Hydrology and Hydrogeology

Slieveacurry Renewable Energy Development, Co. Clare

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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 Slieveacurry Renewable Energy Development (Proposed Project) located in the townland of Glendine North and adjacent townlands, Co. Clare, on water aspects (hydrology and hydrogeology) of the receiving environment.

The objectives of the assessment are:

- Produce a baseline study of the existing water environment (surface water and groundwater natural resources) in the area of the Proposed Project;
- Identify likely significant effects of the Proposed Project on surface water and groundwater natural resources during construction, operational and decommissioning phases of the project;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and,
- Assess cumulative effects of the Proposed Project and other local developments (as described in Chapter 2: Background to the Proposed Project of this EIAR).

The Proposed Project is described in full in Chapter 4: Description of the Proposed Project 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.

Where the 'Proposed Wind Farm Site' is referred to, this refers to the portion of the Site containing the proposed 9 no. turbines and ancillary infrastructure, excluding the Proposed Grid Connection Site and Proposed Enhancement Site.

The 'Proposed Turbines' refers to the 9 no. turbines associated with the Proposed Wind Farm Site as outlined above.

Where the 'Proposed Grid Connection Site' is referred to, this refers to the part of the Site containing the extension to the Slievecallan existing 110kV substation and the 33kV underground cabling route from the Proposed Turbines to the substation at Slievecallan.

Where the 'Proposed Enhancement Site' is referred to, this refers to the portion of the Site containing the proposed biodiversity, ornithology enhancement and management areas, excluding the Proposed Wind Farm Site and Proposed Grid Connection Site.

As detailed in Chapter 1 Section 1.1.1 of the EIAR, the Proposed Project has been designed (along with the application of appropriate mitigation measures) with consideration of the reasons for refusal on the previous application for a renewable energy development at the Site, in particular reasons regarding a key understanding of land and ground conditions, peat stability and peat and spoil management within the Site.

As the design of the Proposed Project was refined relative to the above, the Proposed Wind Farm Site drainage was also designed in with consideration of the reasons for refusal, such as incorporating the management of peat and spoil in dedicated management areas within the Proposed Wind Farm Site.

The proposed drainage design approach has successfully been employed at numerous existing wind farm developments across the county including the nearby Cahermurphy Wind Farm, Glenmore Wind Farm and Slievecallan Wind Farm.

The Water Study Area for assessing the Proposed Project potential zone of impact and the hydrological cumulative effects assessment includes the surface water catchments of the Annagh River and Inagh River.

The Water Study Area surface water catchments are shown on **Figure 9-1** below (Regional Hydrology Map).

9.1.2 Statement of Authority

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

Our core areas of expertise and experience include upland hydrology and windfarm drainage design. We routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types.

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

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 Booltiagh WF, Cahermurphy WF Cahermurphy West WF, Glenmore WF, Crossmore WF and over 60 other wind farm related projects across the country.

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 Seven Hills Wind Farm, Glenmore Wind Farm, Cahermurphy WF and Slievecallen Wind Farm, and over 100 other wind farm related projects across the country.

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 2.7 of this EIAR. Certain issues and matters highlighted with respect the water environment are summarised in **Table 9-1** below.

The GSI provided a standard response which recommended the use of their publicly available geological data sets in the preparation of the EIAR. These data sets, available to view at www.gsi.ie, have been used in the preparation of this chapter as detailed in Section 9.2.1 below. No specific matters or concerns were raised by the GSI regarding the Proposed Project.

Responses from the HSE, OPW and Uisce Éireann are referenced in **Table 9-1** below.

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

Consultee	Matters Raised - Description	Addressed in Section
HSE	*"The Proposed Project has the potential to have a significant impact on the quality of both surface and ground water. All drinking water sources, both surface and ground water, must be identified. Public and Group Water Scheme sources and supplies should be identified in addition to any private wells supplying potable water to houses in the vicinity of the Proposed Project. Measures to ensure that all sources and supplies are protected should be described".* *"Any potential significant impacts to drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas should be considered when assessing potential impacts and any proposed mitigation measures".* *"Any impacts on surface water as a result of the construction of the underground cables should be identified and addressed in the EIAR".*	Sections 9.3.15, 9.5.2.10 & 9.5.2.16
OPW	*"If any new culverts or bridges (or modifications to any existing culverts or bridges) are required to cross watercourses as part of the development or on proposed or existing access roads to serve or access the development, you should be aware that these require consent from the Commissioners of Public Works. This is a requirement of Section 50 of the Arterial Drainage Act of 1945 as amended".* *"Please note that, in the context of seeking consent under Section 50, the current required design standard for bridges or culverts is based on the flood with an annual exceedance probability of 1% (often referred to as the 100 year flood), increased by 20% to cater for the effects of Climate Change".* *"Bridges or culverts are required to be able to convey this design flood without significantly altering the hydraulic characteristics of the watercourse- further details on this issue are available in the brochure and can be clarified depending on the circumstances of any particular proposed bridge or culvert".* *We would recommend that a flood risk assessment be carried out with regard the proposed development and its construction. This should be carried out in accordance with the principles set out in the guidance*	Sections 9.3.6, 9.5.2.8 & 9.5.2.13 **Appendix 9-1 Site Specific Flood Risk Assessment**

Consultee	Matters Raised - Description	Addressed in Section
	document The Planning System and Flood Risk Management.	
Uisce Éireann	*"Uisce Éireann currently operates a water abstraction point in the area, at Lough Doo, approximately 6 kilometres to the south of the proposed development. An initial assessment indicates the chance of hydrological/ hydrogeological interaction is low, but this must be independently confirmed in the finalised the EIAR. Analysis should consider anywhere where a potential hydrological and hydrogeological pathway exists and include any all direct, indirect and cumulative effects on the abstraction points".* *"Further to this, the potential impacts arising from run off and hydrocarbon during construction, operational and decommissioning phases should be addressed to include mitigations against contaminants entering groundwater and surface waters via hydrological and hydrogeological pathways".*	Sections 9.3.15 and 9.5.2.16

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 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/Hydrogeology Chapter of the 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 (EPA, 2022);
- 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);
- GPP5 – Works or Maintenance Near Water (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001;
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2023-2027 (DAFM, 2023).

9.2 Methodology

9.2.1 Desk Study

A desk study of the Site and the Water Study area was completed in advance of undertaking the walkover surveys, drainage mapping and site investigations. This involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation with the following:

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Éireann Meteorological Databases (www.met.ie);
- National Parks and Wildlife Services Public Map Viewer (www.npws.ie);
- EPA/Water Framework Directive Map Viewer (www.catchments.ie);

- Bedrock Geology 1:100,000 Scale Map Series, Sheet 14 (Geology of Galway Bay). Geological Survey of Ireland (GSI, 2004);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 17 (Geology of Shannon Estuary). Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland (2003) – Miltown Malbay Groundwater Body Initial Characterization Report;
- OPW Past Flood Event Mapping (www.floodinfo.ie);
- OPW CFRAM Flood Extents Mapping and National Indicative Fluvial Mapping (www.floodinfo.ie); and,
- Aerial Photography, OSI 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 7th and 8th November 2012, 11th September and 21st November 2019, 26th February 2021, 28th and 29th March, 26th April, 18th July 2024, 16th May and 3rd October 2025 and on 6th and 13th March 2026.

The following geotechnical reports were prepared by Fehily and Timoney (FT) in support of the application:

- Geotechnical and Peat Stability Risk Assessment (**Appendix 8-1**)
- Peat and Spoil Management Plan (**Appendix 4-2**)

A total of no. 914 peat probes were carried out at the Site by FT, MKO, HES and the Applicant since 2012. Peat depths across the Site have been thoroughly investigated and the peat coverage is fully understood.

A total of 7 no. trial pits were carried out under the supervision of FT, which included a trial pit at 5 no. of the 9 no. proposed turbine locations (T1, T2, T3, T5 and T6) and 2 no. trial pits at the proposed borrow pit location to investigate the underlying mineral soil lithology and subsoil/bedrock interface.

The intrusive ground investigations were supplemented by geophysical surveys (2D-resistivity (ERT) and Seismic Refraction (p-wave)), carried out by Minerex Geophysics Ltd. (MGX) on the 11th and 12th February 2025.

The objectives of the non-intrusive surveys included further mapping of ground conditions at 4 no. turbine locations where access with an excavator was not feasible (T4, T7, T8 and T9) and also provide further detail on the proposed borrow pit location as a source of rock and for permanent storage of peat.

The objectives of the site investigations included mapping the distribution and depth of peat 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, peat/spoil management areas, biodiversity enhancement areas and borrow pit). This robust data set was used to inform the impact assessment and final layout design.

Site investigations to address the Water Section of the EIAR included the following:

- Walkover surveys and geological mapping of the Site 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;

- A total of 914 no. peat probes were undertaken by Enerco Energy Ltd., HES, MKO, and FT to determine the thickness and geomorphology of peat overlying parts of the Site;
- Shear vane strength testing was carried out in-situ using a Geonor H-60 Hand-Field Vane Tester;
- Trial pitting (7 no.) by FT and gouge cores (15 no.) by HES to investigate soil, peat and mineral subsoil lithology as well as depth to bedrock;
- Geophysical surveys by MGX to investigate ground conditions in areas of the Site not accessible by an excavator;
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen, temperature and turbidity) were taken to determine the origin of surface water flows (2 no. rounds);
- Surface water sampling (2 no. rounds) for baseline and hydrological characterisation purposes; and,
- Surface water flow measurements (2 no. rounds) of the primary watercourses that drain the Site.

9.2.3 Impact Assessment Methodology

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

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

In addition to the above methodology, the sensitivity/importance of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of importance (NRA, 2008) 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).

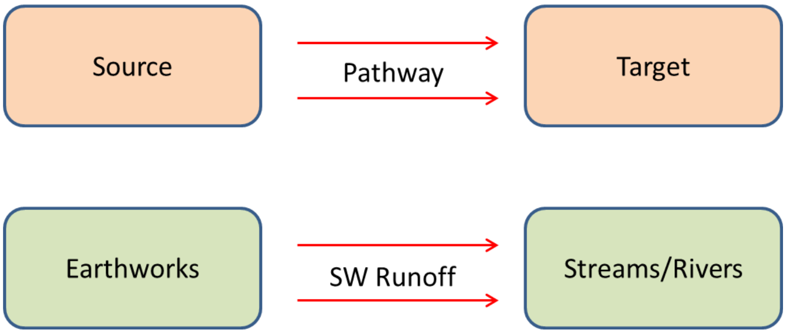
Importance	Criteria	Typical Example
		Flood plain protecting more than 50 residential or commercial properties from flooding. Nationally important amenity site for a wide range of leisure activities.
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable 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.
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.

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

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

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

In order to provide an understanding of the stepwise impact assessment process applied below (Section 9.5), we have firstly presented below a summary guide that defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model and the EPA impact descriptors are combined.

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

Table 9-4 Stepwise impact assessment process

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which a potential impact is generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by engineering design.
Step 6	Post Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post mitigation effects of the identified potential impact source on the receiving environment.

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 (i.e. 914 peat depth probes, 15 no. gouge core, 7 no. trial pits, geophysics, drainage mapping and surface water flow path modelling) and seasonal monitoring carried out were robust and comprehensive.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Site is located approximately 7km south of Ennistimon, Co. Clare and 8km west of Inagh, Co. Clare. The Proposed Wind Farm Site comprises mainly of open blanket bog, coniferous forestry planted on blanket bog and poorly draining agricultural land on the east and south of the Site along with turbary plots.

The Proposed Wind Farm Site is served by a number of existing local, forestry and agricultural roads and tracks. These existing forestry tracks have been in operation for a significant number of years. It is proposed that up to 2.3km of these existing tracks will be utilised by the Proposed Wind Farm Site.

The Proposed Wind Farm Site is characterised by a northeast / southwest orientated topographical divide/ridge of high ground, where the ground slopes steadily to the northwest and southeast away from the ridge. The elevation range of the Site is between 67 and 261m OD.

5 no. Proposed Turbines are located within forestry (T1, T2, T4, T8 and T9) with the other 4 no. Proposed Turbines located on open peatland (T3, T5, T6 and T7).

The Proposed Grid Connection Site 33kV underground cabling route, which measures approximately 7.1km, will connect to the proposed substation extension at the existing Slievecallan 110kV substation located approximately 3.5km to the southeast of the Proposed Wind Farm Site.

The Proposed Grid Connection Site 33kV underground cabling route exits the Proposed Wind Farm Site through forestry for approximately 0.83km, onto a farm track for 0.55km before entering the public road corridor. It stays within the public road corridor for approximately 1.55km. the cable route then exits onto existing forestry /windfarm roads, following these for approximately 4.17km before reaching the proposed substation at Slievecallan substation. The proposed substation extension will be located on an existing cleared and level area where the ground elevation is at approximately 240m OD.

A total of 172.7ha of lands are proposed for enhancement under Biodiversity Management and Enhancement Plan (BMEP). The Proposed Enhancement Site comprises areas of Peatland Restoration, Marsh fritillary Enhancement (grazing management) and Hen Harrier Habitat Enhancement (conifer felling areas and grassland management areas).

13 no. areas within the Site have been selected for biodiversity enhancement measures as part of the Proposed Project and to enhance the Site for species and habitats known to occur within the Site.

The Proposed Enhancement Site includes ten areas of conifer plantation, referred to as Areas A, B, C, D, E, F, G, H, I and J. Additionally, there are two areas of farmland proposed for hen harrier habitat enhancement, referred to as Area 1 and Area 2 and one area of farmland proposed for marsh fritillary enhancement, referred to as Area 3.

9.3.2 Water Balance

Long term Average Annual Rainfall (AAR) and evaporation data was sourced from Met Éireann. The 30 year annual average rainfall (AAR) recorded at Inagh (Mt. Callan), 4km southeast of the Proposed Wind Farm Site, are presented in **Table 9-5.** This is the most appropriate station to use with respect distance and elevation.

Met Éireann (www.met.ie) 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 Site ranges from 1,380 to 1,490mm/year. This is considered to be the most accurate estimate of average annual rainfall from the available sources. The higher modelled rainfall value is used in the water balance presented below.

Table 9-5 Local Average long-term Rainfall Data (mm) recorded at Inagh (Mount Callan) (1981-2010)

Station		X-Coord		Y-Coord		Ht (mAOD)		Opened		Closed		
Mount Callan		122200		166500		81		1953		-		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
178	128	139	90	103	106	116	150	145	186	176	180	1697

The closest synoptic[1] station where the average potential evapotranspiration (PE) is recorded is at Shannon Airport, approximately 31km southeast of the Proposed Wind Farm Site. The long-term average PE for this station is 543mm/yr. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Proposed Wind Farm Site is estimated as 516mm/yr (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: (These rainfall depths are typical for the west of Ireland).

Effective rainfall (ER) = AAR – AE

= 1,490 mm/yr – 516mm/yr

ER = 974mm/yr

Based on groundwater recharge coefficient estimates from the GSI (www.gsi.ie) an estimate of 50mm to 200mm/year maximum annual recharge cap is given for the area of the Proposed Wind Farm Site (recharge coefficient of 5% to ~20%).

Recharge is capped at 50mm/year due to low permeability peat coverage and higher at 200mm/year where peat is thin or absent, but restricted due the poorly productive nature of the underlying bedrock aquifer (refer to Section 9.3.8 which deals with Site hydrogeology). An average 10% groundwater recharge coefficient is taken for the Proposed Wind Farm Site.

This means that the hydrology of the Proposed Wind Farm Site is characterised by high surface water runoff rates (90%) and low groundwater recharge rates (10%). Therefore, conservative annual recharge and runoff rates for the Proposed Wind Farm Site are estimated to be 97mm/yr and 877mm/yr respectively.

Met Éireann's Translate Project (https://www.met.ie/science/translate) provides projections for a range of future climate change scenarios, as Ireland's future climate will depend on global greenhouse gas emissions reductions. The severity of any future climate change will depend on the degree of future warming. In relation to precipitation chances, the models show that summer rainfall may decrease by approximately 9% and winter rainfall could increase by up to 24%. In a scenario where long-term average global temperatures increase by 1.5°C, average winter and summer precipitation rates are projected to be 4.66mm/day and 2.94mm/day respectively in Co. Clare. Meanwhile, in a 4°C scenario, the average winter and summer precipitation rates in Co. Clare are projected to be 5.23mm/day and 2.68mm/day respectively.

