between 80.9µS/cm and 425.9µS/cm. pH values which were mainly neutral to slightly basic/acidic, ranging from 6.02 to 8.44. Turbidity ranged from 0.02 to 0.82NTU.

Table 7.8: Field Hydrochemistry Measurements (02/03/2022 to 19/04/2023)

Location	Watercourse	Temp °C	DO (% Sat)	SPC (µS/cm)	pH	Turbidity (NTU)
SW1	Keerglen	6 – 12.8	89 – 94.5	80.9 – 178.6	6.67 – 7.91	0.02 – 0.62
SW2	Keerglen	6.1 – 9.4	94.5 – 99.6	84.1 – 120	6.91 – 7.88	0.38 – 0.82
SW3	Ballinglen	7.2 – 13.9	90.5 – 97.6	264.2 – 425.9	7.27 – 8.44	0.27 – 0.66
SW4	Keerglen	6.6 – 13	90.6 – 100.9	86.5 – 157.6	6.02 – 7.99	0.14 – 0.52
SW5	Cloonaghmore	6.5 – 15	92.3 – 118	366.2 – 510	7.4 – 8.2	1.32 – 1.87
SW6	Moyne	7.9 – 10.2	85 - 90	600 - 650	7.66 – 7.88	1.18 – 1.78

Surface water grab samples were also taken at these locations for laboratory analysis on 2 no. occasions (2nd March 2022 and 19th April 2023). Results of the laboratory analysis are shown alongside relevant water quality regulations in Table 7.9 below. Original laboratory reports are attached as Appendix 7.3.

Suspended solid concentrations downstream of the Wind Farm Site ranged from <0.1 to 8mg/l. Suspended solid concentrations were below the S.I 293 (of 1988) threshold limit of 25 mg/l in all samples.

Ammonia was found to be at or below the level of detection of the laboratory (0.02mg/l) in all samples downstream of the Wind Farm Site during both monitoring rounds. In relation to ammonia, 7 of the 8 no. samples were found to be of "High" status and below the threshold of -≤0.04mg/l.

BOD ranged between <1 and 3 mg/l. 7 of the 8 no. samples achieved "High" status with respect to S.I. No. 272 of 2009 (i.e. ≤1.3mg/l). Only 1 no. sample exceeded the "Good" status threshold of 1.5mg/l.

Nitrate and orthophosphate concentrations were found to be below the level of detection of the laboratory in all samples. For orthophosphate, all samples were found to be of "High" status and below the threshold of -≤0.025mg/l.

Meanwhile, chloride concentrations ranged from 16.3 to 39.3mg/l.

Table 7.9: Surface Water Quality Data (02/03/2022 and 19/04/2023)

Location	Suspended Solids (mg/l)	BOD_5 (mg/l)	Orthophosphate (mg/l)	Nitrate (mg/l NO_3)	Ammonia (mg/l)	Chloride (mg/l)
EQS	≤25	≤1.3 to ≤1.5	≤0.035 to ≤0.025	-	≤0.065 to ≤0.04	-
SW1	0.4 - 8	<1 - 3	<0.02	<5	0.02 – 0.09	16.3 - 35.8
SW2	<0.1 - <5	<1 - 1	<0.02	<5	<0.02	17.7 - 39.3
SW3	<0.1 - <5	<1 - 1	<0.02	<5	<0.02	21.0 - 34.9
SW4	1.2 - <5	<1 - 1	<0.02	<5	0.03	17.0 - 36.9
SW5	7 - 7.8	<1 - 1	<0.02 – 0.05	<5	<0.02 - 0.02	26.3 - 34.3
SW6	<5 - 5	<1 - 1	<0.02	<5	0.03	23.2 - 33.1

7.3.7.2 Underground Electricity Export Connection

The Biological Q-rating values for the Ballinglen and Cloonaghmore Rivers downstream of the Underground Electricity Export Connection are shown in Table 7.8 above. The Ballinglen River also achieved a Q-rating of Q4-5 at Ballinglen Bridge (RS33B010100) in 2020. Meanwhile, the Cloonaghmore River was assigned a Q-rating of Q3-4 (i.e. Moderate status) in 2022 at Tonrehown Bridge (RS34C030200). Further downstream, the Cloonaghmore River achieved "Good" status (Q4) upstream of Palmerstown Bridge (RS34C030270).

Field hydrochemistry measurements were taken at 3 no. surface water sampling locations (SW3, SW5 and SW6) downstream of the Underground Electricity Export Connection on 4 no. occasions between 2nd March 2022 and 19th April 2023. Electrical conductivity values at these sampling locations ranged between 264µS/cm and 650µS/cm. pH values which were mainly neutral to basic, ranging from 7.27 to 8.44. Turbidity ranged from 0.27 to 1.87NTU.

Surface water grab samples were also taken at these locations for laboratory analysis on 2 no. occasions (2nd March 2022 and 19th April 2023). Results of the laboratory analysis are shown alongside relevant water quality regulations in Table 7.9 above.

Suspended solid concentrations downstream of the Underground Electricity Export Connection ranged from <0.1 to 7.8mg/l. Suspended solid concentrations were below the S.I 293 (of 1988) threshold limit of 25 mg/l in all samples.

Ammonia was found to be at or below the level of detection of the laboratory (0.02mg/l) in 4 of the 6 no. samples downstream of the Underground Electricity Export Connection during both monitoring rounds. All samples were below the threshold value for High status (≤0.04 mg/l) as set out in SI 272 of 2009.

BOD ranged between <1 and 1 mg/l. All samples achieved "High" status with respect to S.I. No. 272 of 2009 (i.e. ≤1.3mg/l).

Nitrate and orthophosphate concentrations were found to be below the level of detection of the laboratory in most samples. For orthophosphate, 5 of the 6 no. samples were found to be "High" status and below the threshold of -≤0.025mg/l. 1 no. samples exceeded the "Good" status threshold for orthophosphate.

Meanwhile, chloride concentrations downstream of the Underground Electricity Export Connection ranged from 21.0 to 34.9mg/l.

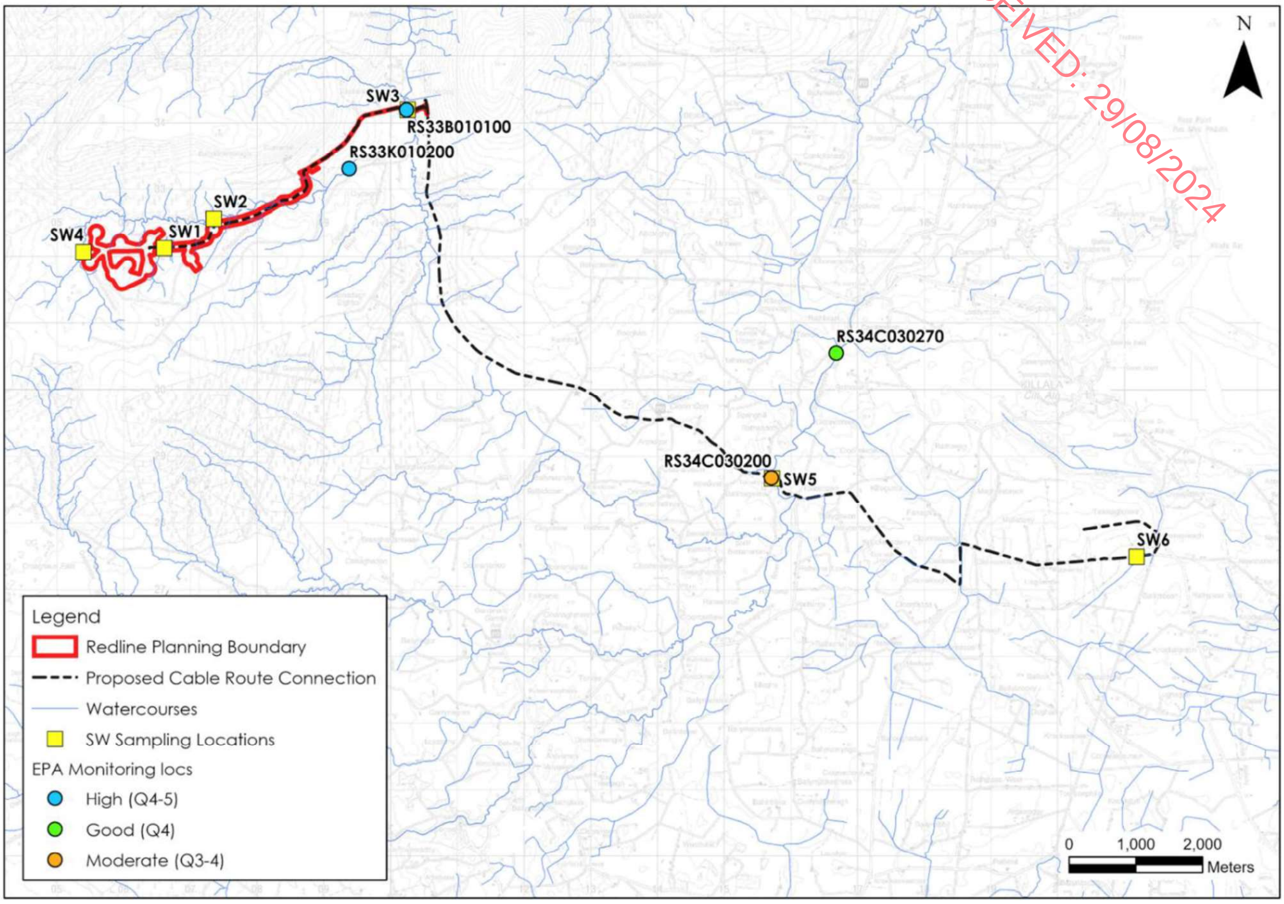

Figure 7.5: EPA Monitoring Locations and HES Sampling Locations

7.3.8 Regional Hydrogeology

7.3.8.1 Wind Farm Site

The Dinantian (early) Sandstones, Shales and Limestones of the Downpatrick Formation, which are mapped beneath the majority of the Wind Farm Site are classified by the GSI as a Poor Aquifer – Bedrock which is generally unproductive except for local zones (Pl). Meanwhile, the Dinantian Pure Bedded Limestones of the Moyny Point Limestone Member are classified as being a Locally Important Karstified Aquifer. A bedrock aquifer map is shown as Figure 7.6.

The Wind Farm Site is underlain by the Belmullet Groundwater Body (GWB) (IE_WE_G_057) which is characterised by poorly productive bedrock. According to the GSI's GWB Characterisation Report (GSI, 2004), the GWB is composed primarily of low transmissivity rocks. Most groundwater flow will occur in the uppermost broken and weathered part of the aquifer and in the vicinity of fault zones. Groundwater recharge occurs diffusely through the subsoils; however, recharge is limited by peat and the low permeability bedrock. Groundwater flowpaths are short (30-300m) with groundwater discharging rapidly to nearby streams and small springs. Groundwater flow directions will follow local topography, with the overall flow direction being towards the coast.

7.3.8.2 Underground Electricity Export Connection

The western section of the Underground Electricity Export Connection is underlain by a Poor Bedrock Aquifer and the Belmullet GWB as described above.

Meanwhile, the eastern section is underlain by a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (LI). This section of the Underground Electricity Export Connection is underlain by the Bellacorick-Killala GWB (IE_WE_G_0041) which is characterised by poorly productive bedrock.

The GSI's GWB Characterisation Report (GSI, 2004) states that this GWB is comprised of low transmissivity rocks. Most groundwater flow will occur in the uppermost broken and weathered part of the aquifer and in the vicinity of fault zones. Flow paths are likely to be up to 300m, with groundwater discharging rapidly to nearby streams and small springs. Overall groundwater flow direction is to the west.

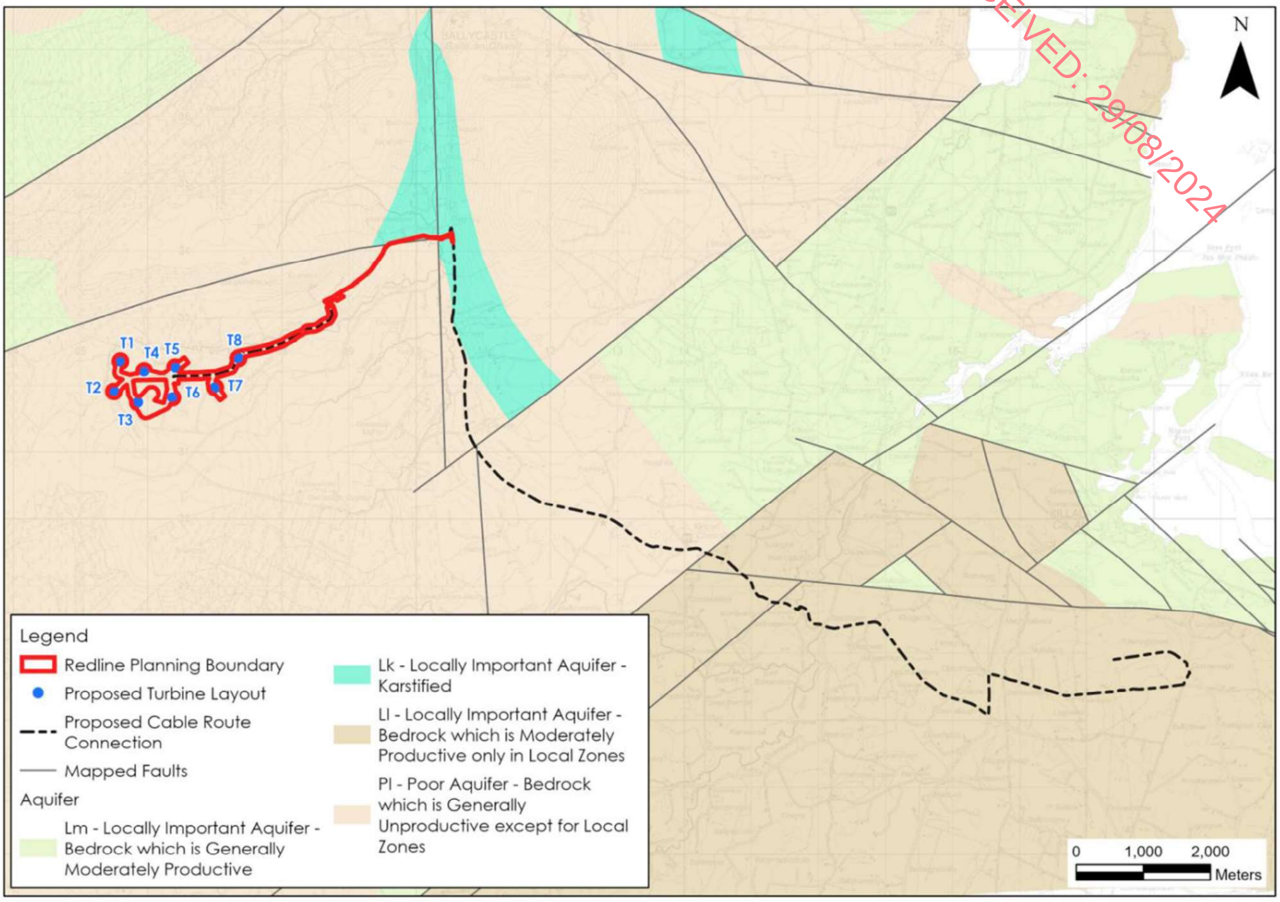

Figure 7.6: Bedrock Aquifer Map (www.gsi.ie)

7.3.9 Wind Farm Site Hydrogeology

Due to the presence of cutover blanket peat at the Wind Farm Site and the bulk low permeability of the underlying mineral subsoil deposits (silt dominated), local groundwater recharge will be minimal. Groundwater recharge is likely to be limited to areas where the peat is thin or absent i.e. along the Keerglen and Ballinglen river valleys.

Groundwater movement through the underlying subsoil deposits will be relatively slow unless higher permeability sands or gravels are present. IDL completed 15 no. trial pits at the Wind Farm Site, including 9 no. trial pits at the proposed wind turbine locations, on 4th and 5th April 2023. A summary of the trial pit logs and groundwater strikes at the proposed wind turbine locations are shown in Table 7.10.

Groundwater strikes were recorded at 4 no. proposed turbine locations. The groundwater strikes generally occurred where more granular subsoils including SAND and GRAVELS were encountered, although several strikes were also recorded in the more cohesive SILT deposits.

Table 7.10: Trial Pits Logs and Groundwater Strikes (FT, 2023)			
Wind Turbine No	**Total Depth of TP (m)**	**Groundwater Ingress (mbgl)**	**Lithology in which ingress occurred**
T1	3.4	2.8	Slightly sandy slightly gravelly SILT
T2	3.6	2.7	Slightly sandy gravelly SILT with occasional cobbles
T3	3.0	2.5	Slightly sandy silty GRAVEL with occasional cobbles
T4	3.5	0.5	Pseudo fibrous PEAT
		1.3	Slightly sandy gravelly SILT with occasional cobbles
		3.4	Gravelly silty SAND with occasional cobbles
T5	4.5	None	TP dry on excavation
T6	2.7	None	TP dry on excavation
T7	4.5	None	TP dry on excavation
T8	4.5	None	TP dry on excavation

Groundwater level monitoring was also completed along 2 no. piezometer transects located in the vicinity of T1 (Transect 2) and T2 (Transect 1). Each transect comprised of 3 no. piezometer couples with deep and shallow piezometers. Manual water level monitoring was completed on 6 no. occasions between 13th May 2022 and 19th April 2023. The recorded water levels are presented in Table 7.11 The water level monitoring data shows that groundwater follows surface topography and flows to the west/northwest before discharging into the Keerglen River. Please note that T2P3 and T2PH3 along Transect 2 were damaged and no water levels were recorded in these piezometers. Nevertheless the data recorded from the other 5 no. piezometer couples provides adequate water level data to show that the water levels in the peat are subsoils are, as expected, falling towards the Keerglen River.

