9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of a Proposed Wind Farm and Proposed Grid Connection (i.e. the 'Proposed Project') at Cooloo and adjacent townlands, Co. Galway, on water aspects (hydrology and hydrogeology) of the receiving environment.

The Proposed Project (Proposed Wind Farm and Proposed Grid Connection) is described in full in Chapter 4 of this Environmental Impact Assessment Report (EIAR).

Where the 'Proposed Wind Farm site' is referred to, this refers to the 9 no. turbines and associated foundations and hard-standing areas, turbine delivery route (TDR) accommodation works, access roads, temporary construction compound, underground cabling, peat and spoil repository areas, wind farm drainage, biodiversity enhancement and all ancillary works.

The 'Proposed Grid Connection' relates to the approximately 21km underground 110kV cabling route, on-site 110kV substation, proposed access road, battery energy storage system (BESS) and all associated infrastructure.

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

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 the construction, operational and decommissioning phases of the Proposed Project;
- Proposed mitigation and monitoring measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects following the implementation of mitigation measures; and,
- Assess the potential cumulative effects of the Proposed Project itself as well as other local developments (as described in Chapter 2 of this EIAR).

The Water Study Area for assessing the potential zone of impact and cumulative effects assessment is the River Clare catchment. The River Clare catchment is shown on

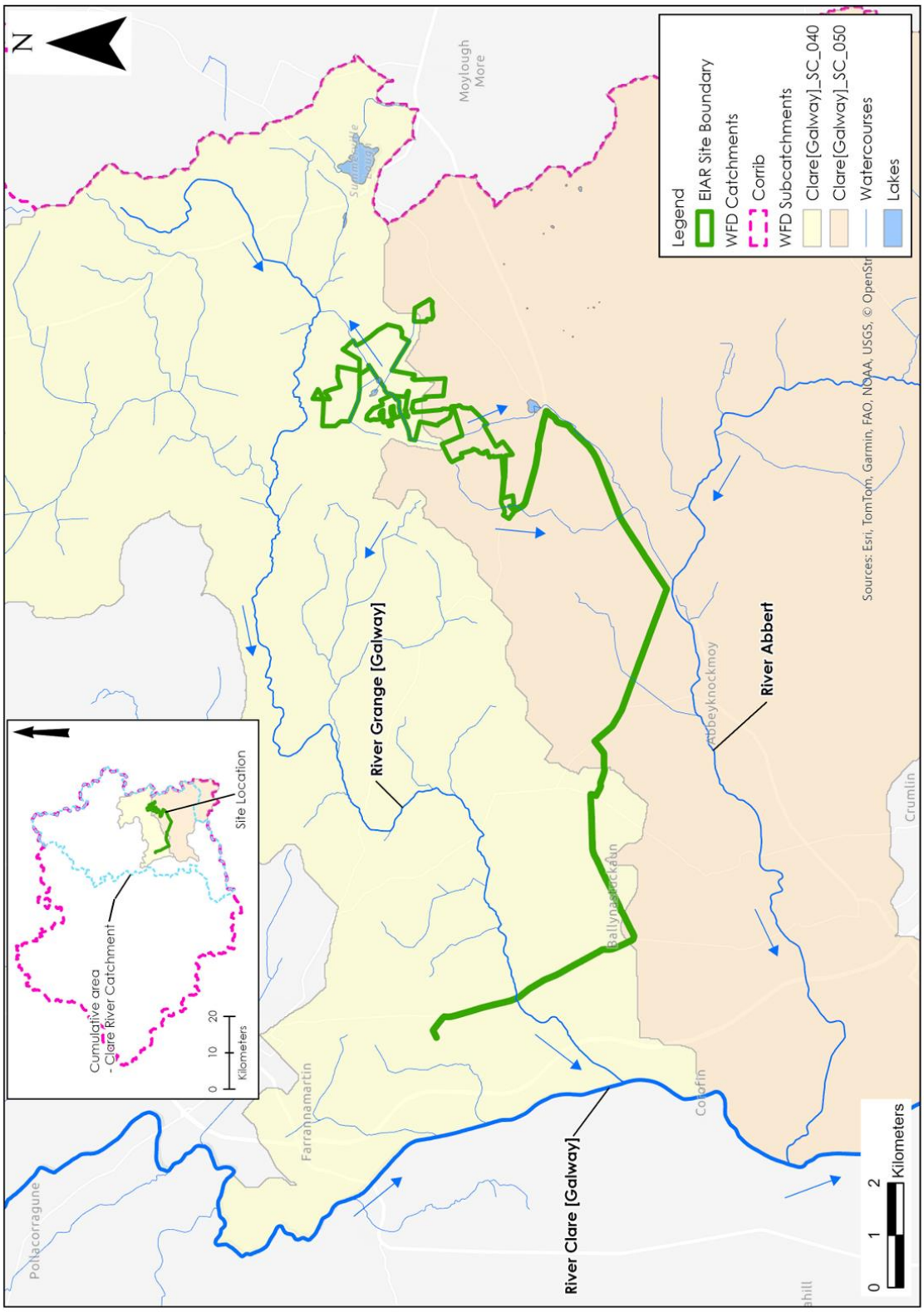


Figure 9-1: Regional Hydrology Mapbelow (Regional Hydrology Map)**.** The River Clare catchment has an area of approximately 1,030km^2. The River Clare catchment drains into Lough Corrib.

9.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice that 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 wetland hydrology and wind farm 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 17 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, karst hydrology and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed over 25 Source Protection Assessments for the GSI/NFGWSs, and for Irish Water and for private developments across the country in a wide variety of hydrogeological settings. 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 Ardderroo Wind Farm, Clonberne Wind Farm, and Oweninny Wind Farm, and over 60 other wind farm related projects across the country. David worked on his first wind energy project in 2010, and he has continued to work on similar projects since then.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is a Civil/Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. Michael has completed over 30 Source Protection Assessments for the GSI/NFGWSs, and for Irish Water, and for private developments across the country in a wide variety of hydrogeological settings. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, karst 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 Slievecallan Wind Farm, Seven Hills Wind Farm, Carrownagowan Wind Farm, and over 100 other wind farm related projects across the country. Michael worked on his first wind energy project in 2003, and he has continued to work on similar projects since then.

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. Subject matters raised by Consultees in their responses with respect to the water environment are summarised in **Table 9-1** below.

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

Consultee	Matters Raised - Description	Addressed in Sections
Geological Survey of Ireland (GSI)	*"Our records show that there is a groundwater drinking water abstraction: Mid-Galway Public Water Supply Scheme (PWS), with a source*	Sections 9.3.9, 9.3.10, 9.3.15, 9.4.1, 9.5.2.1 and 9.5.3.3.

Consultee	Matters Raised - Description	Addressed in Sections
	protection area within the proposed wind farm development study area". "*Key to groundwater protection in general, and protection of specific drinking water supplies, is preventing ingress of runoff to the aquifer. Design of wind farm drainage will need to be cognisant of the water scheme and the interactions between surface water and groundwater as well as run-off".* *"Appropriate design should be undertaken by qualified and competent persons to include mitigation measures as necessary, such as SUDs or other drainage mitigation measures".* *"Also, any excavation/cuttings required should ensure that groundwater flow within the zones of contribution to the groundwater abstraction points is not disrupted, resulting in diminished yields. Note that there could be other groundwater abstractions in the locality for which Geological Survey Ireland has not undertaken studies, and a robust assessment should be undertaken by qualified and competent persons".* *"Given the nearby drinking water sources (Public Water Scheme), the effects of any potential contamination as a result of the wind farm development would need to be assessed".* *"Our Karst Viewer indicates there are numerous karst landforms including enclosed depressions within the proposed wind farm development study area".* *"The Groundwater Data Viewer indicates an aquifer classed as a 'Regionally Important Aquifer - Karstified (conduit)' underlies the proposed wind farm development study area. The Groundwater Vulnerability map indicates the range of groundwater vulnerabilities within the area covered is variable. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability and 'Rock at or near surface' in your assessments, as any groundwater-surface water interactions that might occur would be greatest in these areas".*	
Department of Agriculture, Food and the Marine	*The interaction of these proposed* [felling] *works with the environment locally and more widely, in addition to potential direct and indirect impacts on designated sites and water, is assessed. Consultation with relevant environmental and planning authorities may be required where specific sensitivities arise (e.g. local authorities, National Parks & Wildlife Service, Inland*	Sections 9.3.14, 9.5.2.2 and 9.5.2.10

Consultee	Matters Raised - Description	Addressed in Sections
	Fisheries Ireland, and the National Monuments Service).	
HSE	*The proposed development 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 development. Measures to ensure that all sources and supplies are protected should be described.*	Section 9.3.15, 9.5.2.1, 9.5.2.11 & 9.5.3.3.
DAU	*"Wetlands are important areas for biodiversity and ground and surface water quality should be protected during construction and operation of the proposed development. The EIAR should include a detailed assessment of the hydrological impacts on wetlands from the proposed development".* *"Flood plains, if present, should be identified in the EIAR and left undeveloped to allow for the protection of these valuable habitats and provide areas for flood water retention (green infrastructure). If applicable the EIAR should take account of the guidelines for Planning Authorities entitled "The Planning System and Flood Risk Management" published by the Department of the Environment, Heritage and Local Government In November 2009".* *"A detailed hydrological assessment should be carried out in terms of the potential impacts arising from the proposed development on Natura 2000, notably Lough Corrib Special Area of Conservation (SAC) (Site Code: 000297) which has direct hydrological links as well as other Natura sites, Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs) within the zone of influence; noting that designated sites at some distance can be intrinsically linked and supported by the surrounding habitats (e.g. agricultural fields) and hydrological processes".*	Sections 9.3.9, 9.3.14, 9.5.2.10 and 9.5.2.16 **Appendix 9-1 Site Specific Flood Risk Assessment**
OPW	*"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*	Sections 9.3.6, 9.5.2.9 and 9.5.2.15 **Appendix 9-1 Site Specific Flood Risk Assessment**

Consultee	Matters Raised - Description	Addressed in Sections
	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". *"With regard to any proposed Grid Connection Route which may cross several water courses, if the cable and ducting are to be buried in the road, as they cross bridges over the water courses, and there is no interference with the opening in the bridge spanning the watercourse, then there is no issue. On the other hand, if it is proposed to pass the cable in its ducting through the opening of any bridge or culvert, this would be considered to be a modification of a bridge and it would require the consent of the Commissioners under Section 50 as mentioned above".* *"We would recommend that a flood risk assessment be carried out with regard to the proposed development and its construction. This should consider all sources, pathways and receptors of flood risk. This should be carried out in accordance with the principles set out in the guideline document "The Planning System and Flood Risk Management" as published by the Minister for the Environment, Heritage and Local Government and the Office of Public Works. Please be aware that this is a separate issue from the requirement to obtain Section 50 consent as mentioned above".*	
Uisce Éireann	*"At present, Uisce Éireann does not have the capacity to advise on the scoping of individual projects. However, in general the following aspects of Water Services should be considered in the scope of an EIA where relevant".* *Where the development proposal has the potential to impact an Uisce Éireann Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified as part of the report".*	Section 9.3.15, 9.5.2.1 and 9.5.3.3.

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 which transposes the provisions of the EIA Directive as amended by the Directive 2014/52/EU into Irish Law;
- S.I. No. 94/1997: European Communities (Natural Habitats) Regulations, 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. 41/1999: Protection of Groundwater Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 294/1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 74/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (repealed by 2000/60/EC in 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 2016;
- 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; and,
- S.I. No. 77/2019: European Communities Environmental Objectives (Surface Water) (Amendment) Regulations 2019.

9.1.5 Relevant Guidance

The Water Section of the EIAR is carried out in accordance with guidance contained in the following:

- Wind Energy Development Guidelines for Planning Authorities, 2006 (the Guidelines (DoEHLG, 2006)) and the Draft Revised Wind Energy Development Guidelines (DoEHLG, 2019);
- Environmental Protection Agency (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- European Commission (2017): Environmental Impact Assessment of Projects – Guidance on the Preparation of the Environmental Impact Assessment Report;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;

- National Roads Authority (2009): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- Forest Services (Draft) Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures;
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;
- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;
- 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);
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006.
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018);
- OPW (2009) The Planning System and Flood Risk Management;
- DOE/NIEA (2015): Wind Farms and Groundwater Impacts – A guide to EIA and Planning Considerations;
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017);
- Land Types for Afforestation (Forest Service, 2016b);
- Forest Protection Guidelines (Forest Service, 2002);
- Forest Operations and Water Protection Guidelines (Coillte, 2013);
- Forestry and Water Quality Guidelines (Forest Service, 2000b); and,
- Forests and Water, Achieving Objectives under Ireland's River Basin Management Plan 2018-2021 (DAFM, 2018).

9.2 Methodology

9.2.1 Desk Study

A desk study of the Proposed Project site ('the Site') and Water Study Area was completed prior to the undertaking of field mapping, walkover assessments and site investigations. The desk study involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the Site and Water Study area. The desk study has been checked and updated, where necessary, in September 2025. This included consultation and review of the following:

- Environmental Protection Agency databases (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann 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 12 (Geology of Longford/Roscommon). Geological Survey of Ireland (GSI, 2003);
- Geological Survey of Ireland (2003) – Clare-Corrib Groundwater Body Initial Characterization Reports;
- OPW Past Flood Event Mapping (www.floodinfo.ie);

- OPW Flood Extents Mapping and National Indicative Fluvial Mapping (www.floodinfo.ie/map/floodmaps);
- GSI/EPA Group Water Scheme and Public Water Scheme Zone of Contribution Reports; and,
- Aerial Photography, OSI 1:5000- and 6-inch base mapping.

9.2.2 Baseline Monitoring and Site Investigations

Walkover surveys, 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 15th August and 24th October 2022, 23rd and 28th March 2023, 20th and 21st August 2024, 22nd May, 8th July 2025 and 3rd September 2025.

The following reports were produced by Gavin and Doherty Geosolutions (GDG) in support of this application:

- Peat Stability Risk Assessment (**Appendix 8-1**)
- Geotechnical Karst Risk Assessment (**Appendix 8-2**)
- Grid Connection Ground Conditions Assessment (**Appendix 8-3**)
- Peat and Spoil Management Plan (**Appendix 4-2**)

As part of the Geotechnical Karst Risk Assessment a geophysical survey was carried out by Minerex Geophysics Ltd on 26th August 2025 (the geophysical survey report is included in the GDG Geotechnical Karst Risk Assessment report).

Site investigations the informed Water Section of the EIAR included the following:

- Walkover surveys, field-based karst mapping and hydrological mapping of the Site area was undertaken by HES whereby water flow directions and drainage patterns were recorded;
- A total of 306 no. peat probes were undertaken by HES, MKO, and GDG to determine the thickness and geomorphology of peat overlying parts of the Site;
- Trial pitting (26 no.) by GDG and gouge cores (10 no.) by HES to investigate soil, peat and mineral subsoil lithology;
- Investigation drilling (2 no. boreholes under supervision of HES) to determine the full geological profile of the Site (i.e. peat, mineral subsoil, and top of bedrock profile) and groundwater conditions;
- Field based karst feature mapping by GDG and HES;
- 2D Resistivity (ERT) survey (4 no. lines) and Seismic survey (1 no. location) by Minerex Geophysics Ltd;
- Continuous groundwater level monitoring at the 2 no. investigation boreholes by means of in-situ data loggers (pressure transducers) between October 2022 and February 2025;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) were taken to determine the origin of surface water flows (2 no. rounds);
- Surface water (2 no. rounds) and groundwater sampling (1 no. rounds) for baseline and hydrological/hydrogeological characterisation purposes; and,
- Surface water flow measurements of the primary watercourses that drain the Site.

9.2.3 Impact Assessment Methodology

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e., negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). 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 of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in

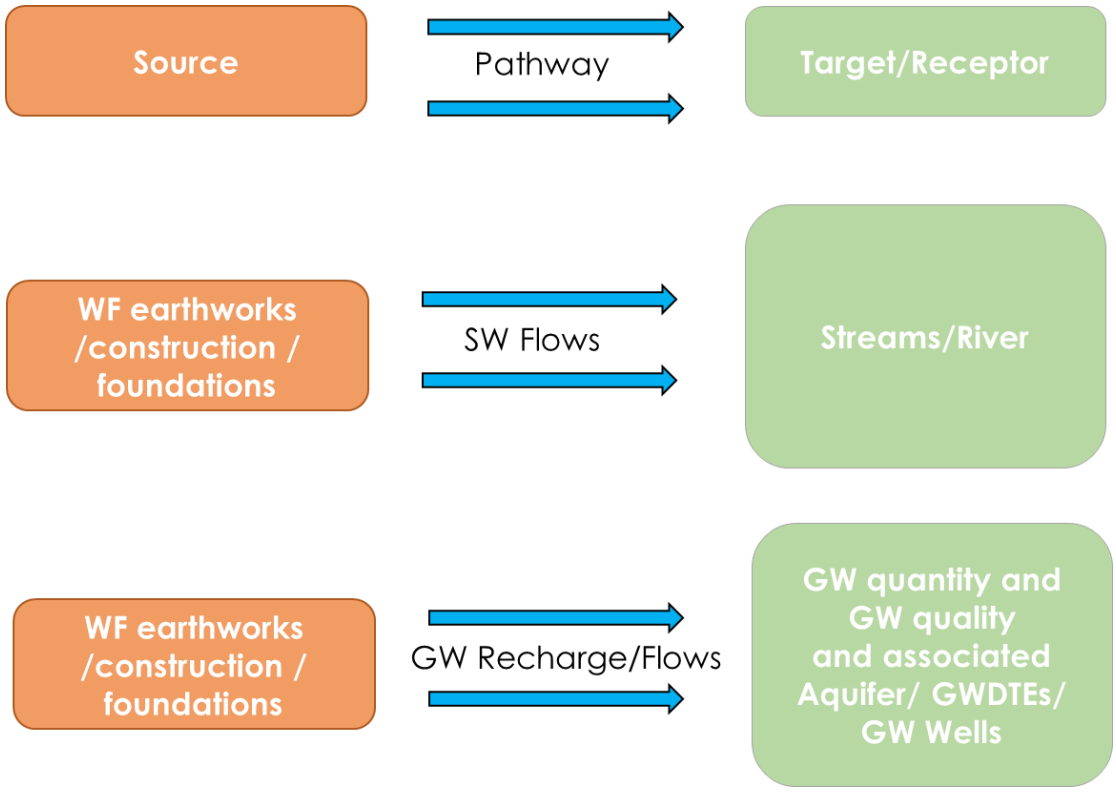
Table 9-2 are used to assess the potential effect that the Proposed Project may have on them.

Table 9-2: Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk)

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

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 (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.

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 and seasonal monitoring carried out were detailed and comprehensive.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Proposed Wind Farm site is located within a rural, agricultural setting in east County Galway, approximately 12km southeast of Tuam. The village of Brierfield is located approximately 1.3km south of the nearest proposed turbine, and the village of Moylough is located approximately 5.3km east of the nearest proposed turbine.

The current land use at the Site, which is mapped by EPA Corine landcover mapping (https://gis.epa.ie/EPAMaps), is dominated by agricultural pastureland (approximately 86%) with peat bogs (approximately 11%) and transitional woodland scrub with mineral extractions (approximately 2% and 1% respectively).

The majority of the northern portion of the Proposed Wind Farm site is bog while the southern portion is mainly grassland pastures. It is likely a large proportion of the grassland pastures were also originally bog prior to being drained and improved for agricultural use. An isolated area of forestry is located centrally within the Proposed Wind Farm site. Peat cutting in the form of private turbary plots is widespread around the edges the bogs. There are also several separate farmsteads within the Proposed Wind Farm site.

The topography of the Proposed Wind Farm site is undulating with gentle slopes typical of a low-lying raised bog setting with surrounding local hills. The elevation of the Proposed Wind Farm site ranges from approximately 65m OD (metres above Ordnance Datum) to 80m OD, with slopes falling to the north and southeast from a high point located centrally with the Proposed Wind Farm site which also coincides with a surface water catchment topographic divide between the Grange River to the north and the Abbert River to the south.

The lower parts (in terms of ground elevation) of the Proposed Wind Farm site are in the west and the north and this is also where most of the bog coverage is. The higher elevated part of the Proposed Wind farm site is located centrally and comprises mainly flat to gently undulating grassland.

The Proposed Wind Farm site is drained by several 1st order[1] watercourses that emerge from the peatland areas. There is also a high density of man-made drainage associated with the peatland and grassland areas. The man-made drainage density is evident on the OSI 6", 25" mapping and aerial imagery. The indicates significant efforts to drain and reclaim the former peat bog land as well as to improve adjacent grassland.

The Proposed Wind Farm site is currently accessible via a network of local public roads and private bog and farms tracks. The proposed construction entrance to the Proposed Wind Farm site and Proposed Grid Connection is off the R332 Regional Road which runs to the southwest of the Proposed Wind Farm site. Operational access will be via an existing track running from the R332 through the Proposed Wind Farm site and at two locations along the L6301 local road. Approximately 1.2km of existing tracks will

[1] A first order stream starts at the top of a catchment and has no other streams flowing into it. First-order streams are the smallest in a river system.

be upgraded as part of the Proposed Project. The northern portion of the Proposed Wind Farm site is accessible by a network of public roads.

With regard the main elements of the Proposed Wind Farm site infrastructure, proposed turbine locations T1, T3, T4, T6, T7 and T8 are located on grassland, while turbines T2, T5 and T9 are located on cutover raised bog.

The proposed temporary construction compound, located in the southwest of the Proposed Wind Farm site, is in grassland. The proposed 4 no. peat repositories areas and 5 no. spoil repository areas are located on both grassland and bog.

Proposed Wind Farm access roads are mainly on grasslands, but cutover bog and an approximately 0.6km section of intact raised bog will be crossed by the proposed access road to turbine location T7.

The Proposed Grid Connection 110kV underground cabling route, which measures approximately 21km in length, will connect into the existing Cloon 110kV substation near Tuam, located approximately 10km to the west of the Proposed Wind Farm site. The proposed 110kV on-site substation is located within improved grassland on the edge of bog in the southwest of the Proposed Wind Farm site.

On leaving the proposed substation location at the Proposed Wind Farm site, the cabling route initially follows a farm track for approximately 1km, followed by Proposed Wind Farm site access roads (which is currently grassland) for approximately 1.5km before exiting the Proposed Wind Farm site on the R332. The Proposed Grid Connection cabling route then follows public roads for the remainder of the distance to the Cloon 110kV substation.

TDR accommodation works are required on the N63/R332 junction, where a temporary road will be required just south of Horesleap Lough, in the townland of Slievegorm. There is also an overrun area adjacent to the R332 at the proposed construction Site entrance.

9.3.2 Water Balance

Long term Average Annual Rainfall (AAR) and evaporation data was sourced from Met Éireann (www.met.ie). The 30-year annual average rainfall (1980 - 2010) recorded at Dunmore Garda Station rainfall station, located 13km northwest of the Site, are presented in **Table 9-3**. The AAR for this station is 1,157mm/year.

Met Éireann also provide a grid of average annual rainfall for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the average annual rainfall at the Proposed Wind Farm site ranges from 1,170 to 1,180mm/year. This average annual rainfall is considered to be the most accurate estimate of average annual rainfall from the available sources.

Table 9-3: Local Average long-term Rainfall Data (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Year Start		Year End		
Dunmore G.S.		151500		263500		61		1981		2010		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
123	91	100	71	73	76	73	97	90	123	117	123	1157

The closest synoptic[2] station where the average potential evapotranspiration (PE) is recorded is at Claremorris, approximately 42km northwest of the Site. The long-term average PE for this station is 408mm/year. This value is used as a best estimate of the Site PE. Actual Evaporation (AE) at the Site is estimated as 388mm/year (which is 0.95 × PE).