In addition to average rainfall data, extreme value rainfall depths are available from Met Éireann. **Table 9-6** presents return period rainfall depths for the centre 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 (10-year, 50-year, 100-year). (These extreme rainfall depths are typical for the west of Ireland).

The 10-year rainfall depths will be the basis of the Proposed Wind Farm Site drainage hydraulic design as described further in Section 9.5.2.2 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.

Table 9-6: Return Period Rainfall Depths

Duration	10-year Return Period	50-Year Return Period	100-Year Return Period
15 min	12.5	18.7	22.1
1 hour	19.6	27.8	32.1
6 hour	35	46.3	52
12 hour	43.9	56.4	62.6
24 hour	54.9	68.8	75.5
48 hour	68.2	83.7	91.1

9.3.3 Regional Hydrology

In terms of regional hydrology, the western half of the Proposed Wind Farm Site, including 3 no. Proposed Turbines (T7, T8 and T9), the proposed extension to the existing Slievecallan 110kV substation and approximately 5.6km of the Proposed Grid Connection Site 33kV underground cabling route are located in the Annagh River catchment (Annagh(Clare)_SC_010). The Annagh River drains into Mal Bay approximately 7.5km downstream to the west of the Proposed Wind Farm Site.

The eastern half of the Proposed Wind Farm Site, including 6 no. Proposed Turbines (T1 to T6), along with 1.3km of the Proposed Grid Connection Site are located in the Inagh River surface water catchment (Inagh(Ennistymon_SC_010). The Inagh River flows approximately 0.5km to the northeast of the Proposed Wind Farm Site prior to flowing into Liscannor Bay at Lahinch, approximately 22km downstream of the Proposed Wind Farm Site.

A small section of the Site, which is limited to the Proposed Enhancement Site (Area G) extends into the Annageeragh River catchment on the far south of the Site (Annageeragh_SC_010), which is upstream of Doo Lough.

The Proposed Enhancement Site areas are distributed mainly between the Inagh River and Annagh River surface water catchments, with one of the areas extending into the Annageeragh River catchment on the for south of the Site. A regional hydrology map is shown **Figure 9-1**.

Locally the Site exits within 6 no. Water Framework Directive (WFD) mapped sub-basins. The north-western and southwestern sections of the Site drain into the headwaters of the Glendine River (Glendine (Clare)_010) and the Kildeema River (Kildeema_010) respectively with both rivers entering Mal Bay at the same point south of Spanish Point.

The eastern section of the Proposed Wind Farm Site along with 1.3km of the Proposed Grid Connection Site drains into the Inagh (Ennistymon)_040 sub-basin. The remainder Proposed Grid Connection Site is located in the Annagh(Clare)_010 sub-basin.

The Proposed Enhancement Site areas are distributed mainly between the Inagh (Ennistymon)_040, Glendine(Clare)_010 and Kildeema_010, along with 2 no. areas located in the Inagh (Ennistymon)_010 and one area in the Annageeragh_020.

A local hydrology map is shown as **Figure 9-2**.

A summary of the local hydrology with regard the Site is shown in **Table 9-7** below.

9.3.4 Site Drainage

Proposed Wind Farm Site

The Proposed Wind Farm Site drainage map was created using OSI mapped watercourses, aerial photography, detailed field drainage mapping and LiDAR data. The drainage map shows natural watercourses, drains and modelled potential surface water (runoff) flowpaths.

The use of LiDAR data for mapping potential surface water (runoff) flowpaths is discussed further below in this section. A Proposed Wind Farm Site drainage map is shown as **Figure 9-3**.

The Proposed Wind Farm Site can be broadly divided into four sub-catchments:

The northern portion of the Proposed Wind Farm Site is drained by the Fahanlunaghtamore Stream (EPA Ref: 28F09 which is a tributary of the Inagh River. The Fahanlunaghtamore Stream emerges as four headwater streams within the Proposed Wind Farm Site. Two of these headwater streams emerge from within forestry in the vicinity of Proposed Turbine location T4, one from within open peatland area to the west of Proposed Turbine location T4 and the fourth from agricultural land to the north of Proposed Turbine location T5. Within the Proposed Wind Farm Site there are 4 no. proposed new (natural) watercourse crossing locations within the Fahanlunaghtamore Stream catchment and 1 no. existing (natural) watercourse crossing.

The eastern and southeastern portions of Proposed Wind Farm Site are drained by the Knockacarn Stream (EPA Ref: 28K42) which is also a tributary of the Inagh River. The Knockacarn Stream flows northeasterly within a valley close to the eastern EIAR Site boundary. Three short headwater streams of the Knockacarn Stream emerge from a forested area on the southeastern facing slopes of the Proposed Wind Farm Site. There are no Proposed Wind Farm Site watercourse crossings within the Knockacarn Stream catchment.

The western portion of the Proposed Wind Farm Site is drained by the Ballynew Stream (EPA Ref: 28B27) which is a tributary of the Glendine River. Please note the Ballynew Stream is referred to as the Silverhill River on OSI mapping. The Ballynew Stream emerges as three headwater streams within the Proposed Wind Farm Site. The most northerly headwater stream emerges from within forestry in the vicinity of Proposed Turbine location T9, while the two southerly headwater streams emerge from within open peatland at lower elevations further downslope within the Proposed Wind Farm Site. Within the Proposed Wind Farm Site there is 1 no. proposed new watercourse crossing location within the Ballynew Stream catchment.

The southwestern portion of the Proposed Wind Farm Site is drained by the Letterkelly Stream (EPA Ref: 28L07) and the Kildeema North Stream (EPA Ref: 28K19), both of which are tributaries of the Kildeema River. The Letterkelly Stream emerges from open peatland on the southern slopes of the Proposed Wind Farm Site while the Kildeema North Stream emerges from an area of improved grassland at lower elevations of the Proposed Wind Farm Site. There are no Proposed Wind Farm Site watercourse crossings within the Letterkelly Stream and Kildeema North Stream catchments.

Proposed Grid Connection Site

As summarised in **Table 9-7** below, the Proposed Grid Connection Site underground cable route, passes through 3 no. local catchments (i.e., Kildeema River, Annagh River and Inagh River catchments). There are a total of 15 no. watercourse and culvert crossings along the Proposed Grid Connection Site underground cable route, of which 4 no. are EPA mapped watercourses with the remaining 9 no. being drains.

Proposed Enhancement Site

The Proposed Enhancement Site comprises areas of Marsh Fritillary Habitat Enhancement (grazing management), Hen Harrier Habitat Enhancement (conifer felling areas and grassland management areas), peatland restoration and hedgerow management and replanting. Full details are available in Chapter 4 and **Appendix 6-4** of the EIAR.

Area 3 (proposed Marsh Fritillary Enhancement) is located centrally within the Site and is drained locally by the Fahanlunaghtamore Stream and Ballynew Stream as described above in the Proposed Wind Farm Site drainage. Similarly, there are proposed Hen Harrier Habitat Enhancement conifer felling areas located in the Ballynew Stream (Areas B and C) and Fahanlunaghtamore Stream (Area A) sub-catchments further downstream of the permanent built infrastructure footprint of the Proposed Project.

Also, in proximity to the Proposed Wind Farm Site are proposed Hen Harrier Habitat Enhancement grassland management areas (Areas 1 and 2) which are predominately located in the Knockacarn Stream sub-catchment as also as described above in the Proposed Wind Farm Site drainage.

At more remote locations to the Proposed Wind Farm Site there are Hen Harrier Habitat Enhancement conifer felling areas (Areas F and H) located on the lower slopes of Slievecallan which are drained by headwater streams of the Inagh River on the eastern slopes, by headwater streams of the Annageeragh River on the southern slopes, and by the Kildeema River on the western slopes. Refer to **Table 9-7** below for local hydrology at the Proposed Enhancement Site. Area G within the Annageeragh River drains into Doo Lough.

Table 9-7 Summary of Local Hydrology and Proposed Project

Proposed Project	Local Drainage (& Sub-Basin)	Proposed Project Infrastructure
Proposed Wind Farm Site	Fahanlunaghtamore Stream (Inagh(Ennistymon_040)	4 no. turbines, 1 no. borrow pit, 2 no. temporary construction compounds, met mast & 4 no. peat/spoil management areas
	Knockacarn Stream (Inagh(Ennistymon_040)	2 no. turbines
	Letterkelly Stream (Kildeema_010)	1 no. turbine
	Ballynew Stream (Glendine(Clare)_010	2 no. turbines & 1 no. 4 no. peat/spoil management area
Proposed Grid Connection Site	Knockacarn Stream (Inagh(Ennistymon_040)	1.3km underground cable
	Kildeema_010	2.4km underground cable
	Annagh(Clare)_010	3.2km underground cable and extension to existing Slievecallan 110kV substation

Proposed Project	Local Drainage (& Sub-Basin)	Proposed Project Infrastructure
Proposed Enhancement Site	Fahanlunaghtamore Stream (Inagh(Ennistymon_040)	Hen Harrier Habitat Enhancement (Area A) Marsh fritillary Enhancement (Area 3)
	Knockacarn Stream (Inagh(Ennistymon_040)	Hen Harrier Habitat Enhancement - Farmland (Area 1 & 2) Hen Harrier Habitat Enhancement (E & J)
	Letterkelly Stream (Kildeema_010)	Hen Harrier Habitat Enhancement (Area D) Hen Harrier Habitat Enhancement - Farmland (Area 1)
	Ballynew Stream (Glendine (Clare)_010	Hen Harrier Habitat Enhancement (Area B & C) Marsh Fritillary Enhancement (Area 3)
	Cloonlaheen East (Annageeragh_020)	Hen Harrier Habitat Enhancement (Area G)
	Drumcullaun (Inagh(Ennistymon_040)	Hen Harrier Habitat Enhancement (I)
	Inagh Inagh(Ennistymon_010)	Hen Harrier Habitat Enhancement (Area F & H)