The locations of the piezometer transects are shown on Figure 7.7.

Table 7.11: Groundwater Level Monitoring in Piezometers (13/05/22 to 19/04/2023)							
Location	**Deep/Shallow**	**WL (mOD)**					
		13/05/2022	**02/08/2022**	**21/09/2022**	**29/11/2022**	**29/03/2023**	**19/04/2023**
T1P1	Deep	171.473	171.722	171.743	171.823	171.728	171.723
T1PH1	Shallow	172.068	172.035	171.755	172.115	172.105	172.085
T1P2	Deep	165.363	165.403	165.213	165.483	165.413	165.373
T1PH2	Shallow	165.398	165.418	165.278	165.398	165.378	165.358
T1PH3	Shallow	157.87	157.82	157.79	157.84	157.73	157.81
T1P3	Deep	157.756	157.706	157.746	157.726	157.746	157.746
T2P1	Deep	159.228	159.208	159.223	159.238	159.238	159.228
T2PH1	Shallow	159.343	159.328	159.298	159.343	159.333	159.303
T2P2	Deep	156.675	157.055	157.135	157.155	157.095	157.105
T2PH2	Shallow	157.345	157.36	157.335	157.325	N/A	157.305
T2P3	Deep	N/A	N/A	N/A	N/A	N/A	N/A
T2PH3	Shallow	148.661	N/A	N/A	N/A	N/A	N/A

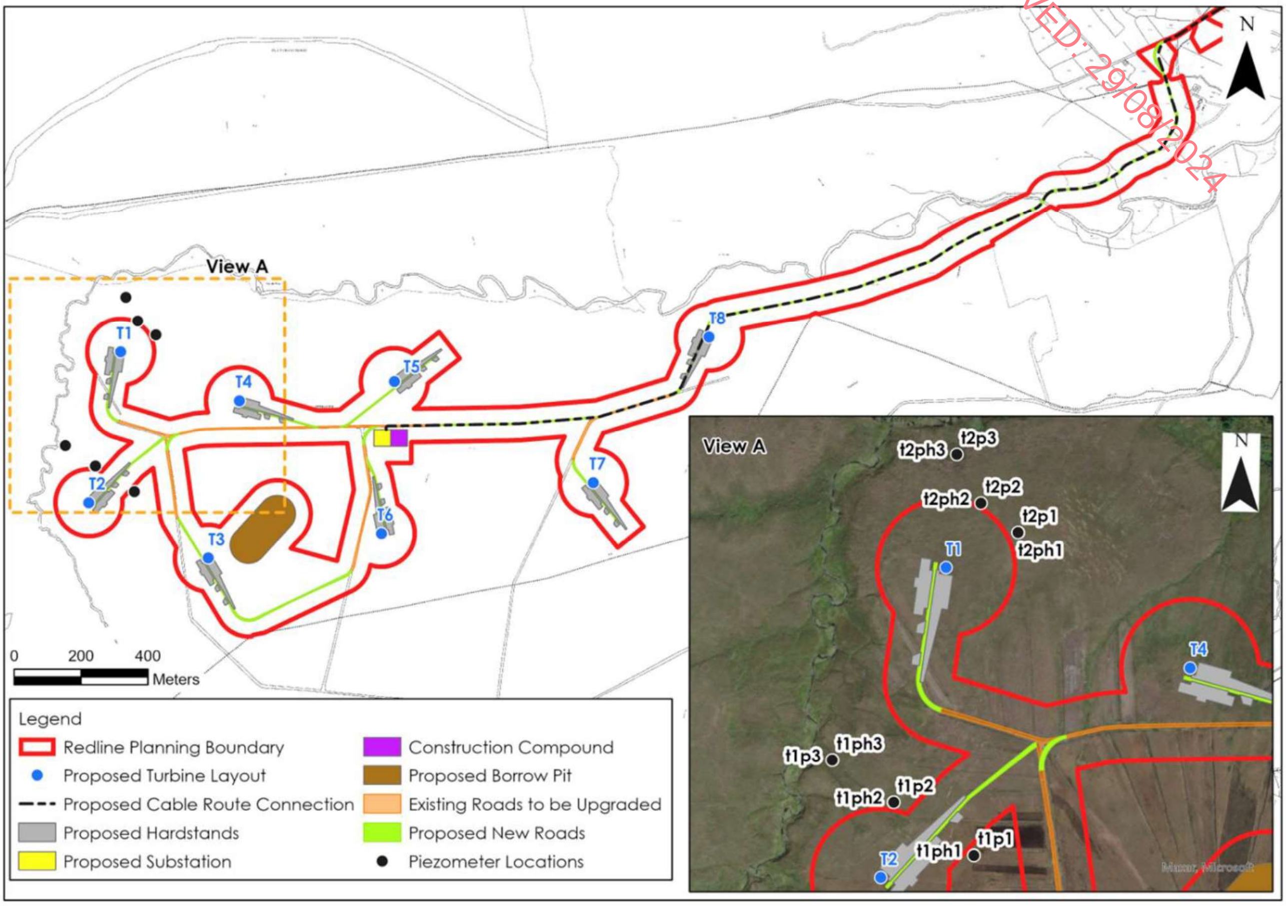

Figure 7.7: Piezometer Transects

7.3.10 Groundwater Vulnerability

7.3.10.1 Wind Farm Site

The GSI describe groundwater vulnerability as a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability embodies the characteristics of the intrinsic geological and hydrogeological features at a site that determine the ease of groundwater contamination. Groundwater vulnerability is related to recharge acceptance, whereby in areas where recharge occurs more readily, a higher quantity of contaminants will have access to groundwater.

The groundwater vulnerability rating of the bedrock aquifer underlying the Wind Farm Site ranges from ‘Low’ to ‘Extreme’. The areas of ‘Extreme’ vulnerability are limited to the immediate vicinity of the Keerglen River channel in the north of the Wind Farm Site. No proposed infrastructure is located in these areas mapped as having ‘Extreme’ groundwater vulnerability, with the exception of the new proposed watercourse crossing over the Keerglen River. Meanwhile, areas in the northeast of the Wind Farm Site, along the main site access road, are mapped as having ‘High’ groundwater vulnerability. All proposed turbines, the borrow pit, substation and welfare facilities are located in areas of ‘Low’ to ‘Moderate’ groundwater vulnerability.

Site investigations at the Wind Farm Site have revealed that the peat depth ranges from 0.2 to 4.8m with an average of 1.59m. The peat is underlain by glacial tills comprising of silts and sands. Bedrock was encountered in 3 no. trial pits at depths of 0.2 to 3.7m. However, based on the site investigation data, depth to rock is likely to be in excess of 4m across much of the Wind Farm Site. Given the thick deposits of low permeability peat at the Wind Farm Site, the groundwater vulnerability is noted to range from 'Low' to 'High' in accordance with Table 7.12. The area of high vulnerability is limited to the elevated ridge of competent sandstone which corresponds to the location of the proposed borrow pit.

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)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable.
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 m below ground surface.

Table 7.12: Groundwater Vulnerability and Subsoil Permeability and Thickness

7.3.10.2 Underground Electricity Export Connection

The GSI mapped groundwater vulnerability rating along the Underground Electricity Export Connection ranges from 'Moderate' to 'Extreme'. A large area of 'Extreme' vulnerability is mapped in the east of the Underground Electricity Export Connection, in the townlands of Mullafarry and Tawnaghmore.

7.3.11 Groundwater Hydrochemistry

7.3.11.1 Wind Farm Site

There are no groundwater quality data for the Wind Farm Site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting, as groundwater quality impacts are unlikely. There are also no proposed discharge to ground associated with the Proposed Development.

The WFD status for the local groundwater body underlying the Wind Farm Site in terms of water quality is 'Good' and therefore this is assumed to be the baseline condition for groundwater underlying the Wind Farm Site.

The GSI's Belmullet GWB Characterisation Report (GSI, 2004) states that there is limited hydrochemical data for this GWB. The data that is available reveals that the groundwater has a Ca-Mg HCO3 signature with alkalinity ranging from 14-400mg/l CaC03, total hardness ranging from 46-412mg/l and conductivity ranging from 160-752µS/cm.

7.3.11.2 Underground Electricity Export Connection

Details on the available hydrochemistry data for the Belmullet GWB which underlies the western section of the Underground Electricity Export Connection is described above.

The GSI's Bellacorick-Killala GWB Characterisation Report (GSI, 2004) states that the groundwater has a calcium bicarbonate signature. However, the available data is sparse.

7.3.12 Water Framework Directive

The River Basin Management Plan was adopted in 2018 and has amalgamated all previous river basin districts into one national river basin management district. The River Basin Management Plan (2022 - 2027) objectives, which have been integrated into the design of the Proposed Development, include the following:

- Ensure full compliance with relevant EU legislation;
- Build on the achievements of the 2nd Cycle;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least 'good' status by 2027;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at (1) targeting water bodies close to meeting their objectives and (2) addressing more complex issues that will build knowledge for the third cycle.

Our understanding of these objectives is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. Furthermore any development must not in any way prevent a waterbody from achieving at least good status by 2027.

Strict mitigation measures (refer to Section 7.6) in relation to maintaining a high quality of surface water runoff from the development and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the Proposed Development Site will be at least maintained (see below for WFD water body status and objectives) regardless of their existing status.

7.3.13 Groundwater Body Status

Local Groundwater Body (GWB) status information and reports are available at www.catchments.ie.

The Belmullet and the Bellacorick-Killala GWBs both achieved "Good" status in all 3 no WFD cycles (2010-2015, 2013-2018 and 2016-2021). These GWBs have been deemed to be "not at risk" of failing to meet their respective WFD objectives. No significant pressures have been identified to be impacting these GWBs.

Summary WFD information for the GWBs underlying the Proposed Development Site is presented in Table 7.13 below.

Table 7.23: WFD Groundwater Body Status					
GWB	**Overall Status 2010-2015**	**Overall Status 2013-2018**	**Overall Status 2016-2021**	**3rd Cycle Risk Status**	**WFD Pressures**
Belmullet	Good	Good	Good	Not at risk	None
Bellacorick-Killala	Good	Good	Good	Not at risk	None

7.3.14 Surface Water Body Status

A summary of the WFD status and risk result of Surface Water Bodies (SWBs) in the vicinity and downstream of the Wind Farm Site and the Underground Electricity Export Connection are shown in Table 7.14 below.

The Keerglen_010 SWB achieved 'Moderate' status in the latest WFD cycle (2016-2021). This was a deterioration from the 'High' status which this SWB achieved in the 2 no. preceding cycles. The Keerglen_010 SWB is listed as a high ecological status waterbody and is therefore not currently meeting this objective. The Keerglen_010 SWB discharges into the Ballinglen_010 SWB which achieved 'Poor' status in the latest WFD cycle. Further downstream the Ballinglen_020 SWB achieved 'Moderate' status.

The risk status of the Keerglen_010 and Ballinglen_010 SWBs is currently under review. Meanwhile, the Ballinglen_020 has been deemed to be 'at risk' of failing to meet its WFD objectives. Whilst no significant pressures have been identified on the Ballinglen_020 SWB, anthropogenic pressures are listed as impacting the Ballinglen_010 SWB. The draft 3rd cycle WFD Catchment report (EPA, 2021) states that this SWB has experienced a "*decline in both salmon and trout number. The pressure is unknown but siltation is expected to be an issue*". In relation to the Ballinglen_020 SWB the draft catchment report states that there is a possible pressure associated with a Wastewater Treatment Plant, although this requires confirmation.

Meanwhile, within the Moy and Killala Bay catchment and in the vicinity of the Underground Electricity Export Connection, the Breaghwy_010, Cloonaghmore_040 and Cloonaghmore_050 SWBs achieved 'Good' status in all 3 no. WFD cycles. In the vicinity of Killala Business Park, the Moyne_010 SWB achieved 'Moderate' status. The Breaghwy_010, Cloonaghmore_040 and Cloonaghmore_050 SWBs have been deemed to be 'not at risk' of failing to meet their respective WFD objectives. The risk status for the Moyne_010 is currently under review. No significant pressures have been identified on these SWBs.

Table 7.14: WFD Surface Waterbody Status					
SWB	**Overall Status 2010-2015**	**Overall Status 2013-2018**	**Overall Status 2016-2021**	**3rd Cycle Risk Status**	**WFD Pressures**
Keerglen_010	High	High	Moderate	Under Reiver	None
Ballinglen_010	Moderate	Moderate	Poor	Under Review	Anthropogenic
Ballinglen_020	Moderate	Good	Moderate	At risk	(Possible WwTP)
Breaghwy_010	Good	Good	Good	Not at risk	None
Cloonaghmore_040	Good	Good	Good	Not at risk	None
Cloonaghmore_050	Good	Good	Good	Not at risk	None
Moyne_010	Unassigned	Good	Moderate	Under Review	None

7.3.15 Water Resources

7.3.15.1 Groundwater Resources

The GSI do not map the presence of any National Federation registered Group Water Schemes (GWS) or Public Water Schemes (PWS) or an associated Source Protection Area (SPA) within the Wind Farm Site, in the surrounding lands or in the vicinity of the Underground Electricity Export Connection (www.gsi.ie).

The closest mapped GWS is the Crossmolina Eskeragh GWS, located ~13km southeast of the Wind Farm Site. The closest mapped PWS is the Killasser GWS, located ~36km southeast of the Wind Farm Site.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie) and this indicates that there are no wells within 4km of the Wind Farm Site. The closest mapped well is located in the townland of Ballybeg, approximately 5km east of the Wind Farm Site. The well (GSI Name: 1133SWW004) is listed as having a yield of 21.8m^3/day and has agricultural and domestic uses.

We accept that the GSI database does not include all potential water wells. As such, and in order to be conservative, for the purposes of assessment (as completed in Section 7.6.1.13), we assume that there is a groundwater well source at each potential local house location.)

A map of nearby mapped groundwater wells is included as Figure 7.8.

7.3.15.2 Surface Water Resources

The Draft 3rd Cycle Blacksod-Broadhaven Catchment Report (EPA, 2021) states that there are 2 no. SWBs in the catchment which are identified as Drinking Water Protected Areas (DWPAs). These DWPAs are not located downstream of the Wind Farm Site or the Underground Electricity Export Connection.

The Draft 3rd Cycle Moy and Killala Bay Catchment Report (EPA, 2021) states that there are 9 no. DWPAs in this catchment. However, none of these SWBs are located downstream of the Underground Electricity Export Connection.

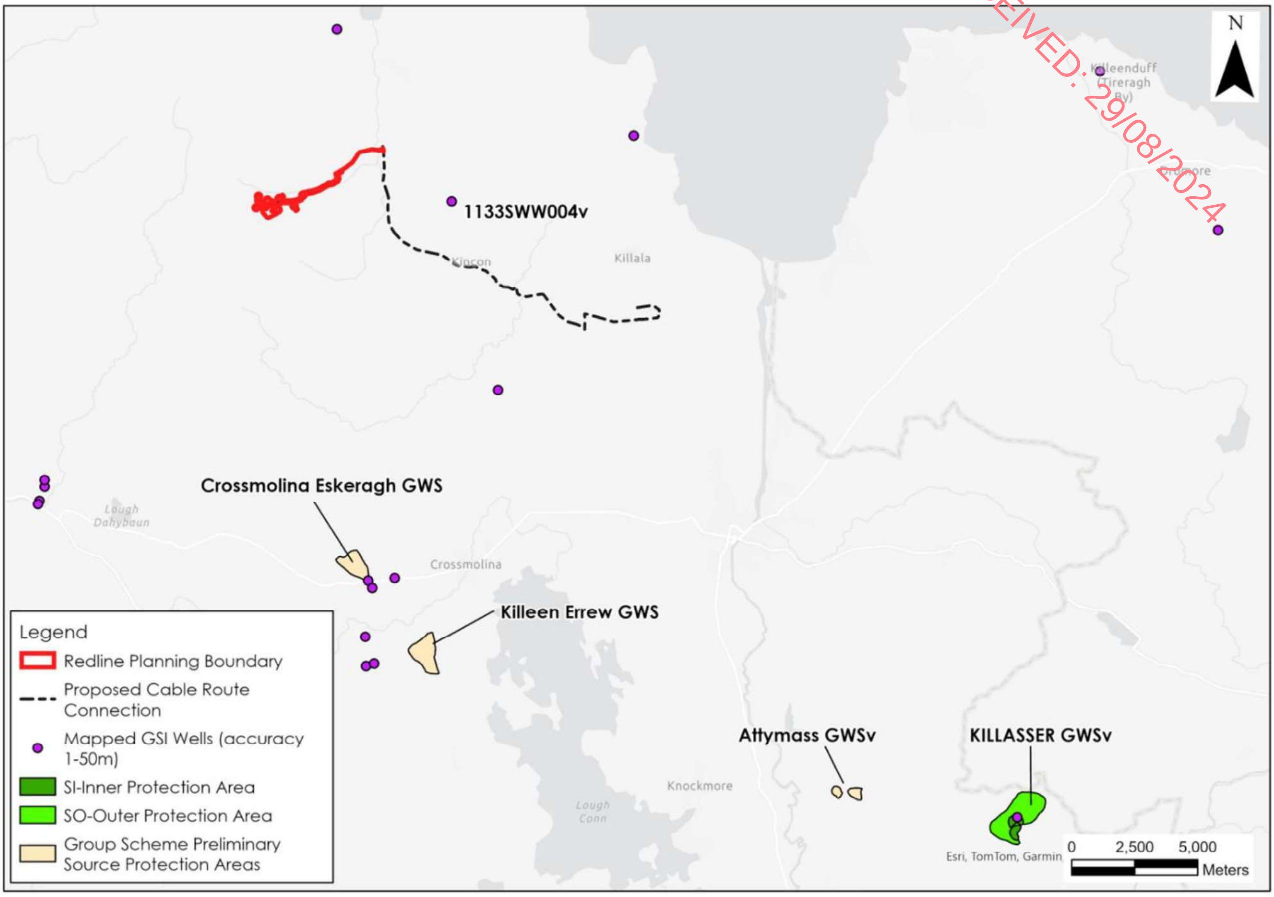

Figure 7.8: Groundwater Resources and Local Mapped Wells (www.gsi.ie)

7.3.16 Designated Sites and Habitats

7.3.16.1 Wind Farm Site

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

Within the Blacksod-Broadhaven surface water catchment the only designated sites with the potential to be impacted by the Proposed Development will occur downstream of the site along the Keerglen and/or Ballinglen Rivers. However, no designated sites are mapped downstream of the Wind Farm Site.

