9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of the Proposed Carrow Wind Farm and Proposed Grid Connection (Proposed Project), Co. Tipperary and Co. Limerick on hydrological (surface water) and hydrogeological (groundwater) aspects of the receiving environment.

The Proposed Project is described in full in Chapter 4 of this EIAR.

The 'Proposed Wind Farm' refers to the 14 no. turbines and supporting infrastructure including the Battery Energy Storage System (BESS), Biodiversity Enhancement and Management Plan (BEMP) Measures and Turbine Delivery Route (TDR) works as detailed description provided in Chapter 4 of this EIAR).

The 'Proposed Grid Connection' refers to the 110kV on-site substation and 37.6km underground 110kV grid connection cabling connecting to the existing Killonan 110kV substation Co. Limerick, and all ancillary works and apparatus. The Proposed Grid Connection is described in detail in Chapter 4 of this EIAR.

Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary and includes both the Proposed Wind Farm and Proposed Grid Connection.

The 'Proposed Wind Farm site' refers to the portion of the Site surrounding the Proposed Wind Farm but excluding the portion of the Site surrounding the Proposed Grid Connection underground cabling route and 110kV substation.

This chapter provides a baseline assessment of the environmental setting of the Proposed Project, as described in Chapter 4, in terms of hydrology and hydrogeology and discusses the potential likely significant effects that the construction, operation and decommissioning of the Proposed Project will have. Where required, appropriate mitigation measures to avoid any identified significant effects to hydrology and hydrogeology are recommended and the residual effects of the Proposed Project post-mitigation are assessed.

The Water Study Area for assessing the potential zone of impact and cumulative effects assessment is the Multeen River catchment, which contains the Proposed Wind Farm and a section of the Proposed Grid Connection cable route, as well as the Mulkear River and Groody River catchments which only contain the Proposed Grid Connection cable route.

Refer to **Figure 9-1** below which shows regional hydrology mapping and the Water Study Area.

9.1.2 Statement of Authority

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

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessment reports for hydrological and hydrogeological aspects for a variety of project types.

This chapter of the EIAR was prepared by Michael Gill, David Broderick and Nitesh Dalal.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 24 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Glenard Wind Farm, Cahermurphy Wind Farm, and Seven Hills Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 19 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Borrisbeg Wind Farm, Upperchurch WF Grid Connection and Knockroe Wind Farm, and over 60 other wind farm related projects across the country.

Adam Keegan (B.Sc., M.Sc.) is a Hydrogeologist with 8 years environmental consultancy experience in Ireland. Adam has worked on numerous Environmental Impact Assessments for infrastructure projects, such as wind farms, strategic housing developments and quarries. Adam has experience in intrusive site investigation works within Limestone bedrock aquifers and experience in trial and production well drilling within areas mapped as Regionally Karstified. Adam has worked on several wind farm EIAR projects, including Croagh WF, Lyrenacarriga WF (SID), Cleanrath WF, Carrownagowan WF (SID), and Fossy WF.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

9.1.3 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 Section 2.6 of this EIAR.

Matters raised by Consultees in their responses with respect to the water environment are summarised in

Table 9-1 below.

Table 9-1: Summary of Water Environment Related Scoping Responses

Consultee	Points Raised (as referenced)	Addressed in Section
Geological Survey of Ireland (GSI)	*"Our records show that there is a groundwater drinking water abstraction Ironmills Public Water Supply Scheme (PWSS) with a zone of contribution/source protection area within the grid connection route and EIAR Site Boundary. Key to groundwater protection in general, and protection of specific drinking water supplies, is preventing ingress of runoff to the aquifer. Design of drainage will need to be cognisant of the public water schemes and the interactions*	Sections 9.3.16.1, 9.3.16.2, 9.5.2.9 and 9.5.2.13

Consultee	Points Raised (as referenced)	Addressed in Section
	between surface water and groundwater as well as run-off. Appropriate design should be undertaken by qualified and competent persons to include mitigation measures as necessary, such as SUDs or other drainage mitigation measures. *Any excavation/cuttings required for realignment should ensure that groundwater flow within the zones of contribution to the groundwater abstraction points is not disrupted, resulting in diminished yields. Note that there could be other groundwater abstractions in the locality for which Geological Survey Ireland has not undertaken studies, and a robust assessment should be undertaken by qualified and competent persons including a survey of all current wells and water abstractions within the vicinity.* *Given the nearby drinking water sources (Public Water Scheme), the effects of any potential contamination as a result of the project would need to be assessed".*	
Uisce Éireann (UÉ)	*"Uisce Éireann notes that the proposed wind farm development is located c. 2.5 km upstream of Uisce Éireann's public water abstraction source in Iron Mills and c. 11 km upstream of Uisce Éireann's public water abstraction source in Springmount. Careful consideration of the potential impacts of the proposed development on all public water sources shall be assessed as well as the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s)".* *"Where the development proposal has the potential to impact an Uisce Éireann Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified as part of the report ".*	Sections 9.3.16.1 and 9.5.2.13
Waterways Ireland	*"This is not within any Zone of Influence of our waterways so we will not be commenting".*	n/a

9.1.4 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 requirements of the following legislation are also complied with:

- Planning and Development Act 2000 (as amended);

- Planning and Development Regulations, 2001 (as amended);
- S.I. No 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 (as amended) 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 as amended, resulting from EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and 79/409/EEC on the conservation of wild birds (the Birds Directive);
- S.I. No. 293/1988: Quality of Salmon Water Regulations;
- 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);
- S.I. No. 684/2007 Waste Water Discharge (Authorisation) Regulations 2007
- S.I. No. 99/2023: European Communities Environmental Objectives (Drinking Water) (Amendment) Regulations 2023;
- S.I. No. 287/2022: European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2022;
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Water) Regulations 2009 as amended;
- S.I. No. 77/2019: European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2019; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (as amended).

9.1.5 Relevant Guidance

The Hydrology and Hydrogeology chapter of this EIAR is carried out in accordance with guidance contained in the following:

- 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 Energy Development Guidelines for Planning Authorities, 2006 (the Guidelines);
- 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;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018);

- European Commission (2017): Environmental impact assessment of projects – Guidance on the preparation of the environmental impact assessment report (Directive 2011/90/EU as amended by 2014/52/EU);
- 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);
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018);
- Tipperary County Development Plan (2022 - 2028); and,
- Limerick County Development Plan (2022 - 2028).

9.2 Assessment Methodology

9.2.1 Desk Study & Preliminary Hydrological Assessment

A desk study of the Site and the Water Study Area was completed to collect all relevant hydrological, hydrogeological and meteorological data. The desk study was completed to supplement site walkover surveys, drainage mapping and site investigations.

The desk study involved consultation with the following sources:

- Environmental Protection Agency Databases (www.epa.ie);
- Environmental Protection Agency's Hydro tool Database (www.catchments,.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Geological Survey of Ireland (GSI);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OPW Flood Mapping (www.floodmaps.ie);
- GSI Groundwater Flood Mapping (www.gsi.ie);
- Department on Environment, Community and Local Government on-line mapping viewer (www.myplan.ie); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

9.2.2 Baseline Monitoring and Site Investigations

A walkover survey, including geological mapping and investigations of the Site, were undertaken by David Broderick of HES (refer to Section 9.1.2 above for qualifications and experience) on 4th, 5th & 8th April, 12th December 2024 and on 12th February and 21st October 2025.

Ground investigations in the form of trial pits (28 no. in total) were carried under the supervision of HES out on the following dates:

- 4th and 5th June 2024 (12 no.
- 12th December 2024 (9 no.)
- 12th February 2025 (7 no.)

The trial pits (28 no.) were carried out at various locations across the Site to provide information on the ground conditions, bedrock and to investigate the potential to develop borrow pits within the Site.

The objectives of the intrusive site investigations included mapping the distribution and depth of soil and mineral subsoils at the Site along with assessing the mineral subsoil / bedrock conditions at key Proposed Project locations (i.e. proposed turbines, temporary construction compounds, existing and proposed access roads, spoil repository areas, borrow pits and 110kV substation/BESS). This data was used to inform the impact assessment and final layout design.

In summary, site investigations to address the Hydrology/Hydrogeology section of the EIAR include the following:

- Walkover surveys and geological mapping of the Site area were undertaken to assess general ground conditions;
- Detailed hydrological mapping of the Site was undertaken whereby water flow directions and drainage patterns were recorded;
- Use of Lidar topographic data to create detailed site drainage mapping;
- Trial pitting (28 no.) and soil cores (10 no.) by HES to investigate soil and mineral subsoil lithology as well as depth to bedrock;
- Mineral subsoils were logged according to BS: 5930;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen, turbidity and temperature) were taken to determine the origin of surface water flows (2 no. rounds); and,
- Surface water sampling (2 no. rounds) for baseline and hydrological characterisation purposes.

9.2.3 Impact Assessment Methodology

Please refer to Chapter 1 of the EIAR for detailed on the impact assessment methodology (EPA, 2022). In addition to the above methodology, the importance of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of importance which are defined in

Table 9-2 for hydrology and **Table 9-3** for hydrogeology are used to assess the potential effects that the Proposed Project may have on them.

Table 9-2: Estimation of Importance of Hydrology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Quality Class A (Biotic Index Q4, Q5). Flood plain protecting more than 50 residential or commercial properties from flooding. Nationally important amenity site for a wide range of leisure activities.
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable water source supplying >1000 homes. Quality Class B (Biotic Index Q3-4). Flood plain protecting between 5 and 50 residential or commercial properties from flooding.
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery. Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2-3). Flood plain protecting between 1 and 5 residential or commercial properties from flooding.

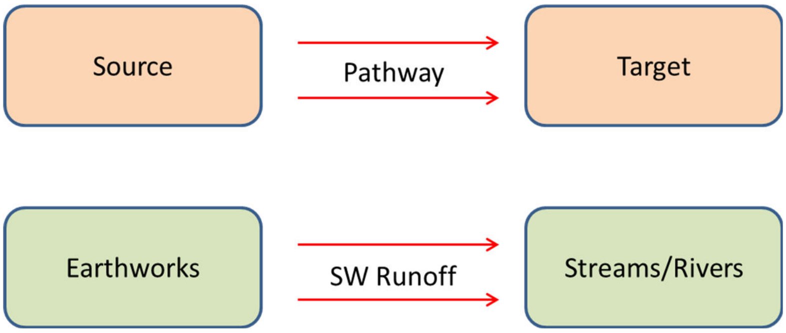
Importance	Criteria	Typical Example
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes. Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

Table 9-3: 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.

9.2.4 Overview of Impact Assessment Process

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



Where potential effects are identified, the classification of effects in the assessment follows the descriptors provided in the Glossary of Impacts contained in EPA, 2022.

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

The assessment of effects is Step No. 6 of 7 in the EIAR process. In order to provide an understanding of the stepwise impact assessment process applied below (Section 9.5), a summary guide is presented below, which defines the steps (Steps 6a to 6g) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA, 2022 impact descriptors are combined.

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

Table 9-4: Impact Assessment Process Steps

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

Step 6a	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 6b	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 6f	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 6g	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

9.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Hydrology and Hydrogeology Chapter of the EIAR. The site investigations and seasonal monitoring carried out are robust and comprehensive.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Proposed Wind Farm, which has a total area of approximately 830ha (hectares) is located approximately 2.4km south of the village of Hollyford and 4.7km north of the village of Dundrum, Co. Tipperary.

The Proposed Wind Farm Site is located in an upland setting and is dominated by coniferous forestry plantations along with agricultural pastural land, mixed forest and transitional woodland-shrub. Apart from three turbine locations (T1, T5 and T9), all other proposed turbine locations are situated in forestry. The Site is accessible via a network of local public roads, forestry tracks and farm tracks. Proposed turbine location T5 is in scrubland while T1 and T9 are in grassland.

The Proposed Wind Farm site setting on the southern foothills of the Mauherslieve Mountains means that topography in the local area is hilly with the Proposed Wind Farm infrastructure spread across several stream valleys that drain southerly within or adjacent to the Proposed Wind Farm site. Ground elevations within the Proposed Wind Farm site range from ~376m OD (metres above Ordnance Datum) on the north to approximately 163m OD on the south. Slopes range from moderate to steep, with the steepest slopes being on the valley sides of the main the streams that drain the Proposed Wind Farm site.

The Proposed Grid Connection route includes for underground cabling from the proposed 110kV substation, located on the south of the Proposed Wind Farm site to the existing Killonan 110kV substation in the townland of Milltown, Co. Limerick. The proposed 110kV substation and BESS setting is rough grassland pastures.

The Proposed Grid Connection underground cable route, measuring approximately 37.6km in length, is primarily located within the public road corridor. Approximately 3.2km is proposed within National Roads, 15.5km proposed within Regional Roads, 16.9km proposed within Local Roads and approximately 2km proposed within agricultural land in Brittas, Co. Limerick. The length of Proposed Grid Connection underground cable route within County Tipperary and County Limerick is 12.5km and 25.1km respectively.

A Biodiversity Enhancement and Management Plan (BEMP) is proposed for areas of the Proposed Wind Farm site. This includes management of 30.3 ha of species rich grassland for Marsh Fritillary habitat enhancement, enhancement of approximately 3.3 ha of semi-natural woodland habitat and planting of plant riparian woodland either side of mapped watercourses within the Proposed Wind Farm site.

TDR temporary accommodation works will be required at 8 no. locations to facilitate the delivery of turbine components and other abnormal loads to the Proposed Wind Farm during the construction phase. The locations are along Regional Road R505 and local roads L1283.

9.3.2 Water Balance

Long term rainfall and evaporation data were sourced from Met Éireann. The 30-year annual average rainfall (1981-2010) recorded at Dundrum (Kilpatrick) rainfall station, located ~3.3km south of the Proposed Wind Farm site are presented in **Table 9-5**. The long-term average annual rainfall at Dundrum (Kilpatrick) station is ~1073mm/year.

Table 9-5 Local Average long-term Rainfall Data

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Dundrum (Kilpatrick)		193,500		145,100		110		1975		-		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
106.9	81.8	83.9	68.6	73.7	79.8	74.9	92.1	85.9	120.9	102.3	101.8	1072.6

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 Proposed Wind Farm site ranges from 1,327 to 1540mm/year. The average annual rainfall is 1,434mm/yr (this is considered to be the most accurate estimate of average annual rainfall from the available sources).

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Shannon Airport, ~55km west of the Proposed Wind Farm site. The long-term average PE for this station is 543mm/year. This value is used as a best estimate of the PE at the Proposed Wind Farm site. Actual Evaporation (AE) at the Proposed Wind Farm site is estimated as 516mm/year (which is 0.95 × PE).

The effective rainfall (ER) represents the water available for runoff and groundwater recharge. The ER for the Proposed Wind Farm Site is calculated as follows:

Effective rainfall (ER) = AAR – AE

= 1,434mm/year – 516mm/year

ER = 918mm/year

Based on groundwater recharge estimates from the GSI (www.gsi.ie), recharge coefficients range from 22% to 25% at the Proposed Wind Farm site. The majority of the Proposed Wind Farm site has a 22% recharge coefficient. Hence 23% is taken as the weighted average recharge coefficient and 77% as the runoff coefficient for the Proposed Wind Farm site.

Therefore, annual recharge and runoff rates for the Proposed Wind Farm site are estimated to be 211mm/year and 707mm/year respectively. This means that the hydrology of the Proposed Wind Farm site is characterised by higher surface water runoff rates and lower groundwater recharge rates. This is largely due to the poorly productive nature of the underlying bedrock aquifers (refer to Section 0 below).

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

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. 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 Proposed Wind Farm site is ~8% under the medium-low emission scenario and the high emissions scenario.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann.

The 10-year rainfall depths will be the basis of the Proposed Wind Farm site drainage hydraulic design as described in Section 9.4.1 below.

Table 9-6 below presents return period rainfall depths for the area of the Proposed Wind Farm site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (5-year, 10-year, 30-year and 100-year). These extreme rainfall depths will be the basis of the proposed wind farm drainage hydraulic design as described further below.

The 10-year rainfall depths will be the basis of the Proposed Wind Farm site drainage hydraulic design as described in Section 9.4.1 below.

Table 9-6: Return Period Rainfall Depths (mm) for the Proposed Wind Farm Site

Return Period (Years)				
Storm Duration	5	10	30	100
5 mins	6.6	8.0	10.7	14.4
15 mins	10.8	11.2	17.5	23.6
30 mins	13.8	16.7	21.9	29.2
1 hours	17.6	21.2	27.4	36.1
6 hours	33.3	39.0	49.1	62.5
12 hours	42.6	49.5	61.5	77.2
24 hours	54.4	62.7	77	95.5
2 days	65.8	74.8	90.1	109.5

9.3.3 Regional and Local Hydrology

Regionally, the Proposed Wind Farm site is located entirely within the River Suir catchment and more locally within the Multeen River surface water catchment within Hydrometric Area No. 16 of the South Eastern River Basin District).

More locally, the Proposed Wind Farm site is mapped to lie within 2 no. surface water sub-catchments. The western portion of the Proposed Wind Farm site is located in the Suir_SC_060 sub-catchment and more locally within the Multeen_010, Multeen_020 and Multeen_030 river sub-basins. All Proposed Wind Farm infrastructure is located in the Multeen_020 sub-basin.

The eastern portion of the Proposed Wind Farm site is mapped within the Multeen[East]_SC_010 sub-catchment and more locally within the Aughnaglanny_010 and Multeen (East)_030 sub-basin. All Proposed Wind Farm infrastructure is located in the Aughnaglanny_010 sub-basin.

The Multeen River discharges into the River Suir approximately 20km downstream of the Proposed Wind Farm site. Refer to **Table 9-7** below for a summary of regional and local hydrology at the Proposed Project.

Regionally, the Proposed Grid Connection is located in the River Suir catchment and the River Shannon catchment. Within the River Suir catchment approximately 5.3km of the cable route and the 110kV substation are located in the Multeen River surface water sub-catchment within the Multeen_020 sub-basin.

Within the River Shannon catchment, the cable route is located in the Mulkear River catchment (24km) and the Groody River catchment (8.3km). Refer to **Table 9-7** below for the sub-basins in which the Proposed Grid Connection cable route is located.

The TDR accommodation works are located in the Multeen(East)_SC_010 and Suir SC_060 sub-catchments.

Refer to **Table 9-7** below for a summary of regional and local hydrology at the Proposed Project.

Refer to **Figure 9-1** and

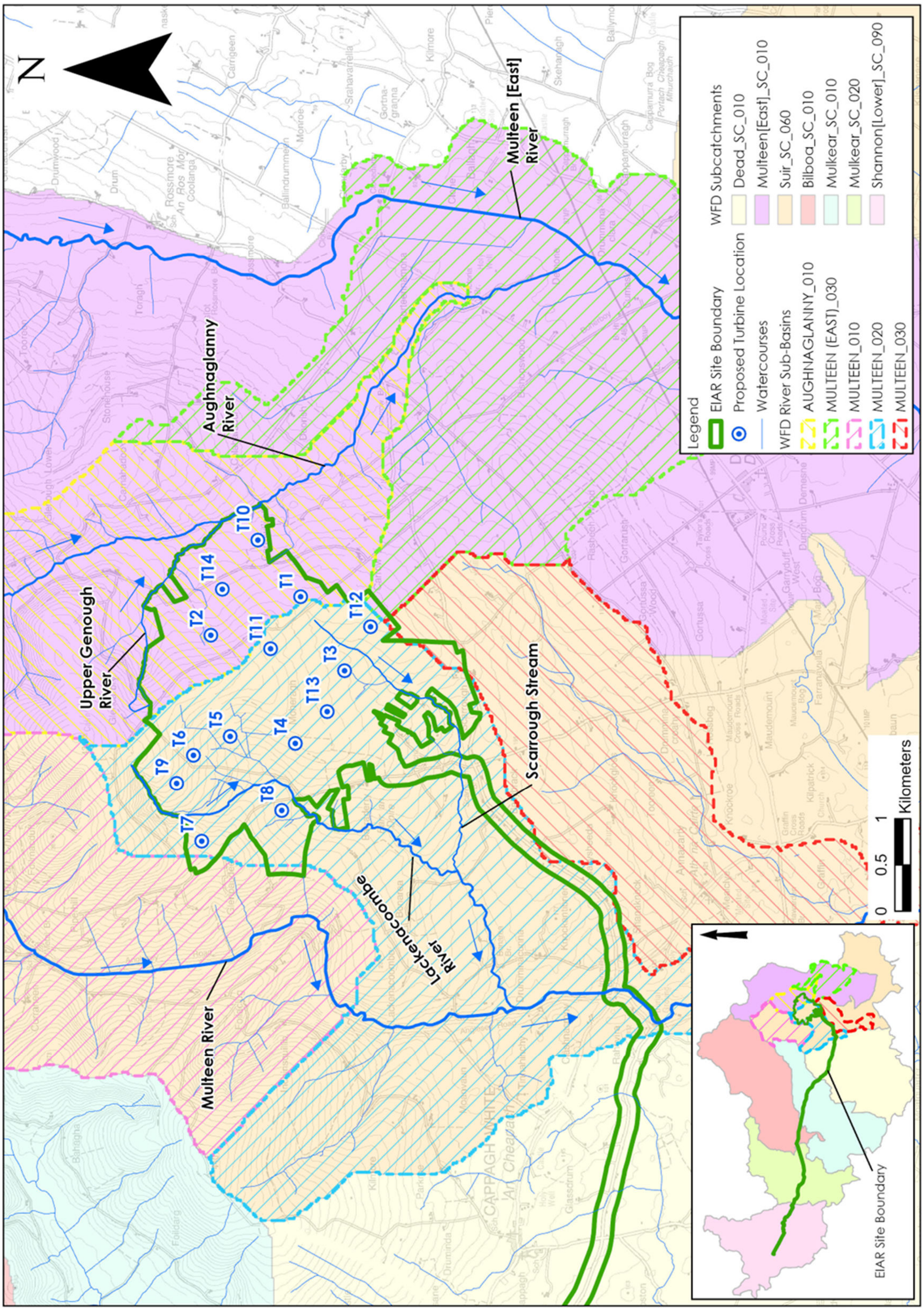


Figure 9-2 below for regional and local hydrology mapping respectively.