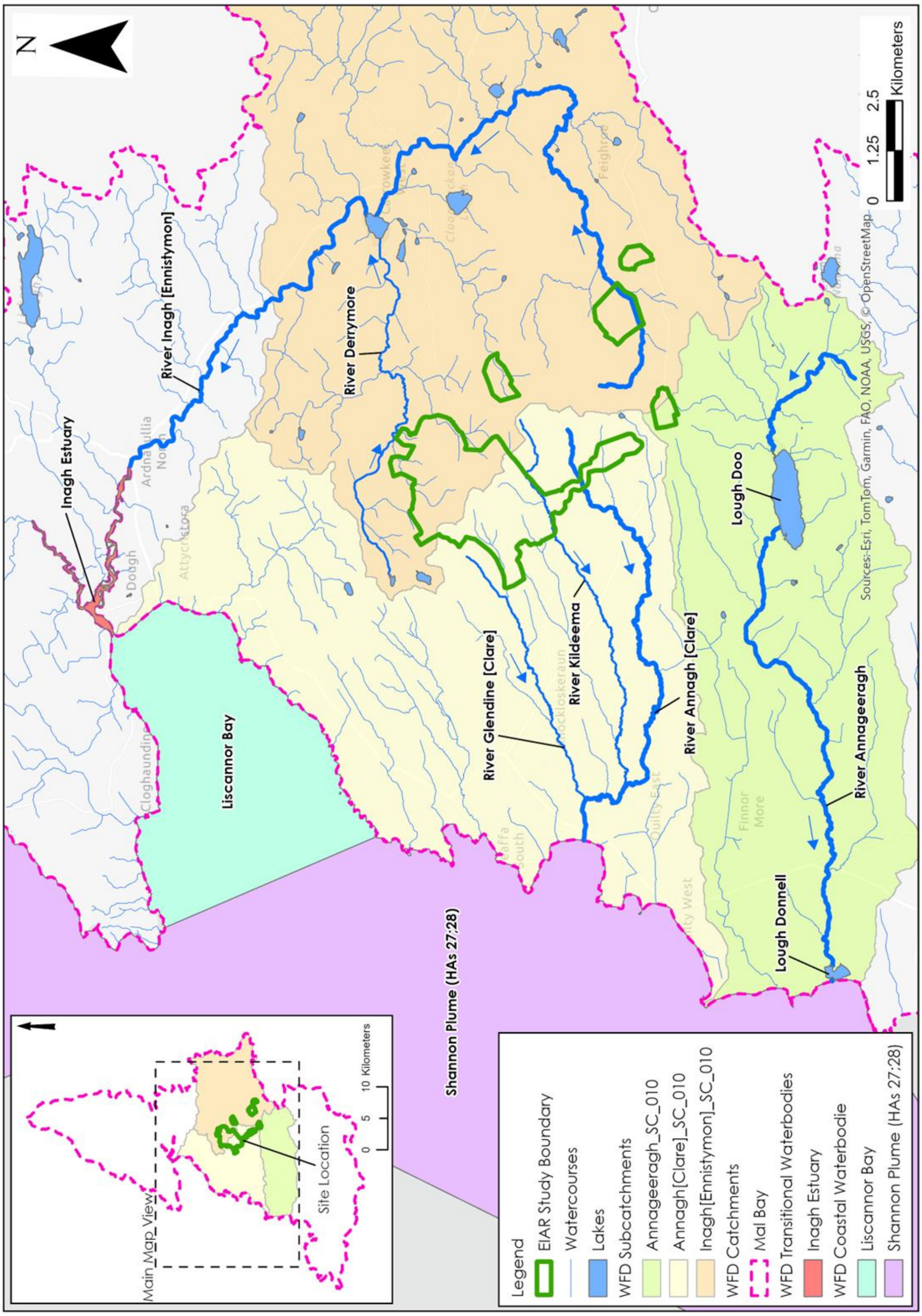


Figure 9-1 Regional Hydrology Map

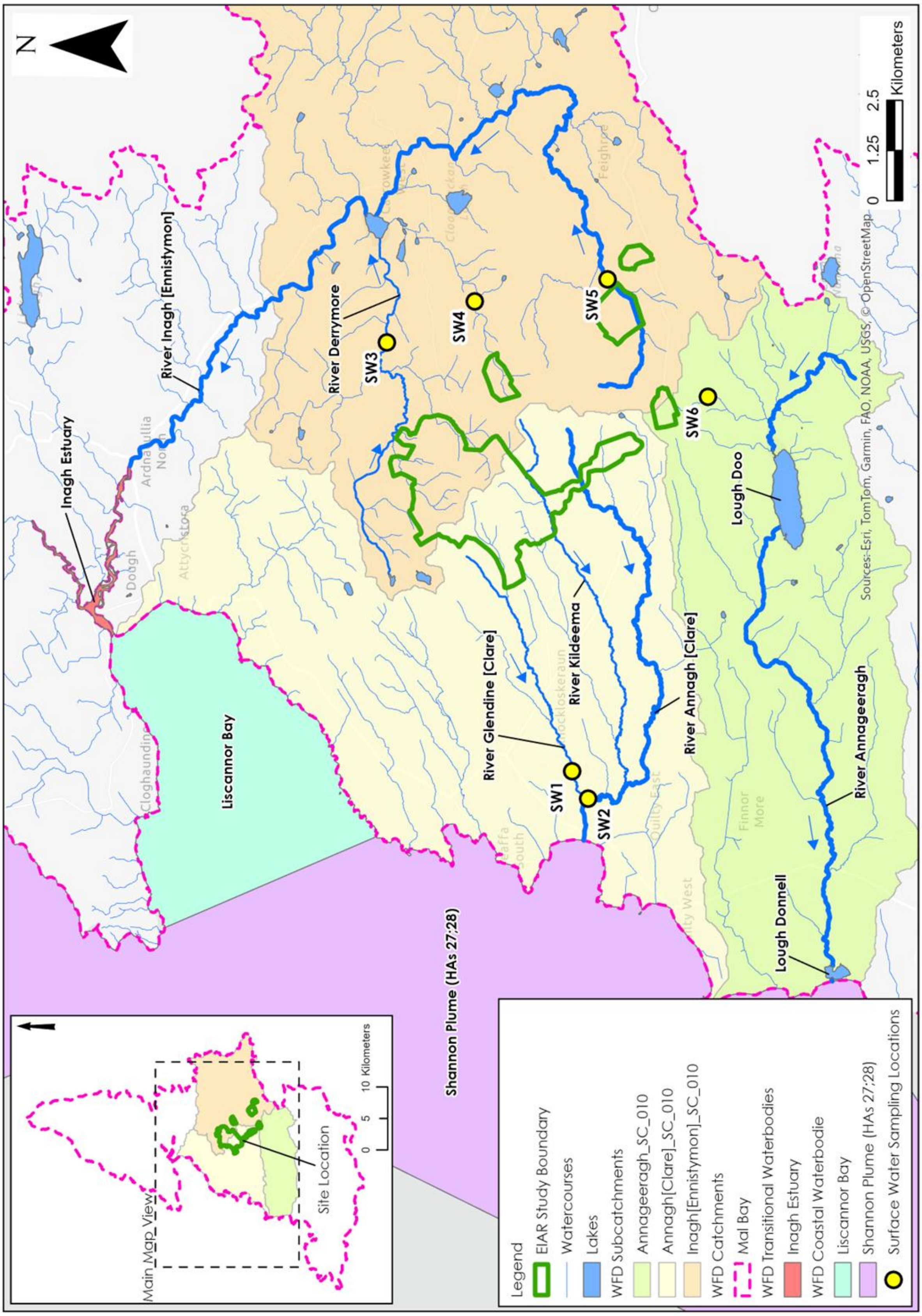


Figure 9-2 Local Hydrology Map

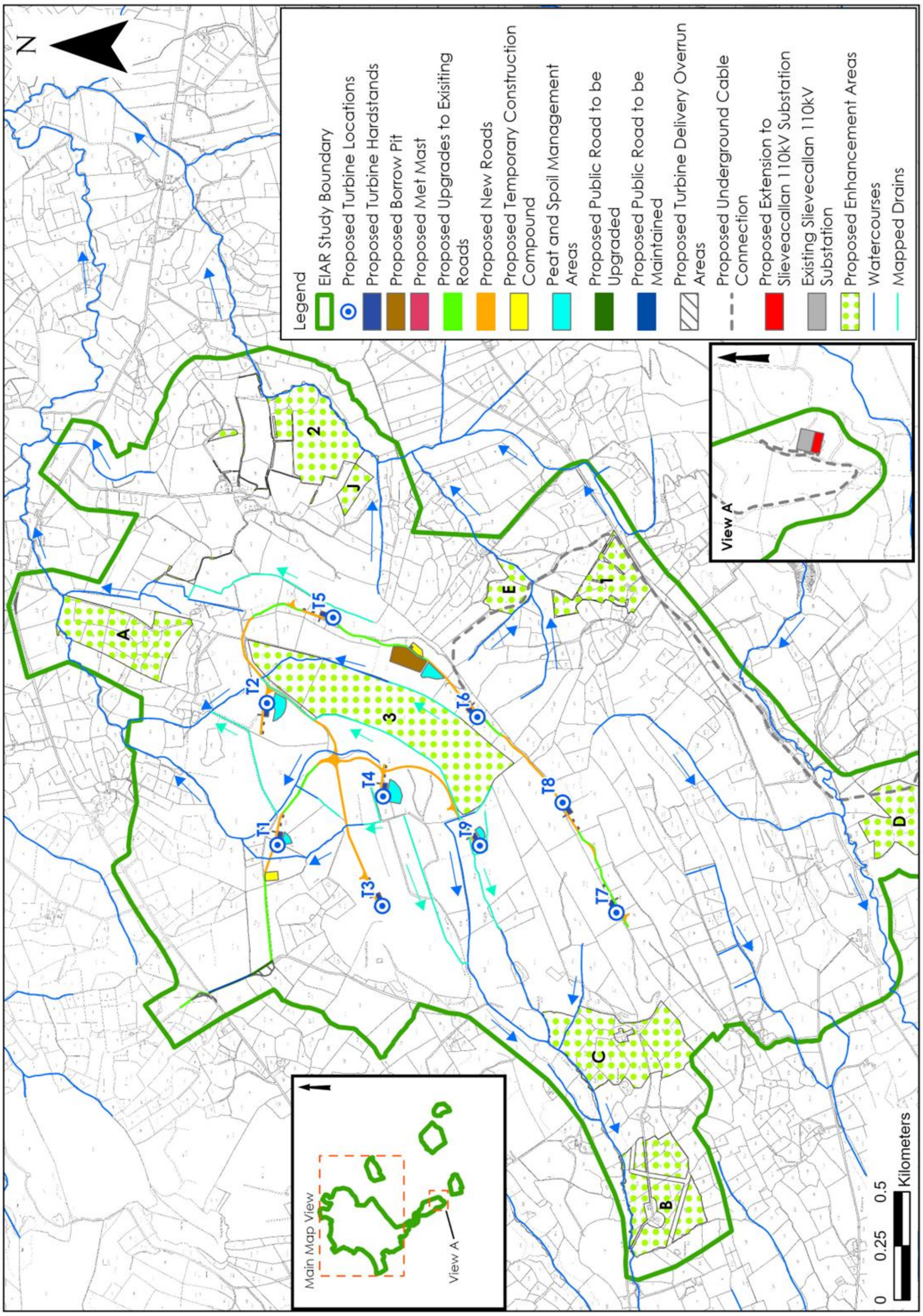


Figure 9-3 Site Drainage Map

9.3.5 Proposed Project Runoff Assessment

This section undertakes a long-term water balance assessment and surface water runoff assessment for the baseline conditions at the Site.

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 Site. The Site drainage design is based on the 10-year return period rainfall event as described further in Sections 9.4.2 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 Site pre-development. The surface water runoff co-efficient for the Site is estimated to be 90% based on the predominant peat coverage and the low permeability bedrock which results in low recharge.

The highest long-term average monthly rainfall (site-specific modelled rainfall values – 1991 to 2020) is 173mm 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** below for the Proposed Wind Farm Site indicates that a conservative estimate of surface water runoff during the highest rainfall month is 1,928,424m^3/month or 62,207m^3/day.

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

Water Balance Component	Depth (m)
Average December Rainfall (R)	0.173
Average December Potential Evapotranspiration (PE)	0.0031
Average December Actual Evapotranspiration (AE = PE x 0.95)	0.0029
Effective Rainfall December (ER = R - AE)	0.170
Recharge (10% of ER)	0.017
Runoff (90% of ER)	0.153

Table 9-9: Baseline Runoff for the Site

Wate Balance Area	Approx. Area (ha)	Baseline Runoff per Wettest month (m^3)	Baseline Runoff per day (m^3) in wettest month
Site	1,260	1,928,424	62,207

9.3.6 Flood Risk Assessment

This section is a summary of a site-specific Flood Risk Assessment (FRA) undertaken for Site. The full FRA report is attached **Appendix 9-1**.

To identify those areas as being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping, CFRAM River Flood Extents maps, 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.

No single or recurring flood incidents within the Site were identified from OPW's Past Flood Event mapping (refer to **Figure 9-4** below). Similarly, identifiable text on local available historical 6" or 25" mapping does not identify any lands that are "liable to flood" within the Site.

The closest OPW mapped past flood event (Flood ID 3929) is located 5.5km downstream of the Site on the Kildeema River. The Ennistimon Area Engineer Meeting Minutes Report (January 2006) states:

> *" The Annagh/KIldeema River downstream of bridge is in a very poor state – overgrown and silted up. Following heavy rainfall and consequent runoff channel back up causes flooding on road and it is impassable. Road is impassable on average once per year. This has been a problem for the past 20 years".*

The closest mapped past flood event in the Inagh River catchment (Flood ID 3895) is located approximately 12km downstream of the Site. The Ennistymon Area Engineer Meeting Minutes Report (January 2006) states the following:

> *"The Inagh River overflowed causing flooding to the N85 at two locations an January 2005. Similar type flooding occurred around 8 months prior to this also. The L5224 was flooded also. Both roads were impassable for 3 to 4 hours. Considerable area of land was also flooded. No houses affected. Cause seems to be heavy rainfall and resulting lack of capacity of Inagh River".*

There are no recorded past flood events mapped within the Glendine River and Annagh River catchments.

The GSI's Winter 2015/2016 Surface Water Flood Map shows surface water flood extents for this particular 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 fluvial flood zones along watercourses within the Site.

No CFRAM Flood Extent fluvial mapping has been completed for any of the surface water catchments in which the Site is located.

National Indicative Fluvial Mapping (NIFM) for the Present Day Scenario does not map any fluvial flood zones within the Site (refer to **Figure 9-5** below). Further downstream of the Site fluvial flood zones are mapped along the Annagh River, Inagh River, Glendine River and Kildeema River. No NIFM fluvial flood zones are mapped at the Site.

Furthermore, the 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 Site.

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.

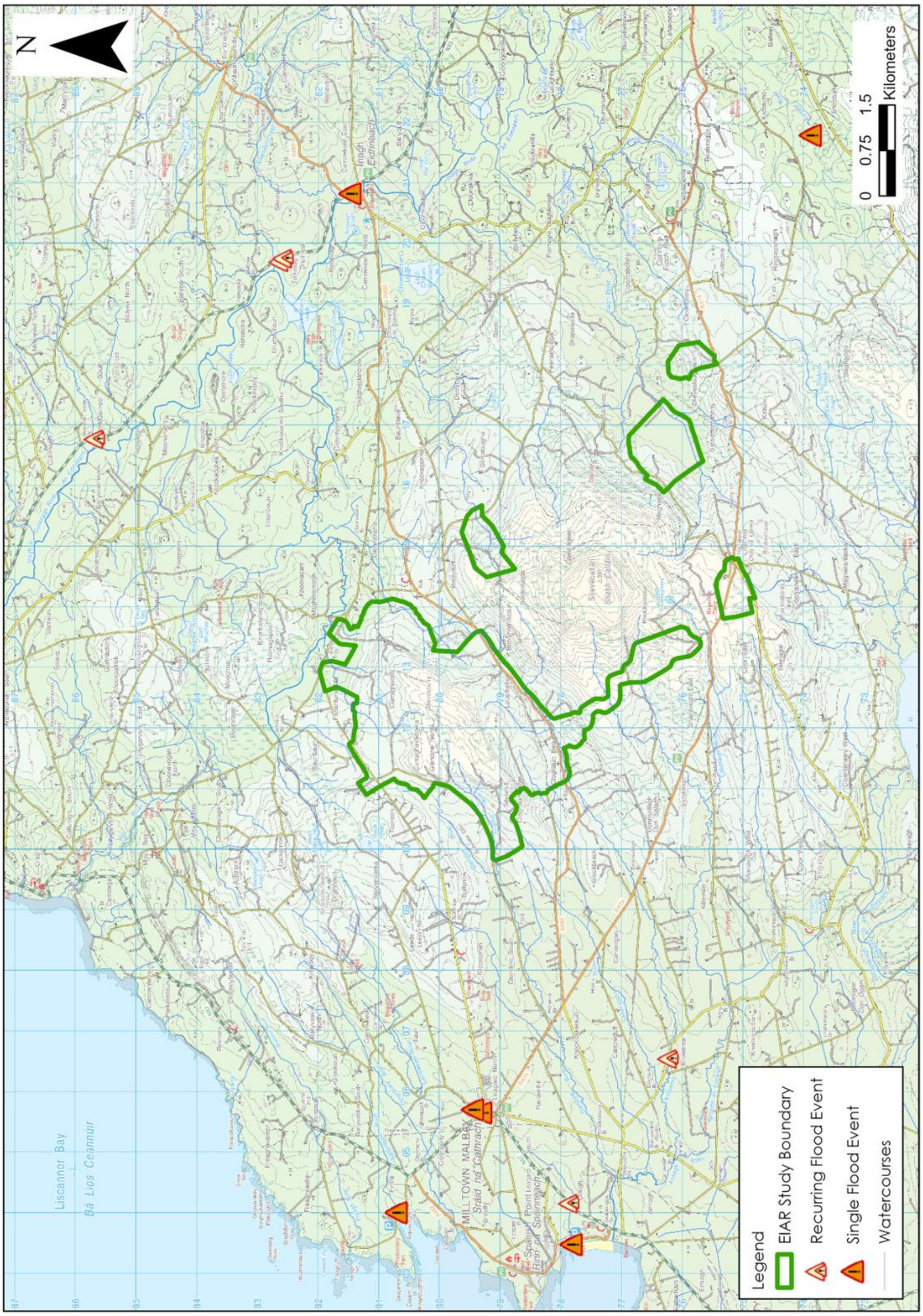


Figure 9-4 OPW Past Flood Events

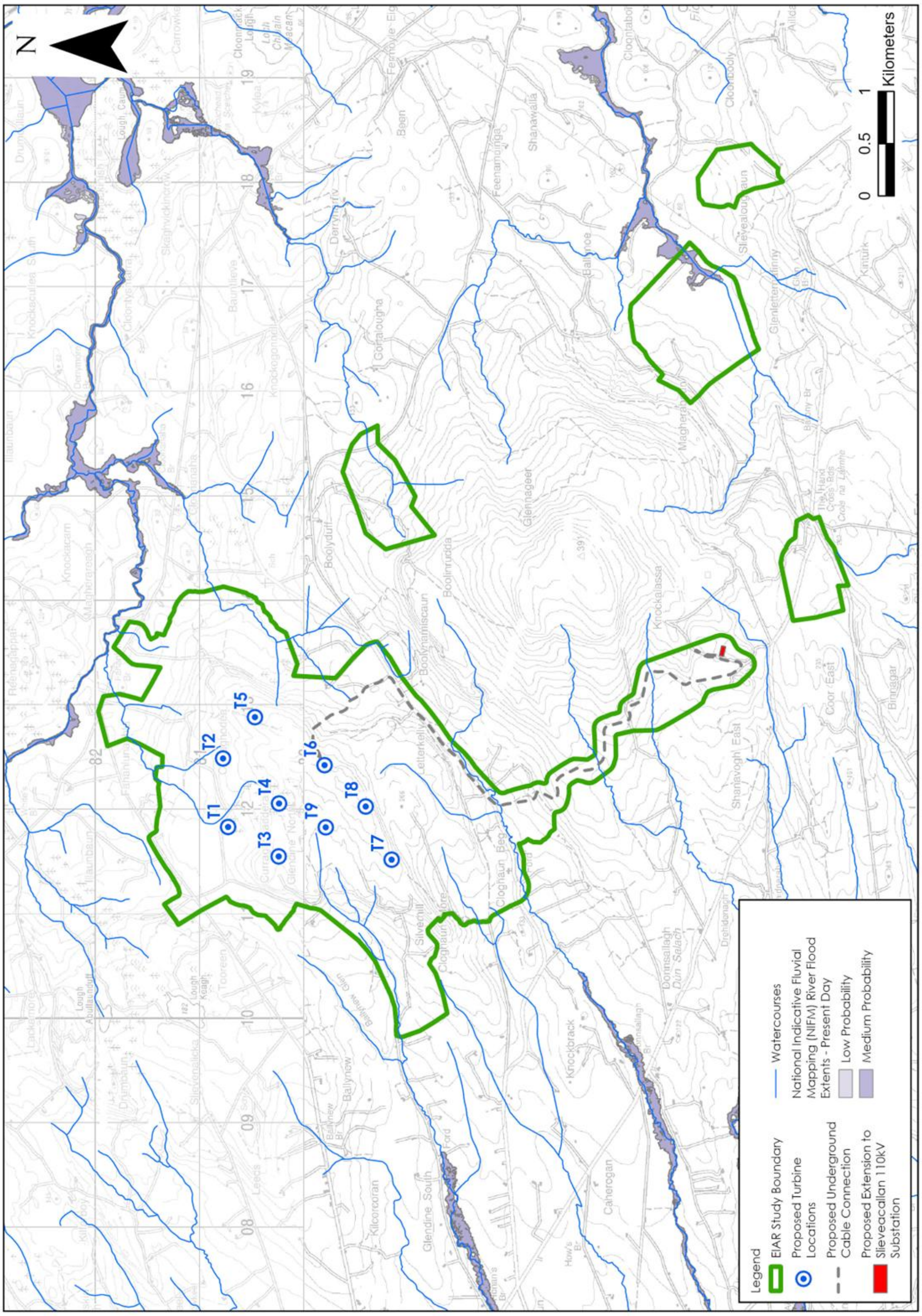


Figure 9-5 NIFM Flood Zone

9.3.7 Surface Water Quality

9.3.7.1 EPA Water Quality Monitoring

EPA biological Q-rating[2] is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High).

EPA Q-rating data (https://www.catchments.ie/data) is available for the Glendine River, Kildeema River, Inagh River and Annageeragh River downstream of the Site. Refer to **Table 9-10** below.

Most recent data (2024) show that the downstream EPA monitoring points on the Glendine River, Annagh River and Annageeragh River have a Q-4 rating (Good Status).

Most recent data (2024) for the Inagh River range from Q3-4 rating (Moderate Status) to Q-4 rating (Good Status).