Ummerantarry Bog NHA (Site Code: 001570) is located in the west of the overall Keerglen landholding. This designated site is located to the west of the Fiddauncushaneen stream and the Keerglen River. The site is considered of conservation importance as it contains intact upland blanket bog and wet heath and features pool systems, flushes and undisturbed blanked bog. The site also contains the Breeding Golden Plover, a species listed in the Irish Red Data Book. The site was originally part of an extensive upland bog habitat which has largely been destroyed by peat cutting and afforestation.

The Glenamoy Bog Complex SAC (Site Code: 000500) is located ~1km northeast of the Wind Farm Site. This SAC is of ecological importance due to a number of E.U. Annex I habitats, including two priority habitats

– blanket bog and machair. The site also supports populations of Habitats Directive listed plant and animal species. The SAC stands at a significant elevation above the Ballinglen River (~149m). Surface and groundwater will flow from the SAC towards the Ballinglen River. Therefore the SAC has no potential to be affected by the Proposed Development.

Other designated sites within 5km of the Wind Farm Site include:

- Bellacorick Bog Complex SAC/pNHA (Site Code: 001922), located ~3.5km to the south. This designated site is not located in the same sub-catchment as the Wind Farm Site.
- Inagh Bog NHA (Site Code: 002391), located ~3.5km to the northwest. This designated site is not located in the same sub-catchment as the Wind Farm Site.
- Glenamoy Bog Complex pNHA (Site Code: 00500), located ~4.5km to the northwest. While located in the same surface water sub-catchment, no hydrological linkages exist between the wind farm site and the pNHA.

A map of local designated sites is shown as Figure 7.9.

7.3.16.2 Underground Electricity Export Connection

Within the Moy-Killala Bay surface water catchment the only designated sites with the potential to be impacted by the Proposed Development will occur downstream of the Underground Electricity Export Connection along the Cloonaghmore River or the Moyne stream.

The Killala Bay/Moy Estuary SPA (Site Code: 004036), SAC/pNHA (Site Code: 000458) exist downstream along the Cloonaghmore River and the Moyne_010 SWBs.

The Killala Esker pNHA (Site Code: 001517) is located ~700m north of Killala Business Park and Tawnaghmore 110kV substation.

A summary of the hydrological and hydrogeological connectivity between the Proposed Development and nearby designated sies is summarised in Table 7.5.

Table 7.15: WFD Surface Waterbody Status

Designated Site	Minimum Distance to Site from EIAR Boundary	Hydrological Connectivity to Designated Site	Groundwater Connectivity to Designated Site
Ummerantarry Bog NHA	~50m to the west of the Wind Farm Site	None - Keerglen River acts as a hydrological barrier	None – All local groundwater discharges to the Keerglen River
Glenamoy Bog Complex SAC	~600m to the northwest of the L51723	None – All works are located downgradient of the SAC	None – all works are located downgradient of the SAC
Bellacorick Bog Complex SAC/pNHA	~3.3km to the south of the Wind Farm Site	None – Located in a separate catchment to the Wind Farm Site. Meanwhile, the SAC/pNHA is located upgradient of the Underground Electricity Export Connection	None – no works are located upgradient of the SAC/pNHA
Inagh Bog NHA	~3.5km to the west of the Wind Farm Site	None – Located in a separate catchment to the Wind Farm Site	None – no works are located upgradient of the NHA
Killala Bay/Moy Estuary SPA	~2.6km downstream of the Underground Electricity Export Connection	Hydrological Connection via the Moyne Stream and the Cloonaghmore River	Limited due to the shallow nature of the proposed works along the Underground Electricity Export Connection
Killala Bay/Moy Estuary SAC	~2.6km downstream of the Underground Electricity Export Connection	Hydrological Connection via the Moyne Stream and the Cloonaghmore River	Limited due to the shallow nature of the proposed works along the Underground Electricity Export Connection
Killala Esker pNHA	~700m north of the end of the Underground Electricity Export Connection at Tawnaghmore Substation	None – Moyne Stream acts as a hydrological barrier	None – All groundwater flows will discharge into the local surface watercourses.

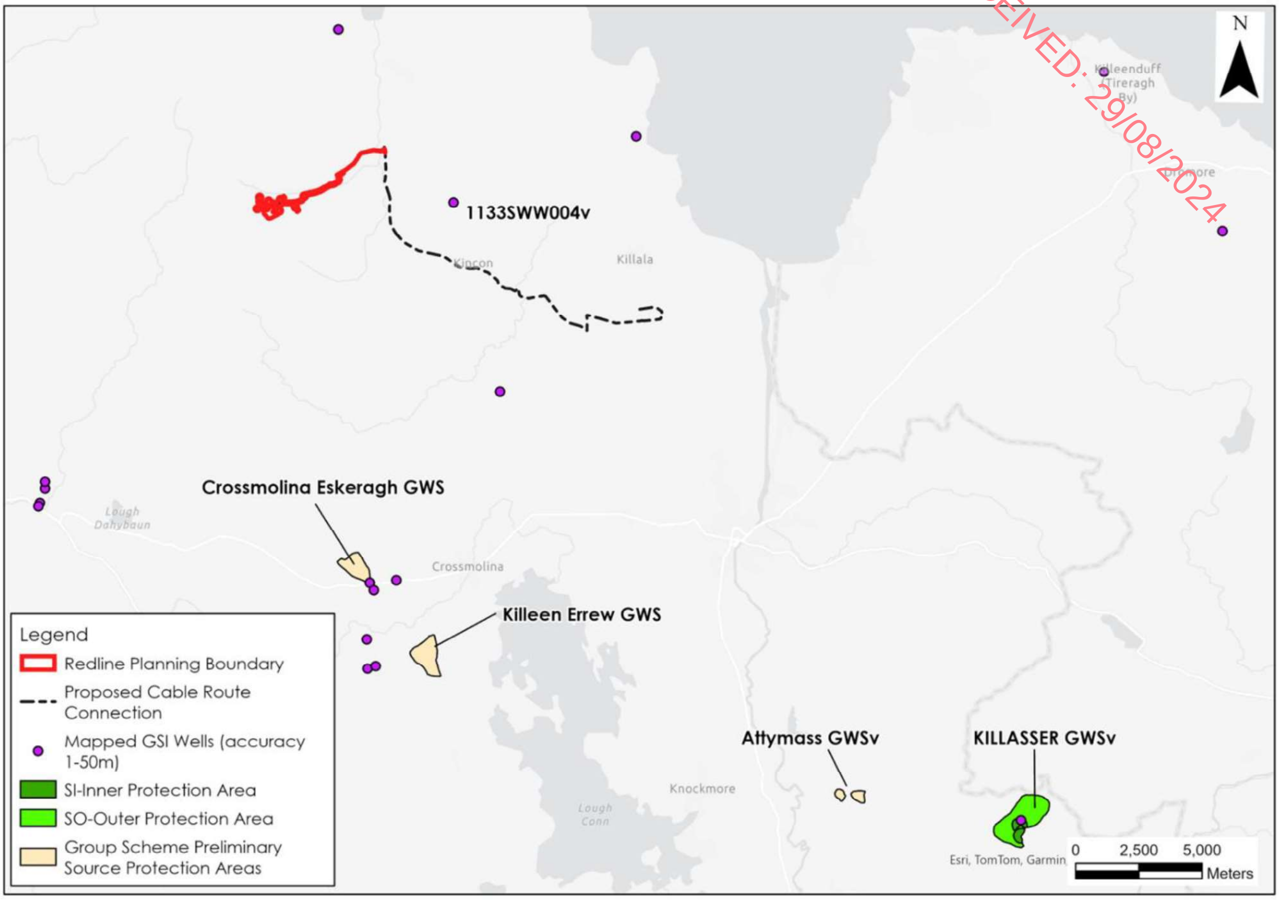

Figure 7.9: Designated Sites Map

7.3.17 Receptor Sensitivity

7.3.17.1 Land, Soils and Geology

This section discusses the sensitivity of the receiving land, soils and geological environment in terms of the Proposed Development and identified those sensitive receptors which will be carried forward into the impact assessment.

The land (land-take), peat, soils, subsoils and bedrock geology at the Proposed Development site will be included in the impact assessment due to their proximal location to the Proposed Development and the potential direct effects that the Proposed Development may have on these receptors.

The Killala Area CGS will also be included in the assessment as the Underground Electricity Export Connection is located within this geological heritage area. The Killala Areas CGS can be considered to be of High Importance due to the presence of a geological feature which has a high value on a local scale.

All other geological heritage areas have been screened out due to the nature of these sites and their distant location from the Proposed Development. There is no potential for effects to occur on these designated sites.

7.3.17.2 Hydrology and Hydrogeology

This section discusses the sensitivity of the receiving hydrological and hydrogeological environment in terms of the Proposed Development and identifies those receptors which will be carried forward into the impact assessment.

Due to the nature of wind farm and Underground Electricity Export Connection developments, being near surface construction activities (i.e. shallow excavations and foundations), effects on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments.

However, general construction works have the potential to contaminate groundwaters with hydrocarbons and cement-based products being used at the Proposed Development site. The following groundwater receptors are identified for impact assessment.

- The Poor Aquifer underlying the Wind Farm Site (Low Importance – refer to **Table 7.2**);
- The Locally Important Aquifer underlying the Underground Electricity Export Connection (Medium Importance – refer to **Table 7.2**);
- The WFD status of the GWBs underlying the Proposed Development site (i.e. Belmullet GWB and Bellacorick-Killala GWB); and,
- Local private groundwater abstractions in the lands surrounding the Proposed Development site.

Surface waters are the main sensitive receptors associated with the Proposed Development, due to the local hydrological regime which is characterised by high runoff rates and low rates of groundwater recharge. The primary potential contamination downstream surface waters are via elevated concentrations of suspended solids and nutrient enrichment.

The quantification of flow volumes presented in Section 7.3.4.2 indicates that the watercourses in the immediate vicinity of the Wind Farm Site (*i.e.* the Keerglen River and its tributaries) will be most susceptible to potential effects. Further downstream, the Ballinglen River will be less susceptible to potential effects (due to larger flow flows) but nevertheless will be screened in due to its proximal location to the Proposed Development. The Keerglen and Ballinglen rivers can be considered to be of Very High Importance based on their assigned Q-rating values (refer to Table 7.7) In terms of the Underground Electricity Export Connection, all watercourses along the Underground Electricity Export Connection will be screened in due to their close proximity to proposed works. The Cloonaghmore River can be considered to be of High to Very High Importance based on its assigned Q-rating values. Further downstream, the estuarine and coastal waters will be less susceptible to potential effects due to their saline nature and the large volumes of waters within these waterbodies.

The following surface water receptors are identified for impact assessment:

- The local surface waters downstream of the Wind Farm Site, including the Keerglen River and its tributaries and the Ballinglen River;
- The local surface waters downstream of the Underground Electricity Export Connection, including the Ballinglen and Cloonaghmore Rivers and the Moyne_010 SWB; and

- The WFD status of the SWBs in the vicinity and downstream of the Proposed Development site.

7.3.17.3 Designated Sites

In terms of designated sites, the Ummerantarry Bog NHA will be screened in due to its proximal location to the proposed works.

The Killala Bay/Moy Estuary SPA (Site Code: 004036) and SAC/pNHA (Site Code: 000458) will be included in the impact assessment due to its location downstream of the Underground Electricity Export Connection along the Cloonaghmore Estuary.

All other designated sites have no potential to be impacted by the Proposed Development due to the lack of hydrological and hydrogeological connections.

7.4 Characteristics of the Proposed Development

The Proposed Development is defined in full in Chapter 3.

In summary the Proposed Development will comprise of 8 no. wind turbines (Turbine tip height range between 176 and 180m, hub height range between 105 and 112 and rotor diameter range between 133 and 150m) and associated hardstanding areas, 1 no. electricity substation, 1 no. borrow pit, 1 no. temporary construction compound, upgrade of existing roads, construction of new site access roads, road widening and accommodation works along the turbine delivery route, site drainage and all associated works. In addition, this EIAR assessed the proposed Underground Electricity Export Connection to the existing Tawnaghmore ESB Substation or a Large Energy User at Killala Business Park and the installation of 1 no. temporary meteorological mast at the Wind Farm Site (note that these will be subject to separate planning permissions in the future but are assessed in this EIAR).

7.4.1 Earthworks and Extraction Volumes

FTC have prepared a Peat and Spoil Management Plan (FTC, 2024)) which describes how peat and spoil, which will be excavated from infrastructure locations, will be handled and placed/reinstated onsite. The Peat and Spoil Management Plan is attached as Appendix 8.2.

The Proposed Development will involve removal of peat, subsoils and in places bedrock for access roads, internal access road networks, internal cable network, hardstanding emplacement, turbine foundations, substation, crane hardstands, construction compound and drainage works. Rock for construction purposes will be sourced from the proposed onsite borrow pit.

Generally, for constructing any structure or platform foundation, such as a turbine base, hardstand or substation, removing all soft material is required to a depth where a suitable bearing material is encountered. Hardcore materials will be extracted from the borrow pit principally by means of rock breaking. The material excavated is required to be properly managed and stored and will be re-used in other elements of the proposed wind farm design.

During turbine construction, peat will be permanently excavated to the substrate to make room for the concrete turbine foundation and a small working area surrounding the foundation footprint. Turbine bases in the range of 25m in diameter are proposed, with detailed foundation design dictated by the local ground conditions and the requirements of the turbine supplier. The plan area of the material to be removed will be dictated by the enabling temporary works design, allowable excavation angle and the mean peat and overburden depths across each turbine location. The design of the turbine base foundations is subject to further ground investigation and the detailed design designer's assessment. Due to the presence of some areas of deep peat some turbine bases may require a piled foundation following confirmatory ground investigations.

Similarly, all turbine crane hardstands, substation, construction compound etc. will be required to be founded on a suitable bearing material requiring the excavation of all peat and other soft ground materials, where present. The platform will be constructed in the excavated area using a suitable specified engineered stone fill. Following the placement of the platform, the excavated peat can be re-used to batter the platform edges and landscape the platform back into the existing topography. The construction grade granular fill will be sourced from off-site quarries.

The total volume of peat and spoil requiring placement/reinstatement at the Wind Farm Site is estimated to be 197,500m³ and 41,100m³ respectively (refer to Table 7.36 below).

There is the capacity to store a total of 195,000m³ of peat and spoil at the borrow pit, whilst 16,000m³ may be used for landscaping around the proposed turbines (it is estimated that ~2,000m³ will be required for landscaping purposes at each turbine location) and there is the capacity to store 36,500m³ in peat placement areas along the site access roads. Therefore, the capacity of the placement/reinstatement areas (327,500m³) is greater than the volume of material which will be generated by the Proposed Development (238,600m³).

It is proposed to obtain some of the hardcore material that will be required during the construction phase of the Proposed Development from the on-site borrow pit. Usable rock may also be won from other infrastructure depending on local ground conditions (i.e. the extraction of rock may be required in order to obtain a level construction area). Any rock obtained from a turbine location will be used to supply the hardcore materials requirement for that turbine's hardstand and access road. Any aggregate material due to a requirement for specific grade, quality or quantity may be sourced from suitable licenced quarries in the local area.