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

$$\text{Effective rainfall (ER)} = \text{AAR} - \text{AE}$$

$$= 1{,}180 \text{ mm/year} - 388\text{mm/year}$$

$$\text{ER} = 792\text{mm/year}$$

According to the GSI subsoil permeability mapping, the Proposed Wind Farm site is dominated by Low permeability subsoils (50% of Site) followed by Moderate permeability subsoils (43% of Site), which represents the peat and glacial subsoils respectively. Subsoil permeability influences the recharge characteristics of a site along with subsoil thickness. The subsoil permeability for 7% of the Site is unmapped.

Based on groundwater recharge coefficient estimates from the GSI, an estimate of 4% recharge is assigned for 50% of the Site (mapped as "*low vulnerability - basin peat*"), while areas mapped as "*moderate vulnerability – moderate permeability subsoil overlain by poorly draining soil"* (30% of Site) and "*moderate vulnerability – moderate permeability subsoil overlain by well-draining soil"* (13% of Site) are assigned a recharge coefficient of 22% and 60% respectively.

Areas mapped as "*where rock is at ground surface or karst feature*" (7% of the Site) are assigned a recharge coefficient estimate of 85%. There are no areas of exposed rock or karst features mapped by the GSI at the Proposed Wind Farm site. This recharge coefficient is used for watercourses that emerge from the Site which is a groundwater vulnerability mapping practice used by the GSI in karst landscapes.

The weighted average recharge coefficient for the Proposed Wind Farm site is estimated to be 15%. The Site hydrology is therefore characterised by overall high surface water runoff rates (85%) and low groundwater recharge rates.

The high drainage density across the Proposed Wind Farm Site (watercourses and manmade drains), is reflective of the low groundwater recharge rates.

Therefore, annual recharge and runoff rates for the Site are estimated to be 119mm/year and 673mm/year 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

[2] 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.

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. Galway. Meanwhile, in a 4°C scenario, the average winter and summer precipitation rates in Co. Galway 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 9-4 below presents return period rainfall depths for the area of the Proposed Wind Farm site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 10-year, 30-year and 100-year). The 10-year rainfall depths are the basis of the Proposed Project drainage hydraulic design as described in Section 9.5.2.3 below.

Table 9-4: Return Period Rainfall Depths (mm) for the Proposed Project site

Return Period (Years)				
Storm Duration	1	10	30	100
5 mins	3.6	7.6	10.6	14.9
15 mins	5.8	12.5	17.4	24.5
30 mins	7.6	15.9	21.8	30.3
1 hour	9.9	20.1	27.2	37.4
6 hours	19.7	37.2	48.7	64.7
12 hours	25.7	47.1	61	80
24 hours	33.5	59.7	76.4	98.9
2 days	42.2	70.6	88	110.8

9.3.3 Regional and Local Hydrology

The Site is located in the regional Lough Corrib (Corrib_030) surface water catchment within Hydrometric Area 30 of the Western River Basin District (WRBD). Lough Corrib is located approximately 23km to the west of the Proposed Wind Farm site. A regional hydrology map is shown as

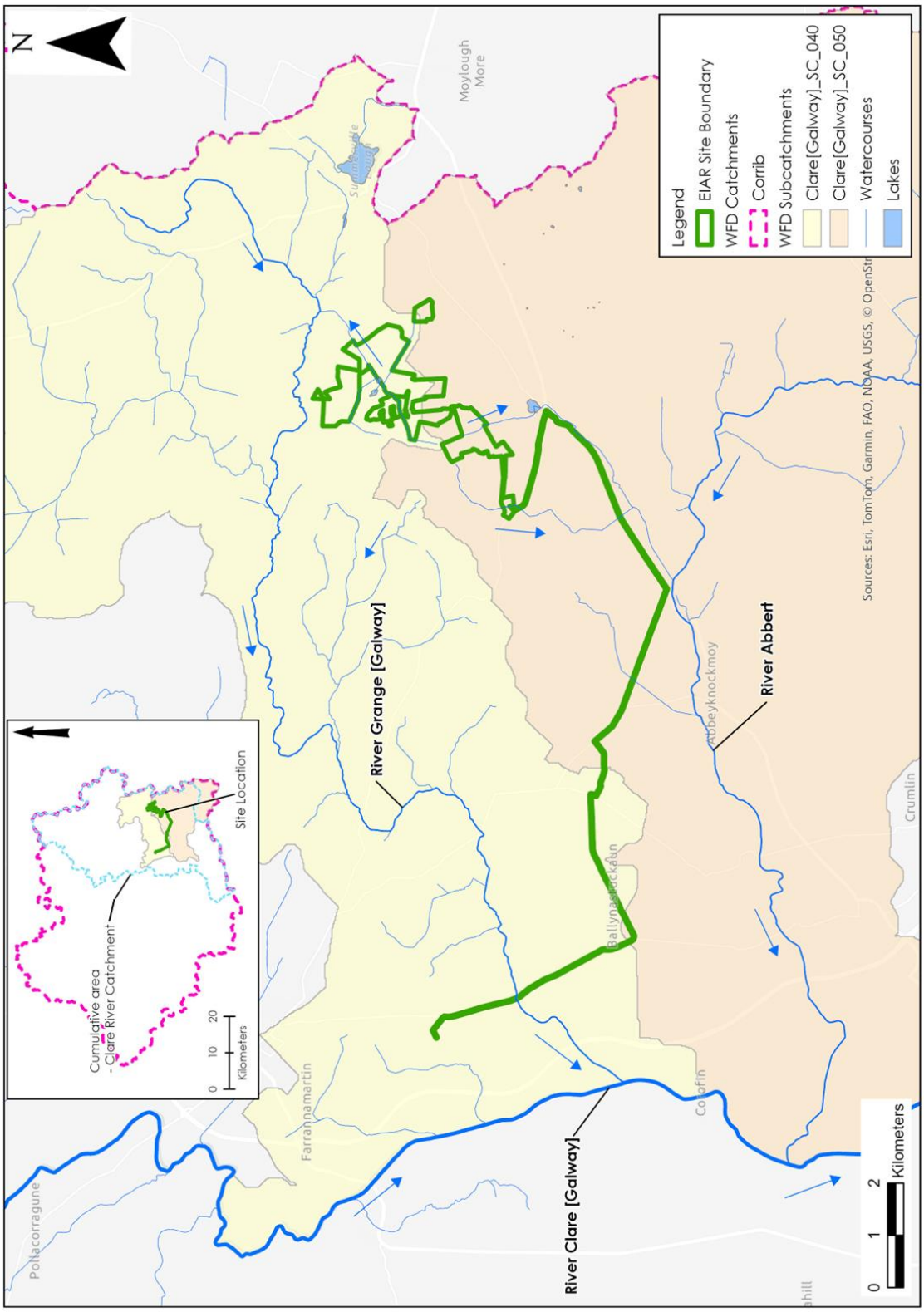


Figure 9-1.

On a more local scale the Site is located in the River Clare catchment wherein it exists within two surface water sub-catchments according to WFD/EPA mapping. The northern portion of the Proposed Wind Farm site, which includes 7 no. turbine locations (T3, T4, T5, T6, T7, T8 and T9), is located in the Clare[Galway]_SC_040 sub-catchment. Within this sub-catchment the Proposed Wind Farm site

drains to the River Clare via the Grange River which is located less than 1km to the north of the Proposed Wind Farm site. The southern portion of the Proposed Wind Farm site is located in the Clare[Galway]_SC_050 sub-catchment where 2 no. turbines T1 and T2, the temporary construction compound and the Site entrance are proposed. Within this sub-catchment the Proposed Wind Farm site drains to the River Clare via the Abbert River which is located approximately 3km to the south of the Proposed Wind Farm site.

Please note that whilst proposed turbine location T3 is mapped by the EPA/WFD to be located in the Clare[Galway]_SC_050, this location actually drains northerly into the Clare[Galway]_SC_040 sub-catchment as observed from on-site field drainage mapping.

The downstream distance to Lough Corrib via the Clare[Galway]_SC_040 is approximately 45km while the distance via the Clare[Galway]_SC_050 sub-catchment is approximately 35km.

The Proposed Grid Connection passes through both the Clare[Galway]_SC_040 (for 7.5km) and Clare[Galway]_SC_050 (for 13.4km) sub-catchments, while the Substation element is located entirely in the Clare[Galway]_SC_050 sub-catchment at the Proposed Wind farm site.

Similar to the Proposed Wind Farm site, the Proposed Grid Connection cable route drains locally to the Grange River and Abbert River within the respective sub-catchments.

The TDR accommodation works on the N63/R332 junction and adjacent to the R332 at the proposed construction Site entrance are located in the Clare[Galway]_SC_050 (i.e. the Abbert River catchment).

A local hydrology map is shown as

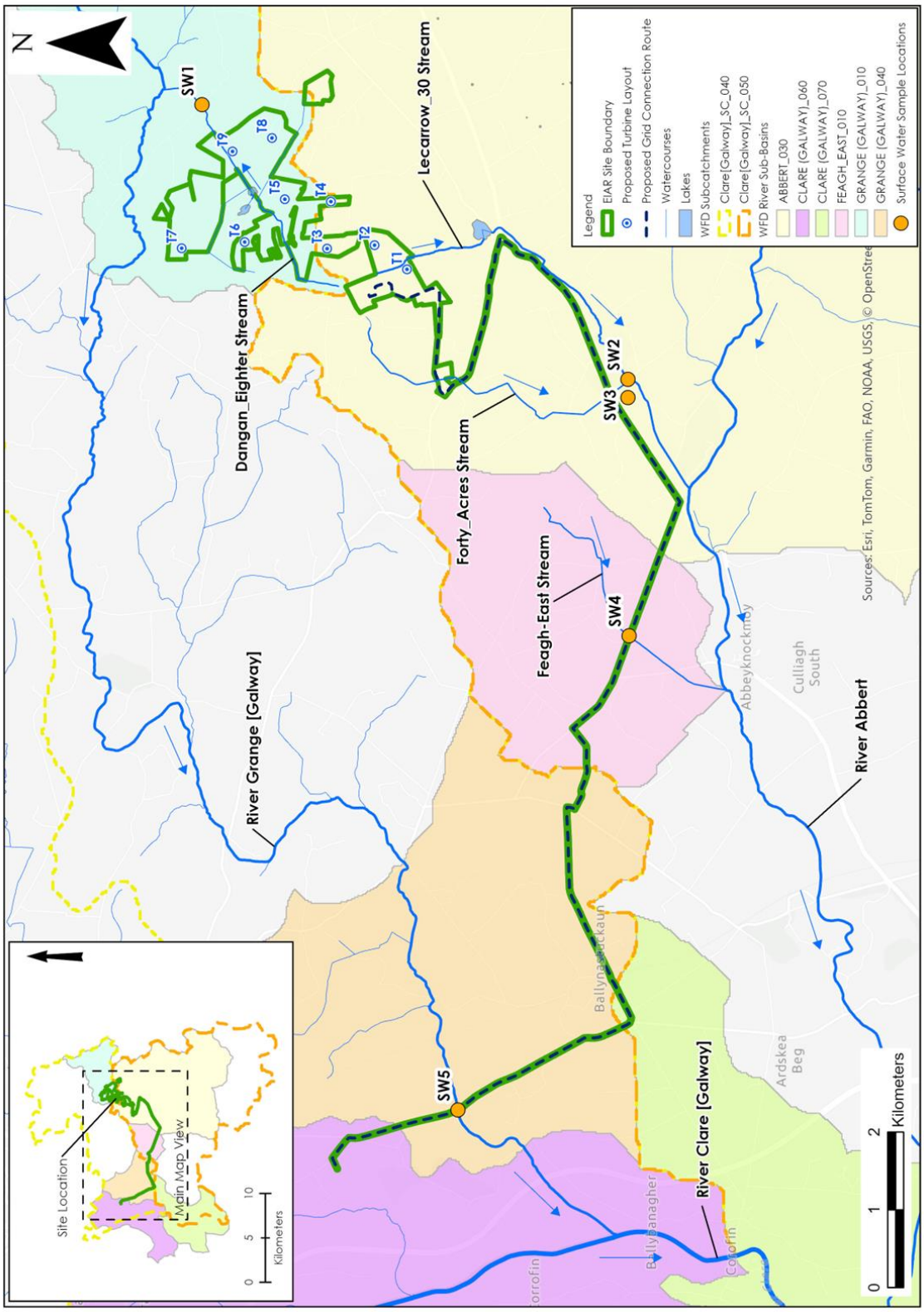

N
SW1
SW2
SW3
SW4
SW5
T1
T2
T3
T4
T5
T6
T7
T8
T9
Lecarrow_30 Stream
Dangan_Eighter Stream
Forty_Acres Stream
Feagh-East Stream
River Grange [Galway]
River Abbert
River Clare [Galway]
Abbeyknockmoy
Culliagh South
Ardskea Beg
Ballynacackaun
Ballynanagher
Corrofin
Legend
EIAR Site Boundary
Proposed Turbine Layout
Proposed Grid Connection Route
Watercourses
Lakes
WFD Subcatchments
Clare[Galway]_SC_040
Clare[Galway]_SC_050
WFD River Sub-Basins
ABBERT_030
CLARE (GALWAY)_060
CLARE (GALWAY)_070
FEAGH_EAST_010
GRANGE (GALWAY)_010
GRANGE (GALWAY)_040
Surface Water Sample Locations
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreet
0
1
2
Kilometers
Site Location
Main Map View
0
5
10
Kilometers

Figure 9-2.

9.3.4 Project Site Existing Drainage

9.3.4.1 Surface Water Drainage Regime

The northern portion of the Proposed Wind Farm Site, within the Clare[Galway]_SC_040 sub-catchment (i.e. the Grange River), is drained by the Dangan Eighter Stream (EPA Code 30D35) which flows into the Grange River approximately 1km downstream of the Site.

3 no. unnamed 1st order streams merge within the Proposed Wind Farm site to form the Dangan Eighter Stream. The 3 no. streams merge close to the location of Derrynacrick Loughs. Derrynacrick Loughs comprise two small, connected loughs that are located within a raised bog area on the northern portion of the proposed Wind Farm site.

None of the 3 no. unnamed streams flow into the larger, furthest upstream lough. 2 no. of the streams flows into the smaller downstream lough, while 1 no. unnamed stream flows into the Dangan Eighter Stream downstream of both loughs. The catchment area of the 3 no. streams comprises both peatland and agricultural land. Proposed turbine locations T3 to T9 drain into the Dangan Eighter Stream via a network of bog and land drains.

The southern portion of the Proposed Wind Farm Site, within the Clare[Galway]_SC_050 sub-catchment, is drained by the EPA named Lecarrow 30 Stream (EPA Code 30L49) and the Forty Acres Stream (EPA 30F16), both of which are headwater streams of the Abbert River which flows approximately 5km downstream of the Proposed Wind Farm site at this location.

The majority of the southern portion of the Proposed Wind Farm site (including proposed turbine locations T1 and T2 as well as the temporary construction compound) drain to the Lecarrow 30 Stream. The Lecarrow 30 Stream then flows to the south before discharging into Horseleap Lough which is located 1km to the south of the Proposed Wind Farm site. Horseleap Lough is a wetland with significant reed vegetation. Lecarrow 30 Stream exits from the southern side of Horseleap Lough and flows for approximately 4km prior to merging with the Abbert River further to the south.

The southwestern portion of the Proposed Wind Farm site, which includes the construction Site entrance and access road, drains to the Forty Acres Stream. The Forty Acres Stream flows south for approximately 3km prior to merging with the Lecarrow 30 Stream at a location 3km downstream of Horseleap Lough. The Substation element of the Proposed Grid Connection also drains to the Forty Acres Stream.

Aside from natural streams draining the Proposed Wind Farm site as described above, there is also a high density of man-made drains located within the cutover bog, agricultural land, and forestry areas. The agricultural and forestry areas typically comprise peaty or poorly draining soil (underlain by SILT and CLAY-dominated/low to moderate permeability glacial tills). Refer to Land, Soils and Geology Chapter 8 and summarised in Section 9.3.9.2 further below also.

Refer to **Figure 9-3** below for a Proposed Wind Farm site drainage map.

As stated previously, the route of the Proposed Grid Connection outside of the Proposed Wind Farm site is largely along public roads.

Along the Proposed Grid Connection cable route there are 4 no. crossings over EPA mapped watercourses within the Clare[Galway]_SC_050 sub-catchment. These include 3 no. crossings on the Forty Acres Stream (1 no. proposed new crossing at the construction Site entrance and 2 no. existing bridge/culvert crossings on public roads) and 1 no. existing crossing on the Feagh East Stream (EPA Code 30F17) which is a 1st order tributary of the Abbert River.

Within the Clare[Galway]_SC_040 sub catchment, there is an existing crossing along the Proposed Grid Connection cable route at 1 no. EPA mapped watercourse which is the Grange River itself.

Refer to

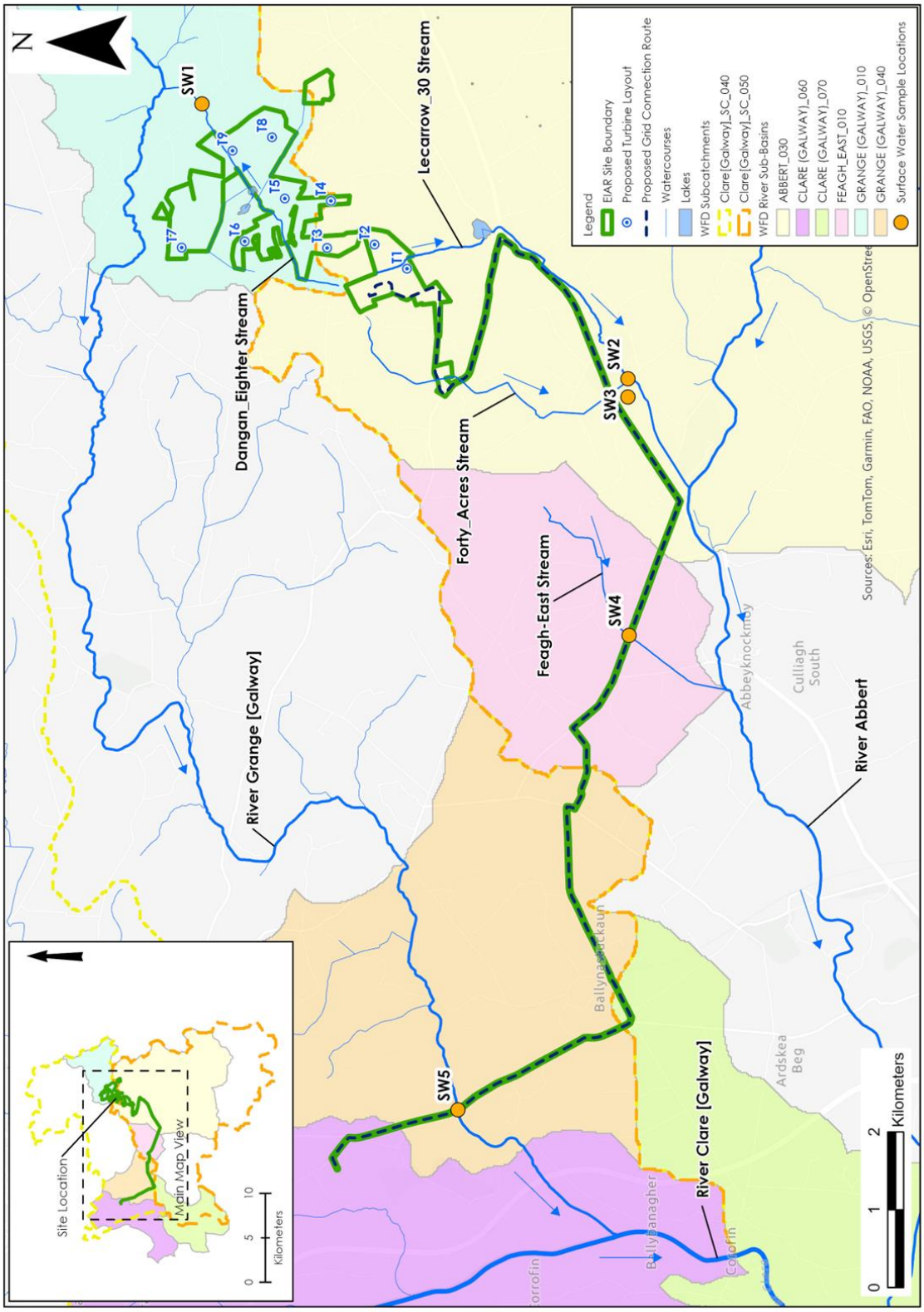


Figure 9-2 (Local Hydrology) for watercourse crossing locations along the Proposed Grid Connection.

9.3.4.2 Surface Water Flow Measurements

Surface water flow monitoring was carried out on the watercourses that drain the Proposed Project site. Flow monitoring locations (SW1 – SW5) details and flow measurements are shown in **Table 9-5** below, while the locations are shown on **Figure 9-2** below.