Table 9-10: Most Recent EPA Q-Rating Data

Watercourse	EPA Station ID	Easting	Northing	Year	EPA Q-Rating Status
INAGH (ENNISTYMON)_010	Crow's Bridge	120296	177960	2024	Q4 (Good)
INAGH (ENNISTYMON)_030	750m d/s Inagh Br (roadside N85) - Site on N85	120418	181771	2024	Q4 (Good)
INAGH (ENNISTYMON)_040	Moananagh Bridge	117027	184865	2024	Q3-4 (Moderate)
INAGH (ENNISTYMON)_050	0.2 km u/s Ennistymon Br	113120	188187	2024	Q3-4 (Moderate)
GLENDINE (CLARE)_010	Knockloskeraun Bridge, S of M	105251	177413	2024	Q4 (Good)
ANNAGH (CLARE)_010	ANNAGH (CLARE) - Stackpoole's Bridge	104585	177040	2024	Q4 (Good)
ANNAGH (CLARE)_010	Bridge u/s Mouth of River	103718	177124	2024	Q4 (Good)
ANNAGEERAGH_010	Br u/s Doo Lough	114630	171961	2024	Q4 (Good)
ANNAGEERAGH_020	Moyglass Bridge	107865	172574	2024	Q4 (Good)

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

9.3.7.2 HES Sampling Results

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), pH (pH units) and temperature (°C) along with turbidity (NTU) were taken at 6 no. surface water sampling locations over 2 no. monitoring rounds completed on 6th and 13th March 2026 within surface watercourses draining and directly downstream of the Site.

The field hydrochemistry results are shown in **Table 9-11** below. The monitoring locations are shown on **Figure 9-2** above.

Electrical conductivity values at the monitoring locations ranged between 36 and 145µS/cm which indicates the flow mainly comprises of surface water runoff (rainfall) from the peat / rocky surface rather than groundwater baseflow.

The pH values were slightly acidic, ranging between 5.8 and 6.9. Slightly acidic pH values of surface waters would be typical of peatland environments as the water is largely rainfall and also due to the decomposition of peat. Turbidity ranged from 0.1 to 2.73 NTU.

Dissolved oxygen saturation ranged between 80 and 98%. The dissolved oxygen levels would be typical for a High Status watercourse and largely exceed the required dissolved lower limit of 80% (Surface Water Regulations S.I. No. 272/2009 as amended).

Table 9-11:Field Hydrochemistry Data (6th and 13th March 2026)

Location ID	Temp °C	DO (% Sat)	EC (µS/cm)	pH	Turbidity (NTU)
SW1	9.7 – 13.9	89 – 98	58 – 74	6.2 – 6.8	0.26 - 2.09
SW2	9.8 – 13.9	92 – 98	36 – 58	5.8 – 6.2	1.43 - 2.73
SW3	9.8 – 11.5	80 – 92	67 – 98	6.6 – 6.8	0.77 - 1.09
SW4	9.7 – 12.5	84 - 97	80 - 120	6.8 – 6.9	0.1 - 0.86
SW5	9.7 – 12.8	84 - 96	85 - 145	6.3 – 6.9	0.8 – 1.5
SW6	9.3 – 12.1	92 - 96	105 - 145	6.3 – 6.9	0.8 – 1.5

** SW (surface water sample locations), FP (random field parameter measurement)*

Results of laboratory analysis are show in **Table 9-12** and **Table 9-13** below alongside relevant Environmental Quality Standards (EQS) values for surface water. Laboratory reports are presented in **Appendix 9-2**.

Total suspended solids ranged from <5mg/L to 16mg/L which is below the European Communities (Quality of Salmonid Waters) Regulation value (S.I. No. 293 of 1988) of 25mg/L.

Results for nitrate, nitrite and phosphorus were at or below the detection limit of the laboratory (i.e. very low levels).

Results for ammonia and orthophosphate achieved 'Good' to 'High' Status with respect the European Communities Environmental Objectives (Surface Waters) Regulations (S.I. 272 of 2009 as amended).

Results for BOD were generally above the 'Good' Status threshold with respect (S.I. 272 of 2009 as amended).

Table 9-12: Analytical Results of HES Surface Water Samples (6th March 2026)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	10	10	<5	<5	<5	<5
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.02	0.04	<0.02	<0.02	0.03	<0.02
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	0.03	0.04	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<5	<5	<5	<5	<5	<5
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloride (mg/L)	-	19.5	21.9	17.2	14.2	17.7	14.9
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	2	2	2	1	6	2
Nitrogen (mg/L)	-	1.2	1.8	1.3	1.2	<1	<1

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

Table 9-13: Analytical Results of HES Surface Water Samples 13th March 2026)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	16	6	<5	7	<5	<5
Ammonia (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.06	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	<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	<0.02
Nitrate - NO_3 (mg/L)	-	<5	<5	<5	<5	<5	<5
Phosphorus (mg/L)	-	0.10	<0.10	<0.10	<0.10	<.10	<0.10
Chloride (mg/L)	-	37.2	22	25.4	27.9	20.9	17.7
BOD	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	6	5	5	3	5	4
Nitrogen (mg/L)	-	1.3	1.3	1.2	1.4	1.0	1.0

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

9.3.8 Hydrogeology

9.3.8.1 Groundwater Body Characteristics

The Site is located in the Milltown Malbay Groundwater Body (GWB). According to WFD mapping the GWB comprise poorly productive bedrock.

The rocks of the Central Clare Group, which underlie the Site are classified by the GSI (www.gsi.ie) as a Locally Important Aquifer, having bedrock which is generally unproductive except for local zones (Ll). The Namurian rocks of the Central Clare Group which comprises sequences of sandstones, siltstone and shale are generally devoid of intergranular 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.

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).

Base flow contribution to streams tends to be low, particularly in summer as the groundwater regime cannot sustain summer base flows due to low storability 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 of the Site (i.e. poorly drained mineral & peaty soil).

Local groundwater flow directions will mimic topography whereby flow paths will be from topographic high points to lower elevated discharge areas at local streams.

9.3.8.2 Site Investigation Summary

A detailed description of the geology of the Site is presented in Chapter 8 of this EIAR. A summary is presented here to inform the hydrogeological characterisation of the Site.

Regional baseline geological data is available from the GSI through their online map viewer (www.gsi.ie). The bedrock across the Site is mapped as the Central Clare Group (SILTSTONE, SANDSTONE and SHALE combinations). Subsoils are predominantly mapped as peat and Namurian sandstone and shale tills.

The follow up site investigations and geotechnical assessments were extensive and consisted of 914 no. peat depth probes, 7 no. trial pits and geophysical surveys. The geological setting of the Site has been thoroughly examined, and the geological/hydrogeological setting is fully understood.

The site-specific data on the geology as well as geotechnical aspects of the Site is included in Section 8.4 of Chapter 8 of this EIAR. The site-specific data is summarised as follows:

- Peat depths recorded across the Site ranged from 0 to 5m with an average depth of 0.7m, which is considered shallow for blanket bog;
- Approximately 81% of recorded peat depth were less than 1m and with 94% of less than 2.0m;
- The peat depths recorded at the Proposed Turbines varied from 0.2 to 2.0m with an average depth of 0.8m (this is considered shallow peat, turbines have successfully been constructed in several metres of peat);

- Of the 9 no. Proposed Turbines, only 3 no. recorded peat depths in excess of 1m (i.e. T1, T4 and T9);
- With respect to the new proposed access roads, peat depths are typically less than 1.0m (average 0.8m) and therefore most roads will be constructed by excavate and replace method;
- At the proposed borrow pit location, peat depths are very shallow (0 - 0.2m);
- No evidence of past failures or any significant signs of peat instability were noted on site by FT at the time of the geotechnical walkover surveys;
- Mineral subsoils were typically described as soft to firm gravelly CLAY or SILT;
- Refusal on bedrock (presumed) was recorded in all 7no. trial pits at depths ranging from 0.3 to 2m;
- Depth to bedrock at Proposed Turbines where trial pits were carried out (T1, T2, T3, T5 and T6) ranged between 0.8m and 1.8m with an average of 1.2m;
- Geophysical surveys identified competent bedrock at Proposed Turbines T4, T7 and T8 at depths ranging between 1 and 5m below ground level (mbgl). Depths to bedrock at proposed turbine location T9 varied between 4.5 and 6.5mbgl;
- Geophysical surveys carried out at the borrow pit identified competent, strong SANDSTONE/SILTSTONE at shallow depths ranging from 1 to 3mbgl; and,
- No bedrock faults or fractures were identified by the geophysical surveys.

9.3.9 Groundwater Vulnerability

The GSI groundwater vulnerability rating is a term used to represent the natural geological 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 concept of groundwater vulnerability was mainly devised for assessing the risk of practices such as manure spreading and wastewater discharge as these are potential pollutants to groundwater. The concept of groundwater vulnerability in wind farms is not as applicable as there are no discharges of potential pollutants to groundwater. The vulnerability rating does however, give information on depth to bedrock which is useful in wind farm design (i.e. foundation earthworks).

The vulnerability of the aquifer underlying the Site is classified as predominately “High” to “Extreme X” by the GSI (www.gsi.ie) with the latter being more prevalent. All Proposed Turbine are located in areas of “Extreme” vulnerability (i.e., <3m peat) (GSI, 1999).

The GSI mapped groundwater vulnerability rating of “High” to “Extreme” is consistent with depth to bedrock confirmed by the site investigations.

- Refusal on bedrock (presumed) was recorded in all 7 no. trial pits at depths ranging from 0.3 to 2m;
- Depth to bedrock at Proposed Turbines where trial pits were carried out (T1, T2, T3, T5 and T6) ranged between 0.8m and 1.8m with an average of 1.2m;
- Geophysical surveys identified competent bedrock at Proposed Turbines T4, T7 and T8 at depths ranging between 1 and 5m below ground level (mbgl); and,
- Depths to bedrock at proposed turbine location T9 varied between 4.5 and 6.5mbgl.

The groundwater vulnerability rating along the Proposed Grid Connection Site has a similar rating range (i.e. Low to Extreme). However, due to the fact that the route of the proposed 33kV underground cabling is along the carriageway of public roads, the vulnerability rating is largely irrelevant.

No excavations or management of spoil are required at the Proposed Enhancement Site.

Due to the low permeability nature of the bedrock aquifer underlying the Site, groundwater flow paths are likely to be short, with recharge emerging close by at seepages and surface streams. This means there is a low potential for groundwater dispersion and movement within the aquifer, therefore making surface water bodies such as drains and streams more vulnerable than groundwater at this Site.

9.3.10 Groundwater Hydrochemistry

There is no groundwater quality data for the Proposed Wind Farm Site and groundwater sampling would generally not be undertaken for this type of development, as groundwater quality impacts would not be anticipated given the overall lack of a significant pollution source, the low potential for groundwater dispersion and movement within the aquifer as outlined in the preceding section.

Namurian bedrock aquifers (including the Central Clare Group) have predominantly $Ca\text{-}HCO^3$ hydrochemical signatures. These signatures vary from 'fresh' signatures to Mg-Na/K-Cl signatures indicative of ion exchange and long flow paths and residence times. A $Ca\text{-}Mg\text{-}HCO^3$ would be expected for groundwaters close to the recharge area of the aquifer (Working Group on Groundwater, 2004). There is a possibility that due to the proximity to the coast the $Ca\text{-}HCO^3$ signature may vary towards a K/Na-Cl due to the influence of seawater chemistry on the rainfall that is recharging the aquifer.

9.3.11 Water Framework Directive Water Body Status and Objectives

The EU Water Framework Directive (2000/60/EC), as amended by Directives 2008/105/EC, 2013/39/EU and 2014/101/EU ("WFD"), was established to ensure the protection of the water environment. The Directive was transposed in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003).

The WFD's Water Action Plan 2024 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 WFD is not compromised.

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.

The River Basin Management Plan (2022 - 2027)/Water Action Plan 2024 objectives, which have been integrated into the design of the Proposed Project, 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 actions and pilot schemes in focused sub-catchments aimed at (1) targeting water bodies close to meeting their objectives and (2) addressing more complex issues that will build knowledge for the 3rd cycle.

Based on these objectives it is understood 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 (i.e. there should be no negative change in status at all as a result of a proposed development).

Strict mitigation measures (refer to Sections 9.5.2 and 9.5.3 below) in relation to maintaining a high quality of surface water runoff from the development and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the Site will be at least maintained (see below for WFD water body status and objectives) regardless of their existing status.

Please refer to the WFD Compliance Assessment report for the Proposed Project (attached as **Appendix 9-3**).

9.3.12 Groundwater Body Status

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

The Milltown Malbay GWB (GWB: IE_SH_G_167) underlies the Site and extends west as far as the coastline. It is assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

9.3.13 Surface Water Body Status

Local River Waterbody status and WFD risk classification are available from (www.catchments.ie) and are summarised in **Table 9-14** below.

Table 9-14 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.

WFD status (2029 – 2024) of river waterbodies that drain the Proposed Wind Farm Site (i.e. Glendine(Clare)_010), Kildeema_010 and Inagh(Ennistymon)_040) range from Moderate to Good Status.

The Annagh(Clare)_010, which only drains the Proposed Grid Connection Site and Proposed Enhancement Site, is assigned a Poor Status.

River waterbodies that drain only the Proposed Enhancement Site include Inagh(Ennistymon)_010 and Annageeragh_020, both of which were assigned Good Status.

With the exception Kildeema_010 and Inagh(Ennistymon)_010, all other river waterbodies status is At Risk due to pressures which are listed summarised in the below table.

Table 9-14: River Waterbody Status and Risk for the Proposed Project

European Code	Sub_basin	Overall Status (2019 – 2024)	Risk Status (3rd Cycle)	Pressure Category
IE_SH_28G020200	Glendine(Clare)_010	Moderate	At Risk	Anthropogenic & Hydromorphology
IE_SH_28K010800	Kildeema_010	Good	Not At Risk	n/a

European Code	Sub_basin	Overall Status (2019 – 2024)	Risk Status (3rd Cycle)	Pressure Category
IE_SH_28A030900	Annagh(Clare)_010	Bad	At Risk	Anthropogenic, Domestic Waste Water, Forestry & Hydromorphology
IE_SH_28I010100	Inagh(Ennistymon)_010	Good	Not At Risk	n/a
IE_SH_28I010300	Inagh(Ennistymon)_040	Moderate	At Risk	Agriculture, Hydromorphology, Forestry, Domestic Waste Water and Anthropogenic
IE_SH_28A030900	Annageeragh_020	Good	At Risk	Forestry and Water Treatment

9.3.14 Designated Sites and Habitats

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 closest designated site to the Site is Slievecallan Mountain Bog NHA (Site code 002397) which exists approximately 2.5km to the southeast of the Proposed Wind Farm Site and approximately 0.21km east of the Proposed Grid Connection Site. The Site has no hydrological connectivity to Slievecallan Mountain Bog NHA.

The Inagh River Estuary SAC (site code 000036) is located approximately 22km downstream of the Site near the town of Ennistymon.

The Mid-Clare Coast SPA (site code 004182), which encompasses a coastal area from Spanish Point south to Doonbeg, is located approximately 7.5km downstream of the Site via the Glendine River, Kildeema River and Annagh River.

Carrowmore Point to Spanish Point and Islands SAC/pNHA (site code 001021), which is largely coincident with the Mid-Clare Coast SPA, is also downstream of the Site via the aforementioned rivers.