Table 7.36: Estimated Peat and Spoil Excavation Volumes (FTC, 2024)

Infrastructure Element	Peat volume (m³)	Spoil volume (m³)
8 no. turbines and hardstands	55,000	12,000
Access roads	90,000	6,500
Substation	5,000	600
Borrow Pit	47,500	22.000
Total (m³)	**197,500**	**41,100**

Table 7.4: Summary of Peat Placement Areas (FTC, 2024)

Infrastructure Element	Peat volume (m³)	Comment
Borrow Pit	195,000	-
Peat Placement along Access roads	36,500	1m high and 15m wide placement area along the upslope side of founded roads where slopes are shallow (<5°)
Landscaping	16,000	2,000m³ of peat will be required for landscaping at each of the turbine locations
Total	**327,500**	-

7.4.2 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against effects on surface water bodies. Two distinct methods will be employed to manage drainage water within the Wind Farm Site. The first method involves 'keeping clean water clean' by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the Wind Farm Site that might carry silt or sediment, and nutrients, to route them towards settlement ponds (or stilling ponds) prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters.

During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated to a high quality prior to being released.

During the construction phase, all runoff from works areas (i.e. dirty water) will be slowed down and treated to a high quality prior to being released. A schematic of the proposed site drainage management is shown as Figure 7.10 below. A detailed drainage plan showing the layout of the proposed drainage design elements is shown in Appendix 7.5 of the EIAR.

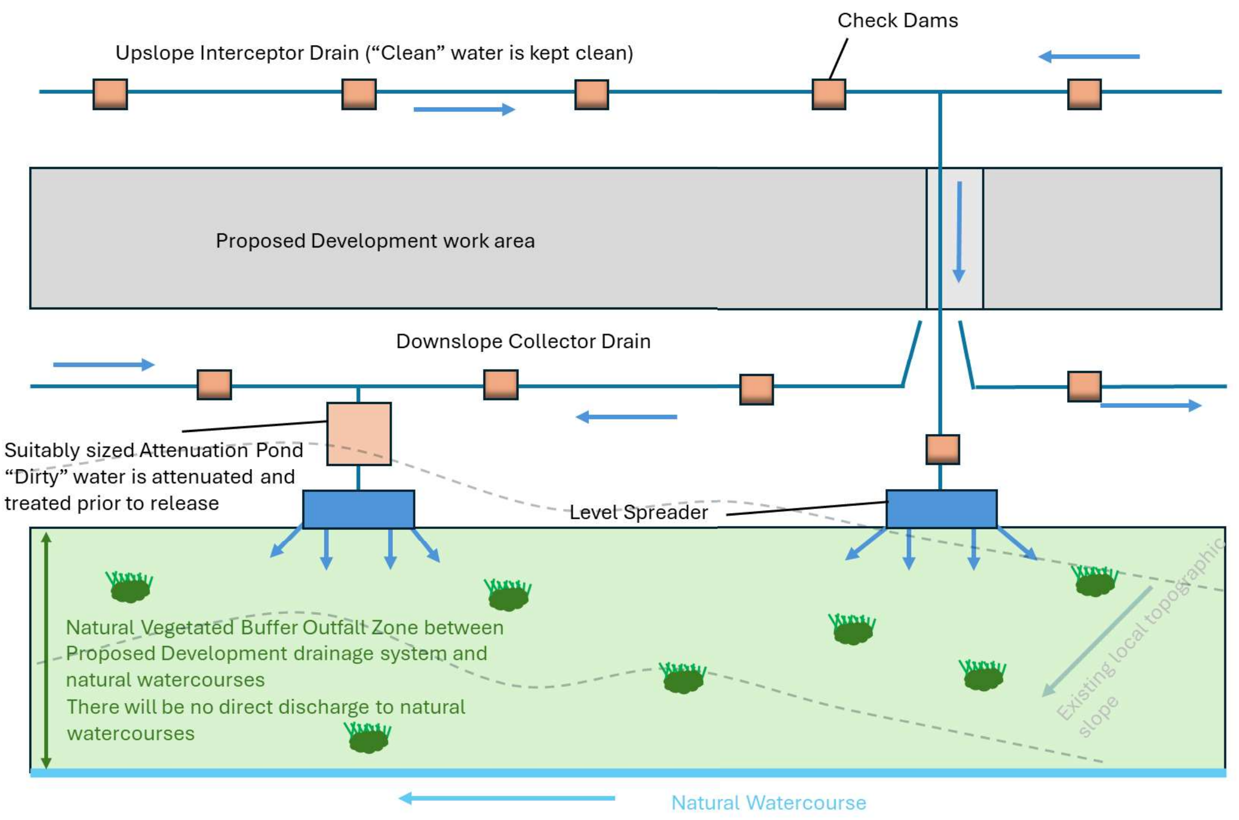

Figure 7.10: Schematic of Proposed Drainage Layout

7.4.3 Development Interaction with Existing Site Drainage Network

In relation to hydrological constraints, a self-imposed buffer zone of 50m has been put in place for on-site natural streams and rivers. Manmade drains at the Wind farm Site are not considered a hydrological constraint and therefore no buffering of these drains has been undertaken.

The best practice design approach to wind farm layouts in existing forestry is to utilise and integrate with the existing infrastructure where possible, whether it be existing access roads or the existing forestry drainage network. Utilising the existing infrastructure means that there will be less requirement for new construction/excavations, which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing manmade drains have no major ecological or hydrological value and can be readily integrated into the proposed wind farm drainage scheme.

In order to integrate the proposed wind farm drainage with the existing drainage (as per the drainage plans included in Appendix 7.5) the following design approach has been implemented:

- Lidar data was used to map in detail the existing drainage at the site and how the proposed infrastructure interacts with this existing drainage. Using these Lidar data potential runoff pathways that are >150m in length have been mapped;
- Lidar data and available aerial photography was used to digitise existing drains within the development area;
- The Proposed Development footprint was divided up into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates were calculated for each catchment based on the 10-year return period rainfall event. These flows are used to design settlement ponds for each drainage catchment;
- Settlement pond(s) required for each development footprint catchment have been designed, and a location has been identified for each proposed pond;
- Cut-off (interceptors drains) are included to locally re-route to existing drains;
- The proposed construction phase settlement ponds are designed for 11hr and 24hr retention times used to settle out medium silt (0.006mm) and fine silt (0.004mm) respectively (EPA, 2006); and,
- The proposed locations of temporary drainage measures that will be installed prior to wind farm construction commencing are identified on the drainage plans.

7.5 Likely Significant Potential Effects

7.5.1 Do Nothing Scenario

If the Proposed Development were not to proceed, the opportunity to generate renewable energy and electrical supply to the national grid would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

If the Proposed Development were not to proceed, the existing land use practices of turbary peat cutting and grazing of cattle would likely continue at the Wind Farm Site.

In terms of hydrology, the existing surface water drainage regime would continue to function and may be extended in places.

7.5.2 Construction Phase Effects

This section identifies the likely significant effects of the construction phase of the Proposed Development and lists the proposed mitigation measures that will be put in place to eliminate or reduce any potential effects. It should be noted that the main potential effects on the hydrological and hydrogeological environment will occur during the construction phase.

7.5.2.1 Effects on Land (Land-Take)

The Proposed Development includes the construction of 8 no. turbines, associated hardstand areas, temporary construction compound, an onsite substation, new access roads and upgrades to the existing road network. The Proposed Development has a total footprint of ~4.8ha (47,855m^2).

These works will result in a change in the land environment within these areas. For example, the proposed development works will result in the loss of upland cutover peat bog as these areas will be replaced by turbine bases, hardstand areas, access roads and other related infrastructure. In addition, ~0.005ha (50m^2) of forestry will be permanently felled to facilitate the Proposed Development. Therefore, the Proposed Development will result in the loss of both upland cutover bog and forestry plantations. The Proposed Development construction works will also result in local topographic changes associated with the removal of overburden.

There will be no effects on the lands adjoining the Wind Farm Site.

Furthermore, no effects on land will occur along the Underground Electricity Export Connection as all works will occur within the carriageway of the existing public road network.

Pathways: Excavation and infrastructure construction.

Receptors: Land (i.e. land upon which the Proposed Development will occur).

Pre-Mitigation Potential Effect: Negative, slight, direct, permanent, likely effect on land (land-take).

7.5.2.2 Contamination of Soil by Leakages and Spillages

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk. The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e., contamination of peat, subsoils and pollution of the underlying aquifer) on the geological and water environment.

Additionally, waste tar removed from the road hardstanding along the Underground Electricity Export Connection will have the potential to affect soil/subsoil geochemistry.

Pathways: Peat, subsoil and underlying bedrock pore space.

Receptors: Peat, subsoil and bedrock.

Pre-Mitigation Potential Effect: Negative, direct, slight, likely, short-term effect on soil, subsoil and bedrock.

7.5.2.3 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including access road construction, turbine base / hardstand construction, construction compound construction, met mast construction, substation construction, cable route works will require varying degrees of earthworks resulting in excavation of peat, mineral subsoil and bedrock where present. It is estimated that construction works will require the excavation of peat and non-peat materials within the Wind Farm Site which will be a significant source of sediment laden water.

Excavation of the Underground Electricity Export Connection trench, ~2m (w) x 1.2m (h), will also require excavation of soils/subsoils.

Potential sources of sediment-laden water include:

- Drainage and seepage water resulting from excavations;
- Stockpiled excavated material providing a point source of exposed sediment; and,
- Erosion of sediment from emplaced site drainage channels.

These activities, if unmitigated, will likely result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects are significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors:

Wind Farm Site: All watercourses within the vicinity and downstream of the Wind Farm Site (Keerglen River and its tributaries and the Ballinglen River) and associated water-dependent ecosystems.

Underground Electricity Export Connection: Downgradient watercourses including the Ballinglen and Cloonaghmore rivers and relevant tributaries and the Moyne stream.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, likely effect in the downstream watercourses and associated water-dependent ecosystems.

7.5.2.4 Excavation Dewatering and Potential Effects on Surface Water Quality

Groundwater seepages will likely occur in turbine base, substation and construction compound excavations, within the wind Farm Site, and these will create additional volumes of water to be treated by the drainage management system. Inflows will require management and treatment to reduce suspended sediment concentrations. No contaminated land was noted at the Wind Farm Site, and therefore pollution issues are not anticipated in this respect.

With respect to the Underground Electricity Export Connection, some minor groundwater/surface water seepages will likely occur in trench excavations and this will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted along the underground electrical cabling route therefore pollution issues are not anticipated.

Pathways: Overland flow, Wind Farm Site and Underground Electricity Export Connection drainage networks.

Receptors:

Wind Farm Site: All watercourses within the vicinity and downstream of the Wind Farm Site (Keerglen River and its tributaries and the Ballinglen River) and associated water-dependent ecosystems.

Underground Electricity Export Connection: Downgradient watercourses including the Ballinglen and Cloonaghmore rivers and relevant tributaries and the Moyne stream.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, unlikely effects on surface water quality.

7.5.2.5 Potential Effects on Groundwater Levels During Excavation Works

Small scale temporary dewatering may occur at some excavations (i.e., turbine bases, cable trenches), and these have the potential to temporarily affect local groundwater levels. However, temporary reductions in groundwater levels by short duration and transient dewatering works will be very localised and of small magnitude due to the nature and permeability of the local subsoil and bedrock geology. Groundwater level effects will not be significant due the local hydrogeological regime and the elevation of the Proposed Development Site. Any effects will be temporary and will be contained within the Wind Farm Site.

No groundwater level effects will occur due to works along the Underground Electricity Export Connection due to the shallow nature of the excavation (i.e. ~1.2m), the excavation of the trench within the road carriageway and the unsaturated nature of the subsoil/bedrock to be excavated.

Pathway: Groundwater flow paths.

Receptor: Groundwater levels.

Pre-Mitigation Potential Effect: Negative, indirect, temporary, imperceptible unlikely effects on local groundwater levels within the Wind Farm Site.

7.5.2.6 Potential Effects Associated with Piled Foundations on the Water Environment

Due to the depth of peat at the proposed turbines locations, a range of foundation scenarios are proposed, including:

- Gravity foundations; and
- Piled foundations.

The following potential scenarios arise in respect of proposed piling works:

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

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

Pathway: Groundwater flowpaths (upward and/or downward pathways, and regional groundwater flows).

Receptor: Groundwater quality in the underlying Belmullet GWB and groundwater hydrochemistry at the surface of the within the peat.

Pre-Mitigation Potential Effect: Negative, moderate, direct, short term, likely effect on groundwater quality/hydrochemistry.

7.5.2.7 Potential Release of Hydrocarbons

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons can cause significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. In addition, the accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbons have 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.

Hydrocarbon storage will not occur during the Underground Electricity Export Connection construction as the works are transient. Vehicles will be refuelled before reaching the Underground Electricity Export Connection.

Pathways: Groundwater flowpaths, Wind Farm Site drainage network and Underground Electricity Export Connection drainage network.

Receptors:

Wind Farm Site: Surface water quality in down gradient rivers (Keerglen river and its associated tributaries and the Ballinglen River) and groundwater quality in the underlying bedrock aquifer.

Underground Electricity Export Connection: Downgradient watercourses including the Ballinglen and Cloonaghmore rivers and relevant tributaries and the Moyne stream, and groundwater quality in the underlying bedrock aquifers.

Pre-Mitigation Potential Effects: Negative, indirect, slight, short-term, unlikely effect on local groundwater quality below the Wind Farm Site and the and Underground Electricity Export Connection. Indirect, negative, significant, short term, unlikely effect on surface water quality downstream of the Wind Farm Site and Underground Electricity Export Connection.

7.5.2.8 Potential 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: European Communities (Quality of Salmonid Waters) Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to aquatic species and habitats.

Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to the introduction of high pH alkaline waters into the system. Batching of wet concrete on site and washing out of transport and placement machinery are the activities most likely to generate a risk of cement-based pollution. Placed concrete in turbine bases and foundations can also have minor local effects on groundwater quality over time. However, due to the limited surface area of exposed concrete, the anoxic conditions below ground, and the high rate of dilution from the wider groundwater system relative to the small volumes of groundwater that would come in contact with the concrete, the potential for impacts are low.

Pathway: Wind Farm Site and Underground Electricity Export Connection drainage networks.

Receptors:

Wind Farm Site: Surface water quality in down gradient rivers (Keerglen River and its associated tributaries and the Ballinglen River) and groundwater quality in the underlying bedrock aquifer.

Underground Electricity Export Connection: Downgradient watercourses including the Ballinglen and Cloonaghmore rivers and relevant tributaries and the Moyne stream, and groundwater quality in the underlying bedrock aquifers.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, short term, unlikely effect on surface water quality. Negative, imperceptible, indirect, short-term, unlikely effect on local groundwater quality.

7.5.2.9 Groundwater and Surface Water Contamination from Wastewater Effluent

Release of effluent from on-site (wind farm site and along the underground electricity export connection route) temporary wastewater treatment systems has the potential to impact on groundwater and surface water quality if conditions are not suitable for an on-site percolation unit. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Pathways: Groundwater flowpaths and Wind Farm Site drainage network.

Receptors: Surface water quality in down gradient rivers (Keerglen River and its associated tributaries and the Ballinglen River) and groundwater quality in the underlying bedrock aquifer.

Pre-Mitigation Potential Effect: Negative, significant, indirect, temporary, unlikely effect on surface water quality and Negative, slight, indirect, temporary, unlikely effect on local groundwater quality.

7.5.2.10 Morphological Changes to Surface Watercourses within Wind Farm Site

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 water courses has the potential to significantly interfere with water quality and flows during the construction phase.

Within the Wind Farm Site, there are a total of 10 no. crossings over natural watercourses (rivers and streams) (EPA-mapped watercourses). These watercourse crossings are detailed below:

- It is proposed to upgrade an existing site access road and associated crossing over an unnamed tributary of the Keerglen River ~170m southeast of T04;
- A new crossing is proposed over an unnamed tributary of the Keerglen River~180m east of the proposed substation;
- New crossings are proposed over unnamed tributaries of the Keerglen River ~250m, 310m, and 340m east of the proposed substation;
- A new crossing over an unnamed tributary of the Keerglen River ~250m northeast of T08;
- There is 1 no. new crossing over the Fiddaunboy Stream ~790m northeast of T08;
- A new crossing over the Keerglen River ~1km northeast of T08;
- A new crossing is proposed over an unnamed tributary of the Keerglen River~250m east of new river crossing;
- A new crossing over an unnamed tributary of the Keerglen River ~100m south of the L51723; and,
- An existing crossing at Ballinglen Bridge along the L51723 (note that no works are proposed at this watercourse crossing).

In addition to the natural watercourses, several manmade drains and smaller hydrological features which are not mapped by the EPA were encountered within the Wind Farm Site during the site walkover surveys.

For the most part these features are not considered to be a significant constraint and can be rerouted around the proposed infrastructure and/or integrated into the proposed drainage design. Many of these features will be culverted where road crossings are proposed. As shown on Figure 7.4, 2 no. crossings are proposed over unmapped natural features (1 no. features ~310m east of the proposed substation and 1 no. feature~230m northeast of T7).

Pathways: Wind Farm Site drainage network.