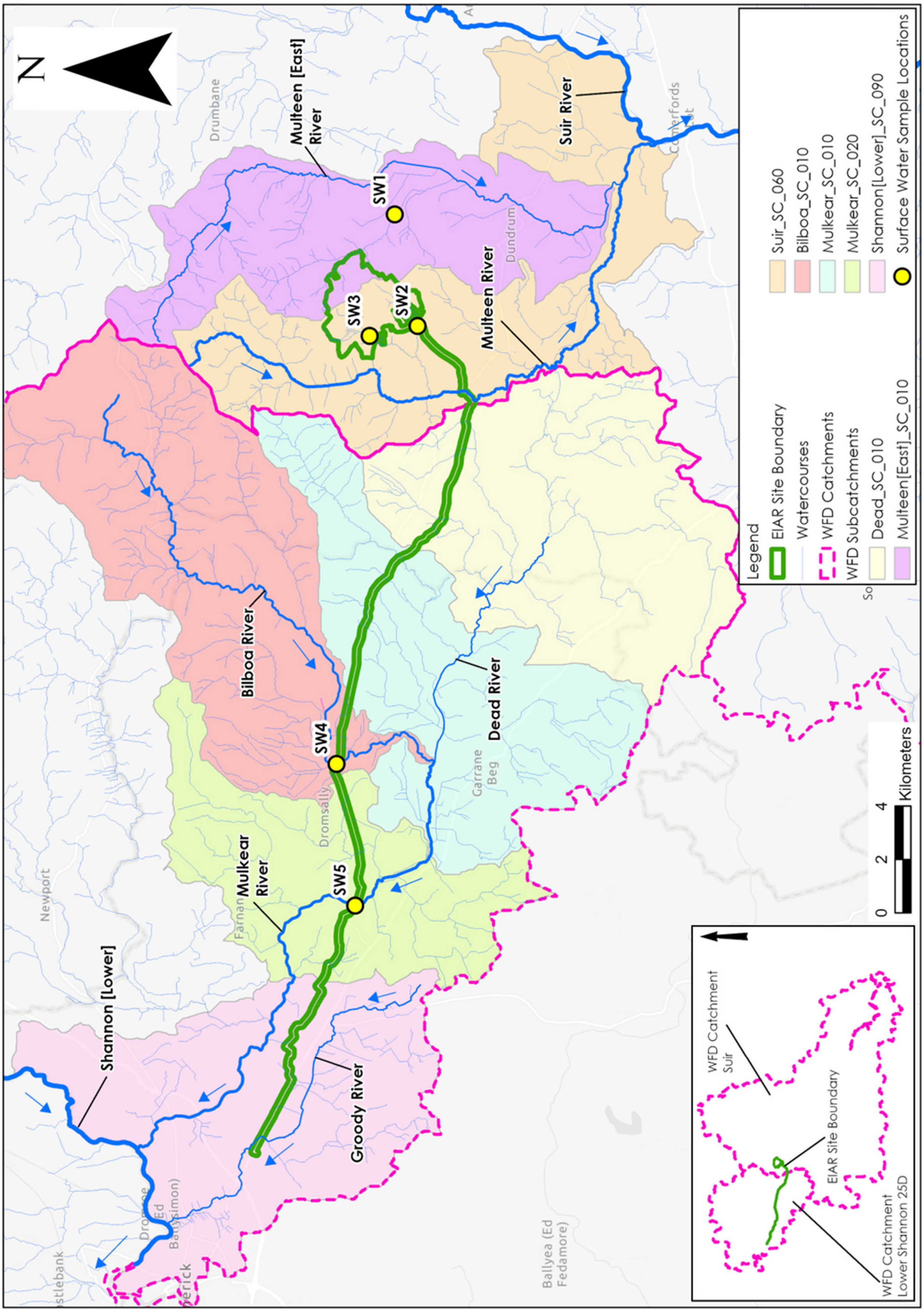


Figure 9-1: Regional Hydrology Map

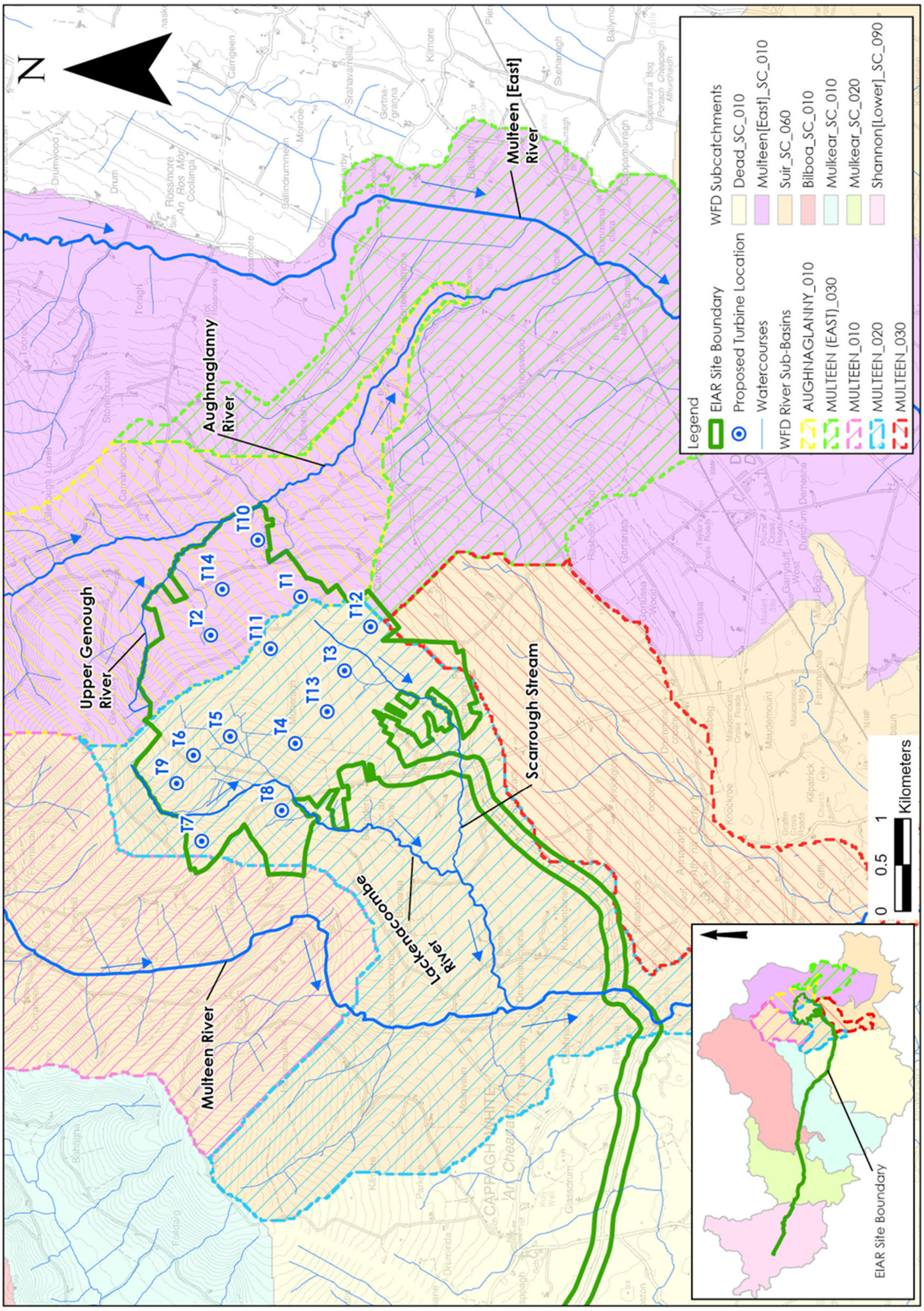


Figure 9-2: Local Hydrology Map

Table 9-7: Regional and Local Hydrology at the Proposed Project Site

Proposed Project Infrastructure	WFD River Sub-Basin	Proposed No. of Watercourse Crossings	WFD Sub-Catchment	Regional Surface Water Catchment
Proposed Wind Farm				
10 no. turbines, BESS, 2 no. borrow pits, 3 no. construction compounds, 2 no. spoil deposition areas and met mast	Multeen_020	10 no. (of which 5 no. are EPA mapped watercourses)	Suir_SC_060	River Suir
4 no. turbines and 1 no. spoil deposition area	Aughnaglanny_010	None	Multeen[East]_SC_010	
Proposed Grid Connection				
Underground Grid Connection cable route and 110kV substation	Multeen_020	2 no. EPA mapped watercourses	Suir_SC_060	River Suir
Underground Grid Connection cable route	Cappawhite Stream_010	2 no. EPA mapped watercourses	Dead_SC_010	Lower River Shannon
	Dead_020	None		
	Toem Stream_010	2 no. EPA mapped watercourses)		
	Cahernahallia_020	2 no. EPA mapped watercourses	Mulkear_SC_010	
	Doon Stream_010	2 no. EPA mapped watercourses		
	Mulkear (Limerick)_010	1 no. EPA mapped watercourses		
	Bilboa_020	4 no. EPA mapped watercourses	Bilboa_SC_010	
	Dooglasha (Cappamore)_010	2 no. EPA mapped watercourses	Mulkear_SC_020	

Proposed Project Infrastructure	WFD River Sub-Basin	Proposed No. of Watercourse Crossings	WFD Sub-Catchment	Regional Surface Water Catchment
	Mulkear (Limerick)_020	1 no. EPA mapped watercourses		
	Mulkear (Limerick)_030	None		
	Mulkear (Limerick)_040	2 no. EPA mapped watercourses		
	Mulkear (Limerick)_050	None		
	Groody_010 river	3 no. EPA mapped watercourses	Shannon[Lower]_SC_090	
Turbine Delivery Route Works				
TDR (8 no. locations with temporary works)	Suir_110	Location 1 (R505, Camus)	Suir_SC_060	River Suir
	Multeen_050	Location 2 (R505, Ballynahinch) Location 3 (R505, Kilshenane)		
	Multeen (East)_040	Location 4 (R505, Dundrum) Location 5 (L1283, Gortarush)	Multeen(East)_SC_010	
	Multeen (East)_030	Location 6 (L1283, Carrow) Location 7 (L1283, Carrow)		
	Multeen (East)_020	Location 8 (L1283, Scarrough)	Suir_SC_060	

9.3.4 Surface Water Flows

There are no OPW gauging stations located in the immediate vicinity of the Proposed Wind Farm site. The closest gauging station is located on the Multeen (east) River upstream of its confluence with the Multeen River at Aughnagross (Station Code: 16005). Here the 95%ile flow is estimated to be 0.317m^3/s. This means that 95% of the time the flow in the Multeen East River at this location is equal to or exceed 0.317m^3/s (317l/s).

EPA's Hydrotool, available on www.catchments.ie, was consulted in order to estimate baseline flow volumes in the local area. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several nodes were consulted in the vicinity and downstream of the Proposed Wind Farm Site.

Figure 9-3 below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes downstream of the Proposed Wind Farm site in the River Suir surface water catchment.

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 16_538 on the Lackenacoombe Stream, upstream of its confluence with the Multeen River and downstream of the Proposed Wind Farm site, is estimated to be 0.017m^3/s (17l/s). Due to the increased catchment size, the 95%ile flow at the nodes along the Multeen River and River Suir are progressively larger.

For example, at Node 16_3268 on the Multeen River downstream of the Multeen (east) River, the 95%ile flow is estimated to be 0.525m^3/s (525l/s). Further downstream, the 95%ile flow in the River Suir, downstream of the Multeen River at Node: 16_4005, is estimated to be 2.997m^3/s (2,997l/s).

The progressively increasing flow volumes downstream of the Proposed Wind Farm site are associated with the increased upstream catchment of the respective waterbodies, most notably in the River Suir which has a catchment area of 880km^2 upstream of the Multeen River confluence.

The catchment area of the Multeen River upstream of the River Suir confluence is 190km^2, therefore is a combined catchment area of 1,070km^2.

The increasing flows in the Multeen River and River Suir are important when assessing potential cumulative effects of the Proposed Wind Farm with other developments in the Water Study Area (refer to Section 0 in the impact assessment section).

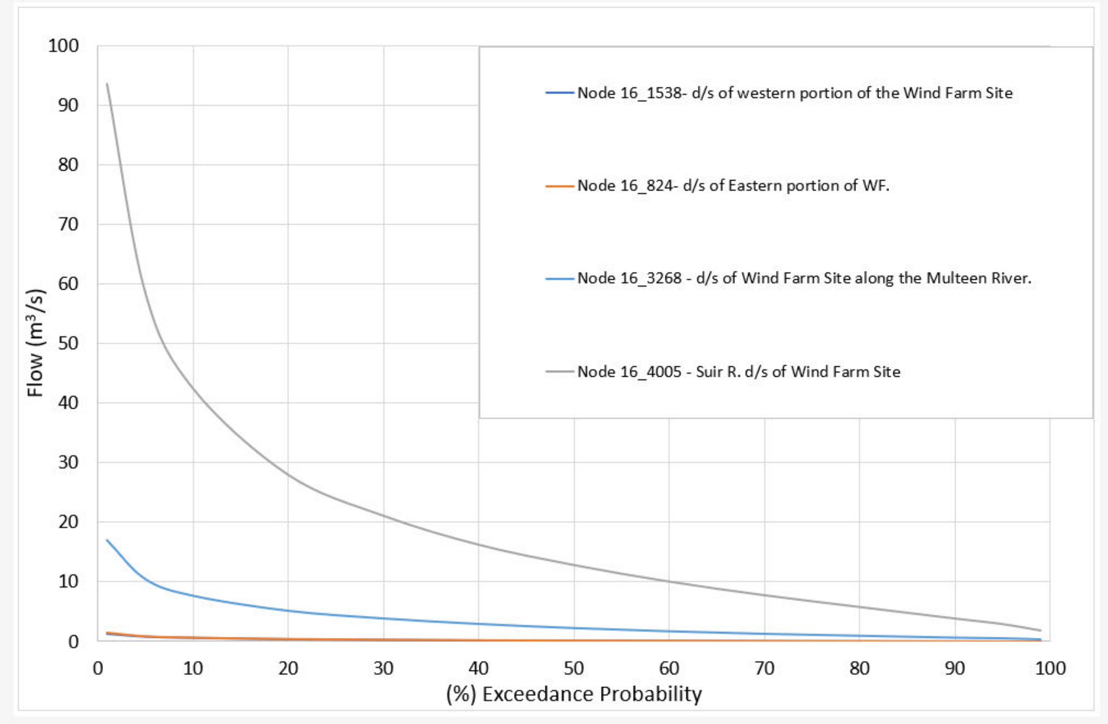


Figure 9-3: EPA Hydrotool Node Flow Duration Curves (Multeen River and River Suir)

9.3.5 Site Drainage

An existing drainage map for the Proposed Wind Farm site is shown as

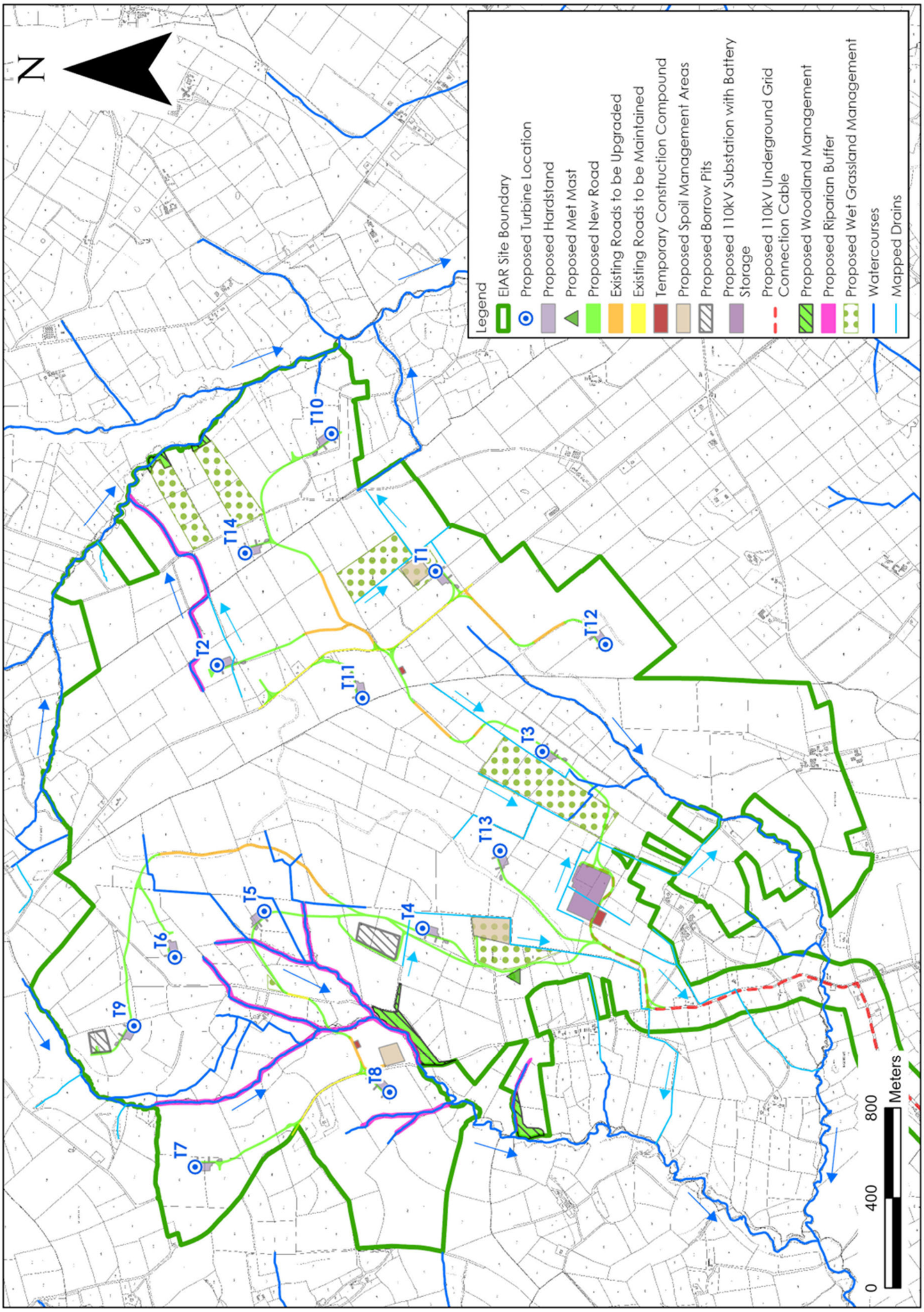

N
Legend
EIAR Site Boundary
Proposed Turbine Location
Proposed Hardstand
Proposed Met Mast
Proposed New Road
Existing Roads to be Upgraded
Existing Roads to be Maintained
Temporary Construction Compound
Proposed Spoil Management Areas
Proposed Borrow Pits
Proposed 110kV Substation with Battery Storage
Proposed 110kV Underground Grid Connection Cable
Proposed Woodland Management
Proposed Riparian Buffer
Proposed Wet Grassland Management
Watercourses
Mapped Drains
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
0
400
800
Meters

Figure 9-5.

The western and central portion of the Proposed Wind Farm site is drained by the Lackenacoombe Stream where several headwater (1st order) streams emerge from the northwest of the Site. The southwestern portion of the Proposed Wind Farm site is drained by the Glasheenyreagha Stream which emerges from two headwater streams on the southern end of the Proposed Wind Farm site.

Within the Proposed Wind Farm site there is an existing bridge crossing along public roads on both the Lackenacoombe Stream and the Glasheenyreagha Stream.

The Lackenacoombe Stream and Glasheenyreagha Stream flow off-site to the southwest and merge approximately 1.2km downstream of the Proposed Wind Farm site, prior to flowing into the Multeen River a further 2km downstream.

The eastern portion of the Proposed Wind Farm site is drained by Aughnaglanny River which flows southerly along the eastern boundary of the Proposed Wind Farm site. Two headwater streams of the Aughnaglanny River emerge from within the Proposed Wind Farm site. The Aughnaglanny River flows into the Multeen River approximately 5km downstream of the Proposed Wind Farm site.

Within the Lackenacoombe Stream catchment there are 6 no. new proposed watercourse crossing locations and 2 no. existing crossings (along forestry tracks) required for the Proposed Wind Farm access roads. Within the Glasheenyreagha Stream catchment 2 no. new proposed watercourse crossing locations are required respectively.

In addition, the drainage map was created using Lidar ground surface elevation data. Lidar data allows detailed mapping on the topographic contours of the Proposed Wind Farm site, thereby allowing identification of potential drainage pathways at the proposed Wind Farm site that are greater than 150m in length. The 150m drainage pathways are not always permanent watercourses but potential drainage pathways for surface water runoff after rainfall events. Based on this assessment the main drainage pathways at the Proposed Wind Farm site are shown and the connectivity (i.e., pathways and outlet points) of these flowpaths with the on-site mapped streams. Refer to the drainage plan drawings **(Appendix 4-3)** for the 150m drainage pathway mapping.

In places the natural drainage is further facilitated by a network of manmade drains. These manmade drains are concentrated within the areas of coniferous forestry and along sections of the existing forestry access roads. Manmade drains were also recorded along the boundaries of many of the agricultural lands during walkover surveys.

The forest plantations are generally drained by a network of mound drains which typically run perpendicular to the topographic contours of the site and feed into collector drains, which discharge to interceptor drains down-gradient of the plantation. Mound drains and ploughed ribbon drains are generally spaced approximately every 15m and 2m respectively. Interceptor drains are generally located up-gradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located up-gradient of forestry access roads. Culverts are generally located at stream crossings and at low points under access roads which drain runoff onto down-gradient forest plantations.