Local designated sites are shown on **Figure 9-6.**

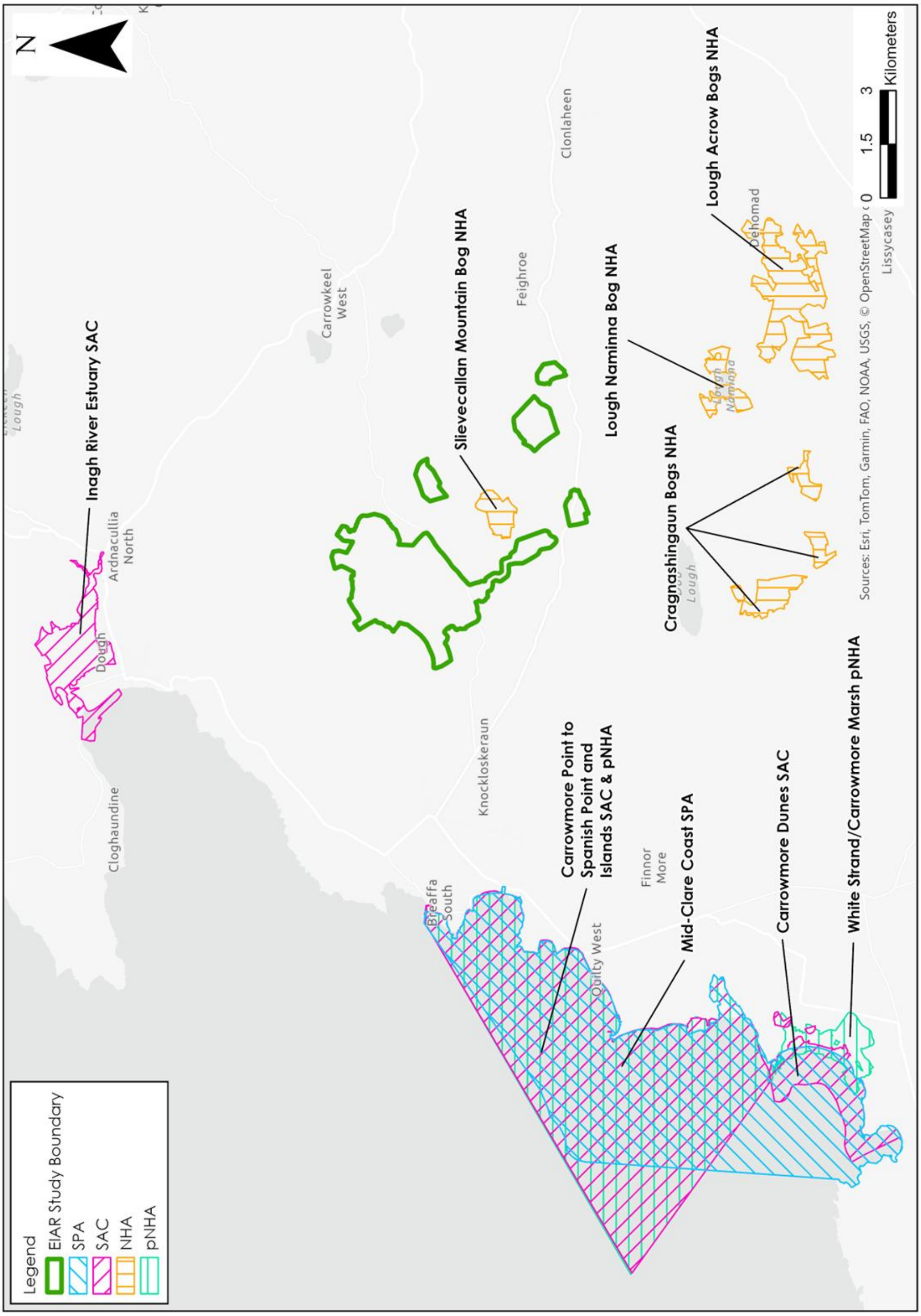


Figure 9-6 Local Designated Sites

9.3.15 Water Resources

9.3.15.1 Public/Group Water Schemes

There are no mapped groundwater source protection areas in the area of the Site. The closest mapped group water scheme is the Kilmaley/Inagh GWS located 5km to the southeast of the Site.

Public water supply surface water abstractions in this area include Lough Naminna (Inagh Kilmaley Group Water Scheme) and Doo Lough. Lough Naminna is located inland, approximately 5km east of the Site. Neither the Proposed Wind Farm Site nor Proposed Grid Connection Site drains into Lough Naminna.

Doo Lough is located approximately 3km to the south of the Site. Neither the Proposed Wind Farm Site nor Proposed Grid Connection Site drains into Doo Lough.

However, Area G associated with Proposed Enhancement Site (Hen Harrier Habitat Enhancement, see **Appendix 6-4** for further details) drains into Doo Lough via a headwater tributary of the Annageeragh River. The Proposed Enhancement Site, which has an area of 7.2ha within this catchment, is located 4km upstream of Doo Lough.

9.3.15.2 Private Domestic Wells

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). Several wells have been mapped by the GSI in the surrounding lands at the Proposed Wind Farm Site, however they have poor locational accuracies (>50m). Shown on **Figure 9-7** are the locations of GSI mapped wells.

These wells are reported as having domestic and agricultural uses. Where available the yields of these wells are typically reported as being poor, ranging from 13.4 to 21.8m^3/day (i.e. poorly productive bedrock). There are no wells with a locational accuracy of ≤50m mapped by the GSI within 1km of the Proposed Wind Farm Site.

Due to the nature of the proposed 33kV underground cabling being mainly within the carriageway of public roads outside the Proposed Wind Farm Site and the shallow nature of the works, no assessment on potential wells located along the Proposed Grid Connection Site (public road or private land sections) was carried out due to the lack of potential effects.

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 down hydraulic gradient of the Proposed Project has a water supply well associated with it (this is unlikely to be the case but is a precautionary assessment).

The majority of these dwellings are remote (>500m) to the permanent built infrastructure footprint of the Proposed Project where deep excavations are required and given the bedrock geology type within the Proposed Wind Farm Site and the unproductive nature of the underlying aquifer there will be very limited 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. Therefore, the general groundwater flow direction at the Proposed Wind Farm Site is expected to be westerly.

As stated in Section 9.3.8.1 above, groundwater flow paths are typically between 30 – 300m in length and given the fact that all dwellings are a minimum of 500m away from the Proposed Turbines and the proposed borrow pit, there is a very low risk of impact. The potential effect on private wells is further assessed in Section 9.5.2.10 below.

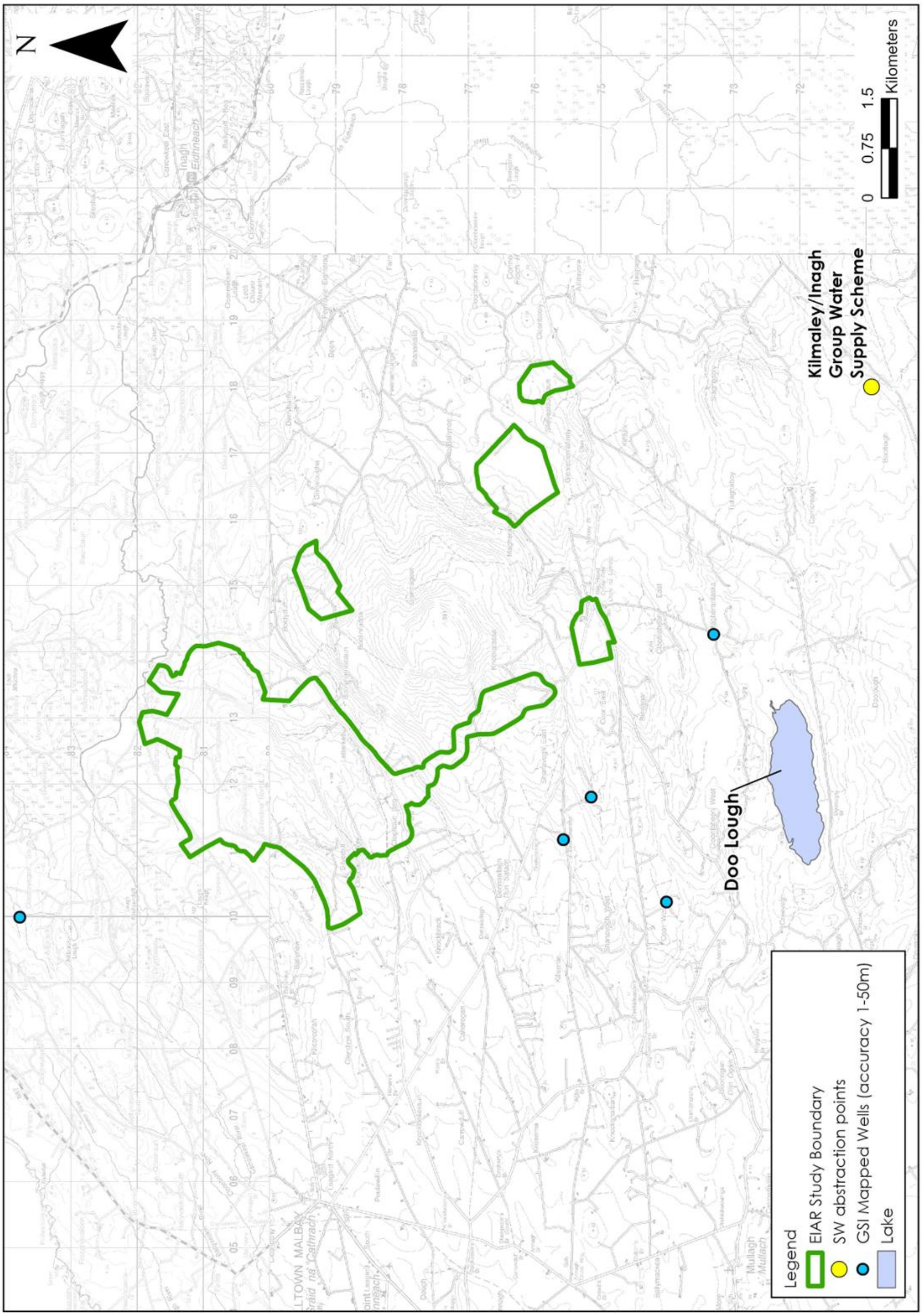


Figure 9-7 Drinking Water Sources

9.3.16 Receptor Sensitivity

Due to the nature of wind farm and 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 risk to groundwater at the Site would be from hydrocarbon spillage and leakages. These are common potential impacts to all construction sites (such as road works and industrial sites). These 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 minor impacts.

Based on criteria set out in **Table 9-3** groundwater at the Site is classed as Sensitive to pollution because the Namurian bedrock is classified as a Locally Important Aquifer (Ll). However, the majority of the Site is covered in peaty poorly draining topsoil which acts as a protective cover to the underlying aquifer. Any contaminants which may be accidently released on-site are more likely to travel to nearby streams within surface runoff. The low permeability of the bedrock means that any contaminant that may reach the bedrock would not disperse and would remain localised to the source or would be removed as runoff during wet periods.

Surface waters such as the downstream Glendine River, Annagh River, Kildeema River, Inagh River and Annageeragh River and are very sensitive to potential contamination. These rivers are not known to be of salmonid quality, but it is considered to be of salmonid potential (see Biodiversity, Chapter 6).

The designated sites that are hydraulically connected (surface water flow paths only) to the Proposed Project include the Mid-Clare Coast SPA (Site Code 004182), Carrowmore Point to Spanish Point and Islands SAC (Site Code 001021) and The Inagh River Estuary SAC (Site Code 000036). These are all coastal/estuarine protected sites and are not freshwater dependant. There are no designated freshwater dependant sites/ecosystems downstream of the Site.

From a hydrological perspective there will be low risk of impact on these marine/estuarine designated sites as they are significantly less sensitive (even without mitigation) compared to a freshwater habitat with regard to construction effects.

Nonetheless, 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. Refer to Section 9.4.2 below.

A hydrological constraints map for the Proposed Wind Farm Site is shown as **Figure 9-8** below. A self-imposed 50m buffer from streams was applied during the constraints mapping and will be maintained during the construction phase. The Proposed Wind Farm Site drainage infrastructure layout will be cognisant of these buffers.

Apart from the 5 no. proposed new (natural) watercourse crossing locations, 1 no. existing (natural) watercourse crossing upgrade, sections of proposed access roads and sections of existing roads for upgrading, the is located outside the delineated 50m buffer zones.

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.

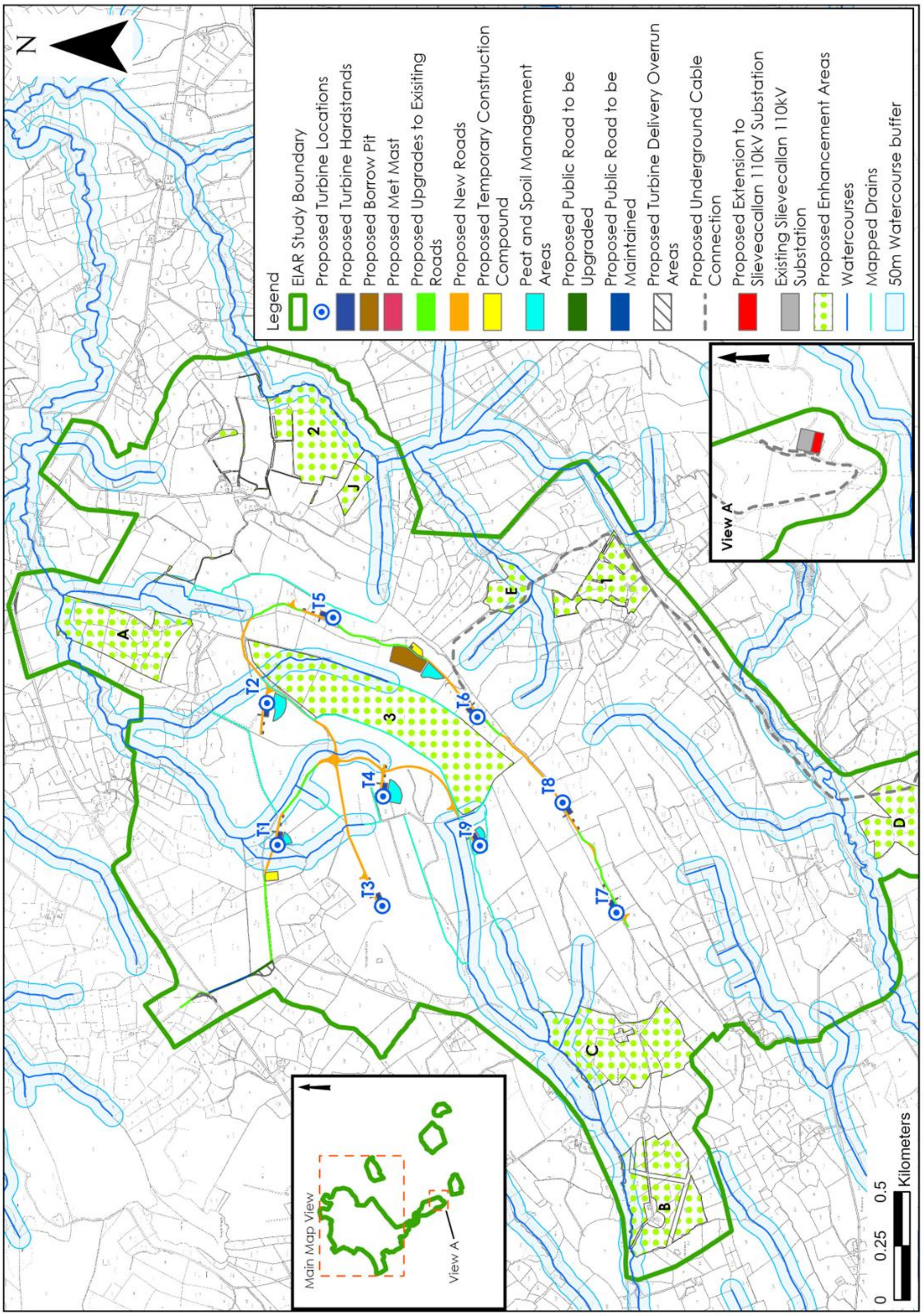


Figure 9-8 Hydrological Constraints Map

9.4 Characteristics of the Proposed Project

9.4.1 Proposed Project Summary

Please refer to Chapter 4 of the EIAR for a description of the Proposed Project (i.e. Proposed Wind Farm Site, Proposed Grid Connection Site and Proposed Enhancement Site).

The main characteristics of the Proposed Wind Farm Site that could impact on hydrology and hydrogeology are:

- Establishment of 2 no. temporary construction compounds, 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 1 no. on-site borrow pit;
- Construction of the 9 no. crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations;
- 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 proposed settlement pond locations (refer to **Appendix 4-3** drainage plan drawings) 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 9 no. turbine foundations, which are expected to be gravity foundation design due to shallow depths to underlying bedrock;
- Underground cabling between Proposed Turbine locations will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling;
- Construction of 5 no. new (natural) watercourse crossing (clear span bridge design) and upgrade of 1 no. existing (natural) watercourse crossing at the Proposed Wind Farm Site;
- Tree felling (total 144ha) for the purposes of Proposed Wind Farm Site construction and also for the Biodiversity Management and Enhancement Plan;
- Establishment of 5 no. dedicated peat and spoil management areas as well as utilising the 1 no. exhausted borrow pit for permanent peat placement;
- Upgrade of 2.3km of existing access forestry tracks and construction of 5.6km of new access tracks using the excavate and replace method which is most appropriate technique for shallow peat.