Receptors: Surface water flows, stream morphology and water quality in the Keerglen River and its tributaries.

Pre-Mitigation Potential Effect: Negative, moderate, direct, long-term, likely effect on surface water flows, local stream morphology and surface water quality.

7.5.2.11 Morphological Changes to Surface Watercourses Along Underground Electricity Export Connection

Outside of the Wind Farm Site the Underground Electricity Export Connection includes a total of 11 no. crossings over EPA mapped watercourses. These crossings are detailed in Section **Error! Reference source not found.** and comprise of 9 no. culvert crossings and 1 no. bridge crossing (Tonrehown Bridge).

The potential proposed crossing methods are as follows:

- Horizontal Directional Drilling (HDD) will be completed at the bridge crossing location. HDD is required due to there being insufficient cover and depth in the bridge to cross within the bridge deck. This method is only employed where standard installation methods are not possible.
- The culvert crossings will be crossed via flat formation crossing.
  - Option A: Where adequate cover exists above a culvert, the standard trench arrangement will be used where the cable ducts pass over a culvert without any contact with the existing culvert or water course. The cable trench will pass over the culvert in a standard trench.
  - Option B: Where the culvert consists of a socketed concrete or sealed plastic pipe and sufficient depth is not available over the crossing, a trench will be excavated beneath the culvert, and cable ducts will be installed in the standard formation 300mm below the existing pipe.

Pathways: Runoff and surface water flowpaths.

Receptors: Surface water flows, stream morphology and water quality (Ballinglen and Cloonaghmore rivers and associated tributaries and the Moyne Stream).

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on downstream surface water flows and surface water quality.

7.5.2.12 Potential Effects on Local Groundwater Well Supplies

The biggest risk to groundwater wells will be from groundwater contamination due to the accidental release of hydrocarbons and cement-based products as a result of construction activities within the Wind Farm Site. No effects are groundwater levels / quantity will occur due to the elevated nature of the Proposed Development Site. No significant dewatering works are proposed for any excavations.

There are no downgradient public or group scheme groundwater supplies that can be impacted by the Proposed Development. However, due to the remote location of the Wind Farm Site, no dwellings are located in the immediate vicinity of the site. The closest dwellings are located to the east of the site, in the valley of the Ballinglen River. The closest dwelling is located ~1.3km northeast of T0.

Due to the shallow nature of the proposed work along the Underground Electricity Export Connection, no effects on private groundwater well supplies will occur.

Pathway: Groundwater flowpaths.

Receptor: Down-gradient groundwater supplies (groundwater wells).

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, long-term, unlikely effect on down gradient water supplies.

7.5.2.13 Use of Siltbuster and Effect on Downstream Surface Water Quality

Siltbusters are regularly used to remove suspended sediments on construction sites by means of chemical dosing and sedimentation (i.e. use of coagulants and flocculants to accelerate the settlement process). The benefits of using enhanced settlement systems on downstream surface water quality are widely known, and are a positive effect. However, potential overdosing with chemical agents means there is a perceived risk of chemical carryover in post treatment water which could result in negative effects on downstream water quality.

Wind farm construction water (i.e. surface water runoff or pumped groundwater) has sometimes very fine particles, particularly clays and peat, with slow settling velocities which do not settle out efficiently, even in a lamella clarifier at normal flow rates. In these cases chemical dosing can be used to aggregate the particles (i.e. force them to combine and become heavier), increasing the particle settling rate and cleaning the water via gravity separation techniques. Agents commonly used include poly aluminium chloride (PAC), aluminium sulphate, ferric iron and ferrous iron. These agents are commonly used in drinking water treatment plants. So their use is widespread, and there is significant scientific knowledge around their use and control.

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of siltbuster systems from northwest Mayo is provided in Figure 7.11. This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

Note that the Siltbuster system will not be used under normal conditions during the construction phase. The mitigation proposed to protect water quality is already outlined above in the preceding sections.

The use of Siltbuster is only proposed as an emergency back up in the event of failure of all other proposed water treatment mitigation measures, e.g. in the event of peat failure. The Siltbuster system is a proven and effective method of water quality treatment during these events. As stated in Section **Error! Reference source not found.**, the Geotechnical and Peat Stability Report showed that the Wind Farm Site has an acceptable margin of safety, is suitable for the Proposed Development and is considered to be at low risk of peat failure. Therefore, it is extremely unlikely that the Siltbuster system will be utilised.

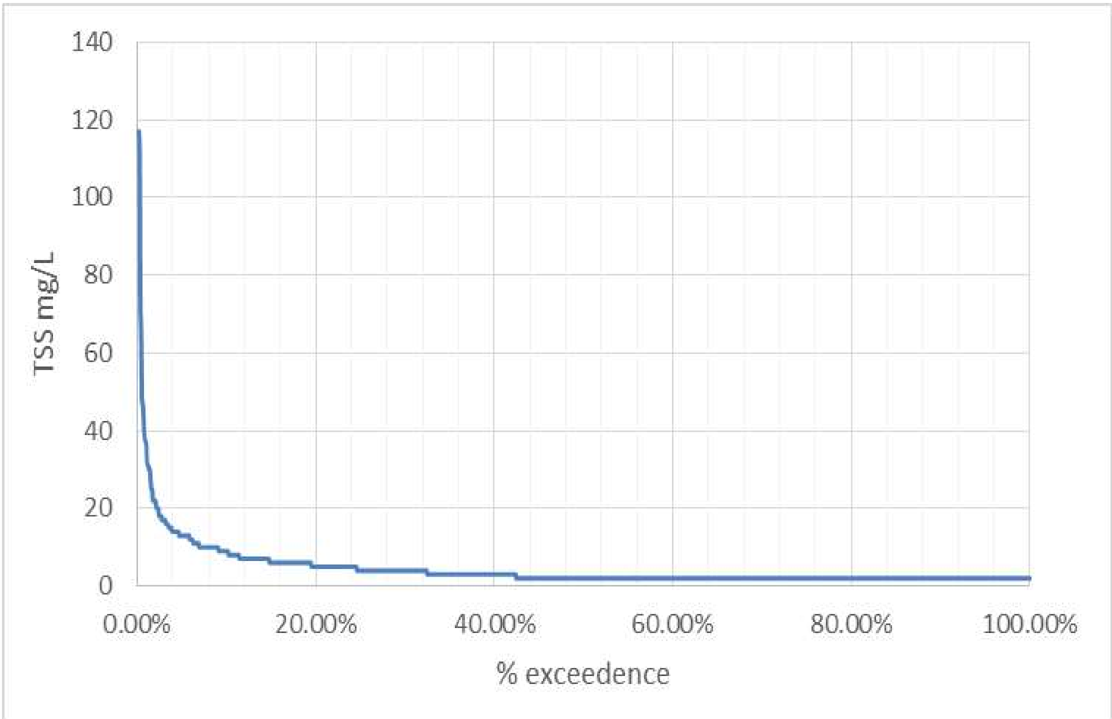

Figure 7.11: Example of treatment capability of Siltbuster treatment

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Keerglen and Ballinglen Rivers) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, unlikely effect on downgradient water quality.

7.5.2.14 Surface Water Quality Effects During Directional Drilling Along the Underground Electricity Export Connection

Surface water quality effects on local watercourses and the downstream Ballinglen and Cloonaghmore rivers may occur during drilling and groundworks associated with potential directional drilling at the bridge crossing locations along the Underground Electricity Export Connection.

It is proposed that directional drilling under the bridge will be undertaken to prevent direct impacts on the watercourse. However, there is a risk of indirect impacts from sediment laden runoff during the launch pit and reception pit excavation works. There is also the unlikely risk of fracture blow out and contamination of the watercourse with drilling fluid.

Pathway: Surface water and groundwater flows.

Receptor: Local watercourses and the downstream Ballinglen and Cloonaghmore rivers.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, likely effect on surface water quality.

7.5.2.15 Potential Effects on Karst Aquifer

There are no mapped karst features in the area of the Wind Farm Site or along the Underground Electricity Export Connection.

However, a section of the Underground Electricity Export Connection Route along the R315 (~1.12km in length) and the proposed temporary access junction and roadway between the R315 and the L51723 are underlain by a Regionally Important Karst Aquifer.

Any potential alteration in local groundwater quality or surface water quality has the potential to impact the Karstic Bedrock Aquifer.

Pathway: Groundwater recharge and surface water drainage.

Receptor: Local karst features and the Regionally Important Karst Aquifer.

Pre-Mitigation Potential Effect: Indirect, negative, slight, unlikely effect on karst features and karst aquifer.

7.5.2.16 Potential Effects on Designated Sites

As stated in Section 7.3.16, Ummerantarry Bog NHA is located in the west of the overall Keerglen landholding. In terms of the Wind Farm Site, there are no other designated sites which are hydrologically or hydrogeologically connected with the Proposed Development.

Meanwhile, the Killala Bay/Moy Estuary SPA (Site Code: 004036) and SAC/pNHA (Site Code: 000458) is located downstream of Underground Electricity Export Connection along the Cloonaghmore River and the

Moyne_010 SWB. The surface water connections from the Underground Electricity Export Connection to the Killala Bay/Moy Estuary could transfer poor quality surface water that may affect the conservation objectives of these designated sites.

Pathways: Surface water and groundwater flowpaths.

Receptors: Ummerantarry Bog NHA and Killala Bay/Moy Estuary SPA/Sac/pNHA.

Pre-Mitigation Potential Effects: Negative, moderate, indirect, temporary, likely effect on designated sites.

7.5.2.17 Potential Effects on WFD Status

The EU Water Framework Directive (2000/60/EC) requires that all member states protect and improve water quality in all waters, with the aim of achieving good status by 2027 at the latest. Any new development must ensure that this fundamental requirement of the Directive is not compromised.

The WFD status for GWBs and SWBs underlying and downstream of the Proposed Development are defined in Section 7.3.13 and Section 7.3.14 respectively. The Keerglen_010 SWB in the vicinity of the Wind Farm Site achieved “Moderate” status. Meanwhile, the Ballinglen_010 and the Ballinglen_020 SWBs achieved ‘Poor’ and ‘Moderate’ status respectively. Along the Underground Electricity Export Connection, the Breaghwy_010 and the Cloonaghmore_050 SWBs achieved ‘Good’ status while the Moyne_010 SWB is of ‘Moderate’ status.

In terms of GWBs the Belmullet and the Bellacorick-Killala GWBs both achieved “Good” status.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in Appendix 7.4.

Pathways: Groundwater flowpaths and surface water flowpaths within the Proposed Development Site.

Receptors: WFD Groundwater Bodies and Surface Water Bodies.

Pre-Mitigation Potential Effect:

Indirect, negative, moderate, short-term, unlikely effect on downstream SWBs.

Indirect, negative, slight, short-term, unlikely effect on the underlying GWBs.

7.5.3 Operational Phase Effects

This section identifies the likely significant effects of the operation phase of the Proposed Development and lists the proposed mitigation measures that will be put in place to eliminate or reduce any potential effects.

Very few potential direct effects are envisaged during the operational phase of the Proposed Development. These may include:

- Some construction vehicles or plant may be necessary for maintenance of turbines which could result in minor accidental leaks or spills of fuel/oil;
- The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater; and,
- In relation to indirect effects, a small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries.

7.5.3.1 Site Vehicles/Plant and Contamination of Peat, Subsoils and Bedrock

Plant and site vehicles used in site maintenance will be run on fuels and use hydraulic oils. Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to land, soils and associated ecosystems. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, and is persistent in the environment.

Pathway: Peat, subsoil and bedrock pore space.

Receptor: Peat, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, direct, slight, short term, unlikely effect on peat, subsoil and bedrock.

7.5.3.2 Use of Oils in Transformers

The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater. Hydrocarbon has a high toxicity to humans, and all flora and fauna, and is persistent in the environment.

Pathway: Peat, subsoil and bedrock pore space.

Receptors: Peat, subsoil and bedrock.

Potential Pre-Mitigation Effect: Negative, direct, slight, short term, unlikely effect on peat, subsoil and bedrock.

7.5.3.3 Replacement of Natural Surfaces with Lower Permeability Surfaces

Progressive replacement of the peat or vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. This could potentially increase runoff from the site and increase flood risk downstream of the development.

In reality, the access roads will have a higher permeability than the underlying peat. However, in the baseline scenario runoff rates are high as a result of the prevailing peat soils (96% runoff). In order to assess the potential change as a result of the access road and hardstand footprints, we have increased the runoff rate to the maximum, i.e., 100% (4% higher than normal). The assessed footprint comprises turbine bases and hardstandings, access roads, amenity links, site entrances, substation and temporary construction compound. During storm rainfall events, additional runoff coupled with the increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

The Underground Electricity Export Connection and haul route works will not involve any alteration of near surface permeability as it is an excavated trench which will be infilled with extracted material, and the existing road surface will also be reinstated.

The emplacement of the proposed permanent development footprint (~4.8ha = total development footprint), as described in Chapter 4, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 1,552m^3/month (Table 7.18). This represents a potential increase of approximately 1.2% in the average daily/monthly volume of runoff from the site area in comparison to the baseline pre-development site runoff conditions (note that this is a worst case scenario and does not consider the presence of the existing site tracks). This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the site being developed, the proposed total permanent development footprint being approximately 4.8ha, representing 5.8% of the Wind Farm Site area of c.81.88ha.

Table 7.18: Baseline Site Runoff versus Development Runoff

Site Area	Approx. Area (ha)	Runoff per Wettest Month (m^3)	Runoff per Day (m^3) in Wettest Month
Baseline Conditions			
Total Site Areal (90% runoff)	81.88	128,421	4,142
Post-Proposed Development			
Permanent Hardstand Area (100% runoff)	4.8	8,327	269
Natural Ground (90% runoff)	77.68	121,646	3,924
Total		129,972	4,193
Net Increase in runoff		1,552	51
% Increase from Baseline		1.2%	

The additional volume is low due to the fact that the runoff potential from the Wind Farm Site is naturally high (90%) (refer to the water balance presented in Section 7.3.9). Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as access tracks will be constructed of permeable stone aggregate. The increase in runoff from the Proposed Development will, therefore, be negligible. This is even before mitigation measures will be put in place.

Pathway: Wind Farm Site drainage network.

Receptors: Surface waters and water-dependent ecosystems.

Pre-Mitigation Potential Effects: Negative, slight, direct, long-term, likely effect on all downstream surface water bodies.

7.5.3.4 Runoff Resulting in Contamination of Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works would be of a very minor scale and would be very infrequent. Potential sources of sediment laden water would only arise from surface water runoff from small areas where new material is added during maintenance works.

These minor activities could, however, result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects could be significant if not mitigated.

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

Maintenance works will likely be contained within the Wind Farm Site boundaries and no maintenance works are likely to be required along the Underground Electricity Export Connection.

Pathway: Wind farm site drainage network.

Receptor: Surface waters flows and surface water quality in the Keerglen and Ballinglen rivers.

Pre-Mitigation Potential Effects: Negative, indirect, slight, temporary, unlikely effect on surface quality.

7.5.3.5 Water Supply at Substation

It is proposed to install a groundwater well adjacent to the substation in accordance with the Institute of Geologists Ireland, Guide for Drilling Wells for Private Water Supplies (IGI, 2007). The well will be flush to the ground and covered with a standard manhole. An in-well pump will direct water to a water tank within the roof space of the control building.

The proposed groundwater well and associated extraction has the potential to effect local groundwater levels in the surrounding lands.

Pathway: Groundwater flowpaths

Receptor: Groundwater levels

Pre-Mitigation Potential Effect: Direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

7.5.3.6 Assessment of Effects on WFD Objectives

There is no direct discharge from the Proposed Development to downstream receiving waters. Mitigation for the protection of surface water during the operational phase of the Proposed Development will ensure the qualitative status of the receiving SWBs will not be altered by the Proposed Development.

Similarly there is no direct discharge to groundwaters associated with the Proposed Development. Mitigation for the protection of groundwater during the operational phase of the Proposed Development will ensure that the qualitative status of the receiving GWB will not be altered by the Proposed Development.

A full assessment of the potential effects of the operational phase of the Proposed Development on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as Appendix 7.4.

7.6 Mitigation and Monitoring Measures

7.6.1 Construction Phase

7.6.1.1 Effects on Land (Land-Take)

Mitigation Measures / Impact Assessment: The Proposed Development layout has been designed to utilise the existing road network at the Wind Farm Site, therefore reducing the area of the site which will be altered from cutover peat bog to site access roads.

The loss of ~10.18ha of cutover peat bog will not have a significant effect on land at the Wind Farm Site. Following the construction phase these areas of the site will be replaced by hardstand areas. This represents a change in landcover of ~12% of the total Wind Farm Site (c.81.88ha). However, the Wind Farm Site itself is set in a wider upland peatland setting and therefore, the effects of cutover peat bog land loss within the wider area will be negligible.

7.6.1.2 Contamination of Soil by Leakages and Spillages

Proposed Mitigation Measures:

- On-site re-fuelling will be undertaken using a double skinned bowser with spill kits kept on site for accidental leakages or spillages;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- Fuels stored on-site will be minimised. All storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an

appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;

- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building (at the substation) will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency response plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (subject of a post-planning pre-construction planning condition).