A schematic of a typical standard forestry drainage network and one which is representative of the site drainage network is shown as

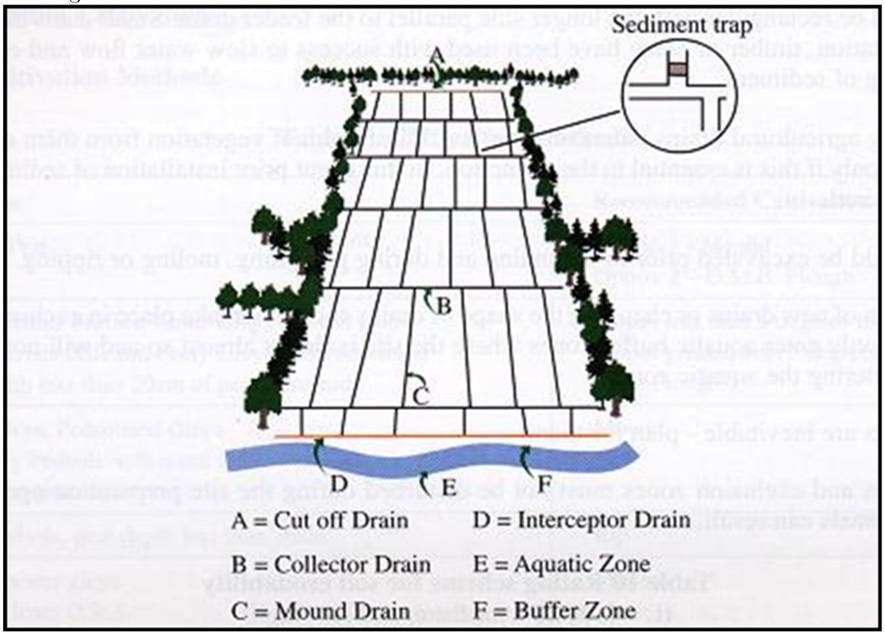


Figure *9-4*. The forestry drains are the primary drainage routes towards the natural streams, but the flows in the higher elevated drains are generally very low or absent most of the time.

Along the Proposed Grid Connection cable route there are 35 no. watercourse crossing locations with 23 no. being EPA mapped watercourses (refer to **Table 9-7** above for locations). All 35 no. crossings are existing culverts and bridges where works are required to accommodate the Proposed Grid Connection cable within or underneath the crossing structure.

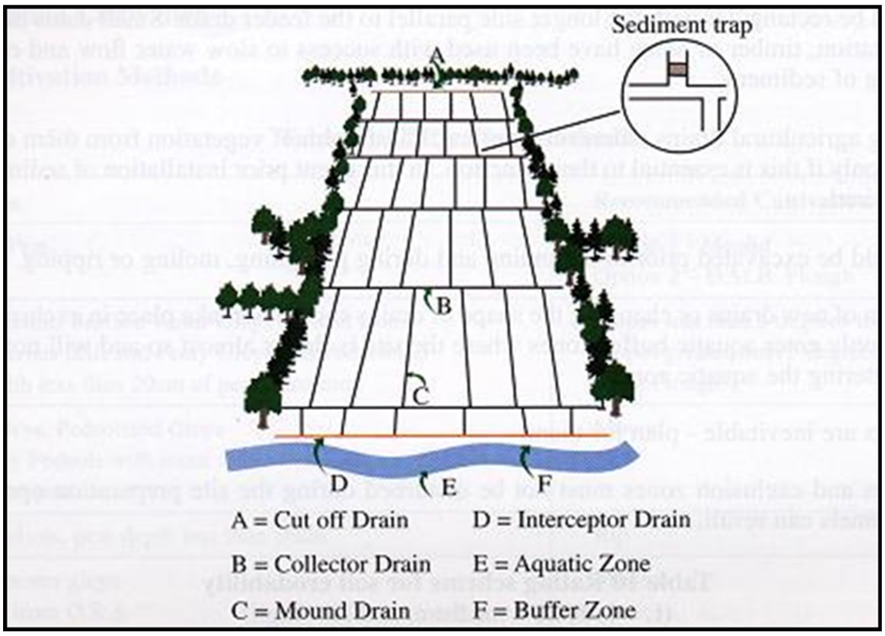


Figure 9-4: Schematic of Existing Forestry Drainage

9.3.6 Baseline Assessment of Windfarm Site Runoff

This section undertakes a long-term water balance assessment and surface water runoff assessment for the baseline conditions at the Proposed Wind Farm. A runoff assessment is not carried out for the Proposed Grid Connection cable as it will be placed underground and mainly along public roads.

The rainfall depths used in this water balance, which are long term averages, are not used in the design of the sustainable drainage system for the Proposed Wind Farm. The Proposed Wind Farm drainage design is based on the 10-year return period rainfall event as described further in Sections 9.4 and 9.5.2.2 below.

The water balance calculations are carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (**Table 9-8**). It represents, therefore, the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Proposed Wind Farm site pre- development. The surface water runoff co-efficient for the Proposed Wind Farm site is estimated to be 77% as described in Section 9.3.2 above.

The highest long-term average monthly rainfall (site-specific modelled rainfall values – 1991 to 2020) is 152mm over December. The average monthly evapotranspiration for the synoptic station at Shannon Airport over the same period in December was 3.1mm.

The water balance presented in

Table *9-9* indicates that a conservative estimate of surface water runoff for the Proposed Wind Farm site during the highest rainfall month is 952,611m^3/month or 30,729m^3/day.

Table 9-8: Water Balance and Average Baseline Runoff Estimates for Wettest Month (December)

Water Balance Component	Depth (m)
Average December Rainfall (R)	0.152
Average December Potential Evapotranspiration (PE)	0.0031
Average December Actual Evapotranspiration (AE = PE x 0.95)	0.0029
Effective Rainfall December (ER = R - AE)	0.149
Recharge (23% of ER)	0.034
Runoff (77% of ER)	0.1147

Table 9-9: Baseline Runoff for the Proposed Wind Farm Site

Proposed Wind Farm site (ha)	Baseline Runoff per month (m^3)	Baseline Runoff per day (m^3)
830	952,611	30,729

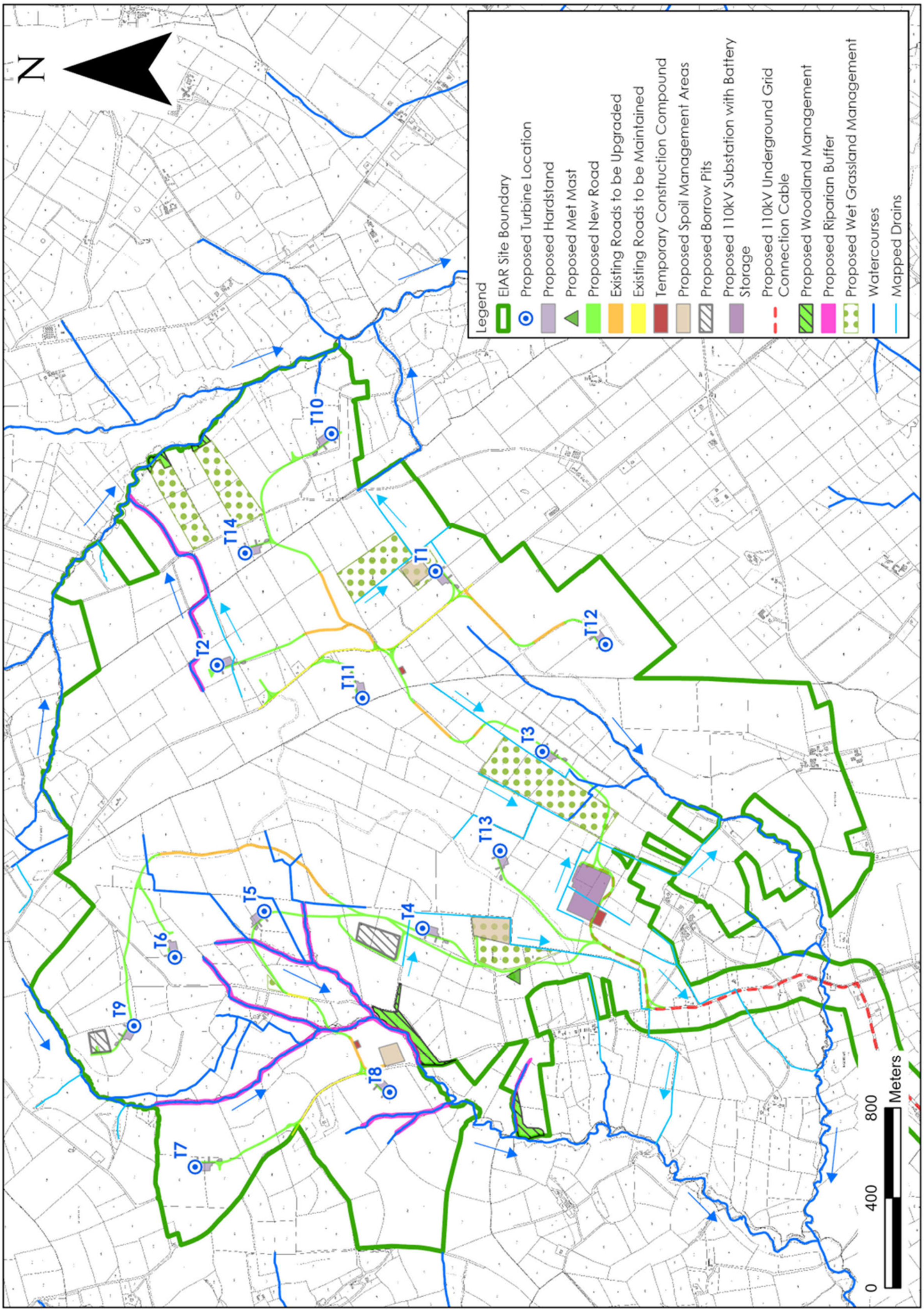


Figure 9-5: Proposed Wind Farm Site Drainage Map

9.3.7 Flood Risk Assessment

This section is a summary of a site-specific flood risk assessment (FRA) undertaken for the Site. The full FRA report is attached **Appendix 9-1**.

To identify those areas as potentially being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping (NIFM), 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 - Floodinfo.ie.

The OPW Past Flood Events Maps have no records of recurring or historic flood instances within the Proposed Wind Farm Site (refer to **Figure 9-6** below). Similarly, identifiable text on local available historical 6" or 25" mapping does not identify any lands that are "*liable to flood*".

The closest mapped past flood events are situated near Hollyford village northwest and upstream of the Proposed Wind Farm site, the nearest being a single flood event mapped south of Hollyford, ~1.4km from the Proposed Wind farm site (ID: 13914).

Recurring flood events are situated in the townland of Cumask, at Dundrum Rossmore Bridge along the Multeen (East) River, ~3.6km southeast (straight line distance) of the Proposed Wind Farm site (ID:4357). According to the OPW Flood Hazard Mapping Programme Flood engineer notes; land and minor road flooding occurs approximately twice a year at this location.

The GSI's 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 along the streams and watercourses which drain the Proposed Wind Farm site. The nearest mapped flood zones are mapped at the location of unnamed lake segments mapped by the GSI ~3.5km southwest of the Proposed Wind Farm site.

No CFRAM mapping has been completed for the area of the Proposed Wind Farm site. The closest mapped CFRAM fluvial flood zones for the present-day scenario are mapped along the River Suir ~20km downstream of the Proposed Wind Farm site. No CFRAM mapping has been completed on the Multeen River or its tributaries. Refer to **Figure 9-7** below for CFRAM flood zones on the River Suir.

The National Indicative Fluvial Mapping (NIFM) for the Present-Day Scenario have mapped flood zones in the immediate vicinity of the Proposed Wind Farm site. Low and medium probability river flood zones are mapped along the Aughnaglanny River as it flows along the eastern boundary of the Proposed Wind Farm site. These flood zones do not extend far beyond the mapped channel of the watercourse at this location and hence do not encroach significantly within the Site itself. Refer to **Figure 9-7** below for NIFM flood zones near the Proposed Wind Farm site.

Further downstream, along the Aughnaglanny River, present day low and medium probability river flood zones are mapped more extensively beyond the mapped channel of the river as it progresses towards the Multeen [east] River. Additionally, low and medium probability NIFM river flood zones are mapped downstream of the Site, along the lower reaches of the Lackenacoombe stream. Fluvial flood zones are also mapped further downstream of the Site along the Multeen River as far as the River Suir.

Therefore, from a fluvial flood risk perspective, the Proposed Wind Farm site is located in Flood Zone C where there is a low risk of fluvial flooding.

Furthermore, the Proposed Wind Farm site is not located within any GSI mapped historic or modelled groundwater flood zones. Also, based on the CFRAM rainfall (pluvial) flood mapping, surface water ponding/flooding is not a notable issue at the Proposed Wind Farm site.

NIFM and CFRAM fluvial flood zones are also mapped along the Proposed Grid Connection cable route at major watercourse crossing locations (i.e. Mulkear River), but this potential flooding has no consequence for the Proposed Grid Connection cable due to the underground nature of the cabling. The 110kV substation element of the Proposed Grid Connection within the Proposed Wind Farm site is located in Flood Zone C (low risk) as described above. Similarly, the TDR works are all temporary and will not be affected by potential flooding.

It is a key design of the Proposed Project to ensure all surface water runoff is treated (water quality control) and attenuated (water quantity control) prior to diffuse discharge at pre-existing greenfield runoff 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.

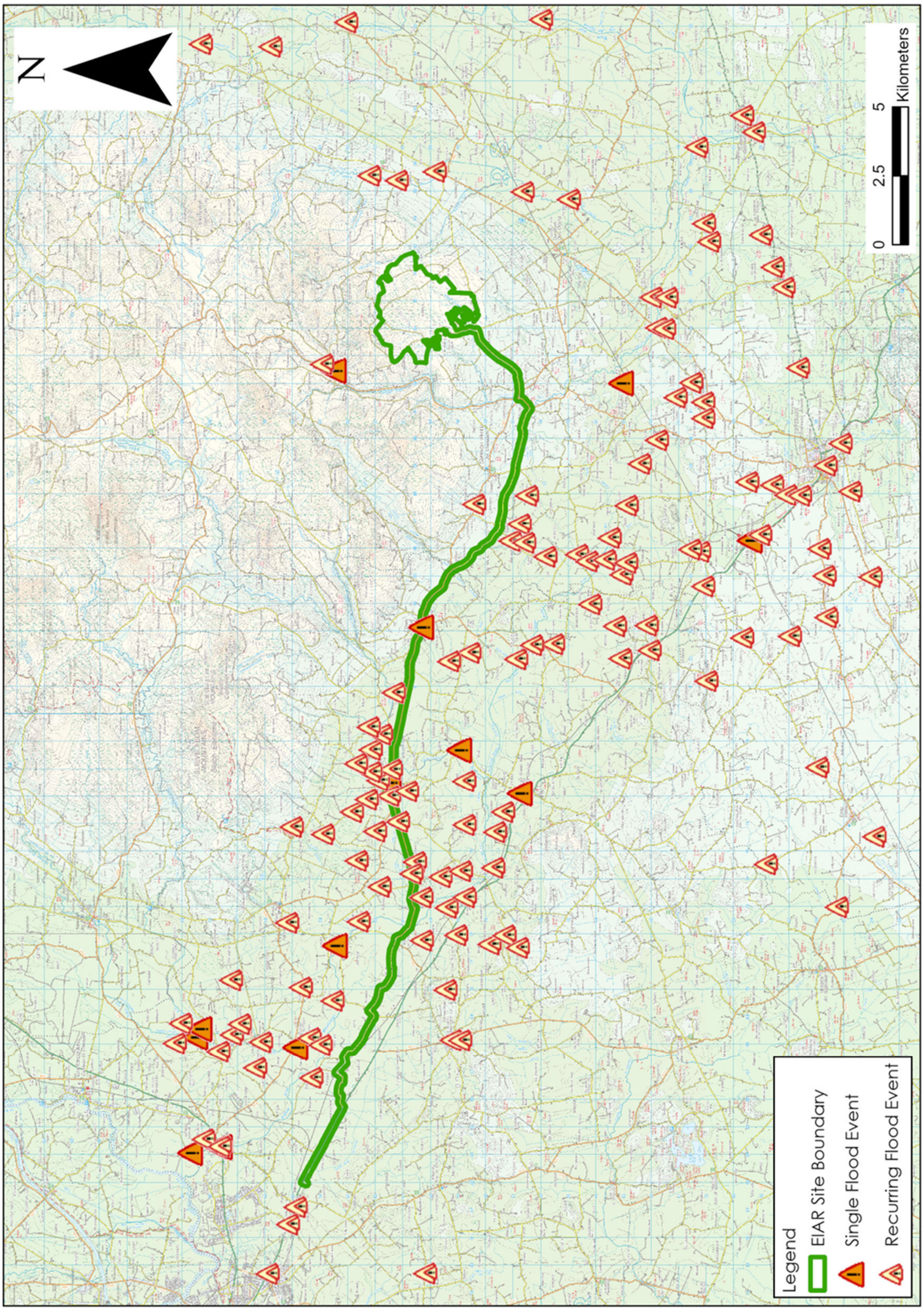


Figure 9-6: OPW Past Flood Event Mapping

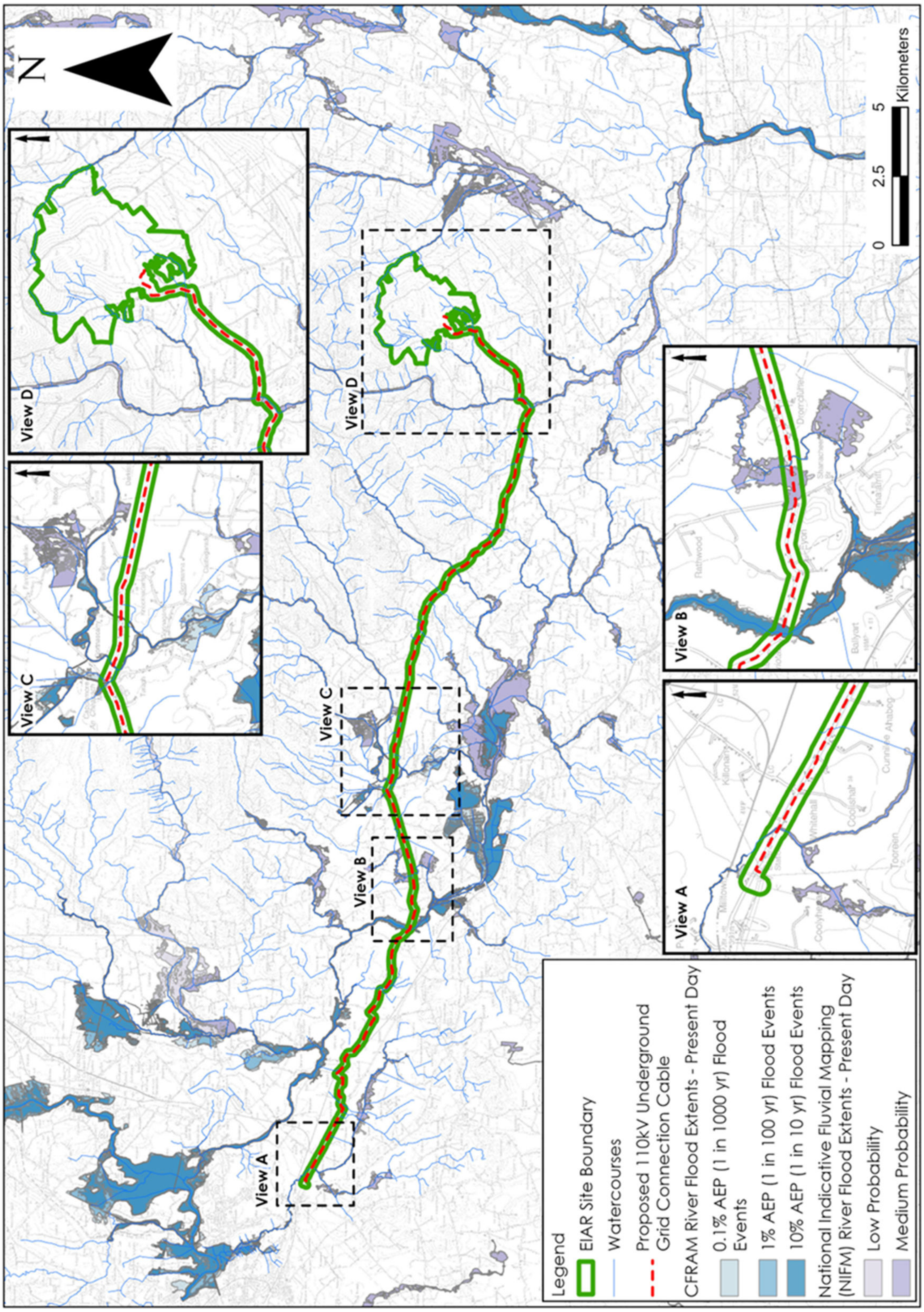


Figure 9-7: NIFM & CFRAM Flood Mapping

9.3.8 Surface Water Quality

9.3.8.1 EPA Water Quality Monitoring

Biological Q-rating[2] data for EPA monitoring points in the local catchments downstream of the Proposed Wind Farm site are shown in **Table 9-10** 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 Q1 (Bad) to 4-5 (High).

There are no EPA monitoring stations located downstream of the Proposed Wind Farm site on the Lackenacoombe Stream. Further downstream the Multeen River, that drains the western portion of the Site, achieved a Q-rating of Q4 (Good status) at Br SW of Annacarty (Station Code: RS16M020780) and at Morpeth Br (Station Code: RS16M020900) in the latest EPA monitoring round (2023).

The Aughnaglanny River which drains the eastern portion of the Site achieved Q3-4 (Moderate status) at Victoria Br in the latest EPA monitoring round (2023). Further downstream the status of the Multeen (East) River ranged from Moderate (Q3-4) to Good (Q4). Further downstream the River Suir at Golden Br. (Station Code: RS16S021500) is also of Good status.

Table 9-10: EPA Water Quality Monitoring Q-Rating Values Downstream of Proposed Wind Farm Site

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Multeen River	Br SW of Annacarty (RS16M020780)	191813.95	145111.37	2023	Q4 (Good)
Multeen River	Morpeth Br (RS16M020900)	194038	141717	2023	Q4 (Good)
Multeen River	Ballinaclogh Br (RS16M021000)	198537.35	140864.75	2023	Q3-4 (Moderate)
Aughnaglanny River	Victoria Br (RS16A050100)	199018.31	148403.71	2023	Q3-4 (Moderate)
Multeen (East) River	Black Br (RS16M080400)	198495.25	144691.69	2023	Q3-4 (Moderate)
Multeen (East) River	Aughnagross Br (RS16M080500)	199088.12	141300.03	2023	Q4 (Good)
Multeen River	Ballygriffin Br (RS16M021100)	200614.11	140378.18	2023	Q3-4 (Moderate)
Suir River	Golden Br (RS16S021500)	201216.82	138392.02	2023	Q4 (Good)

A summary of Q-Rating along the Proposed Grid Connection are shown in **Table 9-11** below.