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

- Approximately 7.1km of an underground cabling route between the Proposed Wind Farm Site and the proposed substation extension at the existing Slievecallan 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);
- The proposed substation extension will be located on an existing cleared and level area where the ground elevation is at approximately 242m OD.
- 15 no. existing watercourse culvert/bridge crossings along the underground cabling routed (4 no. of these are EPA mapped watercourses);
- At all watercourse crossing locations, the cable will be placed either underneath or above the bridge structure or by Horizontal Directional Drilling (HDD); and no in-stream are proposed at any existing crossing location.

The main characteristics of the Proposed Enhancement Site that could impact on hydrology and hydrogeology are:

- A total of 172.7ha of lands are proposed for enhancement under Biodiversity Management and Enhancement Plan (BMEP). The Proposed Enhancement Site comprises areas of Marsh Fritillary Enhancement (grazing management), Hen Harrier Habitat Enhancement (conifer felling areas and grassland management areas) peatland restoration hedgerow management and replanting.
- There will be no excavations required as part of the enhancement works.

9.4.2 Proposed Drainage Management

9.4.2.1 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 Wind Farm Site drainage management is shown as **Figure 9-9** 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. A Surface Water Management Plan is included as **Appendix 4-7** of the EIAR.

9.4.2.2 Drainage Design Approach

The general design approach to wind farm layouts in existing forestry is to utilise 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 and how the proposed infrastructure interacts with this existing drainage. Using these Lidar data potential runoff pathways are mapped that are >150m[3] 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 built infrastructure footprint of the Proposed Project is divided up into drainage catchments (based on topography, outfall locations, catchment size) and then stormwater

[3] We tested several pathway lengths (25m to 250m) and 150m produced the optimal results.

runoff rates are calculated based on the 10-year return period 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)[4];
- Drainage plans also show the proposed locations of temporary drainage measures that will be installed prior to the Proposed Wind Farm Site construction commencing; and,
- With regard the 6 no. Proposed Wind Farm Site (natural) watercourse crossing locations (5 no. new and 1 no. existing), culverts will be designed to accommodate 100-year flood flow (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.

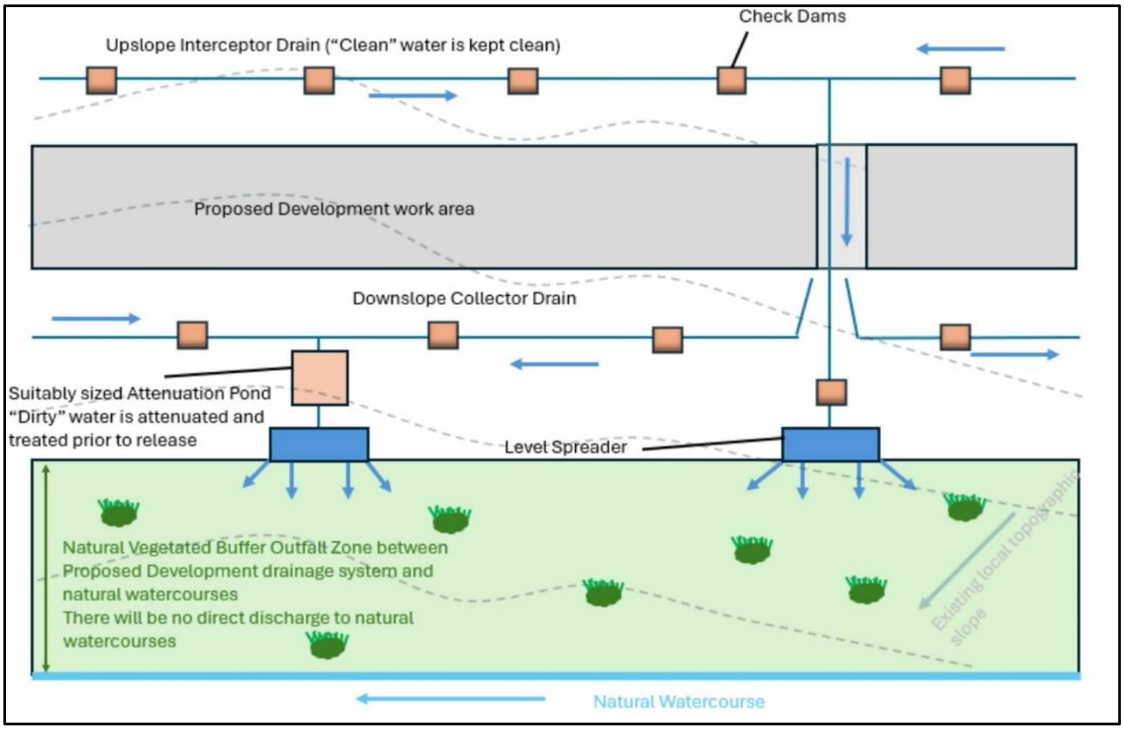


Figure 9-9: Schematic of Proposed Wind Farm Drainage Design

As detailed in Chapter 1 Section 1.1.1 of the EIAR, the Proposed Project has been designed (along with appropriate mitigation) with consideration of the reasons for refusal on the previous application for a renewable energy development at the Site, in particular reasons regarding a key understanding of land and ground conditions, peat stability and peat and spoil management within the Site. As the design of the Proposed Project was refined relative to the above, the Proposed Wind Farm Site drainage was also designed in with consideration of the reasons for refusal, such as incorporating the management of peat and spoil in dedicated management areas within the Proposed Wind Farm Site,

The proposed drainage design approach has successfully been employed at numerous existing wind farm developments across the county including the nearby Cahermurphy Wind Farm, Glenmore Wind Farm and Slievecallan Wind Farm.

[4] *Environmental Management Guidelines - Environmental Management in the Extractive Industry (Non-Scheduled Minerals) (EPA, 2006).*

9.5 Likely Significant Effects and Mitigation Measures

The potential impacts of the Proposed Development and mitigation measures that will be put in place to eliminate or reduce them are set out below.

9.5.1 'Do-Nothing' Scenario

If the Proposed Project were not to proceed, the existing land use practices including forestry, peat cutting and agricultural activities will continue at the Proposed Wind Farm Site. Forestry will be felled as it reaches maturity. Re-planting of these areas with coniferous plantation is likely to occur. Surface water drainage carried out in areas of agriculture, forestry and bogland will continue to function and may be extended in some areas.

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

Furthermore, as this application includes a Biodiversity Management and Enhancement Plan (Appendix 6-4) to be implemented during the development's operation, the opportunity to enhance the site for biodiversity, at a local scale, would also be lost

In the Do Nothing Scenario, there may be a slight change in average annual rainfall at the Site as a result of climate change. This is discussed in Section 9.3.2 above and any change in annual rainfall will result in changes in local recharge and runoff volumes.

9.5.2 Construction Phase – Likely Effects and Mitigation Measures

The likely significant effects of the construction phase of the Proposed Project and mitigation measures that will be put in place to eliminate or reduce them are shown in this section. It should be noted that the main potential effects on the water environment will occur during the construction phase. The assessment considers the Proposed Project as a whole i.e. the Proposed Wind Farm Site, the Proposed Grid Connection Site and the Proposed Enhancement Site. Where this is required to be assessed separately, this is noted in the text.

9.5.2.1 Clear Felling of Coniferous Plantation

A total of 144 hectares of forestry will be felled for the Proposed Project. This includes a total of 20.7 hectares to be removed to facilitate the permanent built infrastructure footprint of the Proposed Project and 123 hectares to be deforested as part of the BMEP.

It should be noted that forestry on the 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 impacts during tree felling occur mainly from:

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

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Glendine River, Kildeema River, Inagh River, Annagh River, Annageeragh River and Doo Lough) and associated dependant ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, likely effect on surface water quality and is Not Significant.

Proposed Mitigation Measures:

All felling 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);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b);
- 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); and,
- Code of Best Forest Practice (Forest Service, 2000)

Mitigation by Avoidance:

There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document *"Forestry and Water Quality Guidelines"* are shown in **Table 9-15.**

Table 9-15 : 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

During the wind turbine 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 9-8**. With the exception of proposed new roads, proposed upgrades to existing roads and proposed watercourse crossings all proposed tree felling areas are located outside of imposed buffer zones. Additional mitigation (detailed below) will be carried where tree felling is required inside the buffer zones.

The large distance between most of the proposed felling areas and sensitive aquatic zones means that potential poor quality (sediment laden) runoff from felling areas will be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required within the 50m buffer, the following additional mitigation measures will be employed.

Mitigation by Design:

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

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

- Brash mats will be used to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal will take place when they become heavily used and worn. Provision will be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction will be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside a local 50 metre watercourse buffer. 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 run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required;
- A permit to refuel system will be adopted;
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors;
- Crossing of streams will not be permitted;
- Trees will be cut manually from along streams and using machinery to extract whole tree; and,
- Travel only perpendicular to and away from stream.

Silt Traps:

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

Drain Inspection and Maintenance:

The following items shall 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 shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall;
- Following tree felling all main drains shall be inspected to ensure that they are functioning;
- Extraction tracks near drains need to 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 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 4-7**).

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;
- Where possible, 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 will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Residual Effect: The residual effect is negative, imperceptible, indirect, temporary, likely effect on downstream water quality and aquatic habitats.

Significance of Effects: With the application of the mitigation outlined above, no significant effects on the surface water quality will occur.

9.5.2.2 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Waters

There will be earthworks required for both the Proposed Wind Farm Site and Proposed Grid Connection Site works and therefore both are assessed herein. No excavations are required for the Proposed Enhancement Site.

Construction phase activities that will require earthworks resulting in removal of vegetation cover and excavation of peat and mineral subsoil (where present) are detailed in Chapter 4. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the underground cable trench resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Glendine River, Kildeema River, Inagh River and Annagh River) and dependant ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, significant, short term, likely effect on surface water quality and is Significant.

Mitigation by Avoidance:

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible. From **Figure 9-8** it can be seen that all of the key areas of the Proposed Project are actually significantly away from the delineated buffer zones with the exception of sections of proposed upgrades to existing roads, proposed new roads, proposed stream crossings and existing stream crossings requiring upgrading. Additional control measures, which are outlined further on in this section, will be undertaken at these locations.

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 operated effectively. The proposed buffer zone will:

- Avoid physical damage to watercourses, and associated release of sediment;
- Avoid excavations within close proximity to surface water courses;
- 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.

Mitigation by Design:

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

Please see **Appendix 4-3** for detailed drainage design drawings and mitigation measures. It should be noted that a network of bog, agricultural and roadside drains already exist at the Proposed Wind Farm Site, and these will be integrated and enhanced as required and used within the Proposed Wind Farm Site drainage system. The integration of the existing drainage network and the Proposed Wind Farm Site network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, stilling 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 Project 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 stilling 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.

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 drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using forestry check dams/silt traps;
- Clean water diversion drains will be installed upgradient of the works areas;
- Check dams/silt fence arrangements (silt traps) will be placed in all existing forestry drains that have surface water flows and also along existing forestry 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.

Refer to the drainage plan (**Appendix 4-3**) for the location of these temporary measures.

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.

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to 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 Site 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 9-16** below.

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

All proposed settlement pond locations have been thoroughly assessed from a geotechnical and peat stability perspective (refer to **Appendix 8-1** for the Geotechnical and Peat Stability Assessment Report).

Table 9-16: Settlement Pond Design

Pond Size W [m] x L [m] x D [m]			Track/Hardstand Catchment Size (m²)		
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:

Level spreaders and vegetation filters will be implemented at the settlement ponds. 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 level spreaders, 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 Proposed Wind Farm Site 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 stand 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).

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 peat/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:

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

Management of Runoff from Peat and Subsoil Management Areas:

It is proposed that excavated spoil and peat will be used for landscaping where required. The excess material will then be placed in 5 no. dedicated peat/spoil management areas as well as placement of peat in the 1 no. proposed borrow pit once the rock is fully extracted.

All proposed peat and spoil storage areas including borrow pits have been thoroughly assessed from a geotechnical and peat stability perspective (refer to **Appendix 8-1** for the Geotechnical and Peat Stability Assessment Report).

All proposed 5 no. peat and spoil management areas, as well as the borrow pit are located outside of 50m watercourse buffer zones (refer to **Figure 9-8**).

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

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

Drainage from peat and spoil storage areas will ultimately be routed to an oversized swale and a number of stilling ponds pond with appropriate storage and settlement designed for a 1 in 10-year return period before being discharged to the on-site drains.

Peat/subsoil reinstatement areas will be sealed with a digger bucket and vegetated as soon possible to reduce sediment entrainment in runoff. Once re-vegetated and stabilised peat/subsoil reinstatement areas will no longer be a potential source of silt laden runoff.

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

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 is included in **Appendix 4-5 of** this EIAR).

Residual Effect: The residual effect is negative, imperceptible, indirect, short term, likely effect on down gradient rivers, water quality, and 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 Impacts on Groundwater Levels During Excavations

Potential groundwater levels effects are only likely at the Proposed Wind Farm Site and not the Proposed Grid Connection Site due to the shallow nature of the underground cabling works.

Potential dewatering of the borrow pit 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 the small nature of the inflows from the mineral subsoils (as already determined by trial pitting and investigation drilling) and the competent and low permeability of the SILTSTONE/SANDSTONE bedrock.

No groundwater level impacts are predicted from the construction of the underground cabling trench, access roads, substation extension, compound or met mast due to the shallow nature of the excavation (i.e., 0 -~1.2m).

Pathway: Groundwater flow paths.

Receptor: Groundwater levels, local aquifer and Milltown Malbay GWB.

Pre-Mitigation Potential Effect: Negative, direct, slight, brief, likely effect on groundwater levels and is Not Significant. No effects on GWBs will occur due to the small dewatering requirements.

Impact Assessment/Proposed Mitigation Measures by Design:

The proposed borrow pit and Proposed Turbine foundations will be in competent SILTSTONE/SANDSTONE bedrock which is generally unproductive in terms of groundwater flow.

Geophysical surveys carried out at the Proposed Wind Farm Site identified competent, strong SANDSTONE/SILTSTONE at shallow depths ranging from 1 to 3mbgl. No bedrock faults or fractures were identified by the geophysical surveys. The geophysical survey demonstrates that the bedrock proposed for extraction at the proposed borrow pit is strong, competent and fit for the purpose of rock extraction and follow-on permanent storage of peat/spoil.

The 9 no. turbine bases are also located in the same bedrock geology albeit excavations will be shallower (3 – 3.5mbgl) and any inflows will be limited to subsoil seepage.

Also, the topographical and hydrogeological setting of the proposed borrow pits and Proposed 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 dewatering is defined 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 area is located on the top of rocky local hills/ridges where the ground elevation is 240mOD and therefore are rock outcrops (which are visible to the eye);
- These elevations are above the elevations of the local valleys and streams;
- The proposed borrow pit will be between approximately 8 – 10mbgl which is notable. However, in the context of the topographical/elevated setting of the proposed borrow 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;
- Regional groundwater flow regime, i.e. large volumes of groundwater flow, will not 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 pit 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 Proposed Turbine bases.

No mitigation is required with regard dewatering.

Residual Effects: Negative, direct, slight, brief, likely effect on groundwater levels. No effects on GWBs will occur due to the small dewatering requirements

Significance of 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. For the reasons outlined above, no significant effects on groundwater levels will occur. There will be no negative effect on groundwater bodies.

9.5.2.4 Excavation Dewatering and Potential Impacts on Surface Water Quality

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

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, borrow pit 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 (Glendine River, Kildeema River, Inagh River and Annagh River).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short term, likely effect to surface water quality and is Not Significant.

Proposed Mitigation Measures:

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

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;

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

Residual Effect: The residual effect is negative, imperceptible, indirect, short term, likely impact 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 Release of Hydrocarbons During Construction and Storage

Hydrocarbons will be required for the Proposed Wind Farm Site, Proposed Grid Connection Site and Proposed Enhancement Site therefore all 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 and surface water (Glendine River, Kildeema River, Inagh River and Annagh River).

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, likely effect to local groundwater quality and is Not Significant.

Indirect, negative, moderate, short term, unlikely effect to surface water quality and is Not Significant.

Proposed Mitigation Measures:

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

- Minimal refuelling or maintenance of construction vehicles or plant will take place on site. Where possible, off-site refuelling will occur at a controlled fuelling station;

- On-site re-fuelling will be undertaken using a fuel truck with spill kits kept on site for accidental leakages or spillages;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuels stored on-site will be minimised. All storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The transformer within the proposed substation extension will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency response plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan (which is contained in **Appendix 4-5**).