7.6.1.3 Clear Felling of Coniferous Forestry

Forestry operations will conform to current best practice Forest Service regulations, policies and strategic guidance documents as well as Coillte and DAFM guidance documents, including the specific guidelines listed below, to ensure that felling, planting and other forestry operations result in minimal potential negative effects to the receiving environment.

- Forestry Standards Manual (Forest Service, 2015)
- Environmental Requirements for Afforestation (Forest Service, 2016a)
- Land Types for Afforestation (Forest Service, 2016b)
- Forest Protection Guidelines (Forest Service, 2002)
- Forest Operations and Water Protection Guidelines (Coillte, 2013)
- Forestry and Water Quality Guidelines (Forest Service, 2000b)
- Forestry and the Landscape Guidelines (Forest Service, 2000c)
- Forestry and Archaeology Guidelines (Forest Service, 2000d)
- Forest Biodiversity Guidelines (Forest Service, 2000e)
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018)
- Coillte Planting Guideline SOP
- A Guide to Forest Tree Species Selection and Silviculture in Ireland (Horgan et al., 2003)
- Management Guidelines for Ireland's Native Woodlands. Jointly published by the National Parks & Wildlife Service (Cross and Collins, 2017)
- Native Woodland Scheme Framework (Forest Service, 2018)
- Code of Best Forest Practice (Forest Service, 2000)

Mitigation by Avoidance:

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

With moderate slopes existing across much of the Wind Farm Site, a 10m setback for felling will be established along all aquatic zones. Buffer zone widths will be increased at vulnerable hydrological features where deemed necessary. This will ensure water quality is protected during the felling operations. However, most of the Proposed Development infrastructure is located outside of the 50m self-imposed hydrological buffer zone, thereby limiting the felling which will occur in close proximity to natural watercourses.

The setback distance from sensitive hydrological features means that adequate room is maintained for the proposed mitigation measures (discussed below) to be properly installed and operate effectively. The buffer/setback zone will:

- Avoid physical damage (river/stream banks and river/stream beds) to watercourses and the associated release of sediment;
- Avoid peat/soil disturbance and compaction within close proximity to surface watercourses;
- Avoid the entry of suspended sediment from works into watercourses; and,
- Avoid the entry of suspended sediment from the drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

In addition to the application of buffer/setback zones, the following supplementary mitigation measures will be employed during felling works:

Mitigation by Design:

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

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- All machinery will be operated by suitably qualified personnel;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Machines will traverse the site along specified off-road routes (referred to as racks);
- The location of racks will be chosen to avoid wet and potentially sensitive areas;
- Brash mats will be placed on the racks to support the vehicles on soft ground, reducing peat and mineral soil disturbance and erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Silt fences will be installed at the outfalls of existing drains downstream of felling areas. No direct discharge of such drains to watercourses will occur. Sediment traps and silt fences will be installed

in advance of any felling works and will provide surface water settlement for runoff from work areas and will prevent sediment from entering downstream watercourses. Accumulated sediment will be carefully disposed of at pre-selected peat and spoil repository areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;

- In areas particularly sensitive to erosion it will be necessary to install double or triple sediment traps and increase buffer zone width. These measures will be reviewed on site during construction;
- Double silt fencing will also be put down slope of felling areas which are located in close proximity to streams and/or relevant watercourses;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded;
- Timber will be stacked in dry areas, and outside watercourse buffer zones. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water runoff;
- Refuelling or maintenance of machinery will not occur within 50m of an aquatic zone or within 20m of any other hydrological feature. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required; and,
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors.

Silt Traps:

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

Pre-emptive Site Drainage Management :

The works programme for the felling operations will also take account of weather forecasts and predicted rainfall in particular. Operations will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily/weekly basis, as required, to allow site staff to direct proposed and planned construction activities:

- General Forecasts: Available on a national, regional and county level from the Met Éireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3-hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

- Rainfall Radar Images: Images covering the entire country are freely available from the Met Éireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Éireann provide a 24-hour telephone consultancy service. The forecaster will provide an interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow planned works to be safely executed (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests any of the following is likely to occur:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24-hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Timing of Proposed Felling Works:

Felling will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses.

Drain Inspection and Maintenance:

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

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections the main drainage ditches will be identified. Ideally the pre-felling inspection will be carried out during rainfall;
- Following tree felling all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site, if impeded by silt or debris, will be unblocked; and,
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

7.6.1.4 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Wind Farm Site:

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible, by application of suitable buffer zones (i.e. 50m to main watercourses, and 10m to main drains). All of the key development components within the Wind Farm Site are located significantly away from the delineated 50m watercourse buffer zones with the exception of the upgrading of the existing watercourse crossing, new drain crossings, upgrades to existing site tracks and the new proposed bridge crossing over the Keerglen River.

The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively. The proposed buffer zone will:

- Avoid physical damage (river/stream banks and river/stream beds) to watercourses and the associated release of sediment;
- Avoid excavations within close proximity to surface watercourses;
- Avoid the entry of suspended sediment from earthworks into watercourses; and,
- Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone.

The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. roads) where practicable. This design prevents the unnecessary disturbance of peat and spoil, and reduces the potential for elevated concentrations of suspended solids in runoff.

Presented below are temporary and long-term drainage control measures that will be utilised during the construction phase of the Proposed Development. As stated above there is an existing drainage network in some areas of the Proposed Development Site which comprises of peat drains and natural streams. The measures outlined below will be used in conjunction with the existing drainage network to ensure the protection of all rivers and downstream watercourses.

Source controls:

- Interceptor drains, vee-drains, diversion drains.
- Small working areas, covering temporary stockpiles, weathering off of side-cast peat/spoil, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls:

- Interceptor drains, vee-drains, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

Treatment systems:

- Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as “Siltbuster”, and/or other similar/equivalent or appropriate systems.

There is an existing network of drains present at the Wind Farm Site and in some areas, these will be integrated and enhanced as required and used within the Proposed Development drainage system. The key elements are the upgrading and improvements to water treatment elements, such as in-line controls and treatment systems, including silt traps and settlement ponds.

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

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion;
- Temporary silt traps will be placed in the existing drains downstream of construction works, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- During the operational phase of the wind farm runoff from individual turbine hardstanding areas will be not discharged directly into the existing drainage network but discharged locally at each turbine location through field drains, main drains, and existing settlement ponds;
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across the bog surface and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site;
- Velocity and silt control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works; and,
- Existing culverts will be lengthened where necessary to facilitate access road widening.

Underground Electricity Export Connection:

The vast majority of the Underground Electricity Export Connection is >50m from any nearby watercourse, sections within 50m of the route are confined to existing watercourse crossings at bridges and culverts. It is proposed to limit any works in any areas located within 50m of any watercourse/waterbody including the stockpiling of excavated soils and subsoils.

There are a total of 10 no. crossings over EPA mapped watercourses along the underground electrical cabling connection route. All the crossings are existing bridges and culverts along the public road.

No in-stream works are required at any of these crossings, however due to the proximity of the streams to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work.

Mitigation measures are outlined below.

A constraint/buffer zone will be maintained for all crossing locations where possible, whereby all watercourses will be fenced off. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse.

The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively.

Water Treatment Train:

If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'siltbuster' or similar equivalent treatment train (sequence of water treatment processes)) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to watercourses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be emplaced within drains down-gradient of all construction areas inside the hydrological buffer zones.

Silt Bags:

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters.

Pre-emptive Site Drainage Management:

The works programme for the initial construction stage of the Proposed Development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:

- General Forecasts: Available on a national, regional, and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from

Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,

- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests any of the following is likely to occur, or if on-site monitoring indicates any of the following has occurred:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.

Prior to, and after, works being suspended the following control measures will be undertaken:

- All open excavations will be secured and sealed off;
- Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
- Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Management of Runoff from Spoil Management Areas:

It is proposed that excavated soil will be used for landscaping where required.

During the initial construction of roads, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from works areas.

Where applicable, the vegetative top-soil layer of the spoil management areas will be rolled back to facilitate placement of excavated spoil up to a maximum height of 1.0 metres, following which the vegetative-top soils layer will be reinstated. Where reinstatement is not possible, spoil management areas will be sealed with a digger bucket and seeded as soon possible to reduce sediment entrainment in runoff.

Management of Runoff from underground electrical cabling connection route and existing and proposed access roads:

Where construction will be undertaken along sections of the underground Underground Electricity Export Connection, proposed access road or existing roads requiring upgrade, the drainage management infrastructure (as outlined above) will be in place to manage and control runoff from the trench excavation area. Where the internal electrical cable trench is to be constructed off-road (within the Wind Farm Site) or for the Underground Electricity Export Connection along public roads, surface water control measures such as silt fences will be employed when work is required within hydrological buffer zones.

Timing of Site Construction Works:

Construction of the Wind Farm Site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.

Monitoring:

An inspection and maintenance plan for the on-site drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.

Any excess build-up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing (visual, supplemented with pH, electrical conductivity, temperature, dissolved oxygen and turbidity monitoring), sampling and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event based).

7.6.1.5 Excavation Dewatering and Potential Effects on Surface Water Quality

Proposed Mitigation by Design:

Management of surface water and groundwater seepages and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;
- The interceptor drainage will be discharged to the wind farm site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit;
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur;
- Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken; and,
- A mobile ‘Siltbuster’ or similar equivalent specialist treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

7.6.1.6 Potential Effects on Groundwater Levels During Excavation Works

Mitigation Measures/Impact Assessment:

The Wind Farm Site is underlain by a Poor Aquifer and contains bedrock which is generally unproductive. The site is elevated and groundwater will flow downslope towards the Keerglen River.

The topographical (i.e., the elevation of the turbines) and hydrogeological setting of the turbine locations means no significant groundwater dewatering is expected to be required. Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt. we would generally define dewatering as a requirement to permanently drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor.

Relevant environmental management guidelines from the EPA quarry 2006 guidance document – “Environmental Management in the Extractive Industry” in relation to groundwater issues will be implemented during the construction phase.

7.6.1.7 Potential Effects Associated with Piled Foundations on the Water Environment

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

- Mitigation measures for sediment control are detailed in Section 7.6.1.4.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 7.6.1.8.
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 7.6.1.9.

Proposed mitigation measures relative to piling works will comprise:

- Where driven piles are used, they will have a cross section without re-entrant angles;
- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

Impact Assessment:

The ground conditions at the proposed site can be typically categorised into the following deposits (based on site-specific data):

- Peat –Peat thicknesses ranged from 0.2 to >4.8m with an average of 1.59m.
- The peat is underlain by glacial till comprising of sandy gravelly SILT, silty. Gravelly SAND and sandy, silty GRAVEL.

- The depth to bedrock is typically in excess of 4m with an isolate ridge of hard competent sandstone as shallower depth at the proposed borrow pit location.
- Groundwater - was recorded in the trial pit excavations at depths ranging from 0.5 to 3.7mbgl.

Peat water is perched above the regional groundwater table, with the regional groundwater flow will occur in the underlying bedrock aquifer. Glacial tills that occur between the base of the peat clays may be permeable in local zones where sands and gravels are present, but in general will have a moderate to low permeability due to the presence of silt. Therefore, the two main groundwater systems are the upper acidic peat water, and the lower regional bedrock groundwater water.

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

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

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

Scenario 1: Creating a Pathway for Downward Flow

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

Scenario 2: Creating a Pathway for Upward Flow

No upwelling of groundwater to the peat surface water recorded in any of the site investigation locations recorded across the proposed site.

Notwithstanding this, to ensure upward flow of underlying groundwater via potential pathways created by piling works does not occur, a bentonite seal will be used in a starter pit for each driven pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for piling works to create pathways for upward flow of alkaline groundwater to the bog surface is imperceptible.

Scenario 3: Blocking Regional Groundwater Flow

The scale of the proposed site is important, and it means that the development footprint occurs over ~5.8% (4.8ha) of the Wind Farm Site (c.81.88ha). The area of the piles driven into the ground is distributed over a very large area. At such wide separation distance, the ability of clusters of piles, with small plan areas, to alter or affect regional groundwater flow is imperceptible. Groundwater will simply flow through and/or around these very localised insertions.

7.6.1.8 Potential Release of Hydrocarbons

Proposed Mitigation Measures:

- All plant will be inspected and certified to ensure they are leak free and in good working order prior to use on the wind farm site;
- On-site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double axel custom-built refuelling trailer or truck will be re-filled off site and will be towed/driven around the wind farm site to where machinery are located. The 4x4 jeep/fuel truck will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- Fuels stored on the wind farm site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume for the time period of the construction;
- The electrical control building will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan. Spill kits will be available to deal with accidental spillages.

7.6.1.9 Potential Release of Cement-Based Products

Proposed Mitigation Measures:

- No batching of wet-cement products will occur on the wind farm site. Ready-mixed supply of wet concrete products and/or emplacement of pre-cast elements will take place;
- Pre-cast elements for culverts and concrete works will be used;
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site;
- Where concrete is delivered on the wind farm site, only the chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the

construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be isolated in temporary lined wash-out pits located near the proposed wind farm site compound. These temporary lined wash-out pits will be removed from the wind farm site at the end of the construction phase;

- The contractor will use weather forecasting to plan dry days for pouring concrete; and,
- The contractor will ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.

No additional mitigation measures are required for potential groundwater effects.

7.6.1.10 Groundwater and Surface Water Contamination from Wastewater Disposal

Proposed Mitigation Measures:

- During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used at each of the site construction compound, maintained by the providing contractor, and removed from the site on completion of the construction works;
- Water supply for the site office and other sanitation will be brought to site and removed after use by a licensed contractor to be discharged at a suitable off-site treatment location; and,
- No water or wastewater will be sourced on the site, nor discharged to the site.

7.6.1.11 Morphological Changes to Surface Watercourses within Wind Farm Site

The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. existing site roads) where practicable. 2 no. crossings are located at existing bridges and culverts, with 1 no. crossing proposed for upgrade to the southwest of T04 and no works proposed at Ballinglen Bridge. This design prevents additional unnecessary disturbance at these locations.

The new proposed crossing over the Keerglen River will involve the constriction a new clear span bridge and will result in no disturbance to the existing river channel. All other watercourse crossings will be completed via piped or box culverts. Mitigation measures for the upgrade of the existing crossing and the new proposed crossing are detailed below:

- All proposed new stream crossings will be bottomless or clear span culverts and the existing banks will remain undisturbed. No in-stream excavation works are proposed and therefore there will be no direct impact on the stream at the proposed crossing location;
- Section 50 consent (Arterial Drainage Act, 1945) will be required for the new crossings. The Section 50 requirement will determine final pipe culvert dimensions, but will allow for a minimum 300mm embed of the pipe below the existing bed level, plus sufficient freeboard. The dimensions and design of the clear span bridge over the Keerglen River accompany this planning application;
- IFI will be provided with a copy of the finalised pipe crossing dimensions and construction method statements. If the channels are not fully dried out during the construction period, a water management technique will be employed (dam and pump over or temporary piping) to dry out the

construction reach. Any additional measures stipulated by IFI will be incorporated into the final design and construction method statement for the proposed crossing;

- Instream construction will be carried out in the period July to September inclusive. This is a conservative working window that will help ensure construction occurs during very low or no flow and will minimise the risk of entrainment of suspended sediment in surface water runoff to the Keerglen tributary of the Ballinglen River; and,
- During the near-stream construction work, double row silt fences will be placed immediately down-gradient of the construction areas for the duration of the construction phase. There will be no batching or storage of cement allowed on-site. The bottom edge of geotextile silt fence material will be installed to a 200mm embed below ground level. Stakes will be placed at the ends, on any bends, and at 2m intervals along the silt fence. Stakes will be driven a minimum of 400mm to provide adequate support. The silt fence will have a tensioned wire backing - a minimum of 2 lines of wire run along the stakes. The top wire is used to clip the geotextile onto to hold it up and provide strength against trapped sediment. Silt fences will be checked and maintained weekly at minimum, and always before any forecasted heavy rain event.

Furthermore, with regard to the new proposed clear-span bridge crossing along the Keerglen River, the bridge design has been assessed using flood modelling. The baseline 100-year flood plus climate change flood level at the proposed bridge crossing was modelled as being 117.76mOD. The model was rerun to consider the potential effects of the bridge design and found that with a 300mm freeboard above 117.76mOD as per OPW Section 50 guidance, the flood level remains at 117.76mOD. With this clear-span design, there will be no issues with scour as the river channel will not be blocked or altered in any way.

7.6.1.12 Morphological Changes to Water Courses along Underground Electricity Export Connection

Prior to the commencement of cable trenching or crossing works the following key temporary drainage measures will be installed:

- All existing roadside drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using check dams/silt traps;
- Culverts, manholes and other drainage inlets will also be temporarily blocked;
- A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside the watercourse 50m buffer zone;
- No stockpiling of construction materials will take place along the Underground Electricity Export Connection;
- No refuelling of machinery or overnight parking of machinery is permitted in this area;
- No concrete truck chute cleaning is permitted in this area;
- Works will not take place at periods of high rainfall, and will be scaled back or suspended if heavy rain is forecast;
- Local road drainage, culverts and manholes will be temporarily blocked during the works;

- Machinery deliveries will be arranged using existing structures along the public road;
- All machinery operations will take place away from the stream and ditch banks, apart from where crossings occur. Although no instream works are proposed or will occur;
- Any excess construction material will be immediately removed from the area and sent to a licenced waste facility;
- No stockpiling of materials will be permitted in the constraint zones;
- Spill kits will be available in each item of plant required to complete the stream crossing; and,
- Silt fencing will be erected on ground sloping towards watercourses at the stream crossings if required.