Table 9-5: Surface Water Flow Monitoring Data

Location	Watercourse	08/07/2025	02/09/2025
		Flow (m^3/s)	Flow (m^3/s)
SW1	Dangan Eighter Stream	0.02	0.025
SW2	Lecarrow 30 Stream	0.047	0.054
SW3	The Forty Acres Stream	0.03	0.042
SW4	Feagh East Stream	0.01	0.016
SW5	The Grange River	0.300	0.350

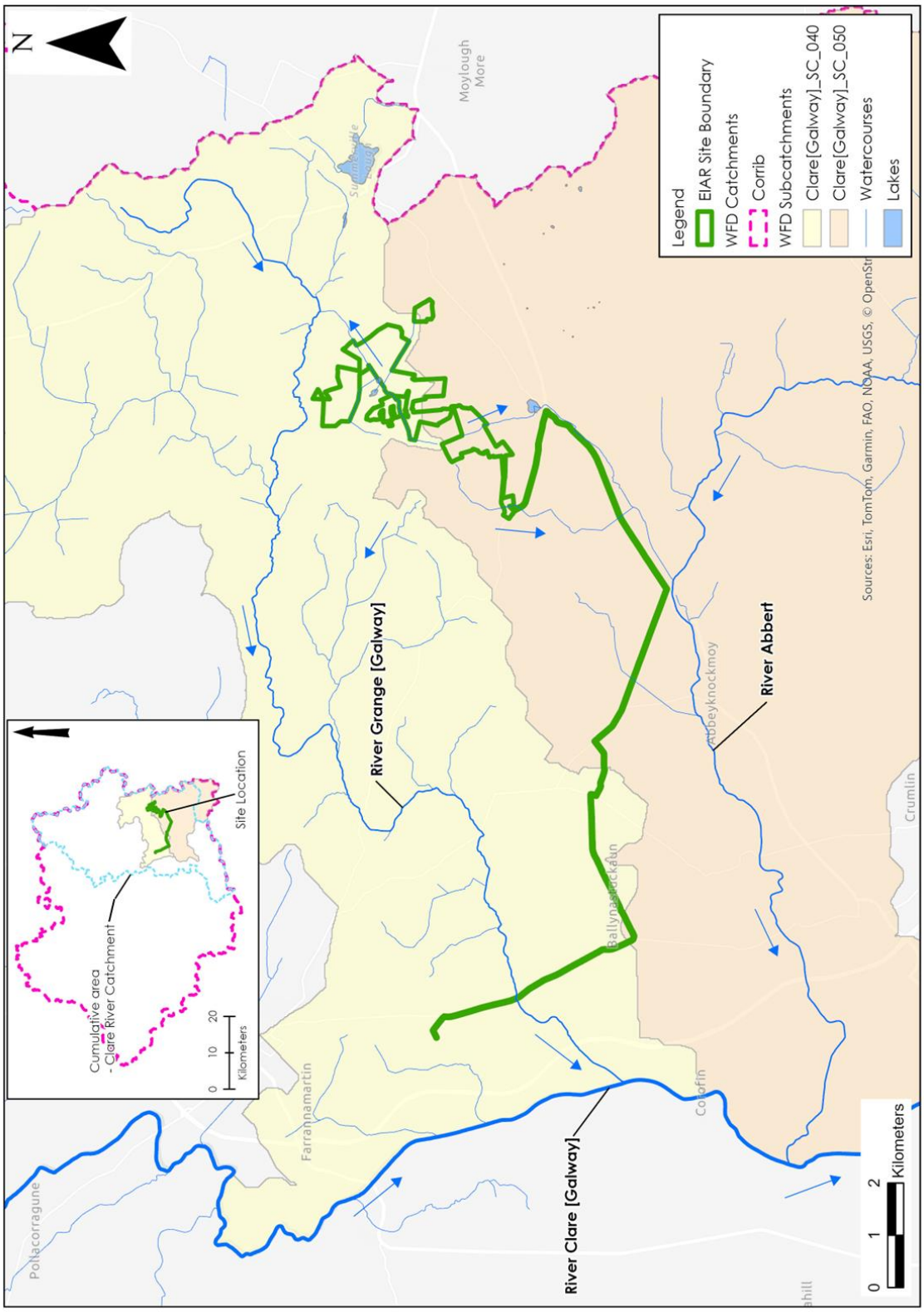


Figure 9-1: Regional Hydrology Map

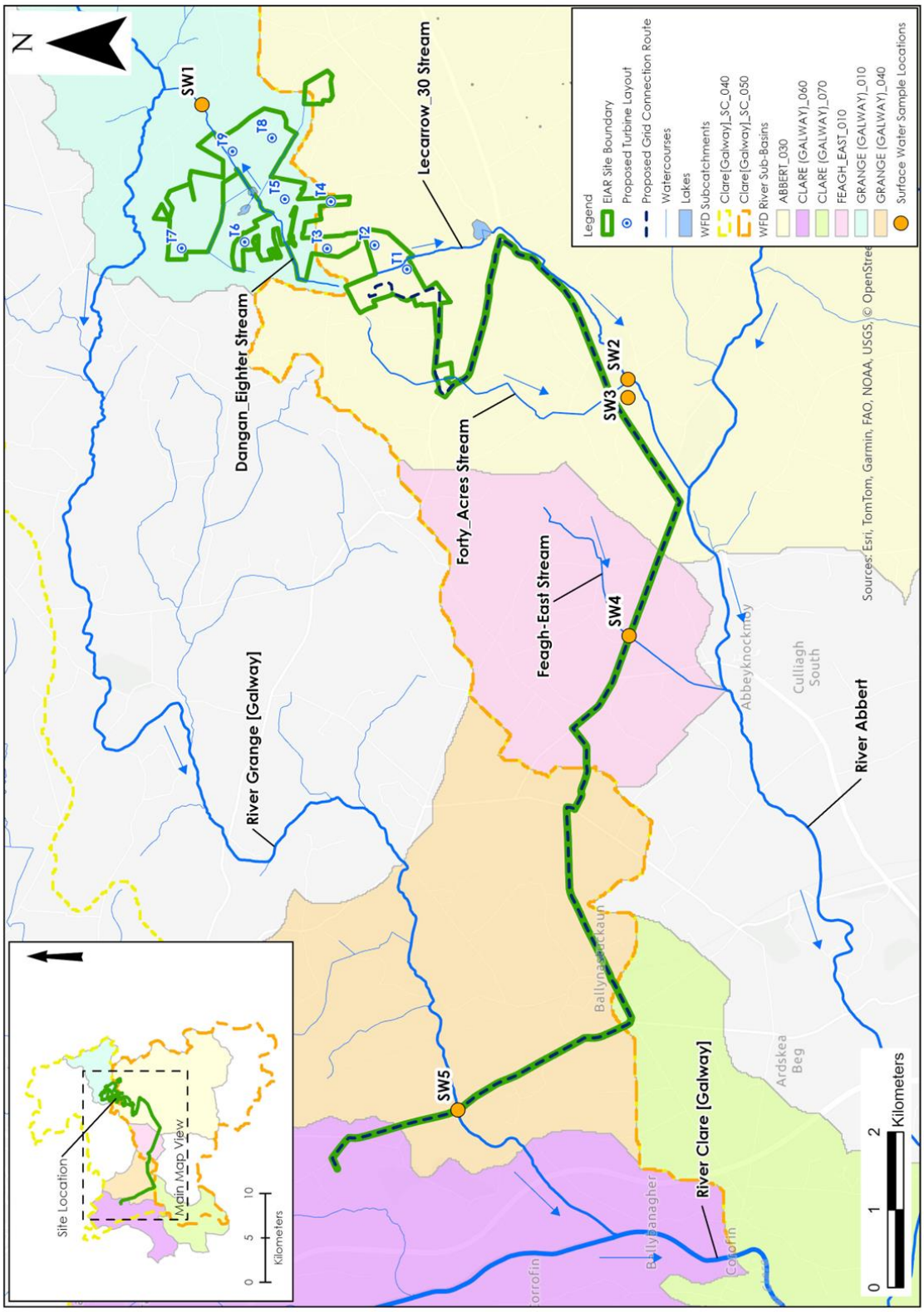


Figure 9-2: Local Hydrology Map

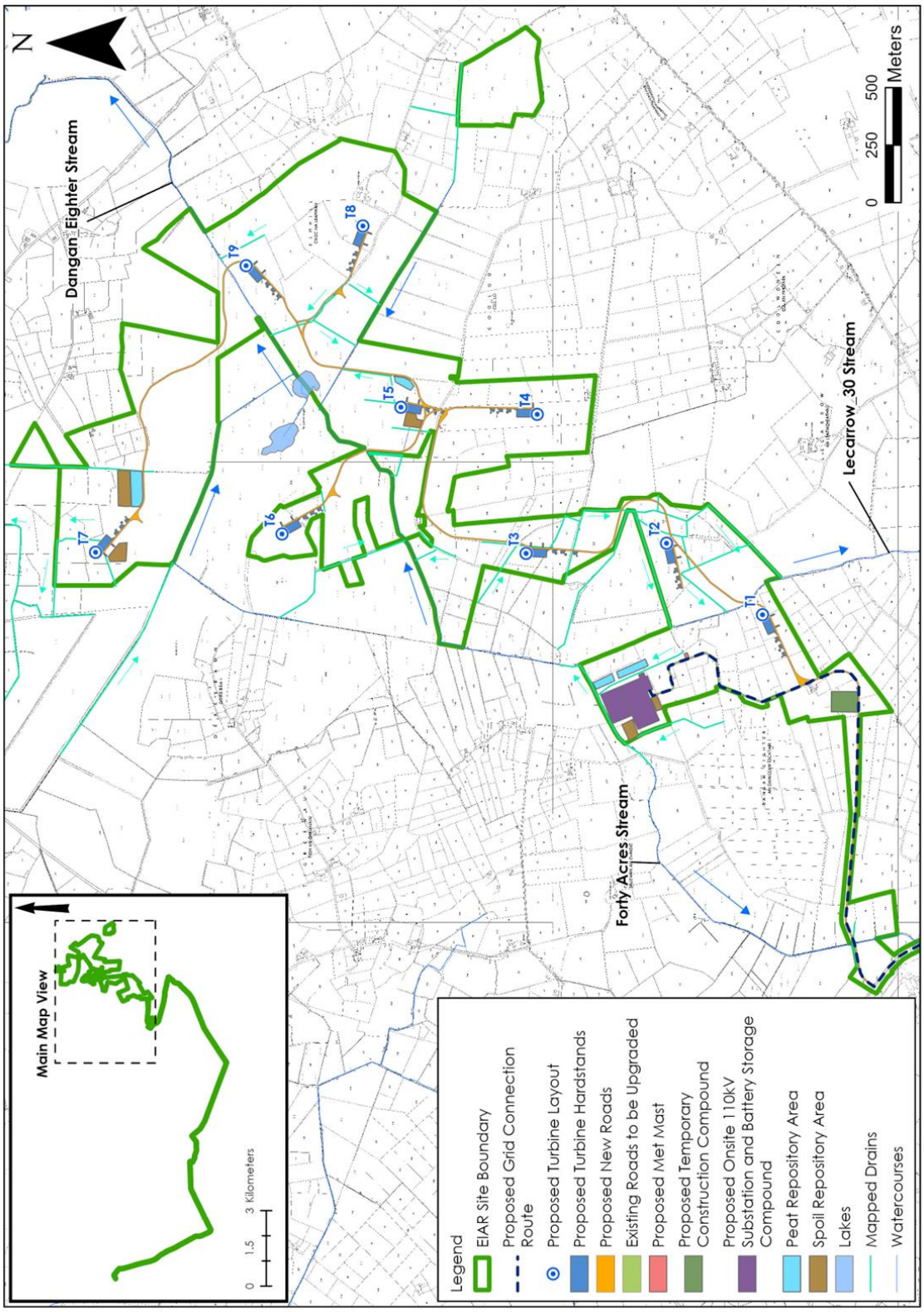


Figure 9.3: Proposed Wind Farm Site Drainage Map

9.3.5 Baseline Assessment of Development Site Runoff

This section undertakes a long-term water balance assessment and surface water runoff assessment for the baseline conditions at the Proposed Wind Farm 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 Proposed Wind Farm site. The Proposed Wind Farm Site drainage design is based on the 10-year return period rainfall event as described further in Sections 9.4.1 and 9.5.2.3 below.

The water balance calculations are carried out for the month (December) with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (**Table 9-6**).

The water balance represents the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Proposed Wind Farm site pre-development (376.5ha). The surface water runoff co-efficient for the Site is estimated to be 85% based on the predominant peat coverage, poorly draining mineral soils and low to moderate permeability glacial deposits (refer to Section 9.3.2 above).

The highest long-term average monthly rainfall (site-specific modelled rainfall values – 1991 to 2020) is 129mm over December. The average monthly evapotranspiration for the closest synoptic station at Claremorris over the same period in December was 3.1mm.

The water balance presented in **Table 9-6** and **Table 9-7** indicates that a conservative estimate of surface water runoff for the Site during the highest rainfall month is 403,552m^3/month or 13,018m^3/day for the Site.

Table 9-6: Water Balance and Baseline Runoff Estimates for Wettest Month (December)

Water Balance Component	Depth (m)
Average Highest Monthly Rainfall (R)	0.129
Average Potential Evapotranspiration (PE)	0.0031
Average Actual Evapotranspiration (AE = PE × 0.95)	0.0029
Effective Rainfall (ER = R - AE)	0.1261
Recharge (15% of ER)	0.0189
Runoff (85% of ER)	0.1071

Table 9-7: Baseline Runoff for the Proposed Project Site

Wate Balance Area	Approx. Area (ha)	Baseline Runoff per Wettest month (m^3)	Baseline Runoff per day (m^3) in wettest month
Proposed Project Site	376.5	403,552	13,018

9.3.6 Flood Risk Assessment

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

The OPW's River Flood Extents Mapping, National Indicative Fluvial Mapping, Past Flood Event mapping (https://www.floodinfo.ie/map/floodmaps/), historical mapping (i.e. 6" & 25" base maps) and GSI Groundwater/Surface Water Flood Maps were consulted to identify those areas of the Site as being potentially at risk of fluvial, pluvial and surface water flooding. Several walkover surveys were also conducted as part of the site-specific FRA.

No recurring flood incidents within the Proposed Wind Farm site were identified from OPW's Past Flood Event Mapping (Refer to **Figure 9-4).**

The nearest mapped past flood events include recurring flood events in low lying lands 0.5km to the south of the Proposed Wind Farm Site at Polladooey (Flood ID: 1813), 0.5km to the southwest of Horseleap Lough (Flood ID: 1814) and 1.2km to the northwest of the Proposed Wind Farm site at Cloondahamper (Flood ID: 1840). The Tuam West Area Engineer Meeting Minutes states that these recurring flood events relate to "*Low lying land floods every year after heavy rain*". The area engineers meeting minutes are available to view at www.floodinfo.ie.

Identifiable map text on local available historical OSI 6" or 25" mapping does not identify any lands that are "*liable to flood*" within the Proposed Wind Farm site. The closet lands to the Site mapped as "*liable to flood*" are low-lying lands located immediately to the southeast and northwest of Horseleap Lough.

There is no OPW CFRAM River Flood Extents Mapping available for the area of the Site as the CFRAM mapping does not cover small watercourses such as those present at the Site.

Therefore, the National Indicative Fluvial Mapping (NIFM) was consulted which has estimated current and future scenario 100-year and 1,000-year fluvial flood zones (**Figure 9-5)** for catchments greater than 5km^2. No NIFM flood zones are mapped within the Proposed Wind Farm site.

NIFM flood zones are mapped further downstream of the Site along the Grange River, the Lecarrow 30 Stream, Forty Acres Stream and the Abbert River where there is some encroachment along the Proposed Grid Connection route. However, due to the underground nature of the cabling, fluvial flooding will have no effect on the Proposed Grid Connection. The 110kV Substation element of the Proposed Grid Connection is not located in a mapped NIFM flood zone.

As the Proposed Wind Farm site is not mapped inside a 100-year or 1,000-year fluvial flood zones, it is therefore located in Flood Zone C (Low Risk), as well as the Substation element of the Proposed Grid Connection.

Also, no CFRAM rainfall (pluvial) flooding is mapped with the Site.

The GSI Groundwater Flood Maps and Winter 2015/2016 Surface Water Flooding Maps have no historic flood zones mapped within the Site. The nearest GSI mapped historic groundwater and surface water flood are the on lands to the south of the Proposed Wind Farm site and around Horseleap Lough.

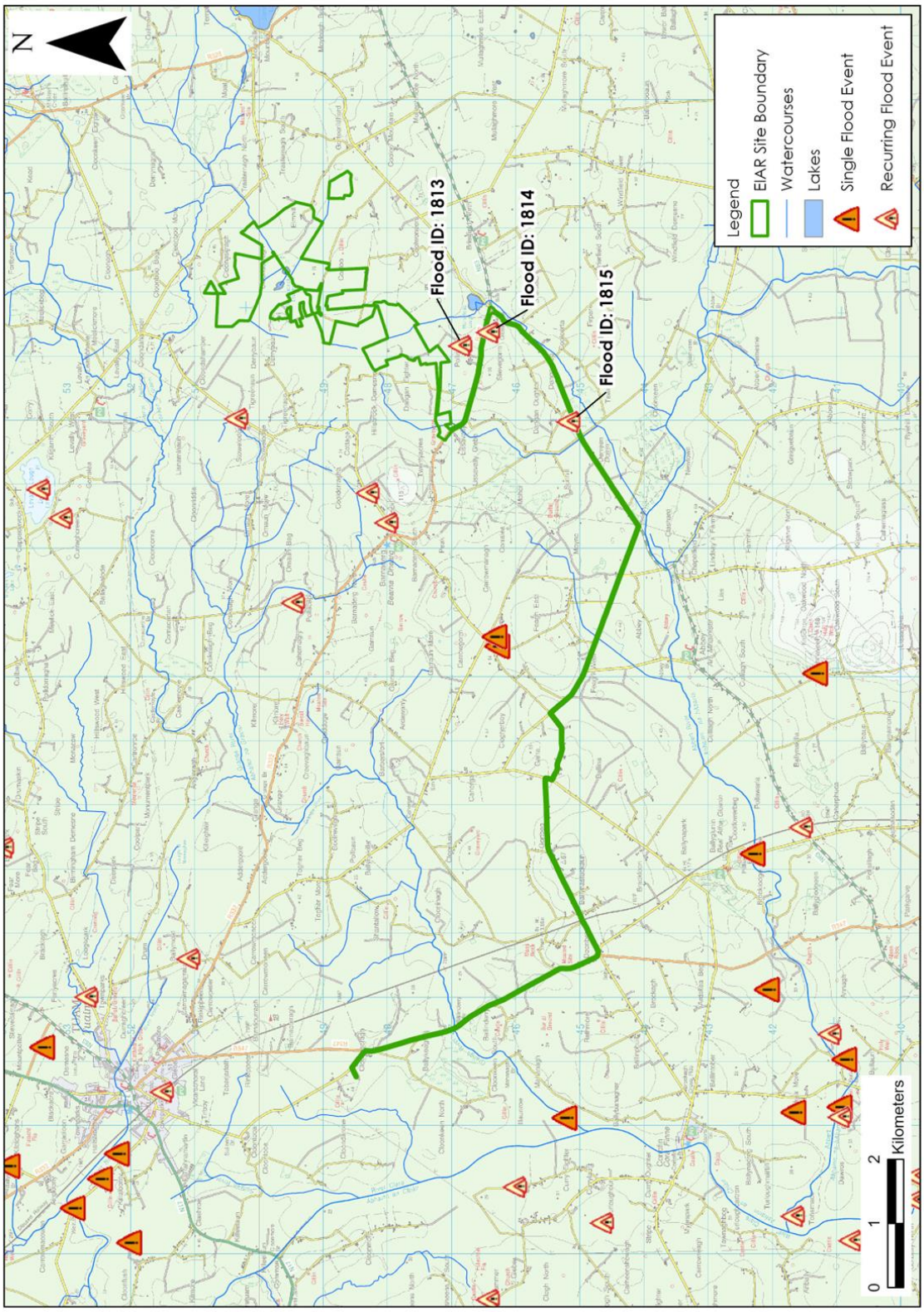


Figure 9-4: OPW Past Flood Event Mapping

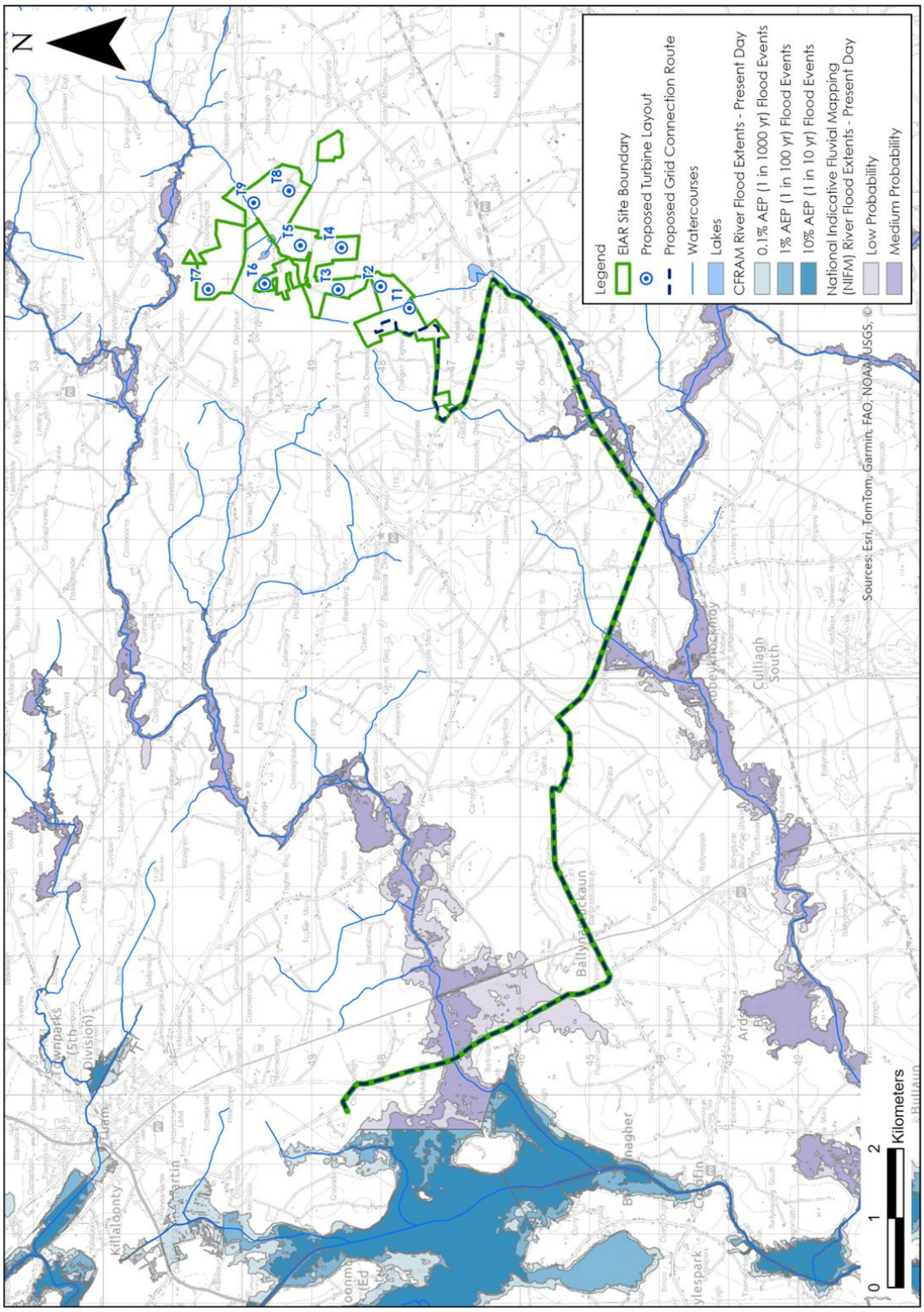


Figure 9-5: OPW NIFM and CFRAM Mapping

9.3.7 Surface Water Quality

Biological Q-rating data for EPA monitoring points on watercourses downstream of the Site are shown in **Table 9-8** below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High).

Most recent data available (2012 to present) show that the Q-rating for the Grange (Galway) River and Abbert River is 'Good' in the vicinity and downstream of the Site. Further downstream the Clare (Galway) River's status is also "Good".

Table 9-8: EPA Biological Q-Rating Data

Waterbody	Station ID	Easting	Northing	EPA Q-Rating Status
Grange (Galway)_010	Bridge near Cloondahamper	155248	251511	(4) Good
Grange (Galway)_020	GRANGE (GALWAY) - Ford N.N.W. of Cornacartan	151020	251647	(4) Good
Grange (Galway)_020	Grange Bridge	148003	249913	(4) Good
Grange (Galway)_030	Cahergal Bridge	147706	247623	(4) Good
Grange (Galway)_040	1.7km u/s Clare River confl.	144054	246094	(4) Good
Clare (Galway)_060	Corrofin Bridge	142639	243390	(4) Good
Abbert_030	Bridge u/s Abbey Bridge	151671	243628	(4) Good
Abbert_040	ABBERT - Pallas Bridge	147305	242292	(4) Good
Abbert_040	Bridge at Bullaun	143625	240781	(4) Good
Clare (Galway)_070	Lackagh Br	141813	236430	(4) Good

Surface water sampling, flow monitoring and field hydrochemistry (measurements of electrical conductivity (µS/cm), pH (pH units), and dissolved oxygen (%)) were taken at 5 no. locations (SW1 – SW5) within surface watercourses downstream of the Proposed Project site on 8th July 2025 and 1st September 2025 (refer to

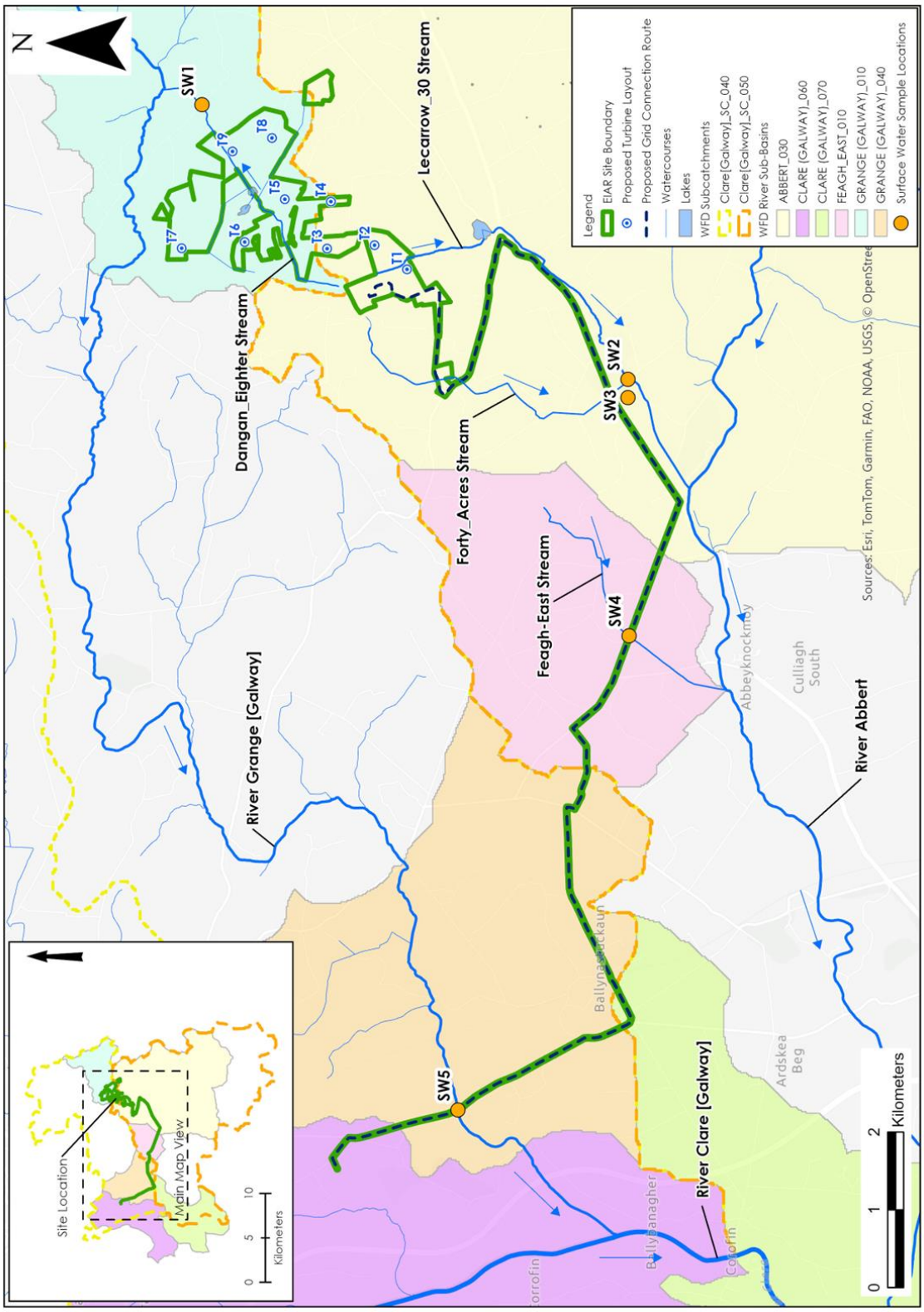


Figure 9-2 for locations). Field hydrochemistry results are presented in

Table 9-9 below.