The eastern section of the Proposed Grid Connection route is drained by the Multeen River which discharges into the Suir River. Recent EPA monitoring along the Multeen River is described above as for the Proposed Wind Farm.

Moving west of the Proposed Wind Farm site, the Proposed Grid Connection route is drained by the Cappawhite Stream, Toem Stream and Cahernahallia which flows into Dead River. Downstream of the cable route the Cappawhite Stream at Gortandrum Bridge (Station Code: RS25C100200) and Toem Stream at Bridge u/s Dead River (Station Code: RS25T050600) have achieved a Q3 rating (Poor status)

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

while the Cahernahallia at Bridge u/s Dead River (Station Code: RS25C010100) have achieved a Q-rating of Q4 (Good status).

The Dead River at Just u/s Dead River (Station Code: RS25P030200), Pope's Bridge (Station Code: RS25D010100) and Derraun Bridge (Station Code: RS25D010200) have achieved a Q3 rating (Poor status).

The next section (westerly) of the Proposed Grid Connection route is drained out by Doon Stream, Bilboa and Dooglasha (Cappamore) which flows down into Mulkear (Limerick) River and the section is also drained out by Mulkear (Limerick) River itself. The Doon stream at Bridge at Gortavalla, SW of Doon (Station Code: RS25D030600) have achieved a Q3-4 rating (Moderate status) while the Bilboa River at Bridge 1.5 km d/s Cappamore (Station Code: RS25B030300) and Pullagh u/s Dead River (Station Code: RS25B030500) have achieved a Q4 rating (Good Status).

The Mulkear (Limerick) River at Dromkeen Bridge (Station Code: RS25M040100), Brittas Bridge (Station Code: RS25M040200) and 2km d/s St 0300 (N of Boher at be (Station Code: RS25M040400) have achieved a Q3-4 rating (Moderate Status) while at Annacotty Br d/s weir (Station Code: RS25M040590) have achieved a Q4 rating (Good Status).

The most westerly section of the Proposed Grid Connection route is drained by Groody River which flows into the Shannon (Lower) River. The Groody river at Killonan Bridge (Station Code: RS25G050150) and Bridge in Ballysimon (G2) (Station Code: RS25G050200) have achieved a Q3-4 rating (Moderate status).

Table 9-11: EPA Water Quality Monitoring Q-Rating Values Downstream of Proposed Grid Connection Routes

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Cappawhite Stream	Gortandrum Br (RS25C100200)	187959.34	146163.48	2021	Q3 (Poor)
Dead River	Just u/s Dead R confl (RS25P030200)	186037.2	143524	2023	Q3 (Poor)
Dead River	Pope's Bridge (RS25D010100)	185598.07	143761.12	2021	Q3 (Poor)
Toem Stream	Br u/s Dead R confl (RS25T050600)	184127	145649	2021	Q3 (Poor)
Dead River	Derraun Br (RS25D010200)	182477.35	146324.76	2021	Q3 (Poor)
Cahernahallia	Br u/s Dead R confl (RS25C010100)	182791.2	148245.9	2021	Q4 (Good)
Doon Stream	Bridge at Gortavalla, SW of Doon (RS25D030600)	181422.93	148938.68	2021	Q3-4 (Moderate)
Bilboa	Br 1.5 km d/s Cappamore (RS25B030300)	177973	150469	2021	Q4 (Good)
Bilboa	Pullagh u/s Dead R (RS25B030500)	177681	147881	2021	Q4 (Good)
Mulkear (Limerick)	Dromkeen Bridge (RS25M040100)	174058.43	148025.51	2021	Q3-4 (Moderate)
Mulkear (Limerick)	Brittas Br (RS25M040200)	172237	150763	2021	Q3-4 (Moderate)
Mulkear (Limerick)	2km d/s St 0300 (N of Boher at be (RS25M040400)	169562	153084	2021	Q3-4 (Moderate)
Mulkear (Limerick)	Annacotty Br d/s weir (RS25M040590)	164286	157626	2021	Q4 (Good)

Watercourse	Station Code	Easting	Northing	Year	EPA Q-Rating Status
Groody	Killonan Br (RS25G050150)	163587	154301	2021	Q3-4 (Moderate)
Groody	Br in Ballysimon (G2) (RS25G050200)	161607	155106	2021	Q3-4 (Moderate)

9.3.8.2 HES Water Quality Monitoring

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units), temperature (°C) and turbidity (NTU) were taken at 5 no. surface water sampling locations over 2 no. monitoring rounds completed on 12th February and 21st October 2025 from surface watercourses draining the Site.

Monitoring locations SW1 to SW3 are located downstream of the Proposed Wind Farm, while monitoring locations SW4 and SW5 are located along the Proposed Grid Connection route. The results are listed in **Table 9-12** below. The monitoring locations are shown in **Figure 9-1** above.

Electrical conductivity values at the monitoring locations ranged between 150 and 210µS/cm which would be typical for the non-calcareous geological setting of the Site. Turbidity ranged from 1.44 to 11.5 NTU with Dissolved Oxygen ranging from 92 to 106% saturation. The pH values were generally slightly basic, ranging between 7.2 and 7.7.

Table 9-12: Field Parameters - Surface Water Chemistry Measurements (12/02/2025 and 21/10/2025)

Location ID	Temp °C	DO (% Sat)	EC (µS/cm)	pH	Turbidity (NTU)
SW1	7.8 - 9.2	92 - 101	150 - 180	7.2 – 7.6	7.7 – 11.5
SW2	9.2 - 10.5	96 - 105	162 - 178	7.2 - 7.7	1.8 – 6.9
SW3	7.8 - 9.5	92 - 101	180 -185	7.3 - 7.5	1.44 – 2.3
SW4	7.3 - 10.3	94 - 106	190 - 210	7.4 - 7.6	2.65 – 3.3
SW5	7.5 – 9.8	98 - 102	174 - 200	7.4 - 7.6	1.47 – 2.3

Surface water grab samples were also taken at these locations for laboratory analysis on 2 no. occasions (same dates as field hydrochemistry). Results of the laboratory analysis are shown alongside relevant water quality regulations in

Table 9-13 and Table 9-14 below. The laboratory reports are attached as
Appendix 9-2.

Total suspended solid results were all under the laboratory detection limits (<5 - <10mg/L) which is below S.I 293/1988 threshold limit of 25 mg/L.

Ammonia concentrations were all reported to be of High status with regards to the threshold of ≤0.04mg/l as detailed in S.I. 272/2009 (as amended).

Similarly, all results for BOD and ortho-phosphate are below the High Status threshold with regard S.I. 272/2009 (as amended).

Results for nitrate, nitrite, phosphorus and nitrogen were all very low with results being below or close to the laboratory detection limits. Chloride ranged between 10.6 and 16.4mg/L which would be typical for surface waters at an inland setting.

Table 9-13: Summary surface water quality data (12th February 2025)

Parameter	EQS	Sample ID				
		SW1	SW2	SW3	SW4	SW5
Total Suspended Solids (mg/L)	25(+)	<10	<10	5	<10	<10
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<5	8.6	6.8	<5	5.9
Phosphorus (mg/L)	-	<0.1	<0.1	<0.1	<0.1	<0.10
Nitrogen (mg/L)	-	1.3	2.5	2	1.2	1.5
Chloride (mg/L)	-	16.4	11.5	12.2	13.4	10.6
BOD (mg/L)	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<1	<1	<1	<1	<1

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

Table 9-14: Summary surface water quality data (21st October 2025)

Parameter	EQS	Sample ID				
		SW1	SW2	SW3	SW4	SW5
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5	<5
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	<0.02	0.03	<0.02	0.02	<0.02
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	0.03	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	5.8	<5	<5	6.2	<5
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrogen (mg/L)	-	1.4	1.5	1.3	1.6	1.4
Chloride (mg/L)	-	11.2	12.6	10.8	11.5	11.5
BOD (mg/L)	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	<1	<1	<1	<1	<1

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

9.3.9 Hydrogeology

9.3.9.1 Overview

The Proposed Wind Farm site is located in the Templemore Groundwater Body (GWB) which is described as 'poorly productive bedrock' according to WFD mapping. At the Proposed Wind Farm site, the sandstone, siltstone and greywacke bedrock formations that make up the underlying GWB are classified by the GSI as being Locally Important Aquifers or Poor Aquifers as described below.

According to GSI mapping (www.gsi.ie) the majority of the Proposed Wind Farm site is underlain by the Cappagh White Sandstone Formation which is described as red & white sandstone, conglomerate and is classified as a Locally Important Aquifer (Bedrock which is Moderately Productive only in Local Zones LI).

The remainder of the Proposed Wind Farm site is underlain by the Hollyford Formation, which is described as greywacke, siltstone & grit and is classified by the GSI as a Poor Aquifer (Bedrock which is Generally Unproductive except for Local Zones PI).

The bedrock formations that underlie the Proposed Wind Farm site are generally devoid of inter-granular permeability. Groundwater flow occurs only in fractures, joints and faults, except for the top few metres of the rock where the rocks are likely to be more fractured and/or weathered. However, recharge into the weathered layer is likely to be limited due to poorly draining soils.

Bedrock fissures are generally poorly connected, with fissure permeability reducing rapidly with depth (GSI, 2003). Most flow is therefore expected to occur in the top 5 to 15m of the bedrock. Due to the low subsoil permeability, and low infiltration rates, a high proportion of the rainwater will leave the site as surface runoff. Where groundwater flow does occur, it is normally relatively shallow and closely linked to surface waters due to short flow paths (30 – 300m).

Baseflow contribution to streams tends to be low, particularly in summer as the groundwater regime cannot sustain summer baseflows due to low storativity with the aquifer. In winter, low permeabilities will lead to a high water table and potential water logging of soils which is consistent with the mapped soil type in the vicinity of streams (i.e. poorly drained mineral & peaty soil). Local groundwater flow directions will generally mimic topography whereby flow paths will be from topographic high points to lower elevated discharge areas at local streams in close proximity.

The section of the Proposed Grid Connection at the Proposed Wind Farm site including the 110kV substation are located in the Templemore GWB as described above. As the Proposed Grid Connection cable route travels westerly its passes into the Slieve Phelim GWB, Ballyneety GWB and Limerick City East GWB.

According to WFD mapping the Slieve Phelim GWB has 'poorly productive bedrock', the Ballyneety GWB has 'karstic bedrock' (limestone) while the Limerick City East GWB is mapped as 'productive fissured bedrock'.

Given the nature of the Proposed Grid Connection cable route primarily along the public road network, along with the shallow nature of the excavations, the proposed trenching works is not likely to have any interaction with the underlying bedrock aquifers.

9.3.9.2 Summary of Site Investigations

A total of 28 no. trial pits were carried out at the Site. Mineral subsoils most encountered were SILT, CLAY or SILT/CLAY combinations and typically presented as very firm to firm, slightly sandy, slightly gravelly and occasionally interbedded with SAND layers. The subsoils are consistent with the underlying parent material (i.e. sandstone bedrock). Refusal on bedrock (presumed) during trial pitting was recorded in 18 of the 28 no. trial pits (64%).

The depth to bedrock at the 18 no. locations ranged between 0m and 3.3m with an average of 1.8m. Trial pits that encountered bedrock were distributed throughout the Proposed Wind Farm site indicating relatively shallow bedrock across the overall Proposed Wind Farm site. At these ground elevations shallow bedrock would be expected and is consistent with GSI mapping (i.e. bedrock outcrop or subcrop).

Only very minor water seepages were recorded from the overburden during the trial pitting, which is likely to be surface water rather than groundwater.

Refusal was recorded on broken (blocky/angular) SILTSTONE/SANDSTONE at most of the trial pit locations (14 no. of 18 no.) that encountered bedrock. The upper broken layer was typically less than 0.2m in depth and was underlain by very strong, competent bedrock that could not be penetrated by the excavator (i.e. refusal).

A weak/soft SILTSTONE/SHALE was recorded at the remaining 4 no. trial pit locations with bedrock strength/competency increasing with depth. This bedrock lithology is consistent with the Hollyford Formation.

No groundwater seepages of any significance were noted from the upper weathered bedrock.

There is GSI record for 1 no. historical Mineral Exploration Boreholes drilled at the Proposed Wind Farm site in 1982. The borehole (GSI Ref: REC_1240), which was drilled to final depth of 60.9mbgl (metres below ground level), was drilled on the north of the Proposed Wind Farm site. Figure 8-2 of Chapter 8 (Land, Soils and Geology Chapter) for the borehole location.

The Borehole log records SANDSTONE/SILTSTONE (Old Red Sandstone) from 4.9 to 39.3mbgl, followed by SILTSTONE/MUDSTONE to 60.9mbgl. No bedrock fracturing or faulting was noted in the drilling logs.

9.3.10 Groundwater Vulnerability

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 vulnerability rating of the bedrock aquifer underlying the Proposed Wind Farm Site is mapped by the GSI (www.gsi.ie) to range from 'Moderate' to 'Extreme' (E & X) with the majority of the Site being mapped as having 'High' vulnerability. Refer to **Table 9-15** below for GSI groundwater vulnerability criteria.

Site investigations at the Proposed Wind Farm site comprising 28 no. trial pits have revealed that the depth to rock is typically shallow across the Site which is consistent with GSI mapping.

18 no. of the 28 no. trial pits carried out at the Proposed Wind Farm site encountered bedrock at depths less than 3m below ground level (mbgl) which would be considered an 'Extreme' rating in accordance with GSI criteria **Table 9-15**.

However, due to the poorly productive nature of the underlying bedrock aquifers, groundwater flowpaths are likely to be short (30 – 300m), with recharge emerging close by and discharging into local surface water streams. This means there is a low potential for groundwater dispersion and movement within the aquifer, therefore surface water bodies such as drains and streams/rivers are more vulnerable (to contamination from human activities) than groundwater at the Proposed Wind Farm site.

The groundwater vulnerability rating along the Proposed Grid Connection cable route has a similar rating range (i.e. Low to Extreme). However, due to the fact that the route of the Proposed Grid Connection cable is along the carriageway of public roads, the vulnerability rating is not applicable.

Table 9-15: Groundwater Vulnerability and Subsoil Permeability and Thickness

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.

9.3.11 Groundwater Hydrochemistry

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

The GSI's Characterisation Report for the Templemore GWB states that there is limited hydrochemical data for this GWB. Electrical Conductivity values range from 273 to 683 uS/cm with most values tending to be around 300uS/cm. Values for hardness are variable but generally the water appears to be slightly hard to hard.

The GSI's Characterisation Report for the Slieve Phelim GWB states that Groundwaters from all rock unit group aquifers within this groundwater body have a calcium-bicarbonate signature. Groundwaters from the Silurian strata range from slightly hard to hard (90–360 mg/l CaCO3). In association, alkalinities range from 60 to 270 mg/l (as CaCO3) and electrical conductivities from 260–600 µS/cm. pHs are neutral, with lab. pHs in the range 7.12–7.33.

Limited hydrochemical data are available for the Ballyneety GWB. The hydrochemical signature of groundwaters from Caherconlish WS is calcium-bicarbonate, as would be expected in this GWB. Data indicate typically Hard (220 355 mg/l as CaCO3) groundwater, with high alkalinities (190–320 mg/l as CaCO3) and electrical conductivities (680-710 µS/cm), and neutral pHs. Background chloride concentrations may be higher than in the central Midlands, due to closer proximity to the sea.

The GSI's Characterisation Report for the Limerick City East GWB states that no relevant hydrochemical data are available for the limestone aquifer in this GWB for assessment. By analogy with other pure limestone aquifers, the groundwater is likely to be hard to very hard, with corresponding high alkalinity and conductivity, and a neutral pH. It is likely to have a calcium–bicarbonate signature. Water quality data from volcaniclastic aquifers in nearby GWBs indicate conductivities of between 470–700 µS/cm. In general, background chloride concentrations will be higher than in the Midlands, due to proximity to the sea.

9.3.12 Water Framework Directive Water Body Status & Objectives

The WFD is implemented through the River Basin Management Plans (RBMP) which comprises a six-yearly cycle of planning, action and review. RBMPs include identifying river basin districts, water bodies, protected areas and any pressures or risks, monitoring and setting environmental objectives. In Ireland the first RBMP covered the period from 2010 to 2015 with the second cycle plan covering the period from 2018 to 2021, and the third cycle covers the period from 2022 to 2027[3]. The RBMPs are forward looking.

The Water Action Plan 2024 is Ireland's 3rd River Basin Management Plan (2022 - 2027). The objectives of the Water Action Plan 2024 have been integrated into the design of the Proposed Project and include:

- Ensure full compliance with relevant EU legislation;
- Prevent deterioration;
- Meet the water standards and objectives for designated protected areas;
- Protect high-status waters; and,
- Implement targeted action and pilot schemes in focus sub-catchments aimed at (i) targeting water bodies close to meeting their objective and (ii) addressing more complex issues that will build knowledge for future cycles.

[3] *The WFD RBMP cycles are forward looking plans, so 2009-2015 (1st Cycle), 2016-2021 (2nd Cycle), and 2022-2027 (3rd Cycle) are the plans and they use status from the previous 6 years.*
The EPA updates status every three years, but they also complete an additional assessment mid-RBMP cycle. The mid-cycle status does not get reported to the Commission.
The linkage between the two is that the 2nd Cycle plan uses the 2009-2015 status, the 3rd Cycle plan uses the 2016-2021 status. The 2013-2018 status was not used in the RBMP and the 2019-2024 status will not be used in the next RBMP.

Our understanding of these objectives is that water bodies, 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.

9.3.13 Groundwater Body Status

Local Groundwater Body (GWB) and Surface water Body (SWB) status information is available from (www.catchments.ie).

Please refer to the WFD Compliance Assessment report (attached as **Appendix 9-3** of the EIAR) for full details and status of GWB's. A summary is provided in **Table 9-16** below.

The Templemore GWB underlying the Proposed Project site achieved "Good" status in all 4 no. WFD cycles. The status of these GWBs is defined based on the quantitative status and chemical status of each GWB. The Templemore GWB has been deemed to be "at risk" of failing to meet its WFD objectives.

The Slieve Phelim GWB underlying the Proposed Grid Connection route, has achieved "Good" status is "not at risk" with no significant pressure identified on it.

The Ballyneety GWB and the Limerick City GWB, also underlying the Proposed Grid Connection route have achieved "Good" status in the latest round (2019-2024).

The Ballyneety GWB is "not at risk" with no significant pressure identified while the Limerick City East is "at risk" with Agriculture and Domestic Waste Water as identified significant pressures.

Table 9-16: WFD Groundwater Body Status

GWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	Overall Status 2019-2024	3rd Cycle Risk Status	WFD Pressures
	Proposed Wind Farm					
Templemore	Good	Good	Good	Good	At risk	Agriculture & Anthropogenic
	Proposed Grid Connection					
Templemore	Good	Good	Good	Good	At risk	Agriculture and Anthropogenic
Slieve Phelim	Good	Good	Good	Good	Not at risk	None
Ballyneety	Good	Good	Good	Good	Not at risk	None
Limerick City East	Poor	Good	Good	Good	At risk	Agriculture & Domestic Waste Water

9.3.14 Surface Water Body Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) in the vicinity and downstream of the Proposed Project site are shown in **Table 9-17** below.

Table 9-17 below gives summary details of the WFD river sub-basins in which the Site is directly located. Please refer to the WFD Compliance Assessment report (attached as **Appendix 9-3**) for details and status of all river waterbodies/sub-basins in the Water Study Area.

The western portion of the Proposed Wind Farm Site is located in the Multeen_020 river sub-basin, which is assigned "Good" status in the latest round (2019 – 2014). With respect to risk status, the Multeen_020 is "not at risk" of failing to meet its WFD objectives.

The eastern portion of the Proposed Wind Farm site is mapped within the Aughnaglanny_010 river sub basin and drained by the Aughnaglanny_010 SWB which achieved "Moderate" status in the latest WFD cycle.

The Aughnaglanny_010 SWB is also a High ecological status objective waterbody. The risk status of the Aughnaglanny_010 is "at risk". Agriculture and forestry are listed as a significant pressure on this SWB.

The WFD status of river waterbodies along the Proposed Grid Connection cable route typically range from Poor to Good with Agriculture being the most common pressure within the SWBs.

Further details are provided in the WFD Compliance Assessment attached as **Appendix 9-3.**

Table 9-17: WFD Surface Waterbody Status for The Proposed Project

SWB	Overall Status 2013-2018	Overall Status 2016-2021	Overall Status 2019-2024	Risk Status 3rd Cycle	Pressures
Proposed Wind Farm site					
Aughnaglanny_010	Moderate	Good	Moderate	At risk	Agriculture & Forestry
Multeen_020	Good	Good	Good	Not at risk	None
Proposed Grid Connection					
Cappawhite Stream_010	Poor	Poor	Poor	At Risk	Agriculture and Urban Waste Water
Toem Stream_010	Poor	Poor	Poor	At Risk	Agriculture, Hydromorphology and Invasive Species
Cahernahallia_020	Good	Good	Good	Not at risk	None
Doon Stream_010	Good	Moderate	Moderate	At risk	Agriculture and Urban Run-off
Bilboa_020	Good	Good	Good	Not at risk	None
Dooglasha (Cappamore)_010	Moderate	Poor	Poor	Review	-
Groody_010	Moderate	Moderate	Moderate	At Risk	Agriculture and Urban Run-off
Dead_010	Poor	Poor	Poor	At Risk	Agriculture, Hydromorphology and Industry
Dead_020	Moderate	Poor	Poor	At Risk	Agriculture
Mulkear (Limerick)_010	Good	Moderate	Moderate	At Risk	Agriculture
Mulkear (Limerick)_020	Good	Moderate	Moderate	At Risk	Agriculture
Mulkear (Limerick)_030	Good	Moderate	Moderate	Review	-
Mulkear (Limerick)_040	Good	Moderate	Moderate	At Risk	Agriculture
Mulkear (Limerick)_050	Good	Good	Good	Not at risk	None

9.3.15 Designated Sites and Habitats

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).