Please note that the mitigation measures for HDD are detailed in Section 7.6.1.15.

7.6.1.13 Potential Effects on Local Groundwater Well Supplies

Mitigation Measures/Impact Assessment:

There are no local groundwater well supplies in the vicinity of the Wind Farm Site. All local dwellings are located significant distances to the east of the proposed development infrastructure (>1km).

Regardless if private wells are located downslope of the Proposed Development Site or not (or if wells are installed in the future), the potential for effects is negligible for the following conclusive reasons:

- The Wind Farm Site is underlain by an aquifer of low permeability;
- Groundwater flowpaths are therefore typically very short (~300m maximum) and follow surface topography;
- Consequently, the majority of groundwater flows will discharge into the Keerglen River and its tributaries within the Wind Farm Site and will leave the site as surface water flows and not groundwater flows;
- Therefore, the potential to effect local wells (whether they are downslope or not) is very low as groundwater flowpaths between the Proposed Development infrastructure and potential source typically do not exist due to the large setback distance (>1km);
- Nevertheless, mitigation is provided in the EIAR to deal with typical construction phase groundwater hazards such as oils and fuels; and,
- Therefore, based on our hydrogeological assessment of the Wind Farm Site with regard to groundwater user risk and the proposed mitigation measures, we can robustly say the potential to effect local wells/water supply sources is negligible.

7.6.1.14 Use of Siltbuster and Effect on Downstream Surface Water Quality

Proposed Mitigation Measures:

Chemical dosing is intended to force smaller/lighter particles to join together and therefore be heavy enough to settle out. As such the added chemicals are bound in the flocculant and do not get carried over into the treated discharge water. As such, the risk to water quality relates to operational issues, such as spill management and prevention of overdosing. Measures that will be employed to prevent spills and prevent overdosing and potential chemical carryover include:

- Use of bunded chemical storage areas;
- Loading and unloading of chemical containers by trained staff;
- Use of spill kits and emergency response procedures in the event of a spill;
- The siltbuster system comprises an electronic in-line dosing system which provides an accurate means of adding agents so overdosing does not occur;
- Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff, means the correct amount of chemical is added by the dosing system;
- Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment;
- Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover; and,
- Use of biodegradable chemical agents can be used at very sensitive sites (i.e. adjacent to SACs).

7.6.1.15 Surface Water Quality Effects During Directional Drilling Works Along the Underground Electricity Export Connection

Proposed Mitigation Measures:

- Although no in-stream works are proposed, the drilling works will only be done over a dry period between July and September (as required by IFI for in-stream works) to avoid the salmon spawning season and to have more favourable (dryer) ground conditions;
- The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance;
- There will be no storage of material / equipment or overnight parking of machinery inside the 15m buffer zone;
- Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 15m buffer zone boundary;
- Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse;
- Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;
- The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages;
- Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area;
- Spills of drilling fluid will be clean up immediately and stored in an adequately sized skip before been taken off-site;

- If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works);
- This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed percolation area at least 50m from the watercourse.
- The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing;
- Any sediment laden water from the works area will not be discharged directly to a watercourse or drain;
- Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted;
- Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse;
- If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied;
- On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion;
- The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated;
- There will be no batching or storage of cement allowed at the watercourse crossing;
- There will be no refuelling allowed within 100m of the watercourse crossing; and,
- All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.

Fracture Blow-out (Frac-out) Prevention and Contingency Plan:

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e., Clear Bore Drilling Fluid or similar will be used);
- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage;
- One or more lines of silt fencing will be placed between the works area and the adjacent river;
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility;
- Adequately sized skips will be used where temporary storage of arisings are required;
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse;

- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur then drilling will be immediately stopped;
- Any frac-out material will be contained and removed off-site;
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix; and,
- If the risk of further frac-out is high, a new drilling alignment will be sought at the crossing location.

7.6.1.16 Potential Effects on Karst

The potential for effects on the underling karst aquifer are limited for the following reasons:

- Only a small section of the proposed works area overlies the karst aquifer;
- There are no mapped karst features in the local area; and,
- The proposed works overlying the karst aquifer are minor and transient in nature.

Nevertheless, the following mitigation measures will be implemented:

Site drainage will be put in place in order to prevent any poor quality drainage water reaching any unmapped local karst features (Section 7.5.2.3).

Mitigation measures relating to hydrocarbons, cementitious materials and wastewater disposal as prescribed in Section 7.5.2.7 (hydrocarbons), Section 7.5.2.8 (cement-based products) and Section 7.5.2.9 (wastewater) will provide adequate protection to groundwater and surface water quality and will ensure that groundwater quality will not be impacted.

7.6.1.17 Potential Effects on Designated Sites

Mitigation Measures/Impact Assessment:

<u>Ummerantarry Bog NHA</u>:

Whilst Ummerantarry Bog NHA exists within the overall landholding at Keerglen, it is constrained to the west of the Keerglen River and the Fiddauncushaneen stream. The NHA is of considerable conservation significance as it contains intact upland blanket bog and wet heath and features pool systems, flushes and undisturbed blanket bog.

However, all of the Proposed Development infrastructure is located to the east of the Keerglen River and the Fiddauncushaneen stream. The characteristics of the local hydrological/hydrogeological regime that limit the ability of the Proposed Development to effect the status of this NHA are as follows:

- The Wind Farm Site is underlain by an aquifer of low permeability;
- Groundwater flowpaths are therefore typically very short (~300m maximum) and follow surface topography;

- Consequently, the groundwater flows in the Wind Farm Site will discharge into the Keerglen River and its tributaries;
- The Keerglen River and the Fiddauncushaneen stream therefore act as a hydrological barrier between the proposed development infrastructure and the Ummerantarry Bog NHA (no surface water connections exist between the proposed infrastructure locations and the NHA);
- As described in Section 7.3.9, 2 no. piezometer transects were inserted between the NHA and the nearest proposed turbine locations (T4 and T5). Groundwater level monitoring in the installed piezometers over a period of 12 months found that groundwater flows downslope and discharges into the Keerglen River.

Therefore, based on our hydrogeological assessment of the Wind Farm Site, we can robustly say the potential to effect Ummerantarry Bog NHA is negligible.

Killala Bay/Moy Estuary SPA/SAC/pNHA:

The Killala Bay/Moy Estuary SPA/SAC/pNHA is hydrologically connected to the Underground Electricity Export Connection via the Cloonaghmore River and the Moyne stream. However, the following mitigation measures have been proposed to ensure the protection of surface water quality along the Underground Electricity Export Connection:

- Mitigation measures for sediment control are detailed in Section 7.6.1.4.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 7.6.1.8.
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 7.6.1.9.
- Mitigation measures for directional drilling are detailed in Section 7.6.1.15

7.6.1.18 Potential Effects WFD Status

Proposed Mitigation Measures:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality have been detailed in Section 7.6.1.4 and Section 7.6.1.5 (suspended solids), Section 7.6.1.8 (hydrocarbons), Section 7.6.1.9 (cement-based products), Section 7.6.1.10 (wastewater) and Section 7.6.1.15 (drilling along Underground Electricity Export Connection).

Similarly, mitigation measures for the protection of groundwater quantity and quality have been detailed in Section 7.6.1.6 (groundwater levels), Section 7.6.1.8 (hydrocarbons), Section 7.6.1.9 (cement-based products) and Section 7.6.1.10 (wastewater)

The implementation of these mitigation measures will ensure the protection of downstream SWBs and underlying GWBs.

7.6.2 Operational Phase

7.6.2.1 Use of Oils in Transformers

Proposed Mitigation Measures:

- All transformers and substation areas will be bunded to 110% of the volume of oil used in each transformer/substation;
- An emergency plan for the operational phase to deal with accidental spillages will be contained in the Environmental Management Plan.

7.6.2.2 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Proposed Mitigation by Design:

The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. site access roads) where practicable. This design prevents the unnecessary creating of additional hardstand areas which would increase surface water runoff from the Proposed Development Site.

As part of the proposed wind farm drainage design, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing site drainage network. The new proposed drainage measures will then create significant additional attenuation to what is already present. The operational phase drainage system will be installed and constructed in conjunction with the existing site drainage network and will include the following:

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed into downstream field drains;
- Collector drains will be used to gather runoff from access roads and turbine hardstanding areas of the site likely to have entrained suspended sediment, and channel it to new local settlement ponds for sediment settling;
- On sections of access road transverse drains ('grips') will be constructed where appropriate in the surface layer of the road to divert any runoff off the road into swales/roadside drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of access road sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to existing drains;
- Settlement ponds will be designed in consideration of the greenfield runoff rate; and,
- All surface water runoff from the development will have to pass through the proposed settlement ponds prior to release into the existing site drainage network.

Impact Assessment:

As the part of the proposed wind farm drainage, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing drainage network. The new proposed drainage measures will then in effect create significant additional attenuation to what is already present at the Proposed Development Site. The net effect of this will be a reduction in the overall runoff coefficient of the Wind Farm Site as demonstrated by the use of the Rational Method in Table 7.19 below.

Based on a conservative reduction in the runoff coefficient from 0.90 to 0.85 for the overall site (undeveloped areas) and a reduction from 1.00 to 0.90 for the developed areas (i.e. greenfield runoff rates), there would a potential 5.7% reduction in runoff volumes from the Proposed Development Site. This assessment demonstrates that there will be no risk of exacerbated flooding down-gradient of the site as a result of the Proposed Development. The Proposed Development will in effect retain water for longer periods.

Table 7.195: Surface water Runoff Assessment for Proposed wind Farm Drainage

Site Area	Area (m^2)	Runoff Coefficient	Runoff Volume (m^3) per Wettest Month	Total Site Runoff Volume (m^3)/ Wettest Month
Wind Farm Without Drainage Controls				
Undeveloped Area	77.68	0.90	121,646	129,972
Development Footprint	4.8	1.00	8,326	
Wind Farm With Proposed Drainage Controls				
Undeveloped Area	77.68	0.85	114,888	122,382
Development Footprint	4.8	0.90	7,494	
Estimated Potential Reduction in Site Runoff Volumes (%)				7,410

7.6.2.3 Runoff Resulting in the Contamination of Surface Waters

Proposed Mitigation Measures:

- Mitigation measures for sediment control are the same as those detailed in Section 7.6.1.4.
- Mitigation measures for the control of hydrocarbons are the same as those detailed in Section 7.6.1.8.

7.6.2.4 Water Supply at Substation

Impact Assessment

The abstraction rate for the proposed groundwater well at the substation will be comparable to a domestic well, with a well supplying a single household typically abstracting less than 1m³/day. The well is proposed in a Poor Bedrock Aquifer. This aquifer forms part of the Belmullet GWB which is composed primarily of low transmissivity rocks. Most groundwater flow will occur in the uppermost broken and weathered part of the aquifer and in the vicinity of fault zones. Therefore due to the nature of the bedrock aquifer and the proposed extraction rate, no effects on local groundwater levels will occur.

For these reasons no specific mitigation measures are required.

7.6.2.5 Assessment of Effect on WFD Objectives

No specific mitigation measures are required. The wind farm drainage system will prevent any direct and/or untreated discharge to downstream surface watercourses.

7.7 Post Mitigation Residual Effects

7.7.1 Construction Phase

7.7.1.1 Contamination of Soil by Leakages and Spillages

Post-Mitigation Residual Effect: The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all construction sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect will be a negative, imperceptible, direct, short-term, unlikely effect on peat, subsoils, and bedrock.

Significance of Effects: For the reasons outlined above, and with the implementation of the proposed mitigation measures, no significant effects on peat, subsoils and bedrock will occur.

7.7.1.2 Erosion of Exposed Subsoils and Peat During Construction of Infrastructure

Post-Mitigation Residual Effect: Peat soils and spoil can be eroded by vehicle movements, wind action and by water movement. To prevent this all excavation works will be completed in accordance with a detailed Peat and Spoil Management Plan, material will remain within the Proposed Development site and reseeding and planting will be completed to bind landscaped peat and spoil together. Following implementation of these measures the residual effected will be a negative, slight, direct, short-term, likely effect on peat and subsoils by erosion and wind action.

Significance of Effects: For the reasons outlined above, no significant effects on soils, subsoils or bedrock will occur.

7.7.1.3 Clear Felling of Coniferous Forestry

Post-Mitigation Residual Effect: The potential for the release of suspended solids to watercourse receptors during tree felling is a risk to water quality and the aquatic quality of the receptor. Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, indirect, temporary, likely effect on downstream watercourses and associated water-dependent ecosystems.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

7.7.1.4 Earthworks Resulting in Suspended sediment entrainment in Surface waters

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on watercourses in the vicinity and downstream of the Wind Farm Site (Keerglen River and its tributaries and the Ballinglen River) and along the Underground Electricity Export Connection (Ballinglen and Cloonaghmore rivers and the relevant tributaries and the Moyne stream).

Significance of Effects: For the reasons outlined above, no significant effects on surface water quality will occur.

7.7.1.5 Excavation Dewatering and Potential Effects on Surface Water Quality

Post-Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, indirect, short-term, unlikely effect on local surface water quality.

Significance of Effects: For the reasons outlined above no significant effects on the surface water quality will occur.

7.7.1.6 Potential Effects on Groundwater Levels During Excavation Works

Post-Mitigation Residual Effects: Due to significant elevation of the Wind Farm Site and the local hydrogeological regime (Poor Aquifer), along with the relatively shallow nature of the proposed works, the potential for water level drawdown effects at receptor locations is negligible. The residual effect will be a negative, imperceptible, indirect, short-term, unlikely effects on local groundwater levels within the Wind Farm Site.

Significance of Effects: For the reasons outlined above, no significant effects on groundwater levels will occur.

7.7.1.7 Potential Effects Associated with Piled Foundations on the Water Environment

Post-Mitigation Residual Effects: The proposed piling works potentially pose a threat to groundwater quality in the underlying regional groundwater system, and also could potentially create a pathway for upward migration of alkaline groundwater to the peat surface. These potential effects will not arise at the proposed site due to a combination of the prevailing ground conditions, groundwater conditions, and proposed mitigation measures that will ensure the potential pathways for interaction of shallow (acidic peat water) and deeper (alkaline) groundwater are prevented from occurring. In additional, due to the small footprint of proposed pile clusters, and the significant spacing between turbine bases where pile clusters are proposed, the potential for such pile clusters to block regional groundwater flow is imperceptible at that scale. The proposed piled foundations therefore have no potential to change the WFD status or impact the WFD objectives of the underlying Belmullet GWB. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on groundwater flow, and ground quality/peat water hydrochemistry.

Significance of Effects: For the reasons given above, no significant effects on regional groundwater and the Belmullet GWB will occur, and no significant effects on peat water hydrochemistry will occur from proposed piling works.

7.7.1.8 Potential Release of Hydrocarbons

Post-Mitigation Residual Effect: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on groundwater and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

7.7.1.9 Potential Release of Cement-Based Products

Post Mitigation Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be a negative, Indirect, imperceptible, short term, unlikely effect on surface water quality and an indirect, negative, imperceptible, long term, unlikely effect on local groundwater quality.

Significance of Effects: For the reasons outlined above no significant effects on surface water quality will occur.

7.7.1.10 Groundwater and Surface Water Contamination from Wastewater Disposal

Post-Mitigation Residual Effect: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all construction sites containing welfare facilities. Proven and effective measures to mitigate the release of wastewater on site have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be a negative, imperceptible, indirect, short-term, unlikely effect on surface water or groundwater quality.

Significance of Effects: For the reasons outlined above no significant effects on surface water or groundwater quality will occur.

7.7.1.11 Morphological Changes to Surface Watercourses within Wind Farm Site

Post-Mitigation Residual Effects: The potential for the construction of watercourse crossings and associated in-stream works is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to protect water quality have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, direct, long-term, unlikely effect on downstream water quality and aquatic habitats.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, no significant effects on the surface water quality will occur.

7.7.1.12 Morphological Changes to Surface Watercourses Along the Underground Electricity Export Connection

Post-Mitigation Residual Effect: The potential for the release of suspended solids and other contaminants to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect will be a negative, imperceptible, direct, long term, likely effect on surface water flows and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water flows and surface water quality will occur.

7.7.1.13 Potential Effects on Local Groundwater Well Supplies

Post-Mitigation Residual Effects: For the reasons outlined in the impact assessment above (separation distances, and prevailing geology, topography and groundwater flow directions), the residual effect will be a negative, imperceptible, indirect, long-term, unlikely effect in terms of quality or quantity on local groundwater abstractions.

Significance of Effects: For the reasons outlined above, no significant effects on existing groundwater supplies will occur.