Electrical conductivity values for the local streams ranged between 536µS/cm and 733µS/cm which would be typical of streams in a catchment underlain by pure bedded limestones. pH values which were all slightly basic ranged from 8.0 to 8.3 which is also typical for this setting.

Dissolved oxygen saturation ranged between 96 and 133%. The dissolved oxygen levels would be typical for a High Status river and largely exceed the required dissolved lower limit of 80% (Surface Water Regulations S.I. No. 77/2019).

Table 9-9: Field Hydrochemistry Data

Location	EC (µS/cm)		pH [H^+]		Dissolved Oxygen %	
	08/07/2025	01/09/2025	08/07/2025	01/09/2025	08/07/2025	01/09/2025
SW1	578	562	8.2	8.0	98	102
SW2	600	620	8.1	8.1	98	99
SW3	662	653	8.2	8.1	99	96
SW4	733	720	8.3	8.2	133	99
SW5	536	550	8.2	8.1	117	112

Surface water grab sampling was also conducted at monitoring locations SW1 – SW5 on the dates referred to above. Results of analysis are show in **Table 9-10** and

Table 9- 11 below alongside relevant Environmental Quality Standards (EQS) values for surface water. Laboratory reports are presented in **Appendix 9-2.**

Table 9-10: Analytical Results of HES Surface Water Samples (08/07/2025)

Parameter	EQS	Sample ID				
		SW1	SW2	SW3	SW4	SW5
Total Suspended Solids (mg/L)	25(+)	<5	<5	<5	<5	<5
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.02	<0.02	<0.02	<0.02	<0.02
Nitrite NO_2 (mg/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<4.4	<4.4	<4.4	8.4	6.2
Phosphorus (mg/L)	-	0.78	0.31	0.51	0.22	0.15
Nitrogen (mg/L)	-	1.6	<0.1	3.1	2.4	1.9
BOD (mg/L)	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	1	1	1	1	1

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

Table 9- 11: Analytical Results of HES Surface Water Samples (01/09/2025)

Parameter	EQS	Sample ID				
		SW1	SW2	SW3	SW4	SW5
Total Suspended Solids (mg/L)	25(+)	<5	42	<5	<5	7
Ammonia N (mg/L)	Good Status: ≤0.065 High Status ≤ 0.04(*)	0.14	<0.02	<0.02	0.03	<0.04
Nitrite NO_2 (mg/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01
Ortho-Phosphate – P (mg/L)	Good Status ≤ 0.035 to High Status: ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<4.43	11.5	<4.43	<4.43	<4.43
Phosphorus (mg/L)	-	<0.10	<0.10	<0.1	<0.10	<0.10
Nitrogen (mg/L)	-	1.7	2.6	1.5	1.6	1.6
BOD (mg/L)	Good Status: ≤ 1.5 High Status: ≤ 1.3(*)	2	<1	1	5	3

(+) 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).

With regard TSS, most results were <5mg/L with the only exceedance above S.I. No. 293/1988 being SW2 on 1st September 2025 when 42mg/L was recorded.

Levels of nutrients are typically low with ammonia N, nitrite, nitrate and orthophosphate present at concentrations close to or below the laboratory detection limits. BOD was very low in the 8th July samples with 1mg/L reported for all samples, but was more variable (1 – 5mg/L) I then 1st September samples.

Ammonia N, BOD and orthophosphate were below "High Status" threshold value with respect of the Surface Water Regulations (S.I. 272/2009 as amended) in the 8th July sampling round.

Results from the 1st September sampling round were more variable with ammonia N and BOD having exceedance above "Good Status" threshold. All results for orthophosphate were below "High Status" threshold in the September sampling round.

9.3.8 Regional & Local Hydrogeology

The Site is located in the Clare-Corrib Groundwater Body (GWB) (IE_WE_G_0020) which has a mapped surface area of 1,344km^2. According to WFD mapping this GWB is karstic in nature.

The bedrock hydrostratigraphic rock unit group type of the Clare-Corrib GWB is predominantly Dinantian Pure Bedded Limestone, which according to GSI mapping, is the lithology of the mapped bedrock formations that underlie the Site (i.e. Croghan Formation, the Burren Formation and Visean Limestones (undifferentiated)). Dinantian Pure Bedded Limestone is classified by the GSI as a Regionally Important Karstified Aquifer which is dominated by conduit flow (Rkc).

A bedrock aquifer map with GSI karst feature mapping is shown as **Figure 9-6** below.

Dinantian Pure Bedded Limestone rocks are generally devoid of intergranular permeability. Groundwater flows through fissures, faults, joints and bedding planes. In pure bedded limestones these openings are sometimes enlarged by karstification, which significantly enhances the permeability of the rock. Karstification can be accentuated along structural features such as fold axes and faults. Groundwater flow directions through karst areas can be very variable due to the heterogenous nature of karstification/weathering within a rock that is otherwise devoid of groundwater. Groundwater flows

through a network of solutional enlarged bedding planes, fissures and conduits at depth. At shallower depths (i.e. top of bedrock) groundwater flows through epikarst (refer to Section 9.3.9.3 below).

Overall, groundwater flow direction within the Clare-Corrib GWB is reported to be to the southwest, with all groundwater flowing towards and discharging to Lough Corrib (GSI, 2004).

Both point recharge and diffuse recharge occurs in this GWB. Diffuse recharge occurs over the GWB via rainfall percolating through the permeable subsoil. In areas of deep peat and low permeability glacial till, recharge to the underlying aquifer is limited to point recharge such as swallow holes, collapse features/dolines, and losing streams (GSI, 2004).

9.3.9 Site Hydrogeology

9.3.9.1 Introduction

Ground investigations and follow up seasonal hydrogeological monitoring were carried out between 2022 and 2025 to characterise the geological and hydrogeological setting of the Proposed Wind Farm site.

The drilling investigations (BH1 and BH2) were targeted around the area where the Mid Galway Public Water Supply (PWS) Source Protection Areas (SPA) overlaps with the Site (refer to Section 9.3.15.1 below for groundwater supply details).

BH1 is located 350m to the southwest of turbine T1, while BH2 is located 250m to the northeast of turbine T2. Only these two turbines are also located inside the GSI/EPA mapped Mid Galway Public Water Supply PWS SPA.

In order to determine the full geological profile (soil/peat, subsoil, and bedrock) below the Proposed Wind Farm Site, 306 no. peat probes, 10 no. gouge cores, 26 no. trial pits, and 2 no. boreholes (BH1 & BH2) and geophysical surveys were carried out at the Site. The boreholes were finished as monitoring wells to allow seasonal water level monitoring to be completed.

Also, one rotary core borehole (GSI-17-003) from the GSI borehole database was previously drilled on the north of the Proposed Wind Farm site, approximately 390m east of turbine T7 which also provides geological information for the Site.

Geophysical surveys (2D Resistivity and seismic) were also conducted in areas of the Proposed Wind Farm site to assess bedrock conditions, particularly to assess the potential for bedrock karstification.

A summary of the site investigations is provided in the following below. However, refer to the Land, Soils, and Geology (Chapter 8) for more comprehensive information relating to the intrusive site investigations and geophysical surveys conducted at the Site. For ease of reference, a site investigation map is shown below as **Figure 9-7** below.

Following the drilling investigations, groundwater levels were continuously monitored between October 2022 and February 2025 by in-situ data loggers (pressure transducers) installed in BH1 and BH2 (monitoring wells).

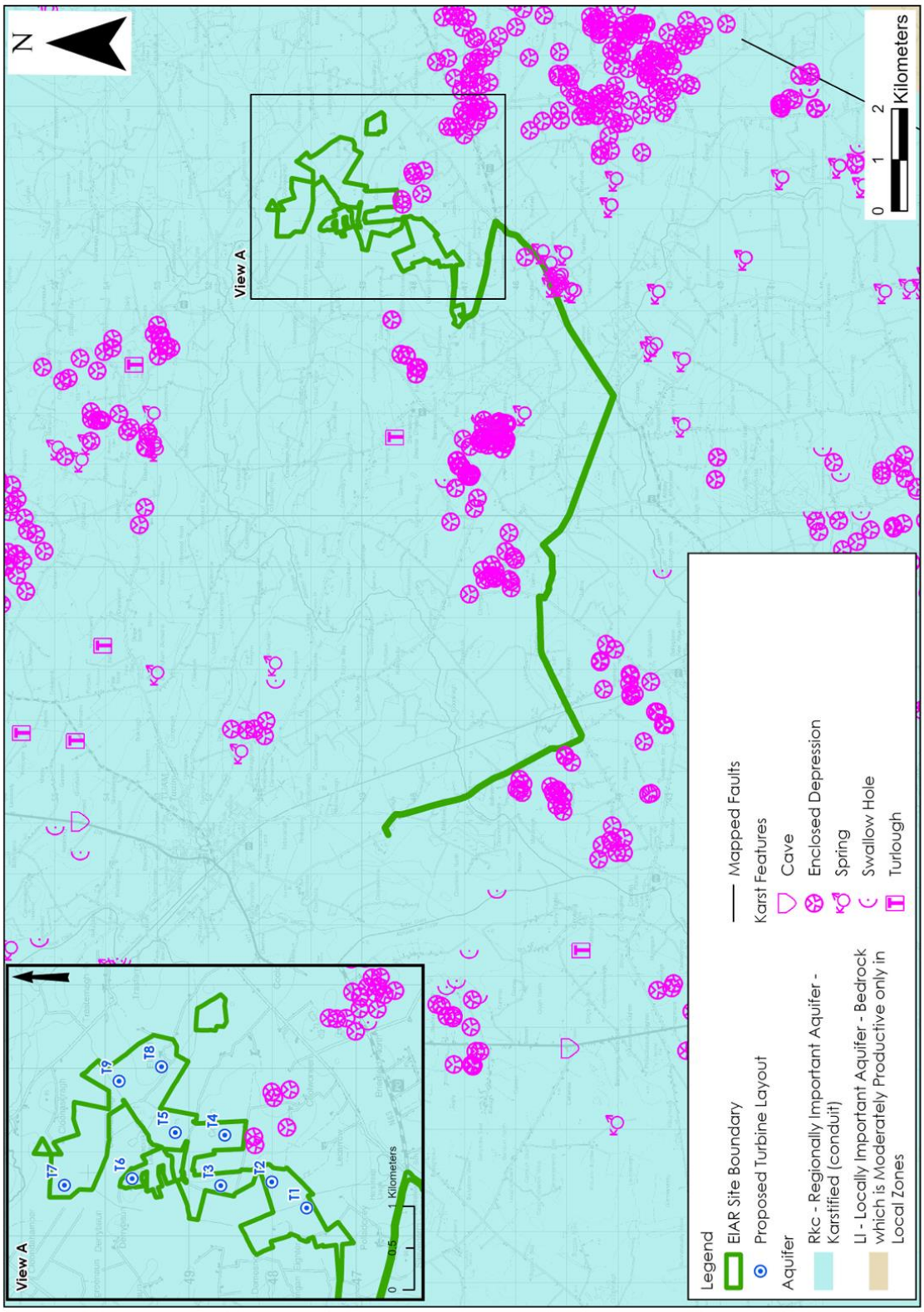


Figure 9-6: GSI Aquifer Mapping

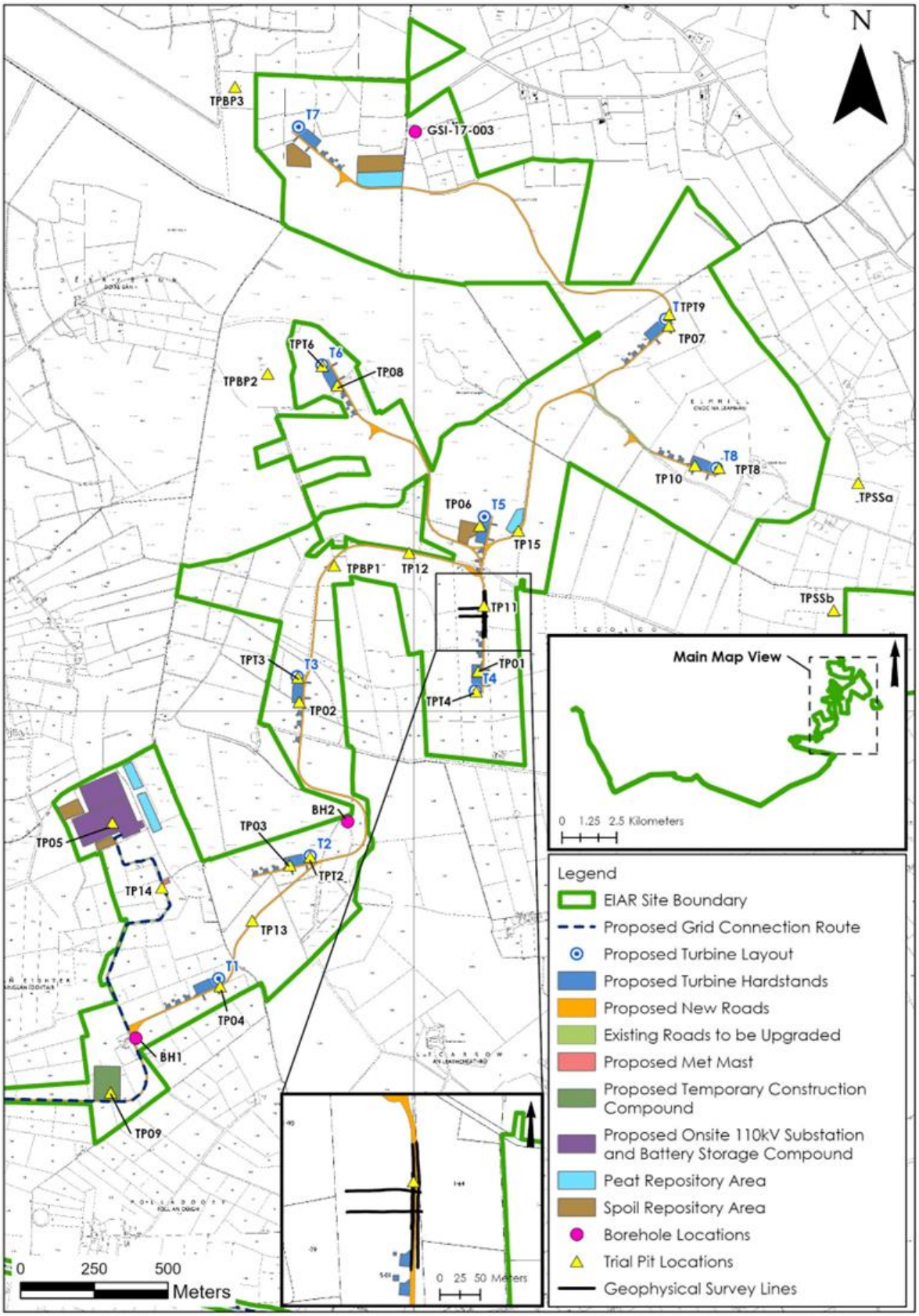


Figure 9-7: Site Investigation Map

9.3.9.2 Ground Investigations Summary

Based on the trial pit, gouge core, drilling investigations and geophysical surveys carried out to date, geological conditions are generally variable across the Proposed Wind Farm site, and comprise PEAT, Lacustrine Marl (CLAY/SILT), Cohesive Glacial Till (CLAY/SILT) and Granular Glacial Till (SAND/GRAVEL) layers overlying typically competent (very strong), massive dark grey LIMESTONE bedrock with MUDSTONE layers. No notable karstification was recorded at any of the site investigation locations.

The primary subsoil type encountered at the Proposed Wind Farm site was a CLAY/SILT dominant subsoil.

Bedrock was confirmed in 14 no. of the 26 no. trial pits, which included 7 no. of the proposed 9 no. turbine locations (T1, T2, T3, T4, T5, T6 and T8).

Depth to bedrock at the trial pit locations ranged from 0.8m to 3.6m with an average of 2.2m. LIMESTONE bedrock was encountered in all trial pits which terminated on rock. The deepest overburden depth was encountered at BH1 where 4.9m of CLAY subsoil was encountered.

10 of the 14 no. trial pits that refused out on bedrock encountered competent, unweathered, grey massive LIMESTONE. While weathered and/or fractured LIMESTONE was only encountered in 4 of the 14 no. trial pits. No epikarst[3] weathering was reported in any of the trial pits that encountered bedrock.

Geophysical surveys were carried out in an area of the Proposed Wind Farm site where several ground surface depressions suggested possible karst features (i.e. enclosed depressions). The depressions are typically very shallow, with the centre of the depression being less than a 0.5m below ground level.

However, the results of the geophysical surveys (2D Resistivity and Seismic) showed fresh, competent LIMESTONE with no evidence of karstification in the underlying bedrock at the ground depression locations). Refer to Section 9.3.9.3 below for further information on karst feature investigations.

As part of the EIAR investigations, BH1 and BH2 were drilled in 2022 in the southern part of the Proposed Wind Farm site where the GSI mapped geology is Undifferentiated Viséan Limestones (refer to **Appendix 8-4** for drilling logs).

BH1 was drilled to a depth of 20m and encountered weak dark grey LIMESTONE with MUDSTONE layers between 4.9 and 7mbgl. Strong dark grey LIMESTONE was encountered between 7 and 20mbgl (with some fracturing between 14.5 and 15mbgl).

BH2 encountered strong to very strong dark grey LIMESTONE with occasional MUDSTONE layers throughout the full depth of borehole (2.6 to 20mbgl).

No karst conduits, significant fractures or groundwater strikes were encountered due to the competent nature of the bedrock. Any groundwater inflows recorded were slow suggesting an overall low permeability limestone.

In addition, one rotary core borehole (GSI-17-003) from the GSI borehole database was previously drilled on the north of the Proposed Wind Farm site, approximately 390m east of turbine T7. The log from this borehole (attached as **Appendix 8-4** of Land, Soils and Geology Chapter), was consulted in order to provide additional information. The available online borehole log indicated that bedrock was

[3] The epikarst is a heavily weathered layer of rock extending less than 10 m below the base of the soil/subsoil (D. Drew, 2018).

encountered at 5 meters below ground level (mbgl) and was drilled to a final depth of 122 meters below ground level (mbgl).

A dark grey argillaceous (impure) LIMESTONE and calcareous MUDSTONE from the Croghan Formation was encountered from 5 to 105mbgl. A very fine-grained argillaceous LIMESTONE of the Ballymore Formation was encountered from 105 to 122mbgl.

What's notable about the known bedrock geology of the Proposed Wind Farm site is that all investigation drilling data available to date (i.e. BH1, BH2 and GSI-17-003) encountered impure argillaceous LIMESTONE (i.e. clay impurities) with MUDSTONE layers. Impure limestone is typically less prone to karstification. MUDSTONE is not prone to karstification.

The presence of impure LIMESTONE and MUDSTONE underlying the north (GSI-17-003) and south (BH1 and BH2) of the Proposed Wind Farm site would suggest the mapped Undifferentiated Viséan Limestone encountered on the south of the Site has a similar lithology to the Croghan Formation encountered at GSI-17-003 on the north of the Site. This suggests a bedrock type similar to the Croghan Formation extends further south into the southern portion Proposed Wind Farm site.

The large coverage of peat bogs, poorly draining soil/subsoil and high drainage density within the Proposed Wind Farm site would also suggest a poorly developed groundwater drainage network. Hence the presence of several surface watercourse at the Proposed Wind Farm site due to low groundwater recharge rates.

A summary of the Wind Farm investigation drilling is shown in **Table 9-12** below.

Table 9-12: Summary BH Drilling Data for Proposed Wind Farm site

Location	Ground Level (m OD)	Depth to Bedrock (m)	Glacial Till Description	Bedrock Description
BH1	75	4.9	Gravelly CLAY	LIMESTONE with MUDSTONE layers
BH2	78	2.6	SAND & GRAVEL	LIMESTONE with MUDSTONE layers
GSI-17-003	80	5	N/S*	LIMESTONE with MUDSTONE layers

*Glacial till type Not specified

9.3.9.3 Karst Features

No GSI karst features are mapped within the EIAR Site Boundary (refer to **Figure 9-6** above), however several karst features ('enclosed depressions') are mapped by the GSI less than 0.5km to the southeast of the Proposed Wind Farm site, with a very high density of karst features mapped approximately 2km further to the southeast of the Site.

What's notable about the high density of GSI karst features mapped 2km to the southeast of the Proposed Wind Farm site is that there is an overall lack of surface water drainage in that area. This indicates a well-developed underground karst drainage system (i.e. very high groundwater recharge rates).

Conversely, in the area of the Proposed Wind Farm site there are several watercourses and numerous man-made drains draining the area of the Site, thereby strongly suggesting a poorly developed groundwater system which impedes recharge to the underlying aquifer. This is consistent with the hydrogeological regime of the Wind Farm site based on site walkover surveys and site investigation data (i.e. peat and poorly draining overburden over impure LIMESTONE/MUDSTONE bedrock).

Also, along the Proposed Grid Connection cable route outside the Proposed Wind Farm site there are numerous GSI mapped karst feature within a 100m corridor of the underground cable route. However, due to the nature the proposed route along public roads, with the cable being placed in a shallow trench within the road carriageway, no karst features are likely to be encountered.

However, the GSI karst database is not exhaustive, and additional potential karst features have been identified during field mapping carried out by GDG as part of the Geotechnical Karst Risk Assessment. Refer to the Land, Soils, and Geology (Chapter 8) for more comprehensive information relating to the Geotechnical Karst Risk Assessment (**Appendix 8-2**).