The Multeen River located immediately downstream of the Site forms part of the Lower River Suir SAC (002137).

Also, the Aughnaglanny Valley pNHA (Site Code: 000948) is located immediately to the east of the Proposed Wind Farm site where the Aughnaglanny River flows close to the eastern Site boundary.

A designated site map for the area is shown as Figure 9-8.

Many of the sub-catchments that the Proposed Grid Connection cable pass through form part of the Lower River Shannon SAC (Site Code: 002165). These include the Cahernahallia River, Bilboa River and Mulkear River.

The Proposed Grid Connection cable route intercepts the Lower River Shannon SAC at three locations where its crosses the Cahernahallia River, Bilboa River and Mulkear River via existing road and bridge structures.

Similar, TDR works at Location 1 (Camus Bridge on River Suir) is located adjacent to the Lower River Shannon SAC, but the works are contained within the carriageway of the R505 at this location.

There are a number of pNHA designated marshes to the south of the Proposed Grid Connection near Cappawhite; namely Kilbeg Marsh, Philipston Marsh and Ballyneil Marsh. The Proposed Grid Connection follows a local public road at this location.

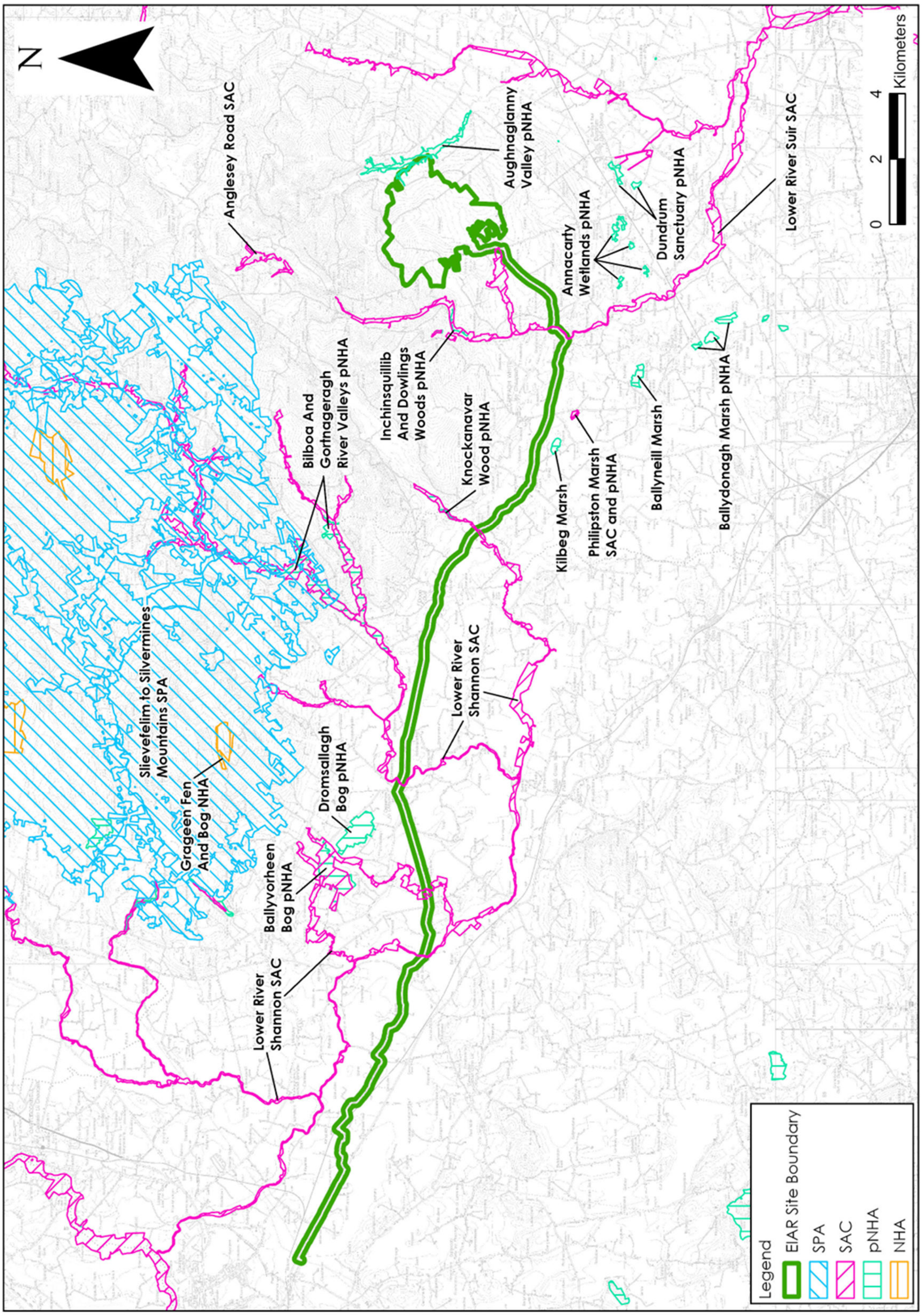


Figure 9-8 Designated Site Map

9.3.16 Water Resources

9.3.16.1 Public Water Supply & Group Water Schemes

The GSI/EPA do not map the presence of any Public Water Schemes (PWS) or Group Water Scheme (GWS) groundwater source protection areas within the Proposed Wind Farm site.

The closest GSI/EPA mapped groundwater source protection area to the Proposed Wind Farm Site is associated with the Ironmills PWS where the boundary of the source protection area is located ~2.6km to the southwest of the Proposed Wind Farm site and adjacent to the Proposed Grid Connection cable route.

Refer to Figure 9-9 below for the locations of groundwater abstractions and mapped source protection areas.

The following information was taken from the Ironmills PWS source protection report which was prepared by the EPA (2013)[4]:

- The source consists of two boreholes, BH1 and BH2 which are about 2m apart and located adjacent to the Multeen River upstream of Ironmills Bridge;
- The boreholes are between 16m and 20.5m deep and abstract groundwater from sand and gravel (alluvial) deposits within the Multeen River valley;
- Records show abstractions rates of between 1,638 and 1,843m^3/day;
- Previous investigations carried out on the source have not identified a strong hydraulic connection between the Multeen River and the boreholes;
- The investigations concluded that any potential losses from the Multeen River due to abstraction would be negligible;
- Therefore, the boreholes are sustained by direct rainfall recharge through the sand and gravel deposits in the locality of the boreholes and runoff from the valley sides;
- The source protection area covers an area of approximately 1.5km^2 which extends 1.5km upstream of Ironmills Bridge; and,
- The boreholes are located approximately 4km downstream of the Proposed Wind Farm site on the Multeen River.

The Proposed Grid Connection cable route passes to the south of the source protection area where it crosses over Ironmills Bridge on the Multeen River. The Proposed Grid Connection cable route does not pass through the mapped source protection area and is downstream of the protection area and source boreholes.

Doon PWS (Cooga Spring) source protection area is located 11km to the west of Proposed Wind Farm site and along the Proposed Grid Connection cable route where it follows Regional Road R505.

The following information was taken from the Doon PWS source protection report which was prepared by the EPA (2010)[5]:

- Spring source (Cooga Spring) is located in grassland approximately 60m to the south and downslope of the R505 Regional Road;
- Groundwater abstraction rates reported between 140 and 200m^3/day;
- The underlying sand and gravel deposits are considered to sustain groundwater flow to the spring with recharge occurring upslope of the R505 to the northeast;
- Ground elevation at the spring location is 72m OD;
- Groundwater levels at the spring range between 0.6 - 1.5mbgl (winter/summer);
- Trial pitting (EPA, 2010) carried out upslope of the spring within the protection area reported groundwater levels between 2 and 3mbgl;

[4] *Environmental Protection Agency (2013/Revision B) Establishment of Groundwater Source Protection Zones – Ironmills Public Water Supply Scheme*
[5] *Environmental Protection Agency (2010) Establishment of Groundwater Source Protection Zones – Doon Water Supply Scheme (Cooga Spring)*

- The source protection area covers an area of approximately 0.22km[2] which extends to the northeast of Regional Road R505; and,
- The source protection area is intercepted by the R505 for approximately 150m. Further upslope the source protection area is intercepted by a local road.

The Proposed Grid Connection cable follows the Regional Road R505 which runs approximately 60m to the north and upslope of the spring. The elevation of the R505 is at approximately 80m OD, which is ~8m higher than the ground elevation at the spring (8.6 - 9.5m higher than the water elevation at the spring). The cable route passes through the source protection area for approximately 150m within the carriageway of the R505. The are existing utilises placed within the R505 at this location including a water main.

The Springmount source (spring) is used to augment the Galtee Regional Water Supply and is located near Golden. The supply produces between 60 – 65m^3 /hour and serves 212 houses with an estimated population of 636. Treatment at the plant includes disinfection and fluoridation.

There is no mapped groundwater source protection area for the spring, however, the Proposed Project site is located more than 11km from the spring and therefore there is no potential for affects.

9.3.16.2 Private Water Supplies

A search of private groundwater well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). There are no wells with a location accuracy of ≤50m mapped by the GSI within 5km of the Proposed Wind Farm site.

There are several wells mapped along the Proposed Grid Connection cable route. The yield class ranges from Poor to excellent with yield capacity ranged from 21.80 to 3052m^3/day and location accuracy ranging from 100m to 1km.

Due to the shallow nature of the Proposed Grid Connection trench works along with the fact the cable will mainly be within the carriageway of public roads outside the Proposed Wind Farm site, no impact assessment on potential wells located along the cable route was carried out due to the lack of potential affects.

As the GSI well database is not exhaustive in terms of the locations of all wells in the area (as the database relies on the submission of data by drillers and the public etc) it is assumed that every private dwelling in the area of the Proposed Wind Farm site has a water supply well associated with it (this is unlikely to be the case but is a worst case scenario assessment).

The majority of these dwellings are remote to the Proposed Wind Farm infrastructure (>700m) and given the bedrock geology type within the Proposed Wind Farm site and the unproductive nature of the underlying aquifer there will unlikely be any hydraulic connection between any potential wells and groundwater flow from the Proposed Wind Farm site.

The groundwater flow direction in the aquifer underlying the Proposed Wind Farm site will mimic the local topography whereby flow paths will be from topographic high points to lower elevated discharge areas at streams and rivers that flow through the Site.

As stated in Section 0 above, groundwater flow paths are typically between 30 – 300m in length and given the fact that all dwellings are more 700m away from proposed turbine locations and the proposed borrow pits, there is a very low risk of impact. The potential effects on private wells is further assessed in Section 9.5.2.9 below.

9.3.16.3 Surface Water Abstractions

Downstream of the Proposed Project site there are 4 no. surface water Drinking Water Protected Areas (DWPA's) where surface water is abstracted for drinking water purposes.

These DWPA's include:

- The Suir_140 DWPA
- The Suir_190 DWPA
- The Suir_210 DWPA
- The Shannon(Lower)_060 DWPA

The closest downstream DWPA to the Proposed Wind Farm site is the Suir_140 DWPA which encompasses a stretch of the River Suir at Cahir. From the Proposed Wind Farm site this is a downstream distance of ~35km. The Suir_190 and the Suir_210 DWPA's are further downstream (>35km downstream) in the River Suir catchment.

The Shannon(Lower)_060 DWPA encompasses a stretch of the Mulkear River near Annacotty, Limerick City which is 12km downstream of where the Proposed Grid Connection cable.

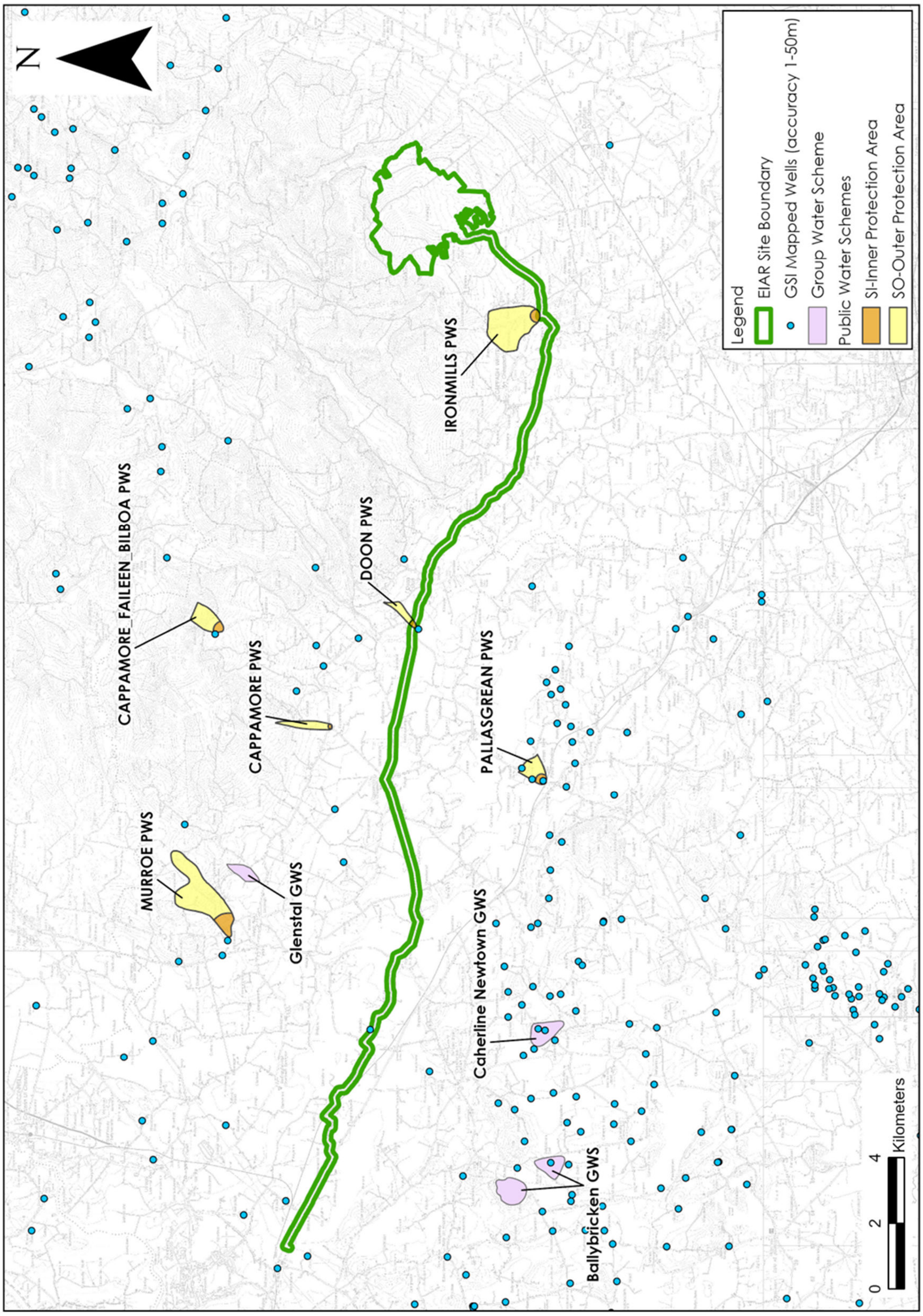


Figure 9-9 Groundwater Supply Source Protection Areas

9.3.17 Receptor Sensitivity and Importance

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

Due to the nature of Proposed Wind Farm and Proposed Grid Connection developments, being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments.

The primary risks to groundwater at the Site would be from cementitious materials, hydrocarbon spillage and leakages, potential piling works. Some of these (cementitious materials, hydrocarbon spillage and leakages, suspended sediment entrainment) are common potential impacts on all construction sites (such as road works and industrial sites).

All potential contamination sources are to be carefully managed at the Site during the construction and operational phases of the Proposed Project and mitigation measures are proposed below to deal with these potential effects.

The following groundwater receptors are identified for impact assessment:

- The Poor and Locally Important Aquifers underlying the Proposed Wind Farm Site. These aquifers can be considered as being of Low to Medium Importance respectively;
- The Locally Important, Locally important gravel, Poor and Regionally Important Aquifers underlying the Proposed Grid Connection route. The Locally Important Aquifer and the Poor Aquifer are of Medium and Low Importance. Meanwhile, the Regionally Important Karstified Aquifer underlying the western section of the Proposed Grid Connection can be considered as being of Very High Importance;
- The WFD status of the GWBs underlying the Proposed Project site (i.e. the Templemore, Slieve Phelim, Ballyneety and Limerick City East GWBs);
- The Ironmills PWS and Doon PWS; and,
- Local private groundwater abstractions in the lands surrounding the Proposed Wind Farm site.

The Springmount Spring groundwater source (Galtee Regional Water Supply) is scoped out due to the 11km distance between the spring and the Proposed Project.

Surface waters are the main sensitive receptors associated with the Proposed Project, due to the local hydrological regime which is characterised by relatively 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 9.3.4 indicates that the watercourses in the immediate vicinity of the Proposed Wind Farm Site will be most susceptible to potential effects.

Further downstream, the watercourses will be less susceptible to potential effects due to increasing flow volumes which provide a greater dilution effect. For example, within the River Suir itself, no significant water quality effects associated with the Proposed Wind Farm Site are likely due to the large upstream catchment and large flows in the River Suir channel.

Due to the large downstream distance to Drinking Water Protected Areas (DWPA's) on the River Suir and River Shannon, these surface abstractions are not likely to be sensitive to works at the Proposed Project.

In terms of designated sites, the sites considered most sensitive to the Proposed Project include the Lower River Suir SAC and Lower River Shannon SAC, with both being located immediately downstream of the Proposed Project. Also, Aughnaglanny Valley pNHA is located downstream of the Proposed Wind Farm site.

Designated marshes to the south of the Proposed Grid Connection cable route near Cappawhite; namely Kilbeg Marsh pNHA, Philipston Marsh pNHA and Ballyneil Marsh pNHA are also potentially downstream of the Proposed Grid Connection cable route, albeit the works will be contained within the carriageway of the public road.

However, comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters. Mitigation measures will ensure that surface runoff from the developed areas of the Site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies and/or designated sites. Any introduced drainage works at the Site will mimic the existing hydrological regime thereby avoiding changes to flow volumes leaving the Site.

A hydrological constraints map for the Proposed Wind Farm site is shown Figure 9-10. A self-imposed 50m buffer from streams/rivers (natural watercourses) was applied during the constraints mapping and will be maintained during the construction phase. The proposed Wind Farm drainage infrastructure layout will be cognisant of these buffers.

Apart from the 9 no. proposed water crossing locations and the hardstand at proposed turbine location T5, the Proposed Wind Farm infrastructure is located away from the delineated buffer zones within the Site.

The large setback distance from sensitive hydrological features means they will not be impacted on by excavations/drains etc. It also allows adequate room for the proposed drainage mitigation measures (discussed below) to be properly installed up-gradient of primary drainage features within sub-catchments. This will ensure attenuation of surface runoff to be more effective.

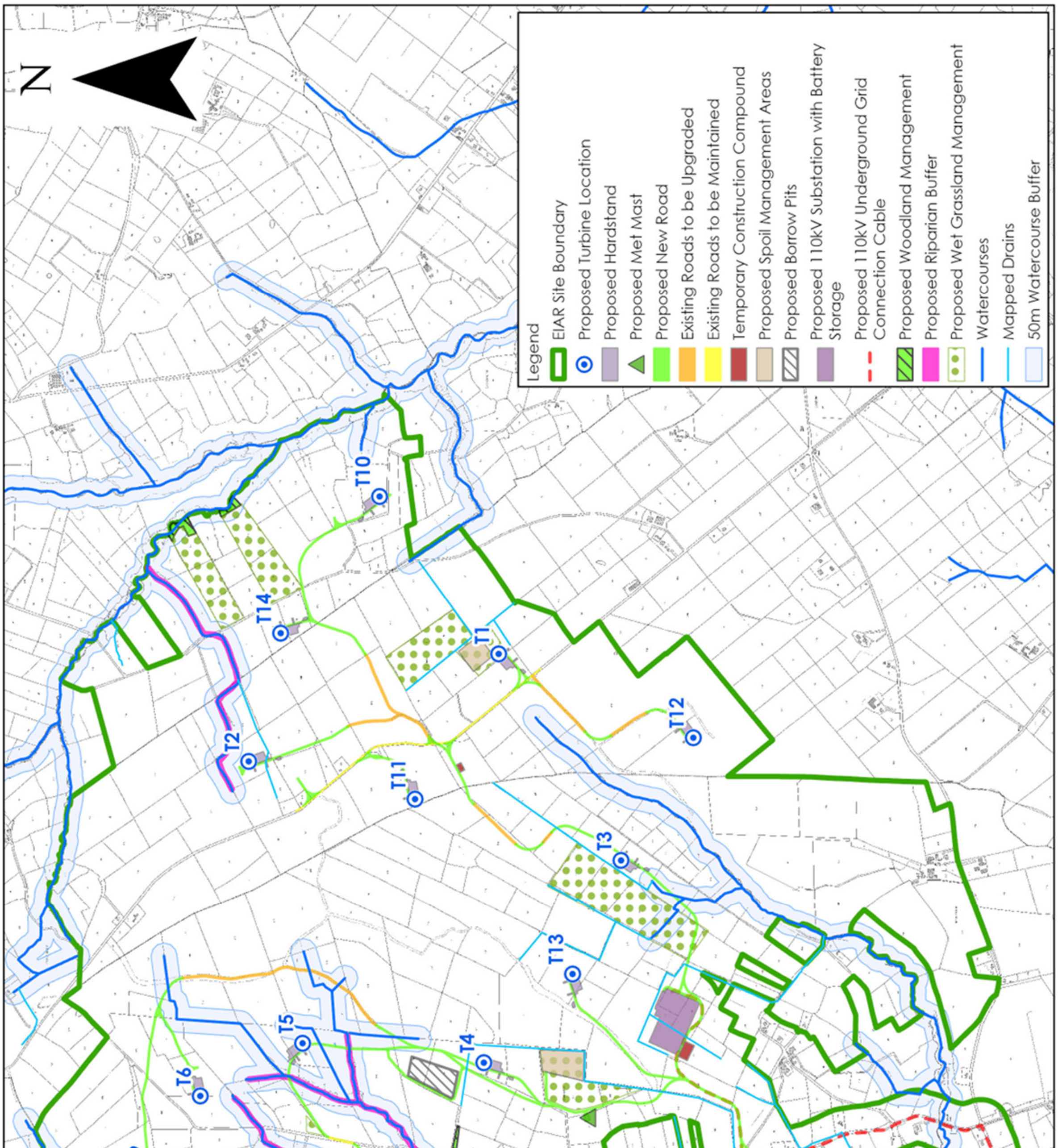


Figure 9-10 Hydrological Constraints Map

9.4 Characteristics of the Proposed Project

The Proposed Project is defined in full in Chapter 4.