7.7.1.14 Use of Siltbuster and Effect on Downstream Surface Water Quality

Post-Mitigation Residual Effects: With the implementation of the dosing technology and the continual monitoring of pre and post treatment water, the appropriate volume of chemical agent can be added to ensure that chemical carryover concentrations are present only in tiny trace amounts which will not cause any effects to receiving waters or associated aquatic ecology. The residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality.

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will not occur. In fact, we consider that the use of siltbuster systems has a significant positive effect in respect of protected surface water quality.

7.7.1.15 Surface Water Quality Effects During Directional Drilling Along the Underground Electricity Export Connection

Post-Mitigation Residual Effect: Due to the avoidance of instream works, the works being mainly carried out in the corridor of a public road along with the proposed mitigation measures the residual effect will be a negative, imperceptible, indirect, temporary, likely effect on surface water in the Ballinglen and Cloonaghmore rivers.

Significance of Effects: For the reasons outlined above, no significant effects on surface water quality will occur.

7.7.1.16 Potential Effects on Karst

Post Mitigation Residual Effect: Due to the minor and transient nature of the works along the Underground Electricity Export Connection and at the temporary access junction and roadway between the R315and the L51723 there is limited potential for effects on the underlying karst bedrock aquifer. Furthermore, the mitigation measures associated with drainage management and the protection of water quality will ensure that the residual effects will be an indirect, negative, imperceptible, short-term, unlikely effect.

Significance of Effects: No significant effects on karst features will occur.

7.7.1.17 Potential Effects on Designated Sites

Post-Mitigation Residual Effects: Construction activities pose a threat to designated sites hydrologically linked with the Proposed Development Site. Proven and effective measures to mitigate the risk of surface and groundwater contamination have been proposed which will break the pathway between the potential source and the downstream receptor. These mitigation measures will ensure that surface water runoff from the Proposed Development Site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or the status or ecology of the protected species and habitats within the designated sites. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on the Killala Bay/Moy Estuary SPA/SAC/pNHA.

Due to the local hydrogeological regime (short groundwater flowpaths) and the lack of any surface water connections between the proposed infrastructure locations and the Ummerantarry Bog NHA, there is no potential for effects on Ummerantarry Bog NHA.

Significance of Effects: No significant effects on designated sites will occur.

7.7.1.18 Potential Effects on WFD Status

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Development will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Development. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration.

No residual effect on Groundwater Body WFD status will occur.

No residual effect on Surface Water Body WD status will occur.

Significance of Effects: For the reasons outlined above, no significant effects on WFD Groundwater Bodies and Surface Water Bodies status, risk or future objectives will occur as a result of the Proposed Development.

7.7.2 Operational Phase

7.7.2.1 Use of Oils in Transformers

Post-Mitigation Residual Effect: The use of hydrocarbons in transformers and substations is a standard risk associated with all operational wind farm sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect will be a negative, imperceptible, direct, short-term, unlikely effect on peat, subsoils, and bedrock.

Significance of Effects: For the reasons outlined above, no likely significant effects on land, soils, subsoils or bedrock will occur.

7.7.2.2 Progressive Replacement of Natural Surface with Lower Permeability Surface

Post Mitigation Residual Effect: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, the residual effect will be a negative, imperceptible, direct, long-term, moderate probability effect on all downstream surface water bodies.

Significance of Effects: For the reasons outlined above, no significant effects on downstream flood risk will occur.

7.7.2.3 Runoff Resulting in the Contamination of Surface Waters

Post Mitigation Residual Effects: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, the residual effect will be a negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality in the Keerglen and Ballinglen rivers (and associated tributaries).

Significance of Effects: For the reasons outlined above, no significant effects on the surface water quality will occur.

7.7.2.4 Water Supply at Substation

Post-Mitigation Residual Effects: Due to the scale of the proposed abstraction and the nature of the bedrock aquifer, the residual effect will be a direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

Significance of Effects: For the reasons given above, and with the implementation of the above mitigation measures, no significant effects on surface water quality or quantity, or groundwater quality will occur.

7.7.2.5 Assessment of Effects on WFD Objectives

Mitigation for the protection of surface and groundwater during the operation phase of the Proposed Development will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Development. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration.

No residual effect on Groundwater Body WFD status will occur.

No residual effect on Surface Water Body WD status will occur.

Significance of Effects: For the reasons outlined above, no significant effects on WFD Groundwater Bodies and Surface Water Bodies status, risk or future objectives will occur as a result of the Proposed Development.

7.8 Decommissioning Phase Effects

The potential effects associated with decommissioning of the Proposed Development will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it may be possible to reverse or at least reduce some of the potential effects caused during construction by rehabilitating construction areas such as turbine bases, hard standing areas. This will be done by covering with peatland vegetation/scraw or poorly humified peat to encourage vegetation growth and reduce run-off and sedimentation. Other effects such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:

> *"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm."*

Mitigation measures applied during decommissioning activities will be similar to those applied during construction where relevant.

Some of the effects will be avoided by leaving elements of the Proposed Development in place where appropriate. The substation will be retained by EirGrid. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Internal roads will remain as amenity pathways. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant effects on the hydrological or hydrogeological environment are envisaged during the decommissioning phase of the Proposed Development.

7.9 Cumulative Effects

The only pathway that the Proposed Development can have cumulative effects with other off site projects or developments is via the drainage and off site surface water network. This hydrological pathway is assessed below.

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

The primary potential for cumulative effects will occur during the construction phase of the Proposed Development as this is when earthworks and excavations will be undertaken at the Proposed Development Site. The potential for cumulative effects during the operational phase of the Proposed Development will be significantly reduced as there will be no exposed excavations, there will be no sources of sediment to reach watercourses, there will be no use of cementitious materials and fuels/oil will be kept to a minimum at the site. During the decommissioning phase, the potential cumulative effects are similar to the construction phase, but to a lesser degree with less ground disturbance.

A detailed cumulative assessment has been carried out for all planning applications (granted and awaiting permission) within a combined river sub-basin zone in the vicinity of the Wind Farm Site. This combined sub-basin areas encompasses the Keerglen_010, Ballinglen_010 and Ballinglen_020 WFD river sub-basins. There will be no potential for cumulative effects downstream of the Ballinglen River due to the large volumes of water within Bunatrahir Bay and the saline nature of these waters. The total cumulative study area for the Wind Farm Site is 44km^2 (4,400ha).

A further assessment has been completed within a 200m buffer zones of the proposed Underground Electricity Export Connection. Due to the shallow nature of the underground cabling connection trench, a 200m buffer zone is an appropriate scale when considering potential cumulative effects on the water environment. The hydrological cumulative study area is shown in Figure 7.12.

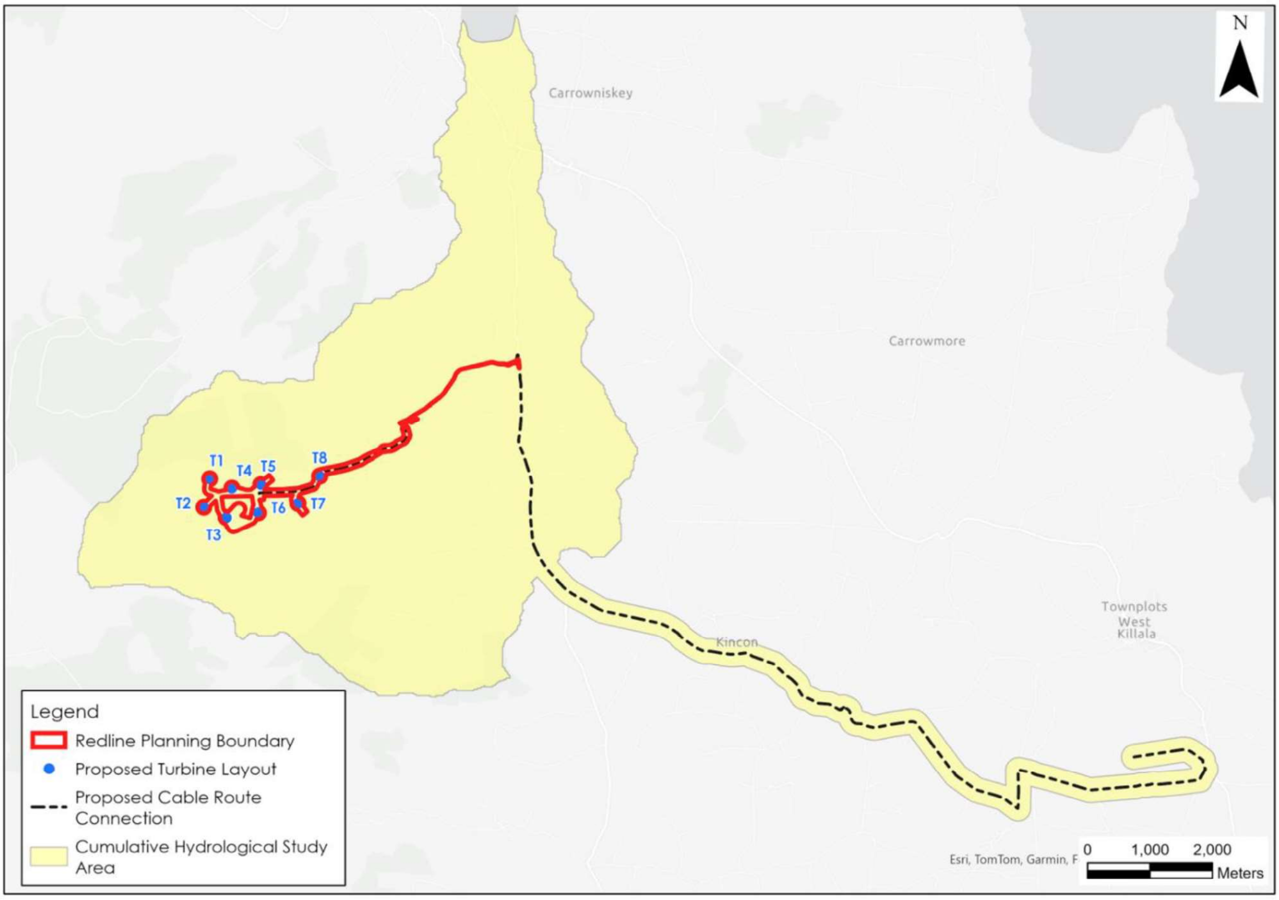

Figure 7.12: Cumulative Study Area

7.9.1 Cumulative Effects with Agriculture

The Wind Farm Site is situated in the catchment of the Ballinglen River which comprises of largely mountainous terrain and upland peat bogs. According the Corine Land Cover mapping (www.epa.ie) (2018), there is a total of 1,350ha of agricultural land within the cumulative water study area. This represents ~31% of the cumulative water study area.

Agriculture is the largest pressure on water quality in Ireland. Agricultural practices such as the movement of soil and the addition of fertilizers and pesticides can lead to nutrient losses and the entrainment of suspended solids in local surface watercourses. This can have a negative effect on local and downstream surface water quality.

In an unmitigated scenario the Proposed Development would have the potential to interact with these agricultural activities and contribute to a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However, the mitigation measures detailed below in Section 7.6.1, 7.6.2 and 7.8 for the construction, operational and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons we consider that there will not be a significant cumulative effect associated with agricultural activities.

7.9.2 Cumulative Effects with Forestry

The Wind Farm Site is situated in the catchment of the Ballinglen River which comprises of largely mountainous terrain and upland peat bogs. According to the Corine Land Cover mapping (www.epa.ie) (2018), there is a total of 67ha of forestry within the cumulative water study area. This represents ~15% of the cumulative water study area.

The most common water quality problems arising from forestry relate to the release of sediment and nutrients to the aquatic environment, and impacts from acidification. Forestry may also give rise to modified stream flow regimes caused by associated land drainage.

Due to the close proximity of these forested areas to the Proposed Development Site and given that they drain to the Roughty River, the potential cumulative effects on downstream water quality and quantity need to be assessed.

However the mitigation measures detailed in Section 7.6.1, 7.6.2 and 7.8 for the construction, operational and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons we consider that there will not be a significant cumulative effect associated with commercial forestry activities.

7.9.3 Cumulative Effects with Turbary Peat Cutting

The Wind Farm Site is situated in the catchment of the Ballinglen River which comprises of largely mountainous terrain and upland peat bogs. According the Corine Land Cover mapping (www.epa.ie) (2018), there is a total of 2,376ha of peat bogs within the cumulative water study area. This represents ~54% of the cumulative study area.

Given, the widespread occurrence of peat bogs within the wider area, it is likely that there are turbary peat cutting activities occurring within the cumulative Wind Farm study area. The construction phase of the Proposed Development may interact with these turbary activities and result in a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However, the areas of private peat cutting will be infinitely small, significantly limiting the potential for cumulative effects to arise with the Proposed Development. Nevertheless, the mitigation measures detailed in Section 7.6.1, 7.6.2 and 7.8 for the construction, operational and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

For these reasons outlined above we consider that there will not be a significant cumulative effect associated with turbary activities.

7.9.4 Cumulative Effects with Other Wind Farm Developments

There are a total of 13 no. operational, consented and proposed wind farms within 20km of the Proposed Development.

Table 7.20 below identifies the surface water catchment and sub-catchment within which these wind farms are located. The only Wind Farm located within the hydrological cumulative study area is the proposed Glenora Wind Farm. 5 of the proposed 22 no. turbines associated with the Glenora Wind Farm are located in the cumulative study area and drain to the Ballinglen River. All other wind farms are located in separate river sub-catchments and have no potential for cumulative effects with the Proposed Development.

The EIARs for the Glenora wind farm development details potential hydrological and hydrogeological issues relating to the operation and decommissioning phases of this development and proposes a suite of best practice mitigation measures designed to ensure that the development does not in any way have a negative effect on downstream surface water quality and quantity. Similarly, the mitigation and best practice measures proposed in this EIAR chapter will ensure that the Proposed Development does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, with the implementation of the proposed mitigation measures there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Development within the cumulative study area. Due to the lack of hydrological connectivity there is no potential for cumulative effects with other wind farm developments.

Table 7.20: Wind Farms within 20km and Potential Hydrological Connectivity

Name	No. Turbines	WFD Catchment (Sub-Catchment)	Hydrological Connectivity with Wind Farm Site
Glenora	22	Blacksod-Broadhaven (Glencullin_SC_010 and Owenmore_SC_010_)	Yes – 5 no. turbines drain to the Ballinglen River
Oweninny (Phase 1)	18	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None – different sub-catchment
Oweninny (Phase 2)	25	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None – different sub-catchment
Oweninny (Phase 3)	18	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None – different sub-catchment
Corvoderry	10	Blacksod-Broadhaven (Owenmore_SC_010)	None – different sub-catchment
Sheskin	8	Blacksod-Broadhaven (Owenmore_SC_010)	None – different sub-catchment
Tirawley	21	Blacksod-Broadhaven (Glencullin_SC_010)	None – no waters associated with the Tirawley WF drain to the Ballinglen River
Bellacorrick	21	Blacksod-Broadhaven (Owenmore_SC_020)	None – different sub-catchment
Sheskin South	21	Blacksod-Broadhaven (Owenmore_SC_010 and _020)	None – different sub-catchment
Killala	6	Moy and Killala Bay (Abbeytown_SC_010 and Cloonaghmore_SC_030)	None – different catchment
Dooleeg	1	Blacksod-Broadhaven (Owenmore_SC_020)	None – different sub-catchment
Gortnahurra	18	Moy and Killala Bay (Cloonaghmore_SC_010 & Deel_SC_020)	None – different catchment
Kilsallagh	13	Blacksod-Broadhaven (Owenmore_SC_ _020)	None – different sub-catchment

7.9.5 Cumulative Effects with Other Developments

A detailed cumulative assessment has been completed for all planning applications (granted and awaiting decisions) within the cumulative assessment area described above.

The planning applications identified within the cumulative study area are for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings. Based on the scale of the works, their proximity to the Proposed Development and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Development (construction, operation and decommissioning phases).

7.10 Assessment of Potential Health Effects

In terms of the hydrological and hydrogeological environment, potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. There are no mapped public or group water scheme groundwater protection zones in the area of the Proposed Development Site. Notwithstanding this, the Proposed Development design and mitigation measures ensures that the potential for effects on the water environment will not be significant. Mitigation measures to deal with potential health effects are a combination of the mitigation measures set out in Sections 7.6.1 and 7.6.2 which all act to protect the land, soils, geological, hydrological and hydrogeological environment.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues.

A detailed Flood Risk Assessment has been caried out for the Proposed Development, summarised in Section 7.3.6. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (Section 7.6.2.2) demonstrates that the risk of the Proposed Development contributing to downstream flooding is insignificant. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

7.11 Risk of Major Accidents and Disasters

Due to the nature of the Wind Farm Site *i.e*. sloping terrain with peat covered slopes, the primary risk of an accident is associated with a peat slide. However, a comprehensive Geotechnical and Peat Stability Report (FT 2024) (Appendix 8.1) has been undertaken for all Proposed Development infrastructure locations, and it concludes that with the implementation of the proposed control (mitigation) measures, the residual risk of a landslide occurring is determined to be negligible/none.

Flooding can also result in downstream major accidents and disasters. However, due to the small scale of the Proposed Development footprint and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Development is negligible/none.

7.12 References

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FT (2024): Geotechnical and Peat Stability Report for Keerglen Wind Farm.

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