Residual Effect: The residual effect is negative, imperceptible, indirect, short term, unlikely effect to local groundwater quality and negative, imperceptible, indirect, short term, unlikely effect to surface water quality.

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

9.5.2.6 Groundwater and Surface Water Contamination from Wastewater Disposal

Wastewater management will be required for both the Proposed Wind Farm Site and Proposed Grid Connection Site and therefore both are assessed herein.

Release of effluent from domestic wastewater treatment systems has the potential to impact on groundwater and surface waters if site conditions are not suitable for an on-site percolation unit.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Down-gradient well supplies, groundwater quality and surface water quality (Glendine River, Kildeema River, Inagh River and Annagh River).

Pre mitigation Effect:

Indirect, negative, significant, temporary, unlikely effect to water quality and is Significant.

Proposed Mitigation Measures:

- It is proposed to manage wastewater from the staff welfare facilities in the control buildings by means of a sealed storage tank, with all wastewater being tankered off site by permitted waste collector to wastewater treatment plants. It is not proposed to treat wastewater on-site.

Residual Effect: No residual effect.

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

9.5.2.7 Release of Cement-Based Products

Cement will be required for both the Proposed Wind Farm Site and Proposed Grid Connection Site 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 ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Peat ecosystems are dependent on low pH hydrochemistry. They are extremely sensitive to 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.

Pathway: Site drainage network.

Receptor: Surface water and peat water hydrochemistry.

Pre-Mitigation Effect: Indirect, negative, moderate, short term, likely impact to surface waters (Glendine River, Kildeema River, Inagh River and Annagh River) and groundwater and is Not Significant.

Proposed Mitigation Measures:

- No batching of wet-cement 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 cement 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; and,
- At proposed turbine foundations, sand blinding, DPM, and lean-mix blinding are used to vertically contain the concrete. While the concrete is contained laterally by temporary/permanent shuttering. The concrete cures within 72hrs.

Residual Effect: The residual effect is negative, imperceptible, indirect, short term, unlikely impact to surface water and groundwater.

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

9.5.2.8 Morphological Changes to Surface Water Courses & Drainage Patterns

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 Site underground cable route. Only the Proposed Wind Farm Site 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 proposed 5 no. new watercourse crossing and proposed upgrade of 1 no. existing (clear span bridge design) and will be required to facilitate the Proposed Wind Farm Site development infrastructure.

Pathway: Site drainage network.

Receptor: Surface water flows (Inagh River and Glendine River), stream morphology and water quality.

Pre-Mitigation Potential Effect: Negative, direct, slight, long term, likely effect on surface water flows and drainage patterns and is Not Significant. In the absence of mitigation measures, there would be no potential for significant effects.

Proposed Mitigation Measures:

- Watercourse crossings 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[5] 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

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

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 (approx. 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.

Residual Effect: The residual effect will be neutral, long-term effect 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.

9.5.2.9 Potential Hydrological Impacts on Designated Sites

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

The designated sites that are hydraulically connected (surface water flow paths only) to the Proposed Project include the Mid-Clare Coast SPA (Site Code 004182), Carrowmore Point to Spanish Point and Islands cSAC (Site Code 001021), White Strand/Carrowmore Marsh (Site Code 001007) and Inagh River Estuary SAC.

From a hydrological perspective there will be low risk of impact on these marine/estuarine designated sites as they are not freshwater dependant ecosystems and therefore less sensitive to sediment input which is the main potential pollutant from the Proposed Project, particularly during construction. Coastal environments are high energy environments that transport tonnes of marine sediments on a daily basis. 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, slight, short-term, likely effect on designated sites and is Not Significant. In the absence of mitigation measures, there is no potential for significant effects.

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 above for the full description of these measures and how they will be applied).

- The proposed mitigation measures 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 Project 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 9.5.2.7).

As stated in Section 9.5.2.2 above, there could potentially be a residual "negative, imperceptible, indirect, 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.

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

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

9.5.2.10 Potential Effects on Local Groundwater Well Supplies

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

In the area of the Site, private dwelling houses (potential well locations) are mainly located along public roads that surround 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 pit.

Construction of the Proposed Grid Connection Site 33kV underground cabling will not have the potential to effect local wells due to the shallow nature of the works along the Proposed Grid Connection Site.

The closest distance between a proposed turbine or borrow pit location and a downstream dwelling house (potential well) is >500m. In order to be conservative and following the precautionary 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 >500m setback distance from potential wells, significant effects on private wells are unlikely.

Pathway: Groundwater flowpaths.

Receptor: Private Groundwater Supplies.

Pre-Mitigation Potential Effect: In the absence of mitigation measures, there will be no effects on local groundwater well supplies.

Impact Assessment:

The Proposed Project will not give rise to significant effect on any potential down-gradient private wells for the following project design and geological reasons

- The large set back distances between turbine and borrow pit location and downstream potential well locations due to project design (>500m);

- The short groundwater flowpath distances (30 – 300m);
- The Proposed Project design 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 Site;
- Localised groundwater flow patterns in the glacial deposits which is towards local streams that flow through the Site;
- Groundwater flow patterns are expected towards the internal watercourses that drain the Proposed Wind Farm Site; and,
- The shallow excavation depths required for the Proposed Grid Connection Site underground cable route.

Proposed Mitigation Measures: None required

Residual Effects: No residual effects on local groundwater wells.

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

9.5.2.11 Potential Effects on WFD status (Proposed Project)

Refer to **Appendix 9-3** for the WFD Compliance Assessment Report.

WFD status and Risk Results for downstream river waterbodies and the underlying GWB are presented in Section 9.3.13 and Section 9.3.12 above.

Due to the hydrogeological regime at the Site (poorly productive bedrock, low recharge regime and short groundwater flowpath distances), the potential to negatively affect the WFD status of the Milltown Malbay GWB is very low, even in the absence of mitigation.

Without mitigation the proposed construction works do have the potential to adversely impact on surface water quality which may negatively impact on the WFD status of these downstream surface waterbodies.

The objectives of the WFD require that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. This is reflected in the strict mitigation measures in relation to maintaining a high quality of surface water from the Site will ensure that the status of surface waterbodies in the vicinity of the Proposed Project will be at least maintained regardless of their existing status. This is also reflected in the supporting WFD Compliance Assessment Report (**Appendix 9-3**).

Pathways: Drainage and surface water discharge routes.

Receptors: Milltown Malbay GWB and Surface waters (Inagh River, Annagh River, Annageeragh River, Glendine River, Kildeema River and Doo Lough) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on river waterbody status and is Not Significant. No effects on GWB WFD status will occur. In the absence of mitigation measures, there will be no potential for significant effects on downstream river waterbodies or the underlying GWB.

Proposed Mitigation Measures:

Comprehensive surface water mitigation and drainage controls are outlined in Section 9.5.2.1 (Felling of Coniferous Plantations), Section 9.5.2.2 (Earthworks), Section 9.5.2.4 (Excavation Dewatering), Section 9.5.2.5 (Hydrocarbons), Section 9.5.2.7 (Cement-based Products) and Section 9.5.2.8 (Morphological Changes to Watercourses). These will ensure the protection of surface water quality and flows in all downstream receiving watercourses.

Residual Effect:

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 WFD status will occur.

Significance of Effects: For the reasons outlined above, and with the implementation of the proposed mitigation, no significant effects on waterbody WFD status will occur.

9.5.2.12 Potential Effects from the Use of Siltbuster (Proposed Project)

Both the Proposed Wind Farm Site and Proposed Grid Connection Site may incorporate 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.

Proposed Project 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 about 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 a site in northwest Mayo is provided in **Figure 9-10** below.

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).

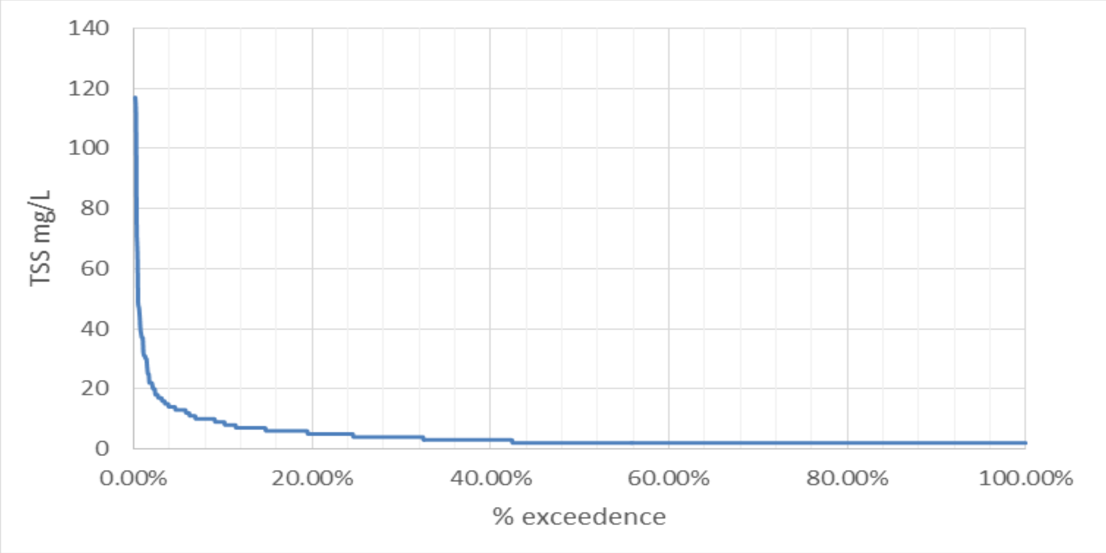


Figure 9-10 : TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Inagh River, Annagh River, Glendine River and Kildeema River) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on river waterbody and designated sites and associated dependent ecosystems and is Not Significant.

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 reagents, so overdosing cannot occur;
- Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff will be carried out, which 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 will be used at very sensitive sites (i.e. upstream of SACs).

Residual Effects: 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 occur. In fact, we consider that the use of siltbuster systems has a significant positive effect in respect of surface water quality.

9.5.2.13 Potential Effects from Earthworks Works and Watercourse Crossings (Proposed Grid Connection)

The Proposed Grid Connection Site comprises approximately 7.1km of 33kv underground cabling and 15 no. existing watercourse crossings along private roads. 4 no. of the watercourses are EPA mapped watercourses with the rest being small unmapped watercourses and drains.

All watercourse crossing locations the cable will be placed either underneath or above the bridge structure or by Horizontal Directional Drilling (HDD). No in-stream are proposed at any existing crossing location.

Pathway: Surface water flowpaths/groundwater paths.

Receptor: Down-gradient water quality (Inagh River, Kildeema River and Annagh River).

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect to surface water quality and is Not Significant. In the absence of mitigation measures, there will be no potential for significant effects on downstream surface waters.

Proposed Mitigation Measures:

Pre-commencement Temporary Drainage Works:

Prior to the commencement of the cable trenching or crossing works 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; and,
- A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside a watercourse 50m buffer zone.

The following mitigation measures will be implemented for the proposed 33kV 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 within 100m of a watercourse crossing;
- No concrete truck chute cleaning is permitted along the Proposed Grid Connection Site underground cabling route;
- 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;
- 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: The residual effect will be negative, imperceptible, indirect, temporary, likely effect on surface water quality.

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

9.5.2.14 Potential Effects on Wetland Hydrology (Proposed Wind Farm)

Only the Proposed Wind Farm Site infrastructure is located in areas of bog and therefore only the Proposed Wind Farm Site is assessed in this section.

Construction phase activities such as excavations, temporary dewatering, drainage installation and peat/spoil storage have the potential to affect local wetland hydrology.

Proposed Wind Farm Site infrastructure is located on blanket bog that has been drained and planted over with coniferous forestry and therefore the baseline peatland hydrology is already heavily modified.

Due to the already drained nature of the peat, no significant additional effects on wetland hydrology will occur.

Pathways: Surface Water and Groundwater flowpaths.

Receptors: Intact bog wetland hydrology.

Pre-Mitigation Potential Effect: Negative, imperceptible to slight (the potential effect varies spatially), direct/ indirect, short to long-term, likely effect on intact bog wetland hydrology and is Not Significant. In the absence of mitigation measures, there will be no potential for significant effects.

Impact Assessment:

As assessed in Section 9.5.2.3 above (groundwater level effects), no significant effects or long-term effects on (deep regional) groundwater levels will occur due to the relatively shallow depth of the gravity foundations (3 – 3.5m deep) and the low permeability nature of the cutover peat and glacial till overburden to be excavated. Significant groundwater inflows into turbine excavations will not occur for these reasons.

Any effects on groundwater levels will only be for a temporary basis during the construction work. Groundwater level effects are unlikely to be perceptible beyond 10m from the turbine base excavation. Once construction is completed and the works area reinstated, the local groundwater levels and peat waters levels (shallow water table) will return to baseline conditions.

2.3km of existing forestry access track for the Proposed Wind Farm Site will also reduce the requirement for new road excavations, thereby help maintain the baseline hydrology of the Site.

All proposed new access track will largely be excavated in shallow peat (average depth 0.8m) which was found to be heavily drained.

No specific mitigation measures for wetland hydrology are required.

Residual Effect: Due to the prevailing hydrogeology/wetland hydrology at the Proposed Wind Farm Site as well as the local and temporary nature of the proposed excavation works as well, final effects across the Proposed Wind Farm Site on wetland hydrology will be negative, imperceptible, direct/indirect and short term.

Significance of Effects: For the reasons outlined above, effects on wetland hydrology will be imperceptible.

9.5.2.15 Potential Effects from the Proposed Biodiversity Management and Enhancement Plan

The Proposed Enhancement Site comprises areas of Peatland Restoration, Marsh fritillary Enhancement (grazing management) and Hen Harrier Habitat Enhancement (conifer felling areas and grassland management areas).

The identified areas of existing forestry will be permanently removed. The timber, brash and stumps will be collected and removed off-site. The area will be allowed to revert to peatland habitat. Pre-mature felling of forestry will be undertaken before the first breeding season of the construction phase of the project programme. This would allow time (i.e. min. three growing seasons) for the clear-felled site to revegetate in advance of the operational phase. Thereby ensuring replacement habitat would be available should the predicted displacement effect occur.

Some of these proposals will disturb local peat, soil and subsoil deposits 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. Blocking of local drains using peat dams and/or plastic dams will be carried out as part of the 'Forest to Bog' enhancement works (see Section 4.4.1 of the BMEP). Given the gently sloping topography and small size of drains and furrows, there will be no potential to negatively alter the hydrological regime of the Site, other than localised rewetting.

Pathway: Drainage and surface water flows

Receptor: Surface water (Glendine River, Kildeema River, Inagh River, Annagh River, Annageeragh River and Doo Lough).

Pre-Mitigation Potential Effect: Negative, direct, slight, temporary, likely effect on water quality due to disturbance associated with proposed restoration works and is Not Significant. In the absence of mitigation measures, there will be no potential for significant effects on downstream surface waters.

Proposed 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. Refer also to Section 9.5.2.1 above for tree felling mitigation.

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 areas will be walked before a machine goes off-road;
- Bog mats will be used where the excavator is required to travel over wet ground;
- A low ground pressure excavator with wide tracks (1.9m or greater) will be used to reduce compaction of the peat and subsoils.; and,
- Standard tree felling water quality protection mitigation as presented in Section 9.5.2.1 above will be employed.

Post-Mitigation Residual Effect: With the implementation of mitigation measures outlined above the residual effect will be a negative, temporary, direct, imperceptible, likely effect on downstream surface water quality.

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

9.5.2.16 Surface Effects on Doo Lough Public Water Supply (PWS)

Doo Lough, which exists downstream of Area G of the Proposed Enhancement Site (Hen Harrier Habitat Enhancement), is used as public water supply for the west Clare area. None of Proposed Wind Farm Site or Proposed Grid Connection Site is located in the surface water catchment to Doo Lough.

However, due to the largely non-invasive nature of the Proposed Enhancement Site works the potential for effects on the water environment is low.

Pathway: Local drainage network.

Receptor: Doo Lough PWS abstraction.

Pre-Mitigation Potential Effect Indirect, negative, imperceptible, short term, unlikely effect and is Not Significant. In the absence of mitigation measures, there will be no potential for significant effects on downstream surface waters.

Impact Assessment & Proposed Mitigation Measures:

As stated previously in the chapter, a comprehensive surface water management plan has been prepared for the Proposed Project, and this will ensure that surface water runoff from the developed areas of the Site will be of a high quality and will therefore not impact on the quality of downstream rivers and lakes. Refer to Section 9.5.2.16 above for proposed mitigation measures at the Proposed Enhancement Site.