The 11 no. potential karst features mapped within Proposed Wind Farm site boundary are also largely focused on the southeast of the Proposed Wind Farm site (same orientation as the GSI mapped karst features), in the area of proposed turbine location T4 and access road. In all, a total of 41 no. potential karst features were mapped by GDG within 1km of the EIAR Site Boundary. Refer to **Figure 9-8** below for GDG karst feature mapping.

The potential karst features on the southeast of the Proposed Wind Farm site are all mapped as potential enclosed depressions/dolines around the area of T4 and access road.

Table 9-13 below summaries the setback distance from key proposed infrastructure locations to the closest mapped potential karst feature (on-site or off-site karst feature, whichever closest).

No potential enclosed depressions are located within the proposed footprint of any of the turbine bases or hardstand areas. However, potential enclosed depressions are located along proposed access roads at 2 no. locations north of turbine T4 (features are referred to as K01 and K02 by GDG). These features were investigated further by geophysical surveys as detailed in Section 8.3.4.4 of the Land, Soils and Geology Chapter.

The follow up geophysical surveys carried out in the area of turbine T4 and its proposed access road to the north provide no evidence of karst features being present as only fresh competent LIMESTONE was detected by the surveys. The total length combined length of the 4 no. 2D Resistivity survey lines is 500m, and no evidence of karstification was identified over this distance (refer to the Land, Soils and Geology Chapter for more detail on the geophysical surveys carried out in the area of turbine T4).

This is also consistent with the findings of trial pits TP01 and TP11 which were carried out at proposed turbine location T4 and access road. Both trial pits encountered grey to dark grey, competent, massive LIMESTONE.

Due to the overall setback distance of potential karst features from most of the key infrastructure locations, the Karst Hazard Rating calculated by GDG is mainly Low with two areas of up to Medium as shown in **Table 9-13** below. A High Hazard Rating was calculated for the proposed turbine T4 where several potential karst features are located.

Following the implementation of mitigation measures proposed by GDG, the residual karst risk at each infrastructure location ranges from low to medium, indicating that development can proceed as long as mitigation measures are implemented (Refer to Appendix H of the Geotechnical Karst Risk Assessment for the complete Karst hazard Matrix which includes access roads).

Table 9-13: Distance to Closest Potential Karst Feature & GDG Overall Karst Hazard Rating

Location	Closest Distance (m)	Feature Type	GDG Feature ID	Karst Hazard Rating *
T1	214	ED	K27	Low – Medium
T2	310	ED	K27	Low
T3	410	ED	K15	Low
T4	40	ED	K39	High

Location	Closest Distance (m)	Feature Type	GDG Feature ID	Karst Hazard Rating *
T5	313	ED	K02	Low
T6	820	ED	K08	Low
T7	960	ED	K31	Low
T8	280	ED	K31	Low - Medium
T9	340	ED	K31	Low
Substation	510	ED	K27	Low
Construction Compound	340	ED	K28	Low

** Refer to Appendix H of the Geotechnical Karst Risk Assessment for the complete Karst hazard Matrix*
ED – Potential Enclosed depression/doline

The potential enclosed depressions/dolines present within the Proposed Wind Farm site are typically very shallow, nearly flat depressions and are present within glacial deposits. The base of the depressions are underlain by several metres of glacial till.

There is no evidence of a swallow hole/sink hole or any channelling/funnelling of surface water runoff to ground. The larger of the depressions were actually noted to hold surface water during wet periods and therefore they appear to not have a significant surface water drainage function at the Site. The land in this area of the Proposed Wind Farm is also poorly draining due to the CLAY dominated subsoils.

A review of aerial photography (www.geohive.ie) as far back as 1995, indicate that none of the more prominent potential enclosed depressions/dolines (i.e. GDG karst feature ID) have notably changed in size or appearance over the 30-year period.

The geophysical surveys carried out in the area of turbine T4 and its access road, show that the ground surface depressions present in that area have not formed due to karstification in the underlying bedrock, but are a geomorphological feature of the overburden.

Nonetheless and as a precautionary measure, a 30m buffer has been applied to all potential on-site enclosed depressions which is consistent with GSI groundwater vulnerability mapping practices. Refer to **Figure 9-10** below for potential karst feature buffer zone mapping.

The 30m buffers informed the layout of the Proposed Wind Farm drainage design (drainage drawings are attached as **Appendix 4-3**) in the proximity of potential enclosed depressions, whereby all proposed wind farm drainage buffered outfalls are located outside of these 30m buffer zones. (refer to Section 9.4.1 below).

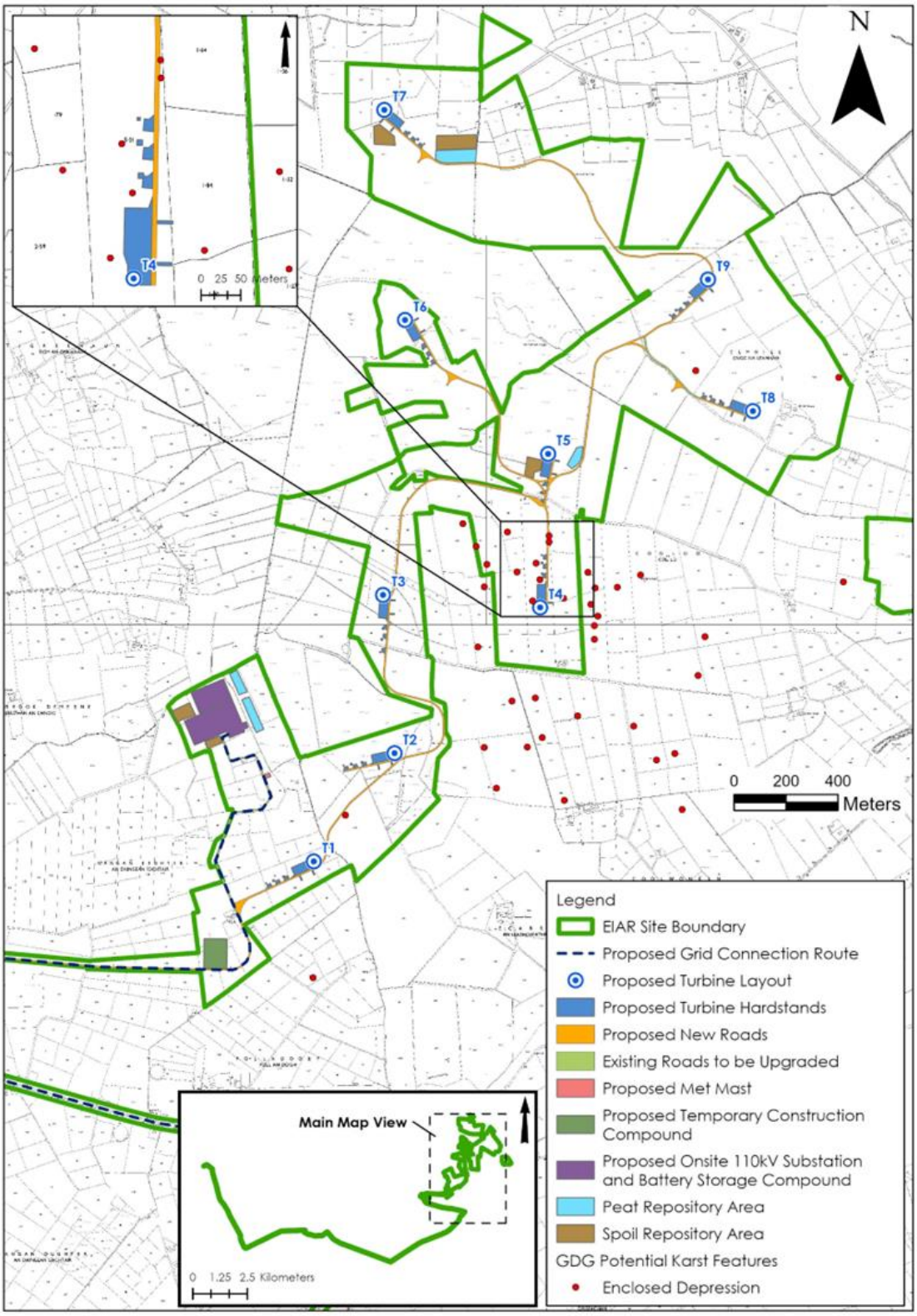


Figure 9-8: GDG Karst Feature Mapping

9.3.9.4 Groundwater Levels

As mentioned above, groundwater level monitoring was carried out at the Proposed Wind Farm site at BH1 and BH2 between October 2022 and February 2025 to assess seasonal changes and variations, particularly in the area of the Mid Galway Public Water Supply (PWS) source protection area (SPA) which overlaps a portion of the Proposed Wind Farm site at the southern end. Refer to **Figure 9-7** above for borehole locations.

Seasonal changes in groundwater levels in the aquifer as well as water level responses to rainfall events provide good information on underground drainage/recharge characteristics within the aquifer.

Monitoring wells (BH1 and BH2) were drilled into bedrock and therefore facilitate the measurement of the groundwater pressure head/level in the bedrock aquifer. Summary groundwater levels for the monitoring period are shown in **Table 9-14** below. Groundwater level plots are shown as **Figure 9-9** below.

BH1 is located 350m to the southwest of turbine T1, while BH2 is located 250m to the northeast of turbine T2. Both these turbines are also located inside the Mid Galway Public Water Supply PWS SPA and hence the reason for carrying out such long-term monitoring (almost 2.5 years of groundwater level monitoring).

Groundwater levels in BH1 over the monitoring period ranged between 72.41m OD (2.59mbgl) and 70.786 m OD (4.21mbgl). Groundwater levels in BH2 over the monitoring period ranged between 77.427m OD (0.57mbgl) and 76.513m OD (1.48mbgl).

The seasonal groundwater level variation/fluctuation at the BH locations ranged between 0.91m (BH2) and 1.6m (BH1) which is a relatively small range of fluctuation/variation. The low seasonal groundwater level variation is typical of peatland/bog settings where groundwater flows/recharge is generally impeded, and groundwater levels are relatively consistent across all seasons.

Typically, groundwater levels in karst limestone bedrock are highly variable and flashy due to well-developed networks of conduits and fractures that allow for rapid groundwater flow, making water levels fluctuate significantly in response to rainfall and other factors. This type of groundwater level response is not observed in BH1 or BH2 and is consistent with the bedrock type encountered at the Site (i.e. impure LIMESTONE/MUDSTONE). The presence of MUDSTONE layers in the bedrock is likely to significantly impeded groundwater flow paths through the aquifer.

The groundwater level subdued responses indicate that there is limited recharge/vertical groundwater flow from the glacial deposits down into the underlying bedrock aquifer at the Proposed Wind Farm site. This is also confirmed by the high stream density and man-made drainage density at the Site. The presence of drainage features implies there is a need to drain surface water, as it cannot recharge/drain readily to the underlying bedrock aquifer underneath.

If there was significant underground drainage occurring because of deeper karstified bedrock, these observed conditions, and indeed the raised bog itself, would not exist at the Proposed Wind Farm site. There would likely be an overall lack or surface water drainage as seen on the lands to the southeast of the Site where there is a high density of GSI mapped karst features.

No karstified bedrock or conduit/fracture networks were encountered in BH1 and BH2 on the south of the Proposed Wind Farm site, and neither in GSI borehole GSI-17-003 on the north of the Proposed Wind Farm site. Similarly, no epi-karst was recorded in the 14 no. trial pits which encountered bedrock at the Proposed Wind Farm site. The lack of karstification was also reflected in the geophysical surveys which encountered fresh, competent limestone over a survey distance totalling 0.5km.

The small range of groundwater level fluctuation/variation in monitoring wells BH1 and BH2 is consistent with the expected low permeability and competent nature of the impure

LIMESTONE/MUDSTONE encountered during drilling at all 3 no. locations (BH1, BH2 and GSI-17-003).

Table 9-14: Groundwater Level Summary Data (October 2022 – February 2025)

Location	Ground Level (m OD)	Min WL (m OD)	Max WL (m OD)	Range (m)
BH1	75	70.786	72.41	1.620
BH2	78	76.513	77.427	0.914

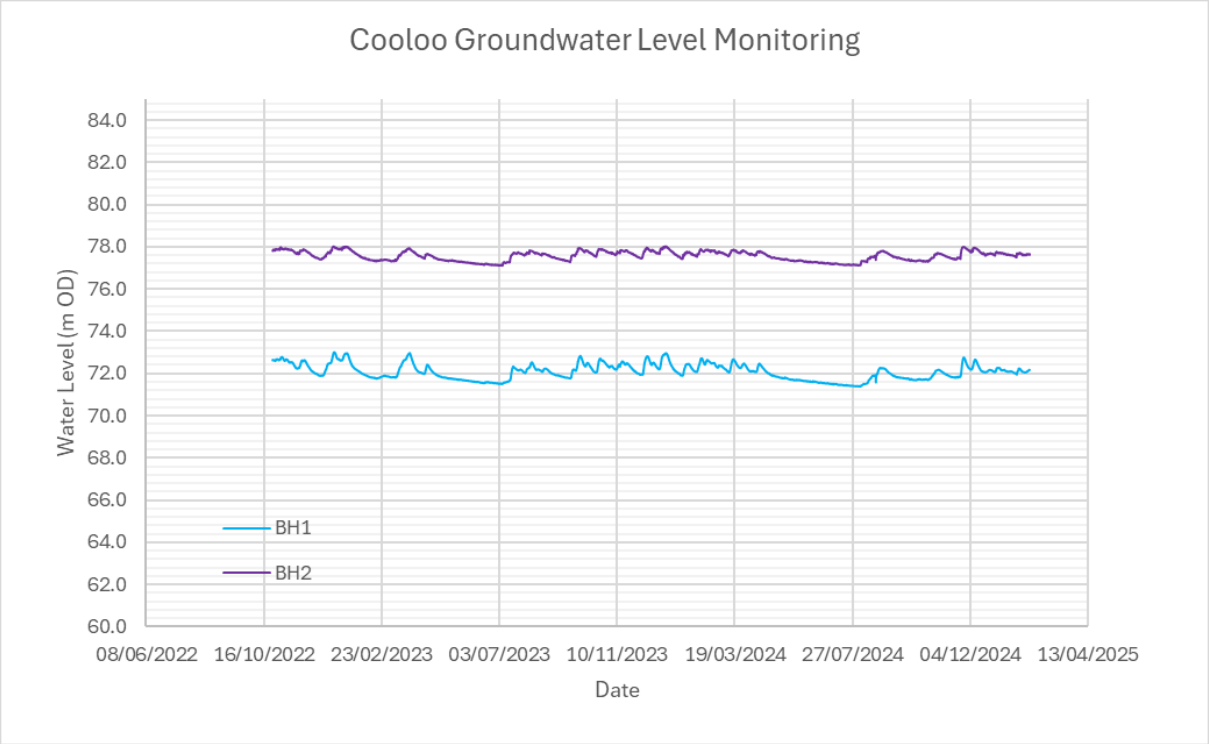


Figure 9-9: Groundwater Level Plots for BH1 and BH2

9.3.10 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 GSI groundwater vulnerability rating of the limestone aquifer underlying the Proposed Wind Farm site is mapped as predominately 'Low' to 'Moderate' in the northern and central parts of the Proposed Wind Farm site, while in the far south of the Proposed Wind Farm site the vulnerability rating ranges from 'High' to Extreme'.

The 'Low' vulnerability rating largely results from the presence of basin peat/cutover bog which covers a large portion of the north of the Proposed Wind Farm site. The 'Moderate', 'High' and 'Extreme' rated areas are typically grassland.

Based on the GSI vulnerability mapping, proposed turbine locations T3, T4, T6, T7 and T8 are mapped in areas of 'Moderate' vulnerability. Proposed turbine locations T2, T5 and T9 are mapped in areas of Low vulnerability, while proposed turbine location T1 and the temporary construction compound are located in an area mapped as 'High' vulnerability.

The Substation element of the Proposed Grid Connection is located in an area mapped as 'Low' to 'Moderate' vulnerability, while the section of the Proposed Grid Connection cable route within the Proposed Wind Farm site is mapped as 'High' to 'Extreme' vulnerability. Similar vulnerability ratings are mapped along the Proposed Grid Connection cable route outside of the Proposed Wind Farm site.

Bedrock was confirmed in 14 no. of the 26 no. trial pits, which included 7 no. of the proposed 9 no. turbine locations (T1, T2, T3, T4, T5, T6 and T8). Depth to bedrock ranged from 0.8m to 3.6m with an average of 2.2m, which equates to a groundwater vulnerability rating of 'Extreme' to 'High' (refer to **Table 9-15** below).

In addition, all watercourses which flow through the Proposed Wind Farm site as described in Section 9.3.4.1 above are assigned an 'Extreme' vulnerability rating by the GSI by means of applying a 30m buffer. In karst areas, potential point recharge zones such as swallow holes, dolines, and streams are assigned an 'Extreme' vulnerability rating which is applied using a 30m buffer around the feature as best practice.

As explained in Section 9.3.16 below, a 50m watercourse buffer (in excess of the GSI 30m buffer) has been applied to all natural watercourses within the Proposed Wind Farm site and apart from proposed watercourse crossings, all proposed infrastructure is located outside these 50m buffer zones.

As stated previously, there are no GSI mapped karst features within the Proposed Wind Farm site and therefore there are no associated GSI mapped karst feature vulnerability buffer zones mapped. However, there is 1 no. GSI mapped karst feature (i.e. a spring) within 30m of the Proposed Grid Connection cable route outside the Proposed Wind Farm site. This feature is located along the N63 approximately 2km to the southwest of Horseleap Lough.

The 13 no. potential enclosed depressions mapped by GDG within the Proposed Wind Farm site have been applied a 30m buffer as a conservative measure, albeit the investigation and geophysical surveys carried out to date at the Site have identified no karstification.

Also as noted above there is no evidence on the ground to suggest these features channel/funnel surface water drainage to ground. These features also typically underlain poorly draining, CLAY dominated subsoils. Refer to **Figure 9-10** below for potential karst feature buffer zones.

No turbine foundation areas are located inside a potential karst feature 30m buffer zone, however the T4 hardstand and associated access road to the north are inside buffer zones associated with potential enclosed depressions. The only other Proposed Wind Farm infrastructure inside a potential enclosed 30m buffer zone is the proposed access road between turbines T1 and T2.

It's also worth noting that no element of the Proposed Grid Connection inside the Proposed Wind Farm site (i.e. substation/BESS) is located inside a potential karst feature 30m buffer zone.

Table 9-15: Groundwater Vulnerability and Subsoil Permeability and Thickness (Groundwater Protection Schemes Report 1999)

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3.0m	0 - 3.0m	0 - 3.0m	0 - 3.0m	-
High (H)	>3.0m	3.0 - 10.0m	3.0 - 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0 - 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

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

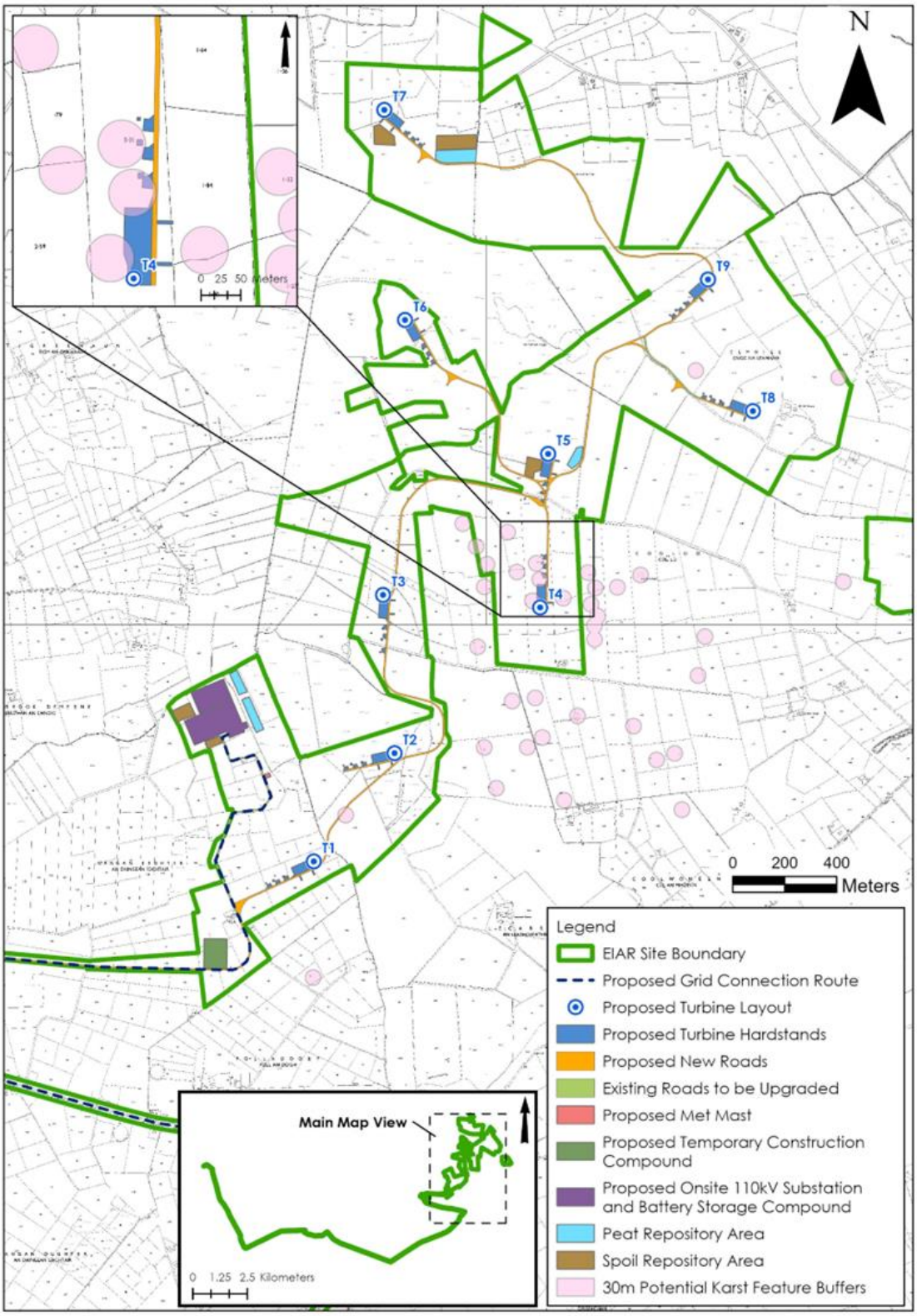


Figure 9-10: Potential Karst Feature Buffer Zones

9.3.11 Groundwater Quality Hydrochemistry

Groundwater sampling of BH1 and BH2 was carried out by HES on 22nd August 2024. Tabulated groundwater quality data are attached as **Appendix 9-3**. Results of the analysis are shown alongside relevant groundwater regulation values and drinking water regulation values (S.I. No. 9/2010 as amended and S.I. No. 99/2023). Original Laboratory certificates are shown in **Appendix 9-2.**

Manganese was the only exceedances with regard the drinking water regulation threshold values. The elevated manganese is naturally occurring in the shaley limestone and mudstone bedrock.

Nutrients such as nitrate, nitrite, phosphorus, and ammonia were low with results being close to the laboratory detection limit in all samples.

Ranges for electrical conductivity (560 - 573µS/cm) and pH (72 - 74) are typical for a limestone aquifer.

9.3.12 Groundwater Body Status

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

The Clare Corrib GWB (GWB: IE_WE_G_0020) underlies the Site and it is assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

The assigned risk status (WFD 3rd Cycle) is At Risk. The main groundwater pressures are reportedly due to agricultural practices.

9.3.13 River Water Body Status

Local River Waterbody status and WFD risk classification are available from (www.catchments.ie) and are summarised in

Table 9-16 below.

Table 9-16 below gives summary details of the sub-basin in which the Site is directly located. Please refer to the WFD Compliance Assessment report (attached as **Appendix 9-4**) for details and status of all river waterbodies/sub-basin in the Water Study Area.

The Proposed Wind Farm site is located within Grange (Galway)_010 and Abbert_030 sub-basins which are both assigned 'Good' status and are 'Not at Risk' of not maintaining Good status.