Please refer to Section 4.1 of the EIAR for a description of the Proposed Project (i.e. Proposed Wind Farm site and Proposed Grid Connection).

The main characteristics of the Proposed Project that could affect the hydrological and hydrogeological environment comprise the following:

- Establishment of 3 no. temporary construction compound, which will involve minor regrading of soil/subsoil and the emplacement of hardstands. Welfare facilities will be provided at the primary temporary construction compounds. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licenced contractor;
- Construction of the site access tracks will predominantly use the excavate and replace technique. This will involve the use of aggregate from 2 no. on-site borrow pits;
- Construction of 14 no. crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations;
- Battery Energy Storage System (BESS) at the proposed 110kV substation;
- Settlement ponds where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning. The proposed settlement pond locations have been assessed for peat instability risks;
- Grey water will be supplied by rainwater harvesting at the substation and water tankered to site where required. Bottled water will be used for potable supply;
- Construction of 14 no. turbine foundations, which are expected to be gravity foundation design due to shallow depths to underlying bedrock;
- Cabling between turbine locations and the on-site 110kV substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling;
- Construction of 9 no. new watercourse crossing (clear span bridge design) and 2 no. existing forestry road watercourse crossing upgrades;
- Tree felling (total 51.6ha) for the purposes of Proposed Wind Farm construction;
- Establishment of 3 no. dedicated spoil repository areas as well as utilising the 2 no. proposed borrow pits for permanent spoil storage; and,
- Upgrade of 4.3km of existing access forestry tracks and construction of 12.6km of new access tracks using the excavate and replace method which is most appropriate technique for mineral soils.

The main characteristics of the Proposed Grid Connection that could impact on hydrology and hydrogeology are:

- Approximately 37.6km of an underground cabling route between the proposed 110kV substation at the Proposed Wind Farm site and the existing Killonan 110kV substation, involving the excavation of a double shallow trench (approximately 1.2m deep), placement of ducting and backfilling with aggregate, lean-mix concrete, and excavated material, as appropriate (depending on the location of the cable trench);
- Construction of the on-site 110kV substation and control building with a subsoil bearing foundation. Welfare facilities will be provided at the substation along with a temporary construction compound;
- 35 no. existing watercourse culvert/bridge crossings along the public road section of the cable route (23 no. being EPA mapped watercourses);
- At the crossing locations the cable will be placed either underneath or above the culvert by open trench method or by Horizontal Directional Drilling (HDD) method; and,
- No in-stream are proposed at any existing crossing location.

9.4.1 Proposed Drainage Management

9.4.1.1 Drainage Design Philosophy

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the 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 Site that might carry silt or sediment, and nutrients, to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters.

During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated to a high quality prior to being released. A schematic of the proposed site drainage management is shown as **Figure 9-11** below.

A detailed drainage plan showing the layout of the proposed drainage design elements during construction and operation is shown in **Appendix 4-3** of the EIAR.

9.4.1.2 Drainage Design Approach

The general design approach to wind farm layouts in existing forestry is to utilizes and integrate with the existing forestry 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 of a requirement for new construction/excavations, which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing forestry drains have no major ecological or hydrological value and can be readily integrated.

The drainage plan is a key component of the Proposed Project and the following is a summary of the approach used in the drainage design:

- Use of available high-resolution 1m DSM Lidar data to map in more detail the existing forestry drainage (that has potential to interact with proposed infrastructure) at the proposed Wind Farm site and how the proposed infrastructure interacts with this existing drainage. Using these Lidar data potential runoff pathways are mapped that are >150m[6] in length. The outcome of this mapping is shown on the drainage plan drawings;
- Lidar data and available aerial photography is used to digitise existing forestry drainage and field drains within the development area;
- The Proposed Wind Farm footprint is divided up into drainage catchments (based on topography, outfall locations, catchment size) and then stormwater runoff rates are calculated based on the 10-year return period (as required by IFI in relation to Planning Ref: P20/658 FI). These flows are used to design settlement ponds for each drainage catchment;
- Settlement pond(s) are then designed for each development footprint catchment, and identified a location for each pond;
- Cut-off (interceptors drains) are re-routed to account for existing forestry and farm land drains;
- The 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)[7];
- Drainage plans also show the proposed locations of temporary drainage measures that will be installed prior to proposed Wind Farm construction commencing; and,

[6] *We tested several pathway lengths (25m to 250m) and 150m produced the optimal results.*
[7] *Environmental Management Guidelines - Environmental Management in the Extractive Industry (Non-Scheduled Minerals) (EPA, 2006).*

- With regard the 10 no. proposed Wind Farm watercourse crossing locations culvert design, the 100-year flood flows (accounting for climate change).

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

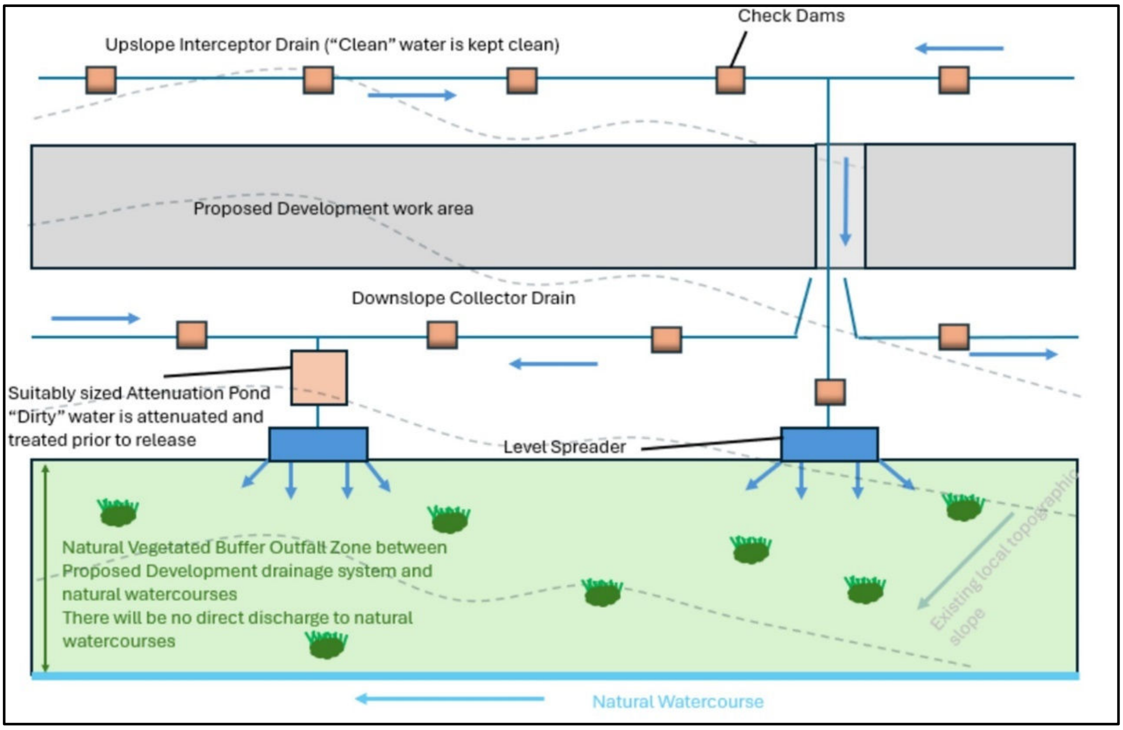


Figure 9-11: Schematic of Proposed Wind Farm Drainage Design

9.5 Likely Significant Effects and Associated Mitigation Measures

9.5.1 Do -Nothing Scenario

If the Proposed Project was not developed, the Proposed Wind Farm Site will continue to function as it does at present, with no changes made to the current land-use of commercial forestry surrounded by agricultural lands. The impact of this is considered neutral in the context of the EIAR. If the Proposed Wind Farm were not to proceed, the opportunity to capture an even greater part of County Tipperary's valuable renewable energy resource 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. The opportunity to generate local employment and investment and to diversify the local economy would also be lost.

If the Proposed Project were not to proceed areas of the Proposed Wind Farm Site would continue to function as a coniferous forestry plantation. Currently felling operations are ongoing in some areas of the Site and, in the Do Nothing Scenario, such forestry operations would continue in these areas. The forestry operations would comprise felling and replanting. All forestry operations would continue to conform with the current best practice Forest Service regulations, policies and guidance documents as well as Coillte and DAFM guidance documents. Some areas of the Proposed Wind Farm Site are utilised as agricultural lands and these land use practices and associated drainage would continue in the Do Nothing Scenario. The Proposed Grid Connection route would remain as public roads and private lands.

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

9.5.2 Construction Phase - Likely Significant Effects and Mitigation Measures

9.5.2.1 Potential Effects of Clear Felling of Coniferous Plantation (Proposed Wind Farm)

Felling works only relate to the Proposed Wind Farm element and not the Proposed Grid Connection. Only the Proposed Wind Farm is assessed herein.

A total of 51.6 hectares of forestry will be felled for the Proposed Wind Farm.

It should be noted that forestry on the Proposed Wind Farm site was originally planted as a commercial crop and will be felled in the future should the Proposed Project proceed or not.

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

Potential effects during tree felling occurs mainly from:

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

- Nutrient release.

These effects have the potential to affect the water quality and fish stocks of downstream water bodies. Potential effects on all watercourses downstream could be significant if not mitigated.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream and Multeen River) and associated water-dependant ecosystems downstream of the Proposed Wind Farm site.

Pre-Mitigation Potential Effect: Indirect, negative, moderate, temporary, likely effect on surface watercourse and associated water-dependent ecosystems.

Proposed Mitigation Measures:

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)

<u>Mitigation by Avoidance:</u>

There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in **Table 9-18.**

Table 9-18 : Minimum Buffer Zone Widths (Forest Service, 2000)

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

However, during the Proposed Wind Farm construction phase a self-imposed buffer zone of 50 metres will be maintained for all streams where possible. These buffer zones are shown on Figure 9-10.

Except for proposed turbine locations T2, T5 and T8, existing road upgrades and proposed new roads at watercourse crossing locations, proposed tree felling areas at the Proposed Wind Farm site are generally located outside of imposed buffer zones (approximately 4.5ha of proposed 51.6ha tree felling is inside of buffers). Additional mitigation (detailed below) will be carried out where tree felling is required inside the buffer zones.

The large distance between most of the proposed felling areas (which are outside the 50m buffer zone) and sensitive aquatic zones means that potential poor-quality runoff from felling areas, will be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes.

The following additional mitigation measures will be employed during tree felling. Additional measures are indicated for felling inside the 50m buffer zone.

<u>Mitigation by Design</u>:

Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods 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 disposal 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 Site 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.

Surface Water Quality Monitoring:

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

Details of the proposed surface water quality monitoring programme are outlined in the Surface Water Management Plan (refer to **Appendix 4-5).**

Criteria for the selection of water sampling points include the following:

- Avoid man-made ditches and drains, or watercourses that do not have year round flows, i.e. avoid ephemeral ditches, drains or watercourses;
- Select sampling points upstream and downstream of the forestry activities;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry;
- Downstream locations will be selected: one immediately below the forestry activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other land-uses where impact increases at third downstream location relative to second downstream location); and,
- The above sampling strategy will be undertaken for all on-site sub-catchments streams where tree felling is proposed.

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

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 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.

9.5.2.2 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

There will be earthworks required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Construction phase activities including access road construction, turbine base/hardstanding construction, construction compound construction, met mast construction, substation construction, grid cable route, spoil management areas and borrow pits which will require varying degrees of earthworks resulting in excavation of soil and mineral subsoil where present. 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 can 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 on all watercourses downstream of the site could be significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Site (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River) and associated water-dependent ecosystems.

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

Proposed Mitigation Measures:

<u>Mitigation by Avoidance</u>

The key mitigation measure during the construction phase is the avoidance of sensitive hydrological features where possible, by application of suitable buffer zones (i.e. 50m to main watercourses) at the Proposed Wind Farm site.

Figure 9-10 it can be seen that all of the key areas of the Proposed Wind Farm infrastructure are actually significantly away from the 50m delineated buffer zones with the exception of access road watercourse crossing locations (9 no. proposed new crossings and 2 no. existing crossings proposed for upgrade). The hardstand at proposed turbine location T5 partially encroach the 50m buffer zone.

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 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.

<u>Mitigation by Design</u>:

- Source controls:
    - Interceptor drains, vee-drains, diversion drains, flume pipes, erosion and velocity control measures such as use of sand bags, oyster bags filled with gravel, filter fabrics, and other similar/equivalent or appropriate systems.
    - Small working areas, covering stockpiles, weathering off stockpiles, cessation of works in certain areas.
- In-Line controls:
    - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters,

weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.

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

It should be noted for this site that an extensive network of forestry and agricultural drains already exists, and these will be integrated and enhanced as required and used within the wind farm development drainage system. The integration of the existing drainage network and the Proposed Wind Farm network is relatively simple. The key elements being the upgrading and improvements to existing water treatment elements, such as in line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

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;
- Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- Runoff from individual turbine hardstanding areas will be not discharged into the existing drain network but discharged locally at each turbine location through settlement ponds and buffered outfalls onto vegetated surfaces;
- Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded, widening will be targeted to the opposite side of the road. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

It should be noted that 2.6km of the Proposed Wind Farm roads already exist (as forestry tracks) and are proposed for upgrade. The upgrading of these roads, albeit presents a potential short-term potential non-significant effect on surface water quality during construction, will be a positive effect in the long-term with regard to improved drainage controls.

Pre-commencement Temporary Drainage Works

Prior to the commencement of road upgrades (or new road/hardstand or turbine base installs) the following key temporary drainage measures will be installed:

- All existing dry forestry or agricultural drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using check dams/silt traps;
- Clean water interceptor drains will be installed upgradient of the works areas;
- Check dams/silt fence arrangements (silt traps) will be placed in all existing drains that have surface water flows and also along existing roadside drains; and,
- A double silt fence perimeter will be placed down-slope of works areas that are located inside the watercourse 50m buffer zone.

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids such as those present in the glacial tills that overlie the site. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be placed 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, the majority of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats Sediment entrapment mats, consisting of coir or jute matting, will be placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Settlement Ponds:
The Proposed Wind Farm infrastructure footprint has been divided into drainage catchments (based on topography, outfall locations, and catchment size) and stormwater runoff rates based on the 10-year return period rainfall event were calculated for various catchment areas in order to size the settlement ponds as shown in **Table 9-19** below.

The 10-year return period rainfall event is a recommendation of the **IFI** relating to a previous application in County Clare (i.e. Cahermurphy 2 Wind Farm, Co. Clare - Planning Ref P20/658) and has been applied to this current application also.

The location and dimensions of proposed settlement ponds are shown on the Proposed Wind Farm site drainage plan drawings (**Appendix 4-3**).

Table 9-19: Settlement Pond Design

Pond Size W [m] x L [m] x D [m]			Track/Hardstand Catchment Size (m^2)		
Return Period	10 yrs	Storm Duration	500	1000	2000
6hr retention for coarse silt		6 hrs	3.4 x 10.6 x 1 m	4.8 x 15.0 x 1 m	6.9 x 21.0 x 1 m
11hr retention for medium silt		12 hrs	3.8 x 12.0 x 1 m	5.5 x 16.5 x 1 m	7.5 x 24.2 x 1 m
24hr retention for fine silt		24 hrs	4.2 x 13.8 x 1 m	6.2 x 18.6 x 1 m	8.6 x 27.0 x 1 m

Level Spreaders and Vegetation Filters:

The purpose of level spreaders is to release treated drainage flow in a diffuse manner, and to prevent the concentration of flows at any one location thereby avoiding erosion. Level spreaders are not intended to be a primary treatment component for development surface water runoff. They are not stand alone but occur as part of a treatment train of systems that will reduce the velocity of runoff prior to be released at the level spreader. In the absence of levelspreaders, the potential for ground erosion is significantly greater than not using them.

Vegetation filters are essentially end-of-line polishing filters that are located at the end of the treatment train. In fact, vegetation filters are ultimately a positive consequence of not discharging directly into watercourses which is one of the mitigation components of the drainage philosophy. This makes use of the natural vegetation of the site to provide a polishing filter for the wind farm drainage prior to reaching the downstream watercourses.

Again, vegetation filters are not intended to be a single or primary treatment component for treatment of works area runoff. They are not sand alone but are intended as part of a treatment train of water quality improvement/control systems (i.e. source controls→check dams→silt traps→settlement ponds→level spreaders →silt fences→vegetation filters).

Water Treatment Train:

A final line of defence will be provided by a water treatment train such as a "Siltbuster". If the discharge water from construction areas fails to be of a high quality during regular inspections, 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.

Pre-emptive Site Drainage Management

The works programme for the entire construction stage of the development will also take account of weather forecasts, and predicted rainfall in particular. Large excavations and movements of soil/subsoil or vegetation stripping will be suspended or scaled back if 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 either of the following is likely to occur:

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

Prior to works being suspended the following control measures will be completed:

- All active excavations will be secured and sealed off;
- Temporary or emergency drainage will be installed to prevent back-up of surface runoff; and,
- No works will be completed during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Management of Runoff from The Spoil Repository Areas:

It is proposed that excavated soil/subsoil (spoil) will be stored in 3 no. dedicated spoil repository areas and also within the 2-no. proposed borrow pit locations when exhausted. Spoil will also be used for landscaping throughout the Proposed Wind Farm site, but only areas outside of 50m watercourse buffers will be considered. The 3 no. spoil repository areas and 2 no. borrow pits are also located outside the 50m stream buffer zones.

Proposed surface water quality protection measures regarding the peat storage areas are as follows:

- During the initial emplacement of spoil at the repository area, silt fences, straw bales and biodegradable matting will be used to control surface water runoff from the enclosure.
- Drainage from the repository areas will be directed to settlement ponds as required or will overflow through controlled overflow pipes.
- Discharge will be intermittent and will depend on preceding rainfall amounts.
- Once the repository has been seeded and vegetation is established the risk to downstream surface water is significantly reduced.

Therefore, at each stage of the spoil repository development the above mitigation measures will be deployed to ensure protection of downstream water quality.

The repository area settlement ponds have been designed to allow a 24hr retention time as per EPA guidance (2006) which is highest level of protection recommended by the EPA with regard to retention time.

Timing of Site Construction Works:

Construction of the 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 construction 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. Inspections will also be undertaken after tree felling.

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. Checks will be carried out on a daily basis.

- During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs will be undertaken for each primary watercourse and specifically following heavy rainfall events (as per the CEMP included in Appendix 4-3 of this EIAR).

Allowance for Climate Change

Climate Change rainfall projections 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 Project, as the turbines have a life span of 35 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. As outlined in the above sections we have designed settlement ponds for a 1 in 10 year return flow. This approach is conservative given that the project will likely be built over a much shorter period (12-18 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

However, the settlement ponds are designed for 1 in 10 years flows with built in redundancy (+20%) to account for climate change effects on rainfall.

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 negative, imperceptible, indirect, short term, likely effect on down gradient rivers, water quality, and water-dependant ecosystems.

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

9.5.2.3 Potential Effects on Groundwater Levels during Excavation Works (Proposed Project)

There will be excavations required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Potential dewatering of the 2 no. borrow pits and other deep excavations (i.e. turbine bases) have the potential to impact on local groundwater levels in the mineral soil and bedrock. However, temporary reductions in groundwater levels by temporary dewatering will be very localised due to small nature of the inflows from the mineral subsoils (as determined by trial pitting) and the competent and low permeability of the SILTSTONE/SANDSTONE bedrock.

There is GSI record for 1 no. historical Mineral Exploration Boreholes drilled at the Proposed Wind Farm site encountered competent SANDSTONE/SILTSTONE (Old Red Sandstone) from 4.9 to 39.3mbgl, followed by SILTSTONE/MUDSTONE to 60.9mbgl. No bedrock fracturing or faulting was noted in the drilling log.

Any dewatering required along the Proposed Grid Connection cable trench and joint bays is likely to be due to surface water runoff rather than groundwater. This is due to the shallow nature of the cable trench and joint bay excavations (~1.2m) and therefore no significant effects on groundwater levels will occur.

Pathway: Groundwater flow paths.

Receptor: Groundwater levels, local aquifers and Templemore GWB.

Pre-Mitigation Potential Effect: Slight, indirect, temporary, likely effects on local groundwater levels. In the absence of mitigation measures, there will be no potential for significant effects on groundwater levels.

Impact Assessment/Proposed Mitigation Measures by Design:

The proposed 2 no. borrow pits are located in competent SILTSTONE/SANDSTONE bedrock which is generally unproductive in terms of groundwater flow. Similar bedrock types underlie the proposed turbine locations.

Also, the topographical and hydrogeological setting of the proposed borrow pits and turbine locations means no significant groundwater dewatering is anticipated to be required during the operation of the borrow pit or turbine base construction.