During the layout optimisation process, all surface waters at the site were classified as very sensitive. Very sensitive surface waters are receptors of high environmental importance such as designated sites (i.e. NHA or SAC), or public drinking water supplies. The surface waters at the Proposed Project were applied the highest possible sensitivity rating and appropriate mitigation measures which include avoidance and best practice engineering design measures are proposed to avoid significant impacts.

In addition, large lakes by their nature are natural sinks for suspended sediments that are transported in by rivers and streams. The retention time of water in lakes the size of Doo Lough (area of approximately 1.3km^2) would be significant and this would ensure that the majority of suspended sediments would settle out prior to the water leaving the lake (it should be noted that the Doo Lough abstraction is at the outfall end of the lake and therefore water which enters via streams must pass through the entire length of the lake before it is abstracted and therefore attenuation is maximised).

To demonstrate the water retention capacity of Doo Lough the volume of the lake is estimated using a conservative average depth of 1.5m. Based on a plan area of 1.3km^2 the total lake volume would be calculated at 1,950,000m^3. Based on a 5%ile flow of 29,880m^3/hr (EPA Hydro-tool) for the Annageeragh River at the lake outfall, there would be a retention time 65 hours. Based on a 50%ile flow of 7,416m^3/hr, the retention time would be 263 hours.

For comparison purposes, the EPA guidance document - *Environmental Management in the Extractive Industry (Non-Scheduled Minerals)* recommends for the removal of fine sized silt particles (0.004mm) settlement ponds should have a minimum 24-hour retention period.

It should be noted that the Proposed Enhancement Site water quality mitigation (refer to Section 9.5.2.16 above) does not rely on the assimilative capacity of streams or lakes to reduce potential water quality impacts. The potential impacts on surface water quality of local streams were determined to be imperceptible to slight and only on a temporary basis. Therefore, surface water quality impacts on the downstream Doo Lough will not occur and therefore impacts on the Doo Lough surface water abstraction will also not occur.

Post Mitigation Residual Effect: No residual effects on Doo Lough PWS will occur.

Significance of Effects: No significant effects on Doo Lough PWS will occur.

9.5.3 Operational Phase – Likely Impacts and Mitigation Measures

9.5.3.1 Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surfaces

Hardstand emplacement will be required at the Proposed Wind Farm Site and Proposed Grid Connection Site. Both are assessed herein.

The potential for increased surface water runoff is the primary potential impact during the operational phase of the Proposed Project.

Progressive replacement of the vegetated surface with impermeable surfaces will decrease the permeability of the ground within the Site footprint (i.e., turbine bases, hardstandings, and to a lesser extent the new access roads) and substation extension. The permeability along the internal underground cabling route through the Proposed Wind Farm Site will not be significantly altered, as the fill material will not be compacted.

The emplacement of the proposed permanent development footprint (8.7ha), 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 1,479m^3/month or 48m^3/day (**Table 9-17**). This represents a potential increase of approximately 0.077% 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 a relatively small area of the overall Site being developed. Specifically, the built infrastructure footprint of the Proposed Project is approximately 8.7ha, representing 0.69% of the total area of the Site (1,260ha).

The additional volume is low due to the fact that the runoff potential from the Site is naturally high (90%). Also, this calculation assumes that all hardstanding areas will be impermeable which considered to be a worst-case scenario. The increase in runoff from most of the development catchment will therefore be negligible and this is before mitigation measures will be put in place. Therefore, there will be no risk of exacerbated flooding down-gradient of the site.

Table 9-17: Baseline Site Runoff V Development Runoff

Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Footprint Area (m^2)	Footprint Area 100% Runoff (m_3) (m^3)	Footprint Area 95% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
1,928,424	62,207	87,000	14,795	13,315	1,479	48	0.077

Pathway: Site drainage network.

Receptor: Surface waters (Glendine River, Kildeema River, Inagh River and Annagh River) and dependant ecosystems.

Pre-Mitigation Potential Effect: Negative, imperceptible, long term, likely effect on all downstream surface water bodies and is Not Significant.

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:

- Interceptor drains will be maintained 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 will 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 will be designed in consideration of the greenfield runoff rate.

Residual Effect: Direct, negative, neutral, long term, likely effect.

Significance of Effects: No significant effects on surface water quality or quantity will occur during the operational phase of the Proposed Project.

9.5.3.2 Potential Effects from Runoff

Site runoff will occur as a result of the built infrastructure of the Proposed Project.

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 refuelling works will be undertaken on site during the operational phase.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Glendine River, Kildeema River, Inagh River and Annagh River) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, long term, likely effect on surface water quality and is Not Significant.

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 and turbine base areas) 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 (refer to **Appendix 4-3**).

Post Mitigation Residual Effects: The residual effects will be negative, imperceptible, indirect, short term, likely 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

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 by the Proposed Project.

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.**

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

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. 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 peatland vegetation/scraw or poorly humified peat 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 turbine infrastructure, as these will be utilised by ongoing forestry works and by local farmers.

The electrical cabling connecting the turbines to the substation extension 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 Proposed 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 substation extension will be retained by EirGrid 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 are envisaged during the decommissioning stage of the Proposed Project.

9.5.5 Risk of Major Accidents and Disasters

The main risk of Major Accidents and Disasters (MADs) at peatland sites is related to peat stability. A Geotechnical and Peat Stability Assessment (**Appendix 8-1**) has been completed for the Proposed Wind

Farm Site and Proposed Grid Connection Site it concludes that the Site has an acceptable margin of safety, and there is a negligible/none risk of peat instability/failure at the Site.

Flooding can also result in downstream MADs. However, due to the small scale of the Proposed Project footprint with regard the overall Site area (0.67%), the naturally high runoff rates, the avoidance of fluvial flood zones (see Section 9.3.6) and with the implementation of the proposed drainage measures, the increased flood risk associated with the Proposed Project is imperceptible. Please refer to **Appendix 9-1** for the site-specific flood risk assessment report.

9.5.6 Assessment of Potential Health Effects (Proposed Project)

Potential health effects arise mainly through the potential for surface and groundwater contamination which can have negative effects on public and private water supplies. Notwithstanding this, the Proposed Project design and mitigation measures ensures that the potential for effects on the water environment will not be significant.

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 been caried out for the Proposed Project, summarised in Section 9.3.6. The lack of Proposed Project infrastructure encroachment into flood zones, combined with the assessment of changes in permeable surfaces (Section 9.5.3.1) demonstrates that the risk of the Proposed Project contributing to downstream flooding is imperceptible. On-site (construction, operation and decommissioning phase) drainage control measures will ensure no downstream increase in local flood risk.

Proposed works within the Doo Lough catchment (public water supply abstraction) is limited to the Proposed Enhancement Site and therefore pose no risk to human health.

9.5.7 Cumulative Impacts

9.5.7.1 Introduction

This section presents an assessment of the potential hydrological cumulative effects associated with the Proposed Project itself as well with 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 bedrock and localised groundwater flowpaths) and the near-surface nature of construction activities, cumulative effects with regard to groundwater quality or quantity arising from the Proposed Project are assessed as not likely.

The potential for cumulative effects will typically be much higher during the construction phase of the Proposed Project as this is when earthworks and excavations will be undertaken at the Site. Similarly, when assessing other developments for cumulative effects (i.e. proposed wind farms in the same catchment where the construction phase could overlap with the construction phase of the Proposed Project), the construction phase will be the worst case period for potential effects.

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.

The cumulative Water Study Area is delineated by the catchments of the Annagh River (which encompasses the Glendine River and Kildeema River catchments) and the Inagh River as these are the catchments in which the Proposed Wind Farm Site and Proposed Grid Connection Site are located. A small portion of the Proposed Enhancement Site extends into the Annageeragh River catchment, but due lack of physical wind farm infrastructure no cumulative effects will occur.

9.5.7.2 Cumulative Effects of the Proposed Project

The potential for cumulative effects with regard elements of the Proposed Project itself (i.e. Proposed Wind Farm Site, Proposed Grid Connection Site and Proposed Enhancement Site) is assessed herein.

The majority of the Proposed Turbines (6 no. of 9 proposed turbines) are located in the Inagh River catchment while the majority of the Proposed Grid Connection Site underground cable route (5.6km of the total 7.1km) and substation extension are located in the Annagh River catchment. The fact the works associated with the Proposed Project are concentrated in separate catchment areas, means no significant hydrological cumulative effects will occur.

Also, the fact that the Proposed Grid Connection Site 33kV underground cabling is mainly along existing private access roads along with the lack of in-stream works, the intermittent and transient nature of the trenching excavations, the Proposed Grid Connection Site is not expected to contribute to hydrological cumulative effects.

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

9.5.7.3 Cumulative Effects with Other Wind Farms

A list of other wind farm developments in the Proposed Project Water Study Area is shown in **Table 9-18** below. A cumulative impact assessment was undertaken regarding other wind farm developments located within the Annagh River and Inagh River catchments.

In terms of the potential impacts of developments on downstream surface water bodies, the biggest risk is during the construction phase of the Proposed Project as this is the phase when earthworks and excavations will be undertaken at the sites.

However, within the Annagh River catchment, the Slievecallan Wind Farm is already operational. Therefore, there is no risk of a construction overlap with the operational Slievecallan Wind Farm and the Proposed Project. Presently, there is no proposals or permissions for other wind farm development in the Annagh River catchment

In terms of operational phase hydrological effects, the total number of turbines that could potentially be operating within the Annagh River catchment is 24 no. (which includes 3 no. from the Proposed Project and 21 no. from the Slievecallan Wind Farm). The total catchment area of the Annagh River catchment is ~105km^2 and therefore this equates to 1 turbine for approximately every ~4.4km^2 which is considered to be low density and therefore, effects on the Annagh River catchment are not anticipated.

The majority of Proposed Turbines are located in the Inagh River catchment (6 no. of 9). However, other wind farm development in the Inagh River catchment is limited to 8 no. operational turbines at Slievecallan Wind Farm and 4 no. turbines from the future proposed Illaunbaun Wind Farm.

In terms of operational phase hydrological effects, the total number of turbines that could potentially be operating within the Inagh River catchment is 18 no. (which includes 6 no. from the Proposed Project, 4 no. from the proposed Illaunbaun Wind Farm and 8 no. from Slievecallan Wind Farm). The total catchment area of the Inagh River catchment is ~140km^2 and therefore this equates to 1 turbine for approximately every ~8km^2 which would not be considered high density. Therefore, effects on catchment hydrology and water quality are not anticipated.

No hydrological cumulative effects with respect other windfarm developments is anticipated due to the fact that majority of the other wind farm turbines are constructed and also due to the low turbine density within the two regional catchments.

Table 9-18: List of Other WF Developments Assessed for Hydrological Cumulative Impacts

Regional Catchment	Wind Energy Developments	Total Turbine No.	Turbine No. in Inagh Catchment
Inagh River	Slievecallan Wind Farm (Operational)	29	8
	Illaunbaun Wind Farm (Proposed)*	6	4
Totals		**35**	**12**
Annagh River	Slievecallan Wind Farm (Operational)	29	21
Totals		**29**	**21**

*It is noted that the proposed Illaunbaun Wind Farm is subject to 2 separate planning applications (5 no. turbines and 1 no. turbine) as outlined in Chapter 2 Section 2.9 of the EIAR, for the purposes of the assessment these are described as a single 6 no. turbine wind farm.

9.5.7.4 Cumulative Effects with Agriculture

According to Corine land cover mapping (www.epa.ie) (2018) the Water Study Area catchments are largely agricultural catchment.

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.

9.5.7.5 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 Proposed Project felling areas are spread across several sub-catchments, thereby reducing the potential for cumulative effects.

In addition, the mitigation measures detailed for the construction, operation and decommissioning phases of the Proposed Project will ensure the protection of downstream surface water quality.

A review of the Department of Agriculture, Food and the Marine Forestry License Viewer shows a number of felling licenses active within the Water Study Area. The forestry subject to these licenses may or may not be felled before the Proposed Project goes to construction stage. Therefore, a search of the active felling licenses will be carried out pre-construction and the Applicant will liaise with forestry contractors to carry out the felling related to the Proposed Project at times that minimise the potential for cumulative effect arising from commercial forestry felling within the same sub-catchments.

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

9.5.7.6 Cumulative Effects with Turbary Peat Cutting Activities

Private peat cutting on turbary plots will likely continue in the vicinity of the Proposed Project site and in the wider cumulative area. The construction phase of the Proposed Project is likely to interact with these turbary activities and result in a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

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

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

9.5.7.7 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).

9.5.8 Conclusion

During each phase of the Proposed Project (construction, operational 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 4-5**).

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

Proposed Biodiversity Management and Enhancement Plan 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 and with other wind farm developments.

9.5.9 EIA Classification Summary

Please see the below table for a summary of all identified impacts for the Proposed Project relating to water.

Table 9-19: Assessment Classification Summary

Topic	Pre-Mitigation Effect	Mitigation Section Reference	Residual Effect	Significance
Construction Phase				
Clear Felling of Coniferous Plantation and Potential Surface Water Quality Effects (Proposed Project)	Temporary, Slight, Negative	Section 9.5.2.1	Temporary, Imperceptible, Negative	Not Significant
Earthworks Resulting in Suspended Solids Entrainment in Surface Waters	Short Term, Significant, Negative	Section 9.5.2.2	Short-Term, Imperceptible, Negative	Not Significant
Potential Impacts on Groundwater Levels During Excavations	Brief, Slight, Negative	Section 9.5.2.3	Brief, Slight, Negative	Not Significant
Excavation Dewatering and Potential Impacts on Surface Water Quality	Short-Term, Moderate, Negative	Section 9.5.2.4	Short-Term, Imperceptible, Negative	Not Significant

Potential Release of Hydrocarbons during Construction and Storage	**Local Groundwater Quality:** Short-Term, Slight, Negative **Surface Water Quality**: Short-Term, Moderate, Negative	Section 9.5.2.5	Short-Term, Imperceptible, Negative	Not Significant
Groundwater and Surface Water Contamination from Wastewater Disposal	Temporary, Significant, Negative	Section 9.5.2.6	No residual effect	Not Significant
Release of Cement Base Products	Short-Term, Moderate, Negative	Section 9.5.2.7	Short-Term, Imperceptible, Negative	Not Significant
Morphological and Hydrological Effects due to Watercourse Crossing Works	Long Term Slight, Negative	Section 9.5.2.8	Long-Term Neutral	Not Significant
Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks and Watercourse Crossings	Temporary, Slight, Negative	Section 9.5.2.13	Temporary, Imperceptible, Negative	Not Significant
Potential hydrological Effects on Designated Sites (Proposed Grid Connection)	Short-Term, Slight, Negative	Section 9.5.2.9	No residual effect	Not Significant
Effects of Construction Works on the WFD Status of Downstream Waterbodies	Temporary, Slight, Negative	Section 9.5.2.11	Short-Term, Imperceptible, Negative	Not Significant
Use of Siltbuster and Impacts on Downstream Surface Water Quality	Temporary, Slight, Negative	Section 9.5.2.12	Temporary, Imperceptible, Negative	Not Significant
Potential Hydrological/Water Quality Effects on River Waterbody Drinking Water	Short-Term, moderate, Negative	Section 9.5.2.16	Short-Term, Imperceptible, Negative	Not Significant

Supply Abstractions (Proposed Project)				
Potential Effects on Local Groundwater Well Supplies from Excavations (Proposed Project)	No effects	Section 9.5.2.10	No effects	Not Significant
Potential Effects on Wetland Hydrology	Short-term to Long-Term, imperceptible to Slight, Negative	Section 9.5.2.14	Short-term to Long-Term, imperceptible, Negative	Not Significant
Biodiversity Management and Enhancement Plan (BMEP) and potential hydrological/water Quality Effects	Temporary, Slight, Negative	Section 9.5.2.15	Temporary, Imperceptible, Negative	Not Significant
Operational Phase				
Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surface (Proposed Wind Farm)	Long-Term, Imperceptible, Negative	Section 9.5.3.1	Long-Term, neutral	Not Significant
Runoff resulting in Suspended Solids Entrainment in Surface Waters	Long-term, Slight, Negative	Section 9.5.3.2	Long-term, Imperceptible, Negative	Not Significant
Potential Effects on WFD Status	No effect	Section 9.5.3.3	No effect	No Effect
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	Not Significant	Not Significant	Not Significant

	construction phase works.			