The proposed Substation element of the Proposed Grid Connection is also located in the Abbert_030 sub-basin. On leaving the Proposed Wind Farm site, the Proposed Grid Connection cable route passes through the Abbert_030, Feagh_East_010, Grange (Galway)_040, Clare (Galway)_070 until the termination of the cable route in the Clare (Galway)_060 sub-basin south of Tuam town.

The sub-basin status along the Proposed Grid Connection cable route ranges from 'Good' to 'Poor'. The Clare (Galway)_060 is the only river waterbody deemed to be 'At Risk' of not achieving Good status. The reported pressure on the Clare (Galway)_060 is hydromorphology.

Table 9-16: River Waterbody Status and Risk for the Proposed Project

European Code	Sub_basin	Overall Status (2016 – 2021)	Risk Status (3rd Cycle)	Pressure Category
IE_WE_30G020200	Grange (Galway)_010	Good	Not At Risk	None
IE_WE_30A010300	Abbert_030	Good	Not At Risk	None
IE_WE_30F170810	FEAGH_EAST_010	Moderate	Unassigned	None
IE_WE_30G020500	Grange (Galway)_040	Good	Not At Risk	None
IE_WE_30C010800	Clare (Galway)_060	Poor	At Risk	Hydro-morphology
IE_WE_30C011000	Clare (Galway)_070	Good	Not At Risk	None

9.3.14 Designated Sites and Habitats

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SAC) and Special Protection Areas (SPAs). A map of designated sites in the local area is shown as **Figure 9-11** below.

The closest designated site to the Proposed Project site is Lough Corrib SAC (Site Code: 000297) which includes sections of the Grange River and Abbert River downstream of the Site. Downstream distance from the Proposed Wind Farm site to Lough Corrib SAC in the Grange River is 3km and 5.5km in the Abbert River.

The Proposed Grid Connection cable route briefly intercepts Lough Corrib SAC where it crosses over the Grange River via an existing bridge on the R347 approximately 9km to the west of the Proposed Wind Farm site.

Derrinlough Bog SAC (Site Code: 002197) is located approximately 3.5km to the northeast of the Proposed Wind Farm site, while Levally Lough SAC (Site Code: 000295) is located 3.5km to the northwest.

Both Derrinlough Bog SAC and Levally Lough SAC are located upstream of the Proposed Project site in the Grange River catchment and therefore no hydrological pathway/connection is present. Given that the dominant groundwater flow direction in the Lough Corrib GWB is to the southwest, the Proposed Project site is also located downstream of both SACs with regard to groundwater flow.

Killaclogher Bog NHA is located approximately 4km to the southeast of the Proposed Wind Farm site where it is located upstream of the Site in the Abbert River catchment and therefore no hydrological pathway/connection is present. The south-westerly groundwater flow in the Lough Corrib GWB means it's also at an up-gradient position with regard groundwater flowpaths.

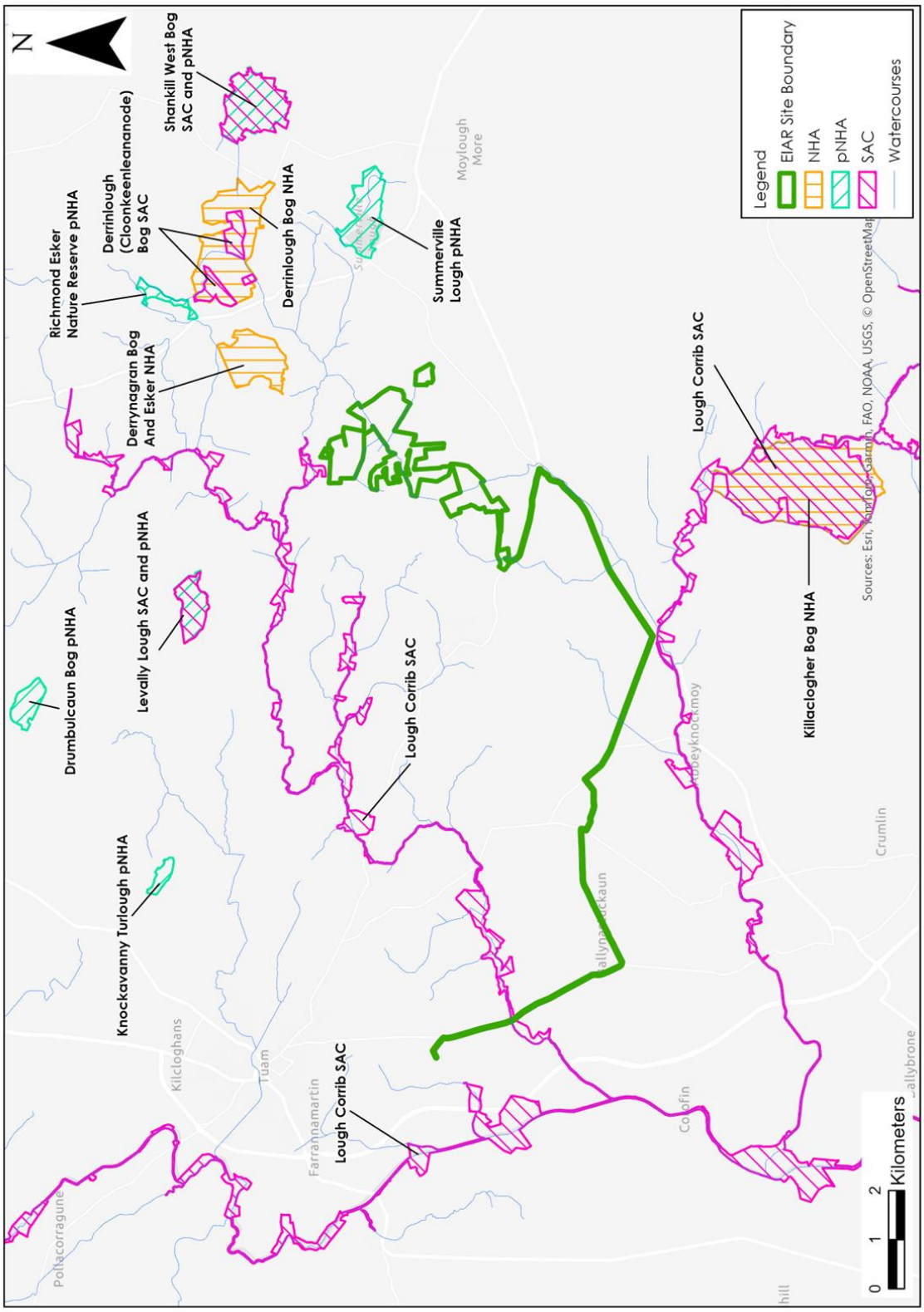


Figure 9-11: Local Designated Sites

9.3.15 Water Resources

9.3.15.1 Public/Group Water Schemes

The most southerly portion (approximately 50ha) of the Site is located in the Mid Galway Public Water Supply (PWS) Source Protection Area (SPA). Refer to **Figure 9-12** below for SPA mapping which is available online and documented in the EPA report *Establishment of Groundwater Source Protection Zones - Mid Galway Public Water Supply Scheme* (May, 2012).

Proposed Project infrastructure elements of the Proposed Wind Farm site inside the SPA include 2 no. turbines locations (T1 and T2) and the proposed temporary construction compound. In addition, approximately 3.8km of the Proposed Grid Connection cable route is located inside the SPA, with the majority of the proposed cable route being along the carriageway of the R332 and N63 roads.

The Mid-Galway PWS abstraction is from the Lecarrow 30 Stream approximately 2km downstream of Horseleap Lough (3km downstream of the Proposed Wind Farm site). The source is largely sustained by numerous karst springs (i.e. overflow springs) located along the banks of Lecarrow 30 Stream downstream of Horseleap Lough.

Surface water flows in the Lecarrow 30 Stream upstream of the springs dry up during dry periods and therefore surface water flows do not make up a significant volume of the source.

It's also worth noting that proposed turbine locations T1 and T2 as well as the construction compound are within the Lecarrow 30 Stream surface water catchment up-stream of Horseleap Lough.

The following summary details were taken from the EPA Establishment of Groundwater Source Protection Zones Report (May, 2012):

- The total SPA area is mapped to be 49.8km^2;
- Dominantly a groundwater fed source from springs;
- According to the EPA (2012) report the source is fed by a network of overflow springs located along the banks of the Lecarrow 30 Stream downstream of Horseleap Lough;
- The estimated median discharge of the Lecarrow 30 Stream at the abstraction location is 19,000m^3/day;
- Average daily abstraction of the source reported to be 4,000m^3/day; and,
- Following chlorination, filtration and UV treatment water from the spring is pumped to a storage tank.

The Barnaderg GWS source springs and borehole is located in close proximity to the Mid Galway PWS and share the same groundwater zone of contribution.

Also, the Feigh East and West Group Water Scheme (GWS) SPA is mapped along the route of the Proposed Grid Connection cable, approximately 3km to the southwest of the Proposed Wind Farm site. However, the Proposed Grid Connection cable route does not pass through the SPA. Based on GSI data, the source is a 35m deep borehole with a reported "Good" yield. The borehole is located 220m from Proposed Grid Connection cable route at an up-gradient location with regard groundwater flow.

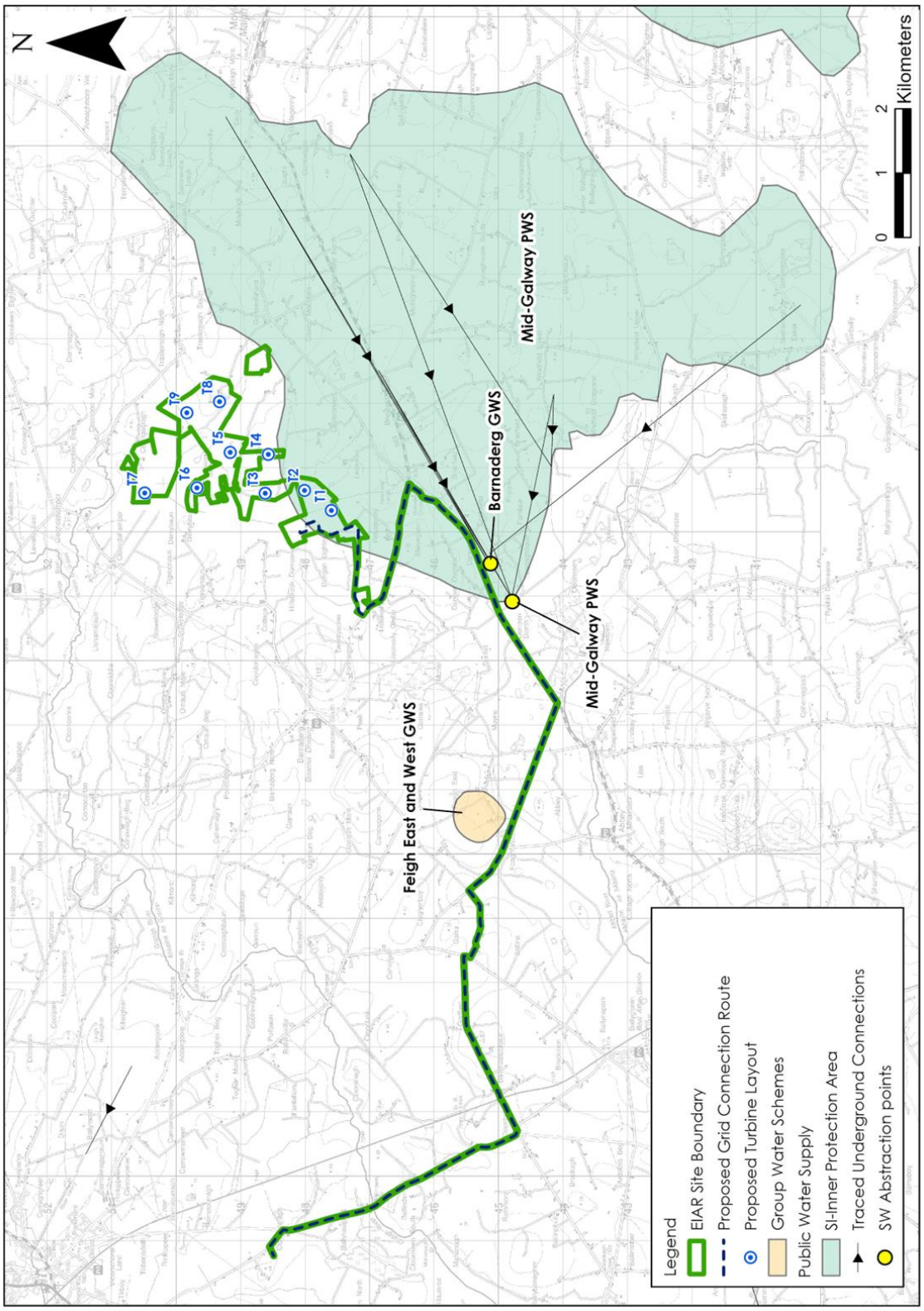


Figure 9-12: GSI/EPA Mapped Groundwater Source Protection Areas

9.3.15.2 Private Domestic Wells

A search of private well locations on the GSI well database (www.gsi.ie) reveal no mapped private wells within 2km of the Proposed Wind Farm site. There are several GSI mapped wells along the Proposed Grid Connection route within a 500m distance.

It is accepted that the GSI database does not include all potential water wells. As such, and in order to be conservative, for the purposes of assessment, as completed in Section 9.5.2.11 below, we assume that there is a groundwater well source at each residential dwelling location as identified in Chapter 5 of this EIAR: Population & Human Health.

Numerous private dwelling houses were identified along the local roads which surround the Proposed Wind Farm site (i.e. potentially down-gradient).

Due to the nature of the Proposed Grid Connection cable being within the carriageway of public roads outside the Proposed Wind Farm site, no assessment on potential wells located along the cable route was carried out due to the lack of potential affects.

GSI mapped wells and private dwelling houses are shown on **Figure 9-13** below.

9.3.15.3 Surface Water Resources

There are no river waterbodies in the vicinity of the Site which are identified as Drinking Water Protected Areas (DWPAs).

The Corrib Lower Drinking Water Protected Area (DWPA, relating to the abstraction at Luimnagh WTP) is located approximately 23km to the west of the Site (35 – 45km downstream of the Proposed Wind Farm site).

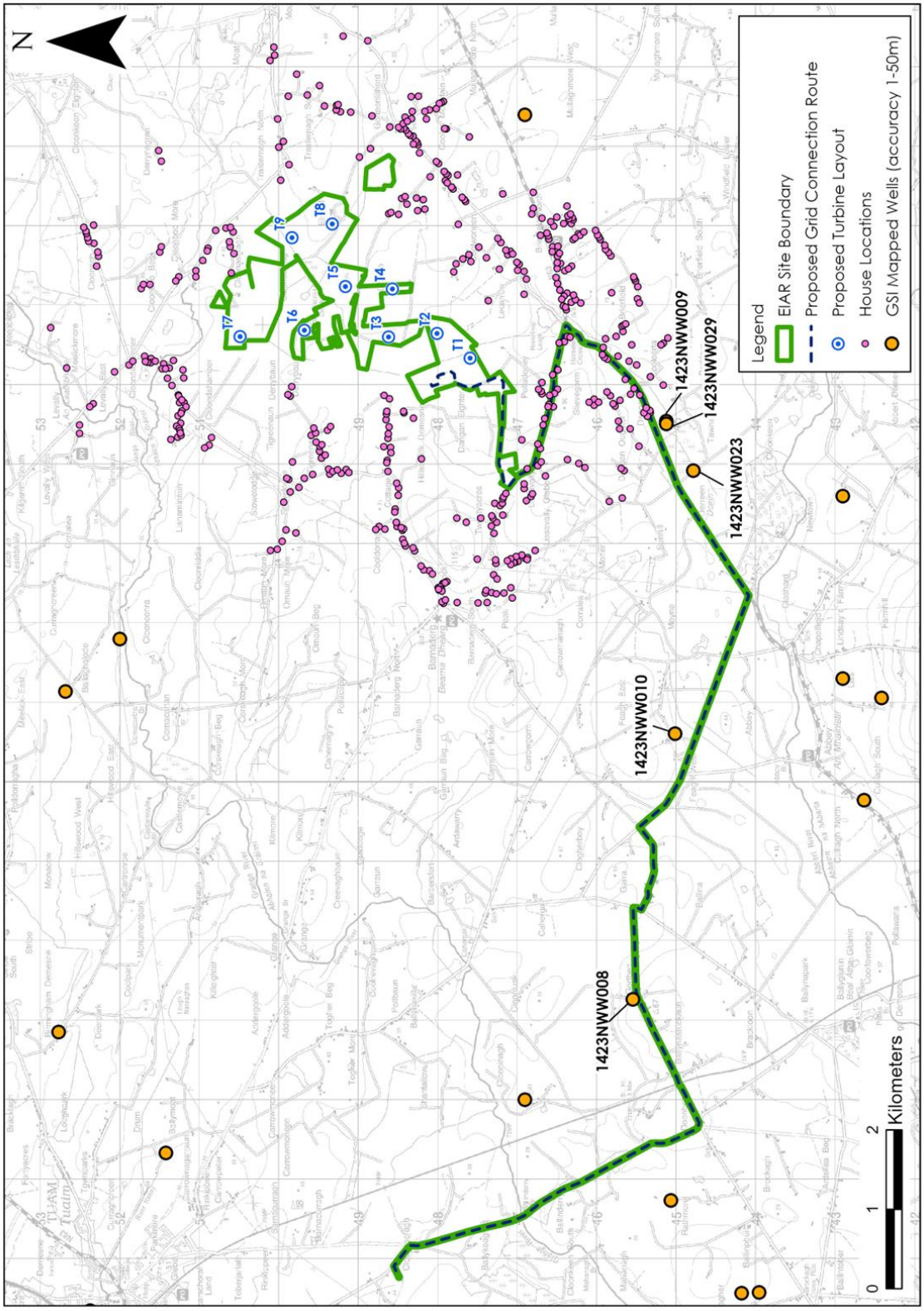


Figure 9-13: GSI Mapped Private Wells and Private Dwellings

9.3.16 Receptor Sensitivity

Due to the nature of Proposed Wind Farm and Proposed Grid Connection developments being near surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the Site would be from hydrocarbon and cement spillage and leakages at excavations locations.

These are common potential impacts at all construction sites (such as road works and industrial sites). These potential contamination sources will be carefully managed at the Site during the construction; operational and decommissioning phases of the Proposed Project and mitigation measures are proposed below to deal with these common hazards.

It is acknowledged that the Site is underlain by a limestone aquifer which is mapped by the GSI as Regionally Important and Karstified. However, a large portion of the Proposed Wind Farm site is covered by low permeability peat, with other parts having poorly draining soil and SILT/CLAY dominant subsoils. Also, the bedrock lithology below Proposed Wind Farm site is a combination of impure LIMESTONE with MUDSTONE which will reduce the overall permeability of the aquifer. The site investigations carried out to date at the Proposed Wind Farm site (i.e. trial pits, borehole drilling and geophysical surveys) did not provide evidence of significant karstification. Targeted geophysical surveys of two ground depressions (i.e. potential karst enclosed depression) did not reveal any evidence of underlying karstification.

The presence of peat/poorly draining soil along with high drainage density at the Proposed Wind Farm site is further evidence of low recharge and poorly developed groundwater drainage system that would not be expected in highly karstified bedrock, if present.

The majority of the Proposed Grid Connection cable is within the carriageway of public roads and due to the shallow nature of the trench excavation, effects on groundwater quality/flows is not expected.

Any contaminants which may be accidentally released on-Site are more likely to travel to nearby streams within surface water runoff. The relatively low permeability of the CLAY/SILT glacial deposits means contaminants are unlikely to reach the bedrock and will instead disperse with the glacial deposits and would remain localised to the source or would be removed as runoff during wet periods.

It is acknowledged that the Mid Galway PWS and Barnaderg GWS sources are a very important local water supply that serves a wide population in the area, and that it is classified as an extremely sensitive water supply source. Considering the source importance and potential sensitivity to impacts from the Proposed Project, specific hydrogeological investigation/monitoring was undertaken to assess the potential effects of the Proposed Project.

Surface waters such as the downstream Abbert River, Grange River and River Clare are all very sensitive to potential contamination as these rivers downstream of the Site form part of the Lough Corrib SAC. The sensitivity of the on-Site watercourses (i.e. Dangan Eighter Stream, The Forty Acres Stream and Lecarrow 30 Stream) is acknowledged and a 50m constraints hydrological buffer has been applied to these watercourses during the layout design phase.

Mitigation measures, as outlined in Section 9.5 below, 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 or groundwater bodies. Any introduced drainage works at the Site will mimic the existing hydrological/hydrogeological regime thereby avoiding changes to flow volumes leaving the Site.

A surface water hydrological constraints map for the Site is shown as **Figure 9-14**. The map shows that the majority of Proposed Project areas (with the exception of watercourse crossings) are located away from areas on the Site that have been determined to be hydrologically sensitive.

The large setback distance (>50m) from sensitive hydrological features means they will not be impacted 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. This will allow attenuation of surface runoff to be more effective.

Also, as a conservative measure and in line with GSI groundwater vulnerability mapping practices, a 30m[4] buffer has been applied to all potential karst features/enclosed depressions within the Proposed Wind Farm site, where all proposed Wind Farm drainage outfall will be located outside of these potential karst buffer zones. As stated previously, none of the potential enclosed depressions at the Proposed Wind Farm site show any hydrological/drainage function.

[4] Please note a 15m buffer is required under the European Union (Good Agricultural Practice For Protection of Water) Regulations 2022 (S.I. 113/2022), therefore a 30m buffer is very conservative.

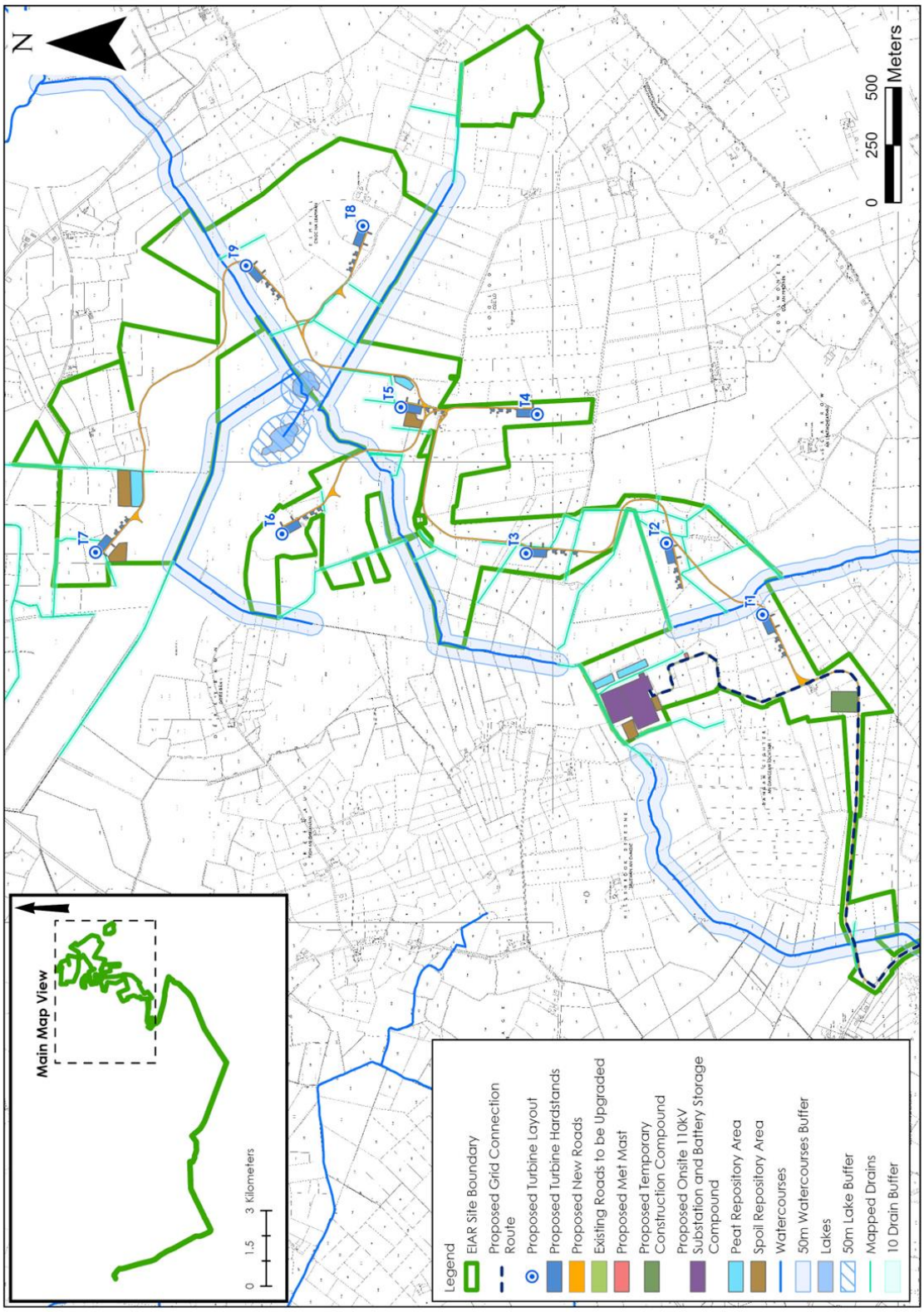


Figure 9-14: Hydrological Constraints Map

9.4 Characteristics of the Proposed Project

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

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

- Establishment of 1 no. temporary construction compounds, which will involve minor regrading of soil/subsoil and the emplacement of hardstand. 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, however, the floating technique will also be used. This will involve the use of aggregate imported from local quarries where required;
- 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 material will also be reinstated during decommissioning;
- 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;
- Cabling between turbine locations and the on-site substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling;
- Construction of 5 no. new watercourse crossing (clear span bridge design);
- Tree felling (0.7ha) for the purposes of turbine and access road construction clearance which will be carried out under felling licence;
- Establishment of 4 no. peat repositories and 5 no. spoil repository area;
- Construction of approximately 0.6km of floating access road on intact raised bog to provide access to proposed turbine location T7;
- 5 no. new watercourse crossings using clear span bridge structures; and,
- Turbine haul route upgrade works at the R332/N63 road junction and at the R332 at the proposed Site entrance.

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

- Approximately 21km of an underground cabling route between the proposed 110kV substation and the existing Cloon substation involving the excavation of a double shallow trench (approximately 1.2m deep), placement of ducting and backfilling with aggregate, lean-mix concrete, and excavated material, as appropriate (depending on the location of the cable trench);
- Construction of the on-site 110kV substation with a subsoil bearing foundation. Welfare facilities will be provided at the substation along with a temporary construction compound;
- Construction of a Battery Energy Storage System (BESS) and Control Building at the proposed substation location; and,
- 4 no. existing watercourse bridge/culvert crossings along the public road section of the cable route with the cable being placed in the bridge/culvert decking or by means of Horizontal Directional Drilling (no in-stream are proposed at any existing crossing location).

9.4.1 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface water bodies. Two distinct methods will be employed to manage drainage water within the Site. The first method involves 'keeping clean water clean' by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas.

The second method involves collecting any drainage waters from works areas within the Site that might carry silt or sediment, and nutrients, to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters.

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

Figure 9-15 below.

Also, as a precautionary measure, due to the presence of potential enclosed depressions/doline karst features at the Proposed Wind Farm site, all surface water drainage outfalls at level spreaders will be outside the 30m potential karst feature buffer zones. As stated previously, none of the potential enclosed depressions at the Proposed Wind Farm site show any hydrological/drainage function.

A detailed drainage plan showing the layout of the proposed construction and operational drainage design elements as shown in

Figure 9-15 and in **Appendix 4-3**.

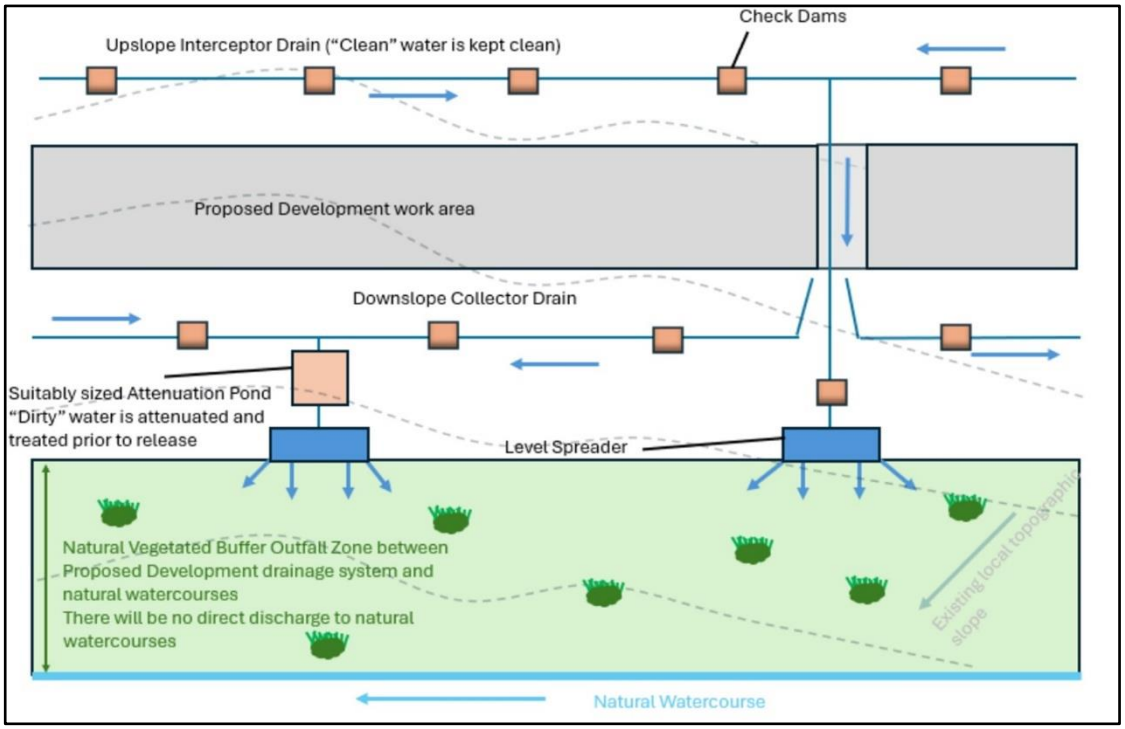


Figure 9-15: Schematic of the Proposed Drainage Management

9.5 Likely Significant Effects and Mitigation Measures

The potential impacts of the Proposed Project 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 Site. Forestry will be felled as its reach's 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.

9.5.2 Construction Phase – Likely Significant Effects and Mitigation Measures

9.5.2.1 Potential Effects on the Mid Galway PWS and Barnaderg GWS Sources (Proposed Project)

The most southerly part (50ha) of the Site is located in the Mid Galway Public Water Supply (PWS) Source Protection Area (SPA). The Barnaderg GWS shares the same groundwater zone of contribution as the Mid Galway PWS.

Proposed infrastructure elements of the Proposed Wind Farm site inside the SPA include 2 no. turbines locations (T1 & T2) and the proposed temporary construction compound. In addition, approximately 3.8km of the Proposed Grid Connection cable route is located inside the SPA, with the majority of the 3.8km being along public roads.

The Mid-Galway PWS abstraction is from the Lecarrow 30 Stream approximately 2km downstream of Horseleap Lough. The source is largely sustained by numerous karst springs (i.e. overflow springs) located along the banks of Lecarrow 30 Stream downstream of Horseleap Lough.

There are very minor surface water flows in the Lecarrow 30 Stream, but this does not sustain the source as the Lecarrow 30 Stream often dries up in summer. The Barnaderg GWS source is located approximately 0.7km upstream of the Mid-Galway PWS on the Lecarrow 30 Stream.

Proposed turbine locations T1 and T2 are within the Lecarrow 30 Stream surface water catchment up-stream of Horseleap Lough.

Quantity effects (i.e. flows/spring discharge volumes) could potentially arise due to deep excavations, dewatering, grouting etc in the bedrock aquifer that supplies groundwater to the spring. Due to the nature of the groundwater flows to the spring (i.e. likely deep bedrock conduit flow), significantly deep excavations, for example turbine base constructed below the top of bedrock, could have the potential to significantly affect flows to the source springs.

Replacement of natural ground with less permeable hardstand areas within the SPA could have potential to affect groundwater recharge within the SPA if the proposed drainage design does not mimic the existing hydrological/hydrogeological/recharge regime.

Potential groundwater quality effects at the Site would be mainly from hydrocarbon and cement spillage and leakages at excavations locations.

Also, any poor-quality surface water runoff from the Proposed Wind Farm works and Proposed Grid Connection cable route excavation areas entering the Lecarrow 30 Stream could potentially reach the source abstraction point downstream of Horseleap Lough.

Pathways: Groundwater flowpaths and recharge (quality effects). Alteration/disruption of groundwater conduits/flowpaths in the bedrock aquifer (quantity and quality effects) as well as surface water flowpaths in the Lecarrow 30 Stream.

Receptors: Mid Galway PWS and Barnaderg GWS sources

Pre-Mitigation Potential Impact: Negative, slight, indirect, short term, unlikely effect on PWS/GWS source quality and quantity.

Impact Assessment/Proposed Mitigation Measures:

Assessment of Quantitative Effect (i.e. flow volumes to the source springs) and Proposed Mitigation Measures

As part of the EIAR investigations, BH1 and BH2 were drilled on the south of the Proposed Wind Farm site within the Mid Galway PWS SPA. The drilling was specifically carried out to investigate the ground and bedrock conditions in the area of proposed turbine locations T1 and T2.

Both boreholes were drilled to a depth of 20m and both encountered competent dark grey, impure LIMESTONE with MUDSTONE layers.

No epi-karst, karst conduits, significant fractures or groundwater strikes were encountered due to the lithology competent nature of the bedrock. Any groundwater inflows recorded were slow, suggesting an overall low permeability LIMESTONE/MUDSTONE formation.

Also, the low seasonal groundwater level variation/fluctuation measured in the boreholes is typical of peatland/bog settings where groundwater flows/recharge is generally impeded. This indicates that there is limited recharge/vertical groundwater flow from the glacial deposits down into the underlying bedrock aquifer at the Proposed Wind Farm site within the SPA.

This is also confirmed by the high man-made drainage density at the Site. Also, the Lecarrow 30 Stream drains the portion of the Proposed Wind Farm site within the SPA which again demonstrates low groundwater recharge and a dominance of surface water runoff as rainfall cannot recharge/drain readily to the underlying bedrock aquifer.

Therefore, due to the nature of the underlying geology (LIMESTONE/MUDSTONE formation) and the prevailing surface water drainage regime within the portion of the Proposed Wind Farm site within the SPA, no effects on groundwater flowpaths towards the Mid Galway PWS or Barnaderg GWS sources are likely to occur due to excavations.

Similarly, the Proposed Grid Connection cable route trenching works will have no potential to effect groundwater flow paths towards the source due to the prevailing underlying geology, shallow nature of the works (approximately 1.2m) and the fact that the proposed section of cable route closest to the abstraction point is along the carriageway public roads.

Also, any proposed wind farm drainage controls within the Mid Galway PWS/Barnaderg GWS SPA will mimic the existing hydrological regime in that all wind farm runoff collected in the Lecarrow 30 Stream will also be released within the catchment (i.e. no net balance change in groundwater recharge /runoff).

Assessment of Quality Effect and Proposed Mitigation Measures

In order for potential contaminants (i.e. oils, fuels, cements, sediments etc) to reach the source abstraction point from the Proposed Project site construction areas, a groundwater or surface water flowpath (pathway) must be present.

Intercepting/unearthing a bedrock conduit/fracture during the construction works would potentially create a direct pathway between the construction work area (i.e. turbine base) and the source. The prevailing geology/hydrogeology described above makes this very unlikely.

Therefore, another potential pathway that exists between the proposed construction areas and the source is indirectly via diffuse recharge through the overlying glacial tills and down into the bedrock aquifer.

The site investigations and groundwater level monitoring data indicates that the majority of the recharge water in the glacial tills actually discharges to drains and the Lecarrow 30 Stream that drains the area of the Site within the SPA. Therefore, only a very small portion of the recharge water in the glacial tills actually passes down to recharge the bedrock aquifer. Therefore, the total volume of recharge occurring within the Site itself that contributes groundwater flow to the overall source discharge is low. Therefore, the potential diffuse recharge pathways between the proposed construction works areas and the spring are extremely limited.

There is one potential enclosed depression/doline mapped within the Proposed Wind Farm site inside the SPA (potential point recharge feature). However, the enclosed depression/doline is remote from proposed turbines T1 & T2 (>200m) and given the underlying geology (LIMESTONE/MUDSTONE) is not likely to be karstic in nature.

Therefore, the most likely pathway from the Proposed Wind Farm site to the Mid Galway PWS abstraction point is surface water flows in the Lecarrow 30 Stream. However, flow in the Lecarrow 30 Stream leaving the Site must pass through Horseleap Lough before reaching the downstream abstraction location. Horseleap Lough is effectively a large natural wetland which will have significant attenuation/treatment capacity. Therefore, even in the absence of any wind farm surface water drainage control mitigation (which won't be the case), surface water effects downstream of Horseleap Lough in the Lecarrow 30 Stream are not likely.

The closet karst feature to the Proposed Grid Connection, according to the GSI, is a spring which is not a potential point source of recharge.

The following mitigation is proposed at <u>all construction works areas inside the SPA:</u>

- No storage of fuels, oils, cements, or chemicals will be permitted within the SPA
- Refuelling of mobile plant (i.e. diggers, dumpers etc) will only be permitted outside the SPA;
- Refuelling of large immobile plant (i.e. cranes) will only be carried out with a refuelling truck that will be removed from SPA immediately after use;
- Spill kit stations will be present at each turbine location (T1 & T2), temporary construction compound and along the Proposed Grid Connection cable route works areas;
- There are no proposed peat or spoil repositories within the SPA as part of design mitigation;

- A geotextile liner will be placed below the founding layer (lean mix concrete) where concrete is to be poured. These both prevent vertical loss of wet concrete at turbine bases;
- Use of perimeter shuttering at turbine basis to prevent lateral loss of wet concrete;
- All temporary cement washout lagoons will be located outside the SPA;
- Works inside the Lecarrow Stream 50m watercourse buffer limited to 1 no. proposed watercourse crossing culvert which will be clear spanning;
- No wind farm drainage will be released inside the 50m watercourse buffer on the Lecarrow 30 Stream;
- No wind farm drainage will be released inside the 30m buffer for the 1 no. potential enclosed depression/doline mapped inside the SPA at the Proposed Wind Farm site
- Drainage control measures at works areas along the Proposed Grid Connection (Refer to Section 9.5.2.15 below); and,
- There will be clear signage in place inside the refined SPA to remind construction workers that the area is inside a drinking water protection area.

Residual Effect: Due to the local hydrogeological and hydrological regime, along with the proposed design measures and mitigation measures, no residual effects on Mid Galway PWS/Barnaderg GWS sources will occur.

Significance of Effects: Due to the local hydrogeological/hydrological regime and with the application of the mitigation outlined above, no effects on the Mid Galway PWS/Barnaderg GWS sources will occur.

9.5.2.2 Clear Felling of Coniferous Plantation and Potential Surface Water Quality Effects (Proposed Wind Farm)

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

Tree felling is a very minor component of the Proposed Wind Farm works with approx. only 0.7ha felling proposed around the area of proposed turbine location T9 and associated infrastructure. This proposed felling is located in the Grange River catchment.

The tree felling activities required as part of the Proposed Wind Farm 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 (Dangan Eighter Stream, Grange River and River Clare) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, likely effect on surface water quality.

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

Mitigation by Avoidance:

There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document *"Forestry and Water Quality Guidelines"* are shown in **Table 9-17**.

Table 9-17: 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 Proposed Wind Farm construction phase a self-imposed buffer zone of 50 metres will be maintained for all streams where possible. These buffer zones are shown on **Figure 9-14**. Approximately 1 ha of tree felling is required inside a 50m buffer zone.

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 (approximately 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;
- 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 nears 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 in 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).

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 potential for the release of suspended solids to watercourse receptors during tree felling is a risk to water quality and the aquatic quality of the receptor. Proven forestry best practice measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effect of the Proposed Wind Farm will be 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.

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

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

Proposed Project construction phase activities that will require earthworks resulting in the removal of vegetation cover and excavation of peat and mineral subsoil (where present) are detailed in Chapter 4 the Description of the Proposed Project. 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 the 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 could be significant if not mitigated.

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient streams and rivers (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River) and dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, significant, long-term, likely effect on surface water quality.

Mitigation by Avoidance:

The key mitigation measure during the construction phase of the Proposed Wind Farm is the avoidance of sensitive aquatic areas where possible From **Figure 9-14** it can be seen that all of the key areas of the Proposed Wind Farm infrastructure are actually significantly away from the 50m delineated buffer zones with the exception of proposed new roads, 5 no. proposed new stream crossings.

Additional control measures, which are outlined further on in this section, will be undertaken at these locations. 10m buffers will be maintained for all drains, albeit drains are not considered sensitive.

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.

It should be noted for this Site is that an extensive network of bog, agricultural and roadside drains already exist, and these will be integrated and enhanced as required and used within the Proposed Project drainage system. The integration of the existing drainage network and the Proposed Project 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 new road/hardstand (or road upgrades) the following key temporary drainage measures will be installed:

- All existing dry drains that intercept the proposed works area will be temporarily blocked down-gradient of the works using temporary 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 drains that have surface water flows and also along existing roadside drains; and,
- A double silt fence perimeter will be placed down-slope of works areas that are located inside the 50m watercourse and 10m drain buffer zones such as at watercourse crossings.

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 50m hydrological buffer zones.

Silt Bags:

Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, the majority of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters or sedimats Sediment entrapment mats, consisting of coir or jute matting, will be placed at the silt bag location to provide further treatment of the water outfall from the silt bag. Sedimats will be secured to the ground surface using stakes/pegs. The sedimat will extend to the full width of the outfall to ensure all water passes through this additional treatment measure.

Settlement Ponds:

The Proposed Wind Farm infrastructure -footprint has been divided into drainage catchments (based on topography, outfall locations, and catchment size) and stormwater runoff rates based on the 10-year return period rainfall event were calculated for various catchment areas in order to size the settlement ponds as shown in **Table 9-18** below.

The 10-year return period rainfall event is a recommendation of the IFI relating to other recent wind farm projects (i.e. Cahermurphy Wind Farm, Co. Clare - Planning Ref P20/658).

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

Table 9-18: Settlement Pond Design

POND SIZE W [M] X L [M] X D [M]			TRACK/HARDSTAND CATCHMENT SIZE (M^2)		
RETURN PERIOD	*10 YRS*	STORM DURATION	500	1000	2000
6HR RETENTION FOR COARSE SILT		6 HRS	3.4 X 10.6 X 1 M	4.8 X 15.0 X 1 M	6.9 X 21.0 X 1 M
11HR RETENTION FOR MEDIUM SILT		12 HRS	3.8 X 12.0 X 1 M	5.5 X 16.5 X 1 M	7.5 X 24.2 X 1 M
24HR RETENTION FOR FINE SILT		24 HRS	4.2 X 13.8 X 1 M	6.2 X 18.6 X 1 M	8.6 X 27.0 X 1 M

Level Spreaders and Vegetation Filters:
The purpose of level spreaders is to release treated drainage flow in a diffuse manner, and to prevent the concentration of flows at any one location thereby avoiding erosion. Level spreaders are not intended to be a primary treatment component for development surface water runoff. They are not stand-alone but occur as part of a treatment train of systems that will reduce the velocity of runoff prior to be released at the level spreader. In the absence of 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 Wind Farm drainage prior to reaching the downstream watercourses.

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

Pre-emptive Site Drainage Management

The works programme for the entire construction stage of the Proposed Project 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 provides a 24-hour telephone consultancy service. The forecaster will provide an interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow 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 Spoil Repository Areas:
It is proposed that excavated spoil and peat will be used for landscaping where required. The excess material will then be placed in 4 no. dedicated Peat Repository Areas (PRA) and 5 no. Spoil Deposition Area (SDA).

All proposed PRAs and the SDA are located outside of 50m watercourse buffers and also outside of 10m drainage ditch buffers.

During the initial construction of repository/deposition 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.

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 potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk

of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters. The residual effects of the Proposed Project will be negative, imperceptible, indirect, short-term, likely effect on down-gradient rivers, water quality, and dependent ecosystems.

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

9.5.2.4 Potential Impacts on Groundwater Levels During Excavations (Proposed Project)

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

Dewatering of the deepest excavations (i.e., turbine bases) have the potential to impact only briefly on local groundwater levels temporarily during construction works. It's worth noting that there is no proposed borrow pit at the Proposed Wind Farm site.

Groundwater level impacts will only be brief and temporary not be significant due to the temporary nature of the works and local geological and hydrogeological regime as outlined below.

Trench excavations along the Proposed Grid Connection are shallow (0 – 1.5m below ground level) and therefore not likely to impact groundwater levels.

Pathway: Groundwater flowpaths.

Receptor: Groundwater levels (Clare Corrib GWB and local bedrock aquifers).

Pre-Mitigation Potential Effect: Direct, negative, slight, brief, likely temporary effect on local bedrock aquifers. No significant effects on the Clare Corrib GWB will occur due to the small dewatering requirements.

Impact Assessment:

No groundwater level impacts are predicted from the construction of the Proposed Grid Connection (including substation & BESS) infrastructure due to the shallow nature of the excavations (i.e. 0 - approximately 1.5m).

Turbine foundations will be gravity base. Due to the relatively shallow depth of the gravity foundations (3 – 3.5m deep) and the low permeability nature of the glacial till overburden (CLAY/SILT) and underlying competent LIMESTONE/MUDSTONE bedrock, significant groundwater inflows into turbine excavations will not occur.

In addition, any effects on groundwater levels will only be for a temporary basis during the foundation construction work. Groundwater level effects are unlikely to be significant beyond 10m from the turbine base excavation. Gravity foundations are proposed at all turbine locations.

Residual Effect: Due to the prevailing geology at the Site, the local and temporary nature of the proposed works, the residual effects of the Proposed Project on groundwater levels will be negative, imperceptible, direct, brief and reversible.

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

9.5.2.5 Excavation Dewatering and Potential Impacts on Surface Water Quality (Proposed Project)

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

Some minor groundwater/surface water seepages will likely occur in turbine base excavations and cabling trenches, and this will create 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 (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River).

Pre-Mitigation Potential Impact: Indirect, negative, moderate, temporary, likely impact to surface water quality.

Proposed Mitigation Measures:

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

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

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

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

9.5.2.6 Potential Release of Hydrocarbons During Construction and Storage (Proposed Project)

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

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

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater (Clare Corrib GWB) and surface water (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River).

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect to local groundwater quality.

Indirect, negative, moderate, short term, unlikely impact to surface water quality.

Proposed Mitigation Measures:

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

- On site re-fuelling of machinery will be carried out using a dedicated fuel truck. The fuel truck will also carry fuel absorbent material and pads in the event of any accidental spillages;
- Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- On-site refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Fuels stored on site will be minimised. Fuel storage areas if required will be bunded appropriately for the fuel storage volume for the time period of the construction and fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be included within the Construction and Environmental Management Plan (**Appendix 4.5**). Spill kits will be available to deal with and accidental spillage in and outside the re-fuelling area.

Residual Effect: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters.

The residual effect of the Proposed Project will be negative, imperceptible, indirect, short-term, unlikely impact to local surface water and groundwater quality.

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

9.5.2.7 Groundwater and Surface Water Contamination from Wastewater Disposal (Proposed Project)

Wastewater management will be required for both the Proposed Wind Farm and Proposed Grid Connection (Proposed Project) 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: Groundwater quality (Clare-Corrib GWB) and surface water quality (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River Abbert River, Grange River & Clare River).