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. We consider that this example is very different in scale and operation from the proposed operation of a temporary shallow borrow pit on the side of a hill. In order to explain this thoroughly we will outline our reasoning in a series of bullet points as follows:

- Firstly, the proposed borrow pit areas are located on the top of hills/ridges where the ground elevation is between 250 and 320m OD;
- All proposed turbine locations are at elevations in excess of 200m OD;
- These elevations are well above the elevations of the local valleys and streams;

- The proposed borrow pits will be between approximately 8 – 10mbgl which is notable. However, in the context of the topographical/elevated setting of the proposed borrows pits, this depth range is relatively shallow;
- The local bedrock comprises SILTSTONE/SANDSTONE and is confirmed to have low intrinsic permeability due to the competency of the rock. This means that groundwater flows will be limited to seepages at worst;
- The flow paths (i.e. the distance from the point of recharge to the point of discharge) in this type of geology is short, localised, and will also be relatively shallow;
- No regional groundwater flow regime, i.e. large volumes of groundwater flow, will be encountered at these elevations;
- Therefore, shallow groundwater inflows will largely be fed by recent rainfall, and possibly by limited groundwater seepage form localised shallow bedrock;
- The sloping nature of the ground/ridges on the hills where the borrow pits is proposed along with the coverage of soil means groundwater recharge is going to be very low;
- As such the shallow groundwater flow system will be small in comparison to the expected surface water flows from the bog surface;
- This means that there will be a preference for high surface water runoff as opposed to groundwater recharge and flow; and,
- Hence, we consider that the management of surface water will form the largest proportion of water to be managed and treated.

Similarly, no significant groundwater dewatering is anticipated to be required during the construction of the turbine bases.

Post-Mitigation Residual Effects: Due to the local topography and confirmed competent, low permeability bedrock along with the prevailing hydrogeology of the Proposed Wind Farm site the potential for groundwater level drawdown impacts is considered negligible. The residual effect will be negative, imperceptible, indirect, temporary, likely effects on local groundwater levels.

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

9.5.2.4 Potential Effects on Surface Water Quality from Excavation Dewatering (Proposed Project)

Pumping water from excavations might be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, borrow pits and cabling trenches, and this will create small additional volumes of water to be treated by the runoff management system. Cable trenching might require removal of water prior to backfilling.

Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the Site and therefore baseline contamination does not occur.

Pathway: Overland flow and site drainage network.

Receptor: Down-gradient surface water bodies (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, temporary, likely effect to surface water quality. In the absence of mitigation measures, there will be no potential for significant effects on downstream surface waters and associated water-dependent ecosystems.

Proposed Mitigation Measures:

Management of excavation inflows 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 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 silt bags or silt buster;
- 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;
- At the turbine locations and borrow pits adequately sized settlement ponds will be constructed to treat pumped water prior to discharge into a local manmade drain; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system can be made available at turbine locations 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.

Post Mitigation Residual Effect: 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 of the Proposed Project will be negative, imperceptible, indirect, short-term, likely effect on local surface water quality.

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

9.5.2.5 Potential Effects from Hydrocarbons Leaks & Spills (Proposed Project)

Hydrocarbons will be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a significant pollution risk to groundwater, surface water and associated ecosystems, and to terrestrial ecology. The accumulation of small spills of fuels and lubricants during routine plant use can also be a pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. It is also a nutrient supply for adapted micro-organisms, which can rapidly deplete dissolved oxygen in waters, resulting in death of aquatic organisms.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater (Templemore, Slieve Phelim, Ballyneety and Limerick City East GWBs) and surface water (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River).

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect to local groundwater quality. Indirect, negative, moderate, short term, unlikely effect to surface water quality. In the absence of mitigation measures, there will be no potential for significant effects on downstream surface waters and local groundwater quality.

Proposed Mitigation Measures:

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

- On site re-fuelling of machinery will be carried out using a dedicated fuel truck. The fuel truck will also carry fuel absorbent material and pads in the event of any accidental spillages;
- Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- On-site refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Fuels stored on site will be minimised. Fuel storage areas if required will be bunded appropriately for the fuel storage volume for the time period of the construction and 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 plan for the construction phase to deal with accidental spillages will be included within the Construction and Environmental Management Plan (**Appendix 4.3**). Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

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 mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters. The residual effect of the Proposed Project will be negative, imperceptible, indirect, short-term, unlikely impact to local surface water and groundwater quality.

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

9.5.2.6 Release of Cement-Based Products (Proposed Project)

Hydrocarbons will be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293/1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment.

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: Site drainage network.

Receptors: Groundwater (Templemore, Slieve Phelim, Ballyneety and Limerick City East GWBs) and surface water (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short term, unlikely effect to surface watercourses and water-dependent ecosystems. Indirect, negative, slight, short term, likely effect to groundwater quality.

Proposed Mitigation Measures:

- No batching of wet-concrete products will occur on site. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- Where possible pre-cast elements for culverts and concrete works will be used;
- Where concrete is delivered on site, only the chute will be cleaned, using the smallest volume of water practicable. 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 will be undertaken at lined concrete washout ponds;
- Weather forecasting will be used to plan dry days for pouring concrete; and,
- The pour site will be kept free of standing water and plastic covers will be ready in case of sudden rainfall event.

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 of 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 negative, imperceptible, indirect, short term, unlikely impact to surface and groundwater quality.

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

9.5.2.7 Potential Effects due to Watercourse Crossing Works (Proposed Wind Farm)

New watercourse crossings (i.e. bridges/culverts) or upgrades of existing crossings will only be required at the Proposed Wind Farm site and not along the Proposed Grid Connection. Only the Proposed Wind Farm is assessed herein.

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.

Construction of 9 no. new watercourse crossing (clear span bridge/culvert design) and upgrade of 2 no. existing crossings on forestry tracks will be required to facilitate the Proposed Wind Farm site infrastructure

Pathway: Site drainage network.

Receptor: Surface water flows (Lackenacoombe Stream, Glasheenyreagha Stream), stream morphology and water quality.

Pre-Mitigation Potential Effect: Negative, direct, slight, permanent, likely effect on surface water flows and drainage patterns. In the absence of mitigation measures, there would be no potential for significant effects.

Proposed Mitigation Measures:

- All proposed 9 no. new stream crossings and 2 no. upgrades will be bottomless or clear span structures, 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;
- Where the proposed cable route follows an existing road or road proposed for upgrade, the cable will pass over or below the culvert within the access road;
- All guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland[8] is incorporated into the design of the proposed crossings;
- As a further precaution, near stream construction work, will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", i.e., May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase. There will be no batching or storage of cement allowed in the vicinity of the crossing construction areas;
- All new river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent; and,
- All crossings will be designed to accommodate a 100-year design flood with allowance for 300mm freeboard

The watercourse crossings will be constructed to the specifications of the OPW bridge design guidelines 'Construction, Replacement or Alteration of Bridges and Culverts - A Guide to Applying for Consent under Section 50 of the Arterial Drainage Act, 1945', and in consultation with Inland Fisheries Ireland. Abutments will be constructed from precast units combined with in-situ foundations, placed within an acceptable backfill material.

Confirmatory inspections of the proposed new watercourse crossing location will be carried out by the Project Civil/Structural Engineer and the Project Hydrologist prior to the construction of the crossing.

In relation to the new proposed culverts and proposed culvert upgrades at forestry drain crossings, the culverts will be suitably sized (minimum 900mm) for the expected peak flows in the relevant drain. All culverts will be installed with a minimum internal gradient of 1% (1 in 100). Smaller culverts will have a smooth internal surface. Larger culverts may have corrugated surfaces which will trap silt and contribute to the stream ecosystem. Depending on the management of water on the downstream side of the culvert, large stone may be used to interrupt the flow of water. This will help dissipate its energy and help prevent problems of erosion. Smaller water crossings will simply consist of an appropriately sized pipe buried in the sub-base of the road at the necessary invert level to ensure ponding or pooling does not occur above or below the culvert and water can continue to flow as necessary.

Post Mitigation Residual Effect: With the application of the best practice mitigation outlined above, the residual effect will be negative, imperceptible, direct, long-term, unlikely impact on stream flows, stream morphology and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on stream morphology or stream water quality will occur at crossing locations.

9.5.2.8 Potential Effects on Designated Sites (Proposed Project)

Designated sites are located downstream to both the Proposed Wind Farm and Proposed Grid Connection. Therefore, both are assessed herein.

[8] *Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters*

The designated sites that are hydraulically connected (surface water flow paths only) to the Proposed Project include the Lower River Suir SAC, Lower River Shannon SAC and Aughnaglanny Valley pNHA.

There are a number of pNHA designated marshes to the south of the Proposed Grid Connection near Cappawhite; namely Kilbeg Marsh, Philipston Marsh and Ballyneil Marsh. The Proposed Grid Connection follows a local public road at this location and therefore effects are not likely even in the absence of mitigation.

Any potential effects on these designated sites will be surface water quality related. However, as described in this chapter measures will be put in place to prevent surface water quality impacts.

Pathway: Surface water and groundwater flowpaths.

Receptor: Designated sites.

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short-term, likely effect on designated sites.

Impact Assessment & Proposed Mitigation Measures:

Drainage mitigation measures for surface water quality protection during the construction phase are summarised again below: (Please refer to Sections 9.5.2.1, 9.5.2.2, 9.5.2.4, 9.5.2.5 and 9.5.2.6 and above for the full description of these measures and how they will be applied).

- The proposed mitigation measures which will include 50m buffer zones for avoidance of sensitive hydrological features (streams and rivers);
- Pre-construction drainage control measures (Section 9.5.2.2);
- Robust drainage control measures (i.e. interceptor drains, swales, settlement ponds and treatment trains such as Siltbuster) will ensure that the quality of runoff from Proposed Development areas will be very high; and,
- Best practice measures with regard use of oils, fuels (Section 9.5.2.5) and cement based compounds (Section 9.5.2.6).

As stated in Section 9.5.2.2 above, there could potentially be a residual "imperceptible, short term, likely effect" on local streams and rivers but this would be very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the downstream designated sites will not occur.

Post Mitigation Residual Effect: No effects on local designated sites from the Proposed Project.

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

9.5.2.9 Potential Effects on Local Groundwater Well Supplies from Excavations (Proposed Project)

There will be excavations required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) and therefore both are assessed herein.

In the area of the Proposed Wind Farm site, private dwelling houses (potential well locations) are mainly located along public roads that intercept the Site.

The biggest risk to potential down-gradient wells will be from where deeper excavations are required such as the turbine bases and borrow pits.

Construction of the Proposed Grid Connection will have very low potential to effect local wells due to the shallow nature of the works within the carriageway of public roads.

The closest distance between a proposed turbine or borrow pit location and a downstream dwelling house (potential well) is >700m. In order to be conservative and following the worst-case assumption, we have assumed that all dwellings in the surrounding lands have a private groundwater well.

However, due to the relatively shallow nature of the deepest excavations (3.5 -8m), the hydrogeological regime and the >700m setback distance from potential wells, significant effects on private wells are unlikely.

Pathway: Groundwater flowpaths.

Receptor: Private Groundwater Supplies.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, short-term, unlikely effect on local wells. In the absence of mitigation measures, there will be no significant effects on local groundwater well supplies.

Impact Assessment:

We are satisfied that the Proposed Project will not impact in any significant way on any potential down-gradient private wells for the following reasons:

- The large set back distances between turbine locations/borrow pit locations and downstream potential well locations (>700m);
- The elevation difference between turbine locations/borrow pit locations and downstream potential well locations (>50m);
- The short groundwater flowpath distances (30 – 300m);
- The Proposed Wind Farm will involve relatively shallow excavations (3.5m - 8mbgl) which are typically located on elevated ground where thereby lessens the true depth of the excavation;
- The moderate - low permeability of the glacial deposits in which the turbine gravity base foundations will be constructed;
- The low permeability and low recharge characteristics of the underlying SILTSTONE/SANDSTONE aquifer that underlies the Proposed Wind Farm site;
- Localised groundwater flow patterns in the glacial deposits which is towards local streams that flow through the Proposed Wind Farm site;
- Groundwater flow patterns are expected towards the internal watercourses that drain the proposed Wind Farm site; and,
- The shallow excavation depths required for Proposed Grid Connection cable and joint bays

Post Mitigation Residual Effects: For the reasons outlined in the impact assessment above (separation distances, and prevailing hydrogeology, topography and groundwater flow directions), it has been assessed the Proposed Project has no potential to impact on local groundwater wells.

Significance of Effects: For the reasons outlined above, no impacts on groundwater well supplies will occur.

9.5.2.10 Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks Works and Watercourse Crossings

Along the Proposed Grid Connection cable route there are 35 no. watercourse crossing locations (23 no. are EPA mapped watercourses).

The watercourse crossing methodologies for the provision of the Proposed Grid Connection underground cabling component at these locations are described in full in Chapter 4 (Section 4.9.2.7) and are summarised below.

- Crossing Using Standard Trefoil Formation – Option A
- Flatbed Formation Under Bridges/Culverts – Option B
- Flatbed Formation over Bridges/Culverts – Option C
- Horizontal Directional Drilling – Option D

In stream works are not required at any watercourse crossing along the Proposed Grid Connection underground cabling route and there no significant effects on water quality are expected.

Pathway: Surface water flowpaths/groundwater paths.

Receptor: Down-gradient water quality (Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River).

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

Proposed Mitigation Measures:

Pre-commencement Temporary Drainage Works:

Prior to the commencement of 110kV substation or cable trenching the following key temporary drainage measures will be installed:

- All existing roadside drains (where present) 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 (where present) 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 on the Levally Stream tributary.

The following mitigation measures are proposed for the underground cabling watercourse crossing works:

- No stock-piling of construction materials will take place along the grid route;
- 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.

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

- 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.

Residual Effect: 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 of the Proposed Project will be negative, imperceptible, direct, long term, likely effect on surface water quality.

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

9.5.2.11 Use of Siltbuster and Effect on Downstream Surface Water Quality (Proposed Project)

Both the Proposed Wind Farm and Proposed Grid Connection could benefit from the use of a siltbuster. Therefore, both are assessed herein.

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 9-12**. 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).

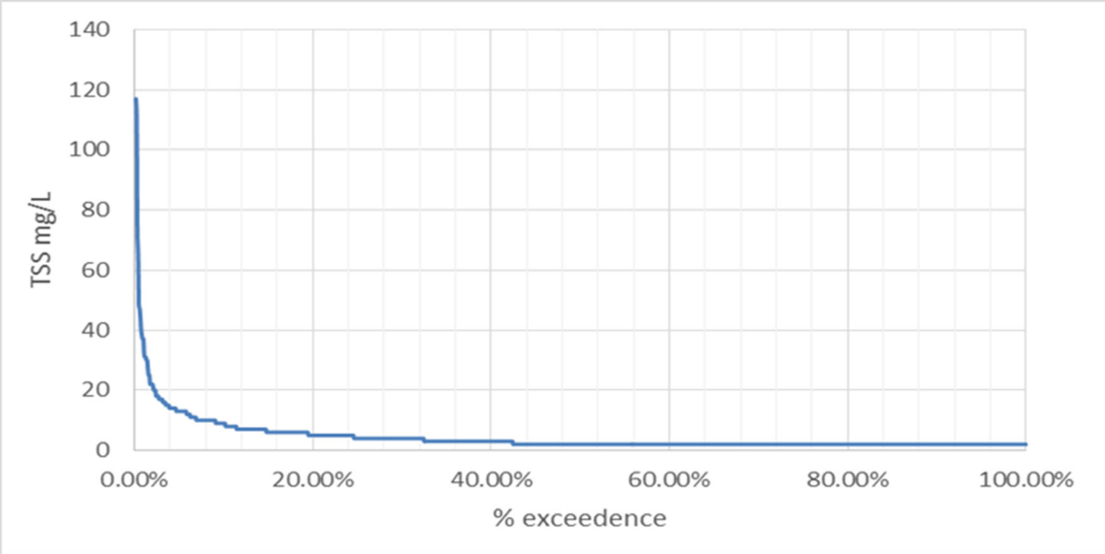


Figure 9-12: Example of treatment capability of Siltbuster treatment

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Proposed Project site (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River) and associated water-dependent ecosystems.

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

Proposed Mitigation Measures:

Measures employed to prevent overdosing and potential chemical carryover:

- 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.

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 is - 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.

9.5.2.12 Potential Effects on Surface Water and Groundwater WFD Status (Proposed Project)

Both the Proposed Wind Farm and Proposed Grid Connection could potentially affect the WFD status of downstream SWBs and GWBs. Therefore, both are assessed herein.

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 Project are defined in Section 9.3.13 and Section 9.3.14 respectively.

A detailed WFD Compliance Assessment Report has been completed in combination with this EIAR Chapter and is included in **Appendix 9-3**.

Pathway: Surface water flowpaths.

Receptor: WFD status of downstream surface water bodies and underlying GWBs.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect on surface water and groundwater bodies.

Proposed Mitigation Measures:

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality at the Proposed Project site have been detailed in Section 9.5.2.1 (clear felling), Section 9.5.2.2 (suspended solids), Section 9.5.2.5 (hydrocarbons), Section 9.5.2.6 (cement-based products) and Sections 9.5.2.7 & 9.5.2.10 (hydromorphological changes).

Similarly, mitigation measures for the protection of groundwater quantity and quality have been detailed in Section 9.5.2.3 (groundwater levels), Section 9.5.2.5 (hydrocarbons) and Section 9.5.2.69.5.2.6 (cement-based products).

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

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

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Project. 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 Project.

9.5.2.13 Potential Effects on Public Water Supplies (Surface Water and Groundwater)

The GSI/EPA do not map the presence of any Public Water Supplies (PWS) or Group Water Schemes (GWS) groundwater source protection areas within the Proposed Wind Farm site.

The closest GSI/EPA mapped groundwater source protection area to the Proposed Wind Farm Site is associated with the Ironmills PWS where the boundary of the source protection area is located ~2.6km to the southwest of the Proposed Wind Farm site along the banks of the Multeen River, immediately upstream of Ironmills Bridge.

The Proposed Grid Connection cable route passes to the south of the source protection area where it crosses over Ironmills Bridge on the Multeen River. The Proposed Grid Connection cable route does not pass through the mapped source protection area and is downstream of the protection area and source boreholes.

Doon PWS (Cooga Spring) is located 11km to the west of Proposed Wind Farm site and along the Proposed Grid Connection cable route where it follows Regional Road R505.

The Proposed Grid Connection cable follows the Regional Road R505 which runs approximately 60m to the north and upslope of the spring. The cable route passes through the source protection area for approximately 150m within the carriageway of the R505.

There are Drinking Water Protection Areas (DWPAs) downstream of the Proposed Project on the River Suir and Mulkear River.

The closest downstream DWPA to the Proposed Wind Farm site is the Suir_140 DWPA which is approximately 35km downstream of the Site. The DWPA on the Mulkear River is 12km downstream of the Proposed Grid Connection cable route.

Pathway: Surface water and Groundwater flowpaths.

Receptor: Ironmills PWS, Doon PWS, Suir_DWPAs and The Shannon(Lower)_060 DWPA.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, unlikely effect on surface water and groundwater sources.

Impact Assessment Proposed Mitigation Measures:

There is no Proposed Project infrastructure located inside the Ironmills PWS and therefore no potential for alteration of groundwater flowpaths or groundwater quality effects. As described in Section 9.3.16.1 above, investigations carried out on the source have not identified a strong hydraulic connection between the Multeen River and abstraction boreholes and therefore potential indirect effects via surface water pathways are not likely.

Therefore, the likelihood of the Multeen River acting as a pathway for contaminants (i.e. runoff) between the Proposed Wind Farm site and the source is very low. Nonetheless, the Proposed Wind Farm drainage mitigation as described in Sections 9.4.1 and 9.5.2.2 will ensure the protection of downstream surface waters including the Multeen River. Also, the filtering effects of the sand and gravel deposits that surround the source boreholes means any suspended sediments in the Mulkear River would not be able to enter the well during pumping.

The Proposed Grid Connection cable passes through the Doon WS source protection area for approximately 150m within the carriageway of the R505. However, due to the fact that cable will be laid within the R505 carriageway along with the shallow nature of the trench excavation no effects on groundwater flowpaths sustaining the spring will occur. There is an existing watermain within the public road which was placed without disrupting the spring.

The R505 carriageway is elevated some 8m above the elevation of spring, therefore shallow groundwater flowpath underneath the R505 carriageway are not likely. It is understood from the source protection that groundwater levels upslope of the spring are 2 – 3m below ground level, which is deeper than the proposed cabling earthworks (~1.2mbgl).

Spills and leaks of fuels hydrocarbons do however present a risk to the source spring during the Proposed Grid Connection construction phase. To mitigate this risk, no refuelling or handling of fuels/oil/lubricants/chemicals will be permitted within 100m of the mapped source protection area boundary.

In addition, to present potential leaching of cement from the cable trenching, a geotextile liner will be placed around the founding layer (lean mix concrete) where concrete is to be poured.

Also, there will be clear signage in place inside the source protection area to remind construction workers that the area is inside a drinking water protection area and that there are restrictions around the use of fuels/oil/lubricants/chemicals.

Due to the large downstream distance to the surface water DWPAs in the Suir and Shannon, along with the proposed drainage control and pollution prevention mitigation no effects on these surface water abstractions will occur.

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the construction phase of the Proposed Project will ensure no negative effects on downstream surface water or groundwater abstractions.

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

9.5.2.14 Biodiversity Enhancement and Management Plan (BEMP) and Potential Hydrological/Water Quality Effects

A Biodiversity Enhancement and Management Plan (BEMP) is proposed for areas of the Proposed Wind Farm. This includes management of 30.2ha of species rich grassland for Marsh Fritillary habitat enhancement, enhancement of approximately 3.3 ha of semi-natural woodland habitat and planting of plant riparian woodland either side of mapped watercourses within the Proposed Wind Farm site.

No earthworks, drain blocking or drainage alterations are proposed as part of the enhancement works and therefore no significant effects on surface water quality or hydrology are anticipated.

Some of these proposals may slightly disturb local vegetation and soil and increase the likelihood of erosion of peat and subsoils. However, due to the largely non-invasive nature of the works the potential for effects on the water environment are limited.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity of the Proposed Wind Farm (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream, Multeen River) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effects: Negative, imperceptible, indirect, short term, likely effect on surface water quality.

Mitigation Measures:

All proposed habitat management and enhancement works will be in accordance with the best practice Forest Service regulation, policies and strategic guidance documents as well as Coillte, DAFM and NatureScot guidance documents to ensure minimal potential negative effects on the local peat, soil and subsoil environment.

Given the nature of the restoration measures the following mitigation measures are proposed:

- Before any works are completed silt fences will be installed to limit the movement of entrained sediment in surface water runoff;
- Proposed off-road routes will be walked in advance of any machinery;
- All machinery operators will be experienced;
- The Proposed Wind Farm site will be walked before a machine goes off-road;

- Bog mats will be used where the excavator is required to travel over wet ground; and,
- A low ground pressure excavator with wide tracks (1.9m or greater) will be used to reduce compaction of the peat and subsoils.