Pre mitigation Effect:

Indirect, negative, significant, temporary, unlikely effect to surface water quality.

Indirect, negative, slight, temporary, unlikely effect to local groundwater.

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 effects of the Proposed Project.

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

9.5.2.8 Release of Cement-Based Products

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

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293 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, unlikely effect to surface waters (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River Abbert River, Grange River & Clare River).

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 located outside of Mid Galway PWS/Barnaderg GWS SPA;
- 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 a sudden rainfall event.

Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status or ecology of downstream waters. The residual effect will be negative, imperceptible, indirect, short-term, unlikely effect to surface water quality.

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

9.5.2.9 Morphological and Hydrological Effects due to New Watercourse Crossing Works (Proposed Wind Farm)

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

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

Construction of 5 no. new watercourse crossing (clear span bridge design) and will be required to facilitate the Proposed Wind Farm Site development infrastructure.

Crossings are required on the Dangan Eighter Stream (3 no.), Lecarrow 30 Stream (1 no.) and Forty Acres Stream (1 no.).

Pathway: Site drainage network.

Receptor: Surface water flows (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Abbert River, Grange River & Clare River Abbert River), stream morphology and water quality.

Pre-Mitigation Potential Impact: Negative, direct, slight, long term, likely effect on surface water flows and drainage patterns.

Proposed Mitigation Measures:

- All proposed 5 no. new stream 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 Ireland5 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; and,
- 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.

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

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

9.5.2.10 Potential Hydrological Effects on Designated Sites (Proposed Project)

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

The closest designated site to the Site is Lough Corrib SAC (Site Code: 000297) which includes sections of the Grange River and Abbert River immediately downstream (north and south respectively) of the Site.

The Proposed Grid Connection cable route briefly intercepts Lough Corrib SAC where it crosses the Grange River along the R347 section of the cable route. However, the Proposed Grid Connection cable will be contained with the carriageway of the R347 at this location.

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

Derrinlough Bog SAC and Levally Lough SAC are located approximately 3.5km to the north of the Proposed Wind Farm site which is an upstream location in the Grange River catchment relative to the Proposed Wind Farm site location and therefore no hydrological or hydrogeological pathway/connection is present and therefore no potential for effects.

Similarly, Killaclogher Bog NHA is located approximately 2.5km to the southeast of the Proposed Wind Farm site where it is also at an upstream location in the Abbert River relative to the Proposed Project site location and therefore no hydrological or hydrogeological pathway/connection is present and therefore no potential for effects.

Pathway: Surface water and groundwater flowpaths.

Receptor: Lough Corrib SAC.

Pre-Mitigation Potential Effect: Indirect, negative, moderate, short-term, likely effect on Lough Corrib SAC.

Impact Assessment & Proposed Mitigation Measures:

Drainage mitigation measures for surface water quality protection during the construction phase are summarised again below: (Please refer to Sections 9.5.2.2, 9.5.2.3 & 9.5.2.5 above for the full description of these measures and how they will be applied).

- The proposed mitigation measures which will include 50m buffer zones for avoidance of sensitive hydrological features (streams and rivers);
- 10m drain buffers;
- Pre-construction drainage control measures;
- 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 9.5.2.6) and cement based compounds (Section 9.5.2.8).

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

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

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

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

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

In the area of the Proposed Project 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. Construction of the Proposed Grid Connection will not have the potential to effect local wells due to the shallow nature of the works at the substation, cable route and end mast locations.

The closest distance between a proposed turbine location and a downstream dwelling house (potential well) is 720m. In order to be conservative and following the worst-case assumption, we have assumed that all dwellings in the surrounding lands have a private groundwater well. However, due to the relatively shallow nature of the deepest excavations (3 – 3.5m) and the 720m setback distance from potential wells, significant effects on private wells is unlikely.

Pathway: Groundwater flowpaths.

Receptor: Private Groundwater Supplies.

Pre-Mitigation Potential Impact: Negative, imperceptible, indirect, short-term, unlikely effect on local wells.

Impact Assessment:

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

- The large set back distances between turbine locations and downstream potential well locations (720m);
- The proposed project will involve relatively shallow excavations (3 – 3.5mbgl) as no borrow pit is proposed;
- The moderate - low permeability of the glacial deposits in which the turbine gravity base foundations will be constructed;
- The low recharge characteristics of the underlying LIMESTONE/MUDSTONE aquifer that underlies the Proposed Wind Farm site;
- Localised groundwater flow patterns in the glacial deposits which is towards local streams that flow through the Site;
- Groundwater flow patterns are expected towards the watercourses that drain the Wind Farm site; and,
- The shallow excavation depths required for Grid Connection cable, Substation and BESS.

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

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

9.5.2.12 Turbine Delivery Route Works (Wind Farm)

TDR works will only be required at the Wind Farm site and not the Grid Connection. Only the Wind Farm is assessed herein.

Minor earthworks are required for the TDR. These include for temporary accommodation works at 1 no. location along the proposed route as well as the proposed construction Site entrance. These TDR works are described in Section 4.4 of the EIAR.

Pathway: Surface water flowpaths.

Receptor: Down-gradient surface water quality (Lecarrow 30 Stream, Forty Acres Stream, Abbert River and Clare River).

Pre-Mitigation Potential Impact: Indirect, negative, slight, short term, likely effect on surface water quality.

Proposed Mitigation Measures:

- All works are minor and localised and cover very small areas;
- These works are distributed over a wide area;
- All works are temporary in nature; and,
- Application of the Pre-Construction Drainage Measures (see Section 9.5.2.3) for surface water quality protection.

Residual Effect: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect of the Proposed Project will be negative, imperceptible, indirect, short-term, unlikely effect on down gradient rivers, water quality, and dependent ecosystems.

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

9.5.2.13 Effects of Construction Works on the WFD Status of Downstream Waterbodies (Proposed Project)

Refer to **Appendix 9-4** for the WFD Compliance Assessment Report.

Both the Proposed Wind Farm and Proposed Grid Connection and the potential to effect WFD status. Therefore, both are assessed herein.

WFD status and Risk Results for downstream river waterbodies and the underlying Clare-Corrib GWB are presented in Sections 9.3.12 & 9.3.13 above.

Due to the hydrogeological regime at the Proposed Wind Farm site (low recharge regime), the potential to negatively affect the WFD status of the Clare-Corrib 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.

Our understanding of the objectives of the WFD is that surface waters, regardless of whether they have 'Poor' or 'High' status, should be treated the same in terms of the level of protection and mitigation measures employed, i.e. there should be no negative change in status at all. This is reflected in the strict mitigation measures in relation to maintaining a high quality of surface water from the Proposed Project 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.

Pathways: Drainage and surface water discharge routes.

Receptors: Clare-Corrib GWS and Surface waters (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on river waterbody status. No effects Clare-Corrib GWB WFD status will occur.

Proposed Mitigation Measures:

Comprehensive surface water mitigation and drainage controls are outlined in Section 9.5.2.2 (Felling of Coniferous Plantations), Section 9.5.2.3 (Earthworks), Section 9.5.2.5 (Excavation Dewatering), Section

9.5.2.6 (Hydrocarbons), Section 9.5.2.8 (Cement-based Products) and Section 9.5.2.9 (Morphological Changes to Watercourses). These will ensure the protection of surface water quality and flows in all downstream receiving watercourses.

Residual Effect: The potential for the release of suspended solids, hydrocarbons, cement-based products or altered flows to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigation measures have been proposed and will break the pathway between the potential pollutant sources and the receptor. The mitigation measures will ensure that surface water runoff from the site will be equivalent to baseline conditions and will therefore have no potential impact on the status, ecology or hydromorphology of downstream waters.

Residual Effect: The residual effect of the Proposed Project is negative, imperceptible, indirect, short-term, unlikely impact on down gradient rivers, water quality, and dependent ecosystems. No effects on the status of the Clare-Corrib GWB 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.

9.5.2.14 Use of Siltbuster and Impacts on Downstream Surface Water Quality (Proposed Project)

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

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

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 northwest Mayo is provided in

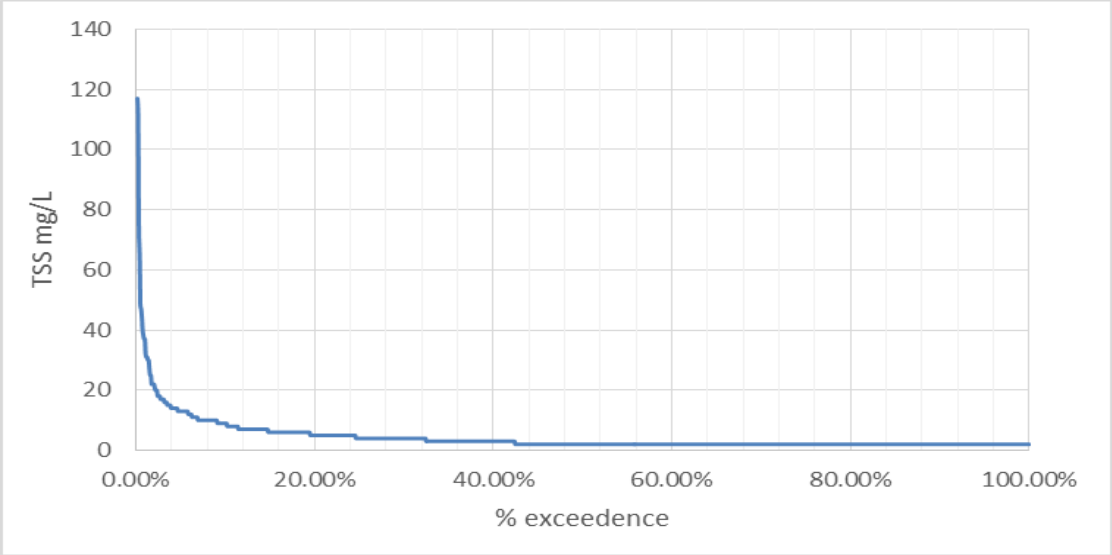


Figure *9-16*. This is a duration curve of downstream water quality data post siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

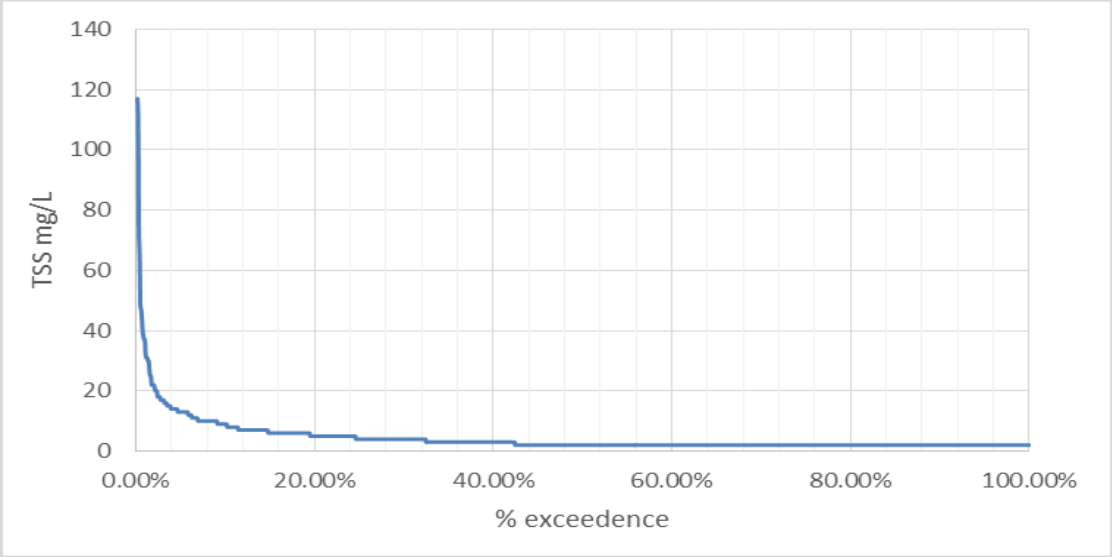


Figure 9-16: TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River) and designated sites and associated dependent ecosystems.

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

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, means the correct amount of chemical is added by the dosing system;
- Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment;
- Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover; and,
- Use of biodegradable chemical agents can be used at very sensitive sites (i.e. upstream of SACs).

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

9.5.2.15 Potential Surface Water Quality Effects of the Proposed Grid Connection Earthworks Works and Watercourse Crossings (Grid Connection)

The Proposed Grid Connection comprises a proposed 110kV on-site substation, approximately 21km of underground cabling route and 4 no. existing watercourse crossings along public roads. Placement of the cable within the crossing structure or Directional drilling will be used (i.e. no instream works).

Pathway: Surface water flowpaths/groundwater paths.

Receptor: Down-gradient water quality (Forty Acres Stream, Feagh East Stream, Abbert River & Grange River).

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

Proposed Mitigation Measures:

Pre-commencement Temporary Drainage Works:

Prior to the commencement of substation, cable trenching or access road 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 or a karst feature 30m karst feature buffer zone.

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

- No stock-piling of construction materials will take place along the grid route;
- No refuelling of machinery or overnight parking of machinery is permitted in this area;
- No concrete truck chute cleaning is permitted in this area;
- Works will not take place at periods of high rainfall, and will be scaled back or suspended if heavy rain is forecast;

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

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

- The drilling fluid/bentonite will be non-toxic and naturally biodegradable (i.e. Clear Bore Drilling Fluid or similar will be used);
- The area around the drilling fluid batching, pumping and recycling plants will be bunded using terram and/or sandbags to contain any potential spillage;
- One or more lines of silt fencing will be placed between the works area and the adjacent river;
- Spills of drilling fluid will be cleaned up immediately and transported off-site for disposal at a licensed facility;
- Adequately sized skips will be used where temporary storage of arisings are required;
- The drilling process / pressure will be constantly monitored to detect any possible leaks or breakouts into the surrounding geology or local watercourse;
- This will be gauged by observation and by monitoring the pumping rates and pressures. If any signs of breakout occur, then drilling will be immediately stopped;
- Any frac-out material will be contained and removed off-site;
- The drilling location will be reviewed, before re-commencing with a higher viscosity drilling fluid mix; and,
- If the risk of further frac-out is high, a new drilling alignment will be sought at the crossing location.

Residual Effect: Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect of the Proposed Project will be negative, imperceptible, direct, long term, likely effect on surface water quality.

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

9.5.2.16 Potential Effects on Wetland Hydrology (Proposed Wind Farm site)

Only the Proposed Wind Farm infrastructure is located in areas of bog and therefore only the Proposed Wind Farm 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 turbine locations T2, T5 and T9 (and associated access roads and hardstand, and associated drainage) are located on cutover bog. Due to the already cutover nature and existing extensive drainage at these locations, no significant additional effects on remaining areas of intact bog nearby are expected.

However, the proposed floating access road to proposed turbine location T7 crosses approximately 0.6km of intact raised bog. In addition to the direct loss of intact bog habitat there will also be significant alteration of surface water flowpaths (surface water flushes) which flow mainly easterly across the alignment of the proposed access road. This will result in indirect hydrological effects on the existing semi-intact habitat.

Pathways: Surface Water and Groundwater flowpaths.

Receptors: Intact bog wetland hydrology.

Pre-Mitigation Potential Effects: Negative, imperceptible to significant (the potential effect varies spatially), direct/ indirect, short to long-term, likely effect on intact bog wetland hydrology.

Impact Assessment/Proposed Mitigation Measures:

As assessed in Section 9.5.2.4 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.

The proposed section of access road leading to proposed turbine T7 will be a floating design with regular cross drains to maintain flowpaths on the surface of the bog as best as possible. However, the presence of the road structure will likely significantly alter the natural drainage characterises of the bog within a 50-100m impact area, regardless of the proposed drainage.

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

However, hydrological effects on intact bog within a 50-100m distance of the proposed turbine T7 access road will be negative, significant, direct/indirect and long term.

Significance of Effects: For the reasons outlined above, effects on wetland hydrology will range from imperceptible across most of the Site with local direct/indirect significant effects along the proposed T7 access road.

9.5.2.17 Biodiversity Management and Enhancement Plan (BMEP)

A Biodiversity Management and Enhancement Plan (BMEP) has been prepared for the Proposed Project and is included as Appendix 6-4 of this EIAR. This plan has been developed to offset the loss of habitats identified within the Proposed Wind Farm site and further enhance the biodiversity of the Proposed Wind Farm and its environs. The following enhancement measures are proposed:

- Development of Bog Woodland/Scrub Communities
- Grassland Enhancement
- Marsh Fritillary Breeding Habitat
- Riparian Vegetation/Replanting
- Fen Habitat Enhancement
- Embankments and Pollinator Nesting Habitats

Pathway: Enhancement measures and targeted revegetation.

Receptor: Site habitats

Pre-Mitigation Potential Impact: Positive, slight, direct, permanent likely effect of BMEP.

Mitigation Measures:

A site-specific monitoring and evaluation programme will be implemented to ensure that the success of the proposed measures remains long-term. It will also assist in situations where the habitat establishment may not have been successful by providing evidence of shortcomings, allowing a revised management plan to be formulated. Monitoring results will be reported by the Project Ecologist within an Annual Environmental Report. Reports detailing the monitoring works carried out, the results obtained and a review of their success, along with any suggestions for amendments to the plan will be prepared. The enhancement plan will be updated and amended where required to improve the efficacy of the enhancement work.

Residual Effect: The likely residual effect of the Proposed Project on Site habitats following the implementation of the BMEP is a moderate, positive, direct, permanent effect on habitats.

Significance of Effects: For the reasons outlined above, all effects will be positive.

9.5.3 Operational Phase – Likely Significant Effects and Mitigation Measures

9.5.3.1 Removal of Vegetation Cover and Progressive Replacement of Natural Surface with Low Permeability Surfaces (Proposed Project)

Hardstand emplacement will be required at both the Proposed Wind Farm site and Proposed Grid Connection. Both 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. It should be noted that approximately 1.2km of the proposed Site roads already exist and are proposed for upgrade. The permeability along the internal underground cabling route through the Site will not be significantly altered, as the fill material will not be compacted.

The emplacement of the Proposed Project footprint, 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 1,655m^3/month (

Table 9-19). This represents a potential increase of approximately 0.41% 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 Proposed Project site being developed. Specifically, the permanent Proposed Project footprint is approximately 10.6ha, representing 3% of the total EIAR Study Area of 376.5ha.

The additional volume is low due to the fact that the runoff potential from the Site is naturally high (85%). 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 imperceptible and this is before mitigation measures will be put in place. This water balance assessment demonstrates that even in the absence of mitigation, the potential to alter the water balance of the Site or downstream hydrology/morphology is imperceptible.

Table 9-19: 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 85% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m^3)	% Increase from Baseline Conditions (m^3)
403,552	13,018	87,500	11,034	9,379	1,655	53	0.41

Pathway: Site drainage network.

Receptor: Surface waters (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River) and dependent ecosystems.

Pre-Mitigation Potential Impact: Negative, imperceptible, indirect, long-term, likely effect on all downstream surface water bodies.

Proposed Mitigation by Design:

The proposed drainage philosophy outlined in Section 9.4.1 states that 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 Proposed Project. The first being 'keeping clean water clean' and the second involving the collection of any drainage waters from work area and to route them towards stilling ponds prior to controlled diffuse release over vegetated surfaces. The second method relates to proposed design measures that will prevent road surface and other hardstand areas acting as preferential flowpaths. All development site runoff will be collected, attenuated, treated and then released in a diffuse and regular manner that does not significantly change the natural drainage regime/hydrology of the site.

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 (**Appendix 4-3**) 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.

These measures will ensure all surface water runoff from upgraded roads and new road surfaces (including hardstands and turbine base areas) will be captured and treated prior to discharge/release. Settlement ponds, check dams and buffered outfalls will prevent roads acting as preferential flowpaths by providing attenuation and water quality treatment.

Residual Effect: Direct, negative, neutral, long term, likely effect of the Proposed Project on surface waters.

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

9.5.3.2 Runoff Resulting in Suspended Solids Entrainment in Surface Waters

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

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

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

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Dangan Eighter Stream, Lecarrow 30 Stream, Forty Acres Stream, Feagh East Stream, Abbert River, Grange River & Clare River) and associated dependent ecosystems.

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

Proposed Mitigation Measures:

The mitigation measures outlined in Sections 9.5.2.3 & 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.

It is proposed that bedrock from off-site sources will be used to construct the sub-base layer of proposed upgraded and new access roads, hardstand areas and turbine base areas. Once installed the subbase layer

will be overlain by a clean capping layer of high-grade stone material which will be sourced from local quarries also.

Residual Effects: With the implementation of the proposed drainage measures as outlined above, and based on the post-mitigation assessment of runoff, residual effects are - Negative, imperceptible, indirect, temporary, unlikely effect on downstream water quality.

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

9.5.3.3 Potential Effects on the Mid Galway PWS & Barnaderg GWS Sources during Operational Phase (Proposed Project)

The most southerly part (50ha) of the Proposed Project site is located in the Mid Galway Public Water Supply (PWS) Source Protection Area (SPA). The groundwater zone of contribution/SPA is the same for the Barnaderg GWS.

Proposed Infrastructure elements of the Proposed Wind Farm site inside the SPA include 2 no. turbines locations (T1 & T2) and the proposed construction compound. In addition, approximately 3.8km of the Proposed Grid Connection cable route is located inside the SPA, with the majority of the 3.8km being along public roads.

During the operational phase, the potential for effects is much more limited than those associated with the construction phases as there is no further excavation/movement of soil/subsoil and the drainage system is fully constructed and operational.

Potential effects on the spring mainly include groundwater quality with regard contaminants such oils and fuels.

No works will be required along the Proposed Grid Connection cable route inside the SPA.

Source: Oils, fuels and Chemicals

Pathway (s): Recharge and surface water flowpaths.

Receptor: Mid Galway PWS & Barnaderg GWS

Pre-Mitigation Potential Impact: Indirect, negative, imperceptible, long term, unlikely impact to Mid Galway PWS and Barnaderg GWS.

Impact Assessment:

As outlined above, the potential for effects during the operational phase of the Proposed Project is much reduced as there are no further construction activities along with the associated potential sources such as hydrocarbons/cement/ exposure of subsoils/bedrock.

During the operational phase of the Proposed Project, the only regular plant which will be required on site will be maintenance/inspection vehicles (jeeps/vans/quads) and these will not be refuelled on-site.

Any hydrocarbons (oil) present within the turbine generator and gear box will be enclosed within a bund with 110% capacity. There will be no storage of fuels, oils and chemicals inside any of the turbines.

Automated oil leak detectors will be placed in each of the turbines which will allow early detection of even the smallest leaks of oil or hydraulic fluid that may arise from components such as the transformer or gearbox.

The automated detection system will then rapidly notify the wind farm operator by cloud-based systems. This early detection system will prevent large leaks of oil or hydraulic fluid.

Residual Effect: Due to the Site hydrology/hydrogeology coupled with the mitigation measures associated with drainage management and the protection of water quality, combined with the lack of any construction type activities no residual effect of the Proposed Project will occur. No residual effect on Mid Galway PWS or Barnaderg GWS.

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

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures (Proposed Project)

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

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

The main risk of Major Accidents and Disasters (MADs) at peatland sites is related to peat stability. A peat stability risk assessment (**Appendix 8-1**) has been completed for the Proposed Project site and it concludes that due to the gentle sloping topography of the Site, and with the implementation of the proposed mitigation measures, that the risk of a peat failure at the Proposed Project site is low.

The Geotechnical Karst Risk Assessment findings showed that the majority of the Proposed Wind Farm infrastructure locations are located in areas of low to medium karst hazard, with additional localised areas of high hazard identified. Following the implementation of mitigation measures, the residual risk at each infrastructure location ranges from low to medium, indicating that development can proceed as long as mitigation measures are implemented and that the risk assessment is further refined following a more detailed confirmatory ground investigation.

Flooding can also result in downstream MADs. However, due to the small scale of the