Post Mitigation Residual Effect: With the implementation of mitigation measures outlined above the no negative effects on surface water quality will occur.

Significance of Effects: No significant effects on surface water quality will occur.

9.5.2.15 Potential Effects from Turbine Delivery Route Works (Proposed Wind Farm)

Minor earthworks are required for the TDR. These include for temporary accommodation works at 8 no. along the proposed route. These TDR works are described in Section 4.4 of the EIAR.

Pathway: Surface water flowpaths.

Receptor: Surface waters in the vicinity of the TDR works (Glasheenyreagha Stream and Multeen River) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, unlikely effect on surface water quality. In the absence of mitigation measures, there will be no potential for significant effects on surface water quality due to the minor nature of the works.

Proposed Mitigation Measures:

- All works are minor and localised and cover very small areas;
- These works are distributed over a wide area;
- All works are temporary in nature;
- All areas will be reinstated shortly after the works and reseeded; and,
- Application of the Pre-Construction Drainage Measures (see Section 9.5.2.2) for surface water quality protection.

Post Mitigation Residual Effect: 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 of the TDR works is no negative effect.

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

9.5.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces (Proposed Project)

Hardstand emplacement will be required at both the Proposed Wind Farm site and Proposed Grid Connection (i.e. 110kV substation). Therefore, both are assessed herein.

Progressive replacement of the soil 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 permeability similar or higher to the underlying soil. However, it is conservatively assumed in this assessment that the proposed access roads and hardstands are impermeable. The assessed footprint comprises turbine bases and hardstandings, access roads, site entrances, substation and temporary construction compounds. During storm rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

Pathway: Site drainage network.

Receptor: Surface waters in the vicinity and downstream of the Site (Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream and Multeen River) and associated water-dependent ecosystems.) and associated water-dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, permanent, moderate probability effect on all downstream surface water bodies.

Effects Assessment:

The emplacement of the proposed permanent footprint (26.1ha), as described in Chapter 4 of the EIAR, (assuming emplacement of impermeable materials as a worst-case scenario) could result in an average total site increase in surface water runoff of approximately 8,948m^3/month or 289 m^3/day **(Table 9-20).**

This represents a potential increase of approximately 0.94% in the average daily/monthly volume of runoff from the Site area in comparison to the baseline pre-development site runoff conditions. 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 26.1ha, representing 3.14% of the Wind Farm Site area of 830ha.

Table 9-20: Baseline Site Runoff V Development Runoff

Site Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)	Hardstanding Area 77% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
952,611	30,729	261,000	38,903	29,956	8,948	289	0.94

The additional volume is low due to the fact that the runoff potential from the site is naturally high (77 %). 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.

Proposed Mitigation by Design:

The operational phase drainage system of the Proposed Project will be installed and constructed in conjunction with the road and hardstanding construction work as described below and as shown on the Drainage drawings submitted with this planning application **(Appendix 4-3):**

- 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 over the ground by means of a level spreader;

- Swales/road side drains will be used to collect runoff from access roads and turbine hardstanding areas of the site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed in the surface layer of the road to divert any runoff off the road into swales/road side 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 road swale 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 watercourses; and,
- Settlement ponds have been designed in consideration of the greenfield runoff rate.

As described above the proposed integration of the wind farm drainage with the existing forestry drainage is a key component of the proposed drainage management within the development. By integration we mean maintaining surface water flowpaths where they already exist, avoid creation of new or altered surface water flowpaths, and maintaining the drainage regime (i.e. normal flow) within each forestry compartment. Critically, there will be no alteration of the catchment size contributing to each of the main downstream watercourses. All wind farm drainage water captured within individual site sub-catchments will be attenuated and released within the same sub-catchments that it was captured.

Post-Mitigation Residual Effect: Direct, negative, neutral, long term, likely effect. Proven and effective measures to attenuate runoff and mitigate the risk of flooding will be employed. The residual effect will be - Neutral, indirect, long term, likely effect on down gradient streams/rivers.

Significance of Effects: No significant effects on downstream flood risk will occur during the operational phase of the Proposed Project.

9.5.3.2 Potential Effects from Surface Water Runoff

Site runoff will occur at the Proposed Wind Farm site and Proposed Grid Connection. Both are assessed herein.

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 are likely to be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works will be of a very minor scale and will be very infrequent. Potential sources of sediment laden water will 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 against.

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers ((Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream and Multeen River) and associated water-dependent ecosystems.) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect on surface water quality. Proven and effective measures to attenuate runoff and mitigate the risk of flooding will be employed

Proposed Mitigation Measures:

The mitigation measures outlined in Sections 9.5.2.2 and 9.5.3.1 will ensure all surface water runoff from upgraded roads and new road surfaces (including hardstand, turbine base areas and substation) will be captured and treated prior to discharge/release. Settlement ponds, checks dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.

It is proposed that bedrock from on-site borrow pits will be used to construct the sub-base layer of proposed upgraded and new access roads, hardstand areas and turbine base areas. Once installed the subbase layer will be overlain by a clean capping layer of high-grade stone material which will be sourced from local quarries also.

Post Mitigation Residual Effects: With the implementation of the proposed drainage measures as outlined above, and based on the post-mitigation assessment of runoff, residual effects will be 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 occur.

9.5.3.3 Potential Effects on WFD Status (Proposed Project)

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

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

A full assessment of the potential effects of the operational phase of the Proposed Project on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as **Appendix 9 3**.

9.5.3.4 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 against.

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

Maintenance works will likely be contained within the Proposed Wind Farm Site and 110kV substation and no maintenance works will be required along the Proposed Grid Connection cable route.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters in the vicinity and downstream of the Proposed Wind Farm site ((Aughnaglanny River, Lackenacoombe Stream, Glasheenyreagha Stream and Multeen River) and associated water-dependent ecosystems.) and associated water-dependent ecosystems.

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

Proposed Mitigation Measures:

Mitigation measures for sediment control are the same as those outlined above for the construction phase.

Mitigation measures for control of hydrocarbons during maintenance works are similar to those outlined in Section 9.5.2.5.

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, we consider that residual effect are - 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 occur.

9.5.3.5 Potential Water Quality Effects from BESS Fire Water Contamination

BESS (Battery Energy Storage System) fires can cause significant water contamination due to the runoff from fire suppression efforts, which may contain hazardous materials like heavy metals (cobalt, nickel, manganese) and toxic compounds (hydrofluoric acid). These pollutants, often produced during thermal runaway, risk polluting local water bodies.

Pathways: Drainage and surface water discharge routes.

Receptors: Groundwater and down-gradient rivers (Lackenacoombe Stream, Glasheenyreagha Stream and Multeen River) and associated water-dependent ecosystems.) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, short term, unlikely effect on surface water and groundwater quality.

Proposed Mitigation Measures:

The proposed fire-water retention design (refer to **Appendix 4-4** for the Fire Risk Management & Emergency Response Plan) for the proposed BESS compound will include capture, contain, and hold contaminated runoff from the worst-credible fire scenarios while keeping it away from drains, groundwater, and off-site receptors.

The objectives of the fire water containment are to:

- Contain all firewater and contaminated rainfall from a worst-case BESS fire without uncontrolled release;
- Segment the compound so a single incident doesn't flood the entire compound or escape the boundary with necessary bunding;
- Provide positive isolation of surface water drains (automatic/manual penstocks), defaulting to "closed on alarm."; and,
- Be chemically compatible with expected contaminants (HF, metals, electrolytes, plastics by-products) and allow safe sampling, treatment, and removal.

Dedicated Firewater Retention Tank(s) will provide the most effective and suitable measure for retaining firewater. The tanks will be rendered impermeable by the use of an appropriate liner and integrity tested. All integrity testing of the tanks will be completed by a suitably qualified competent person and be in line with the Environmental Protection Agency's (EPA) guidance.

All the BESS compound drainage systems will divert automatically to the firewater retention tanks on activation of the site fire detection and alarm system. If storm water management is being used for the dual purpose with firewater retention, then the outlet will be fitted with an automatic valve linked to the fire detection system. Automatic shut-off valves will be tested and maintained as per the site's Safety

Statement and Maintenance Procedures. The fire water retention tanks will be kept clean, and free of debris.

After the fire, the retained water will be sampled, treated, or removed by licensed hazardous-waste contractors.

Post-Mitigation Residual Effects: With the implementation of the proposed firewater retention design no effects on surface water or groundwater quality will occur in the unlikely event of a BESS fire.

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

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The Proposed Project is expected to have a lifespan of ~35 years. Upon decommissioning, the wind turbines and meteorological masts will be dismantled and all above ground components would be removed off-site for recycling.

The potential effects associated with decommissioning of the Proposed Project will be similar to those associated with construction but of a much-reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. A description of the decommissioning works is contained in Chapter 4 of this EIAR.

During decommissioning, it will be possible to reverse or at least reduce some of the potential effects caused during construction, and to a lesser extent operation, by rehabilitating constructed areas such as turbine bases and hard standing areas. This will be done by covering with vegetation to encourage vegetation growth and reduce run-off and sedimentation.

The Proposed Wind Farm Site roadways will be kept and maintained following decommissioning of the wind farm infrastructure, as these will be utilised by ongoing forestry works and by local farmers.

The electrical cabling connecting the site infrastructure to the on-site substation will be removed, while the ducting itself will remain in-situ rather than excavating and removing it, as this is considered to have less of a potential environmental impact, in terms of soil exposure, and thus on the possibility of the generation of suspended sediment which could enter nearby watercourses.

The turbines will be removed by disassembling them in a reverse order to their erection. This will be completed using the same model cranes as used in their construction. They will then be transported off-site along their original delivery route. The disassembly and removal of the turbines will not have an impact on the hydrological/hydrogeological environment at the wind farm site.

Other impacts such as possible soil compaction and contamination by fuel leaks will remain but will be of reduced magnitude than the construction phase because of the smaller scale of the works and reduced volumes on-site.

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".*

Some of the impacts will be avoided by leaving elements of the Proposed Project in place where appropriate. The onsite 110kV electrical substation and 110kV electrical cabling will be retained as a permanent part of the national grid. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects.

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 and hydrogeological environment will occur during the decommissioning stage of the Proposed Project.

9.5.5 Risk of Major Accidents and Disasters

Due to the Proposed Wind Farm site ground conditions (i.e. absence of blanket peat, the firm nature of thin overburden/glacial till coverage, the competency of the underlying bedrock, the lack of recorded historic landslide events along with the predominately Low Landslide Susceptibility rating from the GSI) the risk of ground instability/landslide occurring at the Proposed Wind Farm site is low.

Flooding can result in downstream Major Accidents and Disasters. However, due to the small scale of the Proposed Project footprint, the lack of flood zones at the Site and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Project is low (refer to Section 9.5.3.1).

A site-specific Flood Risk Assessment (**Appendix 9-1**) has also shown that the risk of the Proposed Project contributing to downstream flooding is also very low, as the long-term plan for the site is to retain and slow down drainage water within the existing site. On-site drainage control measures will ensure no downstream increase in flood risk.

A Fire Risk Management & Emergency Response Plan (**Appendix 4-4**) for the proposed BESS compound will be implemented in the unlikely event of a fire.

9.5.6 Assessment of Potential Human Health Effects

Potential human 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 Wind Farm Site. Furthermore, no private wells are located in close proximity to the Proposed Wind Farm infrastructure. Notwithstanding this, the Proposed Project design and mitigation measures ensures that the potential for effects on the hydrogeological will not be significant.

The Proposed Grid Connection cable route passes through the Doon PWS groundwater source protection area. The potential effects are assessed above in Section 9.5.2.13 where mitigation is proposed to ensure there are no water quality effects on this source during the construction phase.

There are 3 no. surface water abstractions downstream of the Proposed Project, along the Suir and Shannon Rivers. Due to the large downstream distance from the Proposed Project, along with the proposed wind farm drainage plan and the proposed mitigation measures, no health effects with regard to these water supplies will occur. The potential for effects is assessed in Section 9.5.2.13 and demonstrated that there is no potential for effects to occur.

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 site-specific Flood Risk Assessment (**Appendix 9-1**) has also shown that the risk of the Proposed Project contributing to downstream flooding is also very low.

The proposed fire-water retention design (refer to **Appendix 4-4** for the Fire Risk Management & Emergency Response Plan) for the proposed BESS compound will contain contaminated runoff from the worst-credible fire scenarios thereby preventing surface water and groundwater contamination.

9.5.7 Cumulative Effect

This section presents an assessment of the potential cumulative effects associated with the Proposed Project and other developments (existing and/or proposed) on the hydrological and hydrogeological environment.

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the local hydrogeological setting (i.e. poorly productive aquifers) and the near-surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are assessed as not likely.

The primary potential for surface water cumulative effects will occur during the construction phase of the Proposed Project as this is when earthworks and excavations will be undertaken at the Site. The potential for cumulative effects during the operational phase of the Proposed Project 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 much lesser degree with less ground disturbance.

Due to the nature of the Proposed Grid Connection cable route being proximately along public roads as well as the transient and intermittent nature of the underground cable earthworks (i.e. only 100 – 200m of trenching will be typically carried out at any one time) no cumulative effects within the Glasheenyreagha Stream, Multeen River, Cahernahallia River, Bilboa River, Mulkear River and Groody River catchments will occur.

The cumulative study area of the Proposed Wind Farm is delineated by the catchment of the Multeen River which has an area of approximately 190km^2 upstream of the River Suir.

Downstream of the Multeen River catchment (i.e. River Suir) no significant cumulative hydrological effects are likely due to the combined large upstream catchment area of the Multeen River and the River Suir (i.e. 190km^2+ 880km^2 = 1,070km^2) and the very high dilution effects afforded by such a large regional catchment, subsequent large surface water flows.

Cumulative effects for other projects and activities are assessed as follows:

- A hydrological cumulative impact assessment is carried out on the Multeen River catchment for large projects such as other wind farm developments and large-scale infrastructure developments only. Other smaller developments have been excluded at this regional scale as cumulative effects are likely to be less than perceptible at this (regional) scale; and,
- The cumulative study area for assessing small projects (i.e. agricultural, forestry and smaller planning applications) only include local sub-basins of the Aughnaglanny River, Lackenacoombe Stream and Glasheenyreagha Stream.

9.5.7.1 Cumulative Effects of the Proposed Project (Wind Farm and Grid Connection)

The potential for cumulative effects with regard elements of the Proposed Project only (i.e. Proposed Wind Farm and Proposed Grid Connection) is significantly diminished due to the fact that the Proposed Wind Farm and Proposed Grid Connection are largely within separate regional surface water catchments.

The Proposed Wind Farm site is only located in the River Suir catchment along with only 5.3km of the proposed total 37.6km underground Proposed Grid Connection cable.

Also, the fact that the Proposed Grid Connection cable route is largely along public roads, the lack of in-stream works, the intermittent and transient nature of the trenching excavations, the Proposed Grid Connection is not expected to contribute to hydrological cumulative effects in the Multeen River, Mulkear River or Groody River catchments.

No significant cumulative effects on the hydrological and hydrogeological environment are envisaged during the construction phase of the Proposed Project.

9.5.7.2 Cumulative Effects with Agriculture

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 Project 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 in Section 9.5 for the construction, operation and decommissioning phases of the Proposed Project 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.

9.5.7.3 Cumulative Effects with Commercial Forestry

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 works can also give rise to modified stream flow regimes caused by associated land drainage.

However, the mitigation measures detailed for the construction, operation and decommissioning phases of the Proposed Project 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.

9.5.7.4 Cumulative Effects with One Off Housing Developments

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

There are applications 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 Site and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Project (construction, operation and decommissioning phases).

9.5.7.5 Cumulative Effects with Other Wind Farms

A list of other wind farm developments in the Proposed Wind Farm cumulative Water Study Area (i.e. Multeen River catchment) is shown in **Table 9-21** below.

With the exception of the permitted Upperchurch WF all wind farm developments are existing and operational. Therefore, there is no risk of a construction overlap with these operational wind farms and the Proposed Project.

Also, the likelihood of a construction phase overlap with the Upperchurch WF (if constructed) is unlikely given the different stages of the planning process the wind farms are at. Nonetheless, only 2 no. of the permitted 22 no. Upperchurch WF turbines are located in the Multeen River catchment. Therefore, even in the worst-case scenario of a construction phase overlap, significant cumulative effects are not likely.

As stated above, the operation of the proposed Carrow Wind Farm (if permitted and constructed) is not expected to result in any significant cumulative effects with the already operational developments in the Multeen River catchment.

Therefore, it can be concluded with high confidence (based on the information available to date) that the Proposed Project is not likely to contribute to cumulative effects with regard other wind farm developments in the cumulative Water Study Area.

Table 9-21: List of Other Wind Farm Developments Assessed for Hydrological Cumulative Effects

Catchment	Wind Energy Development (Status)	Total Turbine No.	Turbine No. in Multeen Catchment
Multeen River	Cappawhite A WF **(Existing)**	8	1
	Cappawhite B WF **(Existing)**	9	5
	Glencarbry I WF **(Existing)**	9	9
	Glencarbry II WF **(Existing)**	2	2
	Glenlough WF **(Existing)**	14	14
	Turaheen Lower WF **(Existing)**	3	3
	Holyford WF **(Existing)**	3	3
	Falleennafinoga WF **(Existing)**	2	2
	Garracummer (Tooreen) WF **(Existing)**	2	2
	Milestone WF **(Existing)**	3	3
	Upperchurch WF **(Granted)**	22	2
	Inchivara Turbine **(Existing)**	1	1
Totals		**78**	**47**

9.5.8 Conclusion

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

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant adverse impacts on water quality and avoid impact on downstream designated sites. A self-imposed 50m stream and lake buffer was used during the layout of the proposed development, thereby avoiding sensitive hydrological features.

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

Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan (Refer to **Appendix 4-3**).

Overall, the Proposed Project presents no significant impacts to surface water and groundwater quality provided the proposed mitigation measures are implemented.

All biodiversity enhancement and management works will be in accordance with the best practice Forest Service regulation, policies and strategic guidance documents as well as Coillte, DAFM and NatureScot guidance documents to ensure minimal potential negative effects on the local peat, soil and subsoil environment.

No significant cumulative impacts on any of the regional surface water catchment or groundwater bodies will occur from the Proposed Project including the Proposed Grid Connection and other wind farm developments.

9.6 EIA Classification Table

Table 9-22 EIA Classification Table

Topic	Pre-Mitigation Effect	Mitigation Section Reference	Residual Effect	Significance
Construction Phase				
Clear Felling of Coniferous Plantation and Potential Surface Water Quality Effects (Proposed Wind Farm)	Temporary, Moderate, Negative	Section 9.5.2.1	Temporary, Imperceptible, Negative	Not Significant
Earthworks Resulting in Suspended Solids Entrainment in Surface Waters	Temporary, Significant, Negative	Section 9.5.2.2	Short-Term, Imperceptible, Negative	Not Significant
Potential Impacts on Groundwater Levels During Excavations	Temporary, Slight, Negative	Section 9.5.2.3	Temporary, Imperceptible, Negative	Not Significant
Excavation Dewatering and Potential Impacts on Surface Water Quality	Temporary, Moderate, Negative	Section 9.5.2.4	Short-Term, Imperceptible, Negative	Not Significant
Potential Effects from Hydrocarbons Leaks & Spills	Short-Term, Slight, Negative	Section 9.5.2.5	Short-Term, Imperceptible, Negative	Not Significant
Release of Cement Base Products	Short-Term, Moderate, Negative	Section 9.5.2.6	Short-Term, Imperceptible, Negative	Not Significant
Watercourse Crossing Works	Permanent, Slight, Negative	Section 9.5.2.7	Long-Term, Imperceptible, Negative	Not Significant
Potential Effects on Designated Sites	Short-Term, Moderate, Negative	Section 9.5.2.8	No Residual Effects	Not Significant
Potential Effects on Local Groundwater Well Supplies from Excavations	Short-Term, Imperceptible, Negative	Section 9.5.2.9	No Residual Effects	Not Significant
Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks Works and Watercourse Crossings	Temporary, Slight, Negative	Section 9.5.2.10	Long-Term, Imperceptible, Negative	Not Significant

Use of Siltbuster and Impacts on Downstream Surface Water Quality	Temporary, Slight, Negative	Section 9.5.2.11	Short-Term, Imperceptible, Negative	Significant Positive Effect
Potential Effects on Surface Water and Groundwater WFD Status	Short-Term, Imperceptible, Negative	Section 9.5.2.12	No residual effect on Groundwater Body WFD status or Surface Water Body WD status will occur.	Not Significant
Potential Effects on Public Water Supplies (Surface Water and Groundwater)	Short-Term, Imperceptible, Negative	Section 9.5.2.13	No negative effects on downstream surface water or groundwater abstractions.	Not Significant
Biodiversity Enhancement and Management Plan (BEMP) and Potential Hydrological/Water Quality Effects	Short-Term, Imperceptible, Negative	Section 9.5.2.14	No Residual Effects	Not Significant
Potential Effects from Turbine Delivery Route Works (Proposed Wind Farm)	Short-Term, Imperceptible, Negative	Section 9.5.2.15	No Residual Effects	Not Significant
Operational Phase				
Progressive Replacement of Natural Surface with Lower Permeability Surfaces (Proposed Project)	Permanent, Moderate, Negative	Section 9.5.3.1	Long-Term, Neutral, Negative	Not Significant
Potential Effects from Surface Water Runoff	Temporary, Slight, Negative	Section 9.5.3.2	Temporary, Imperceptible, Negative	Not Significant
Potential Effects on WFD Status	N/A	Section 9.5.3.3	N/A	Not Significant
Runoff Resulting in Contamination of Surface Waters	Temporary, Slight, Negative	Section 9.5.3.4	Temporary, Imperceptible, Negative	Not Significant
Potential Water Quality Effects from	Short-Term, Significant, Negative	Section 9.5.3.5	No effects on surface water or	Not Significant

BESS Fire Water Contamination			groundwater quality	
Decommissioning Phase				
Water	The potential impacts associated with decommissioning of the Proposed Project will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works.	N/A	N/A	Not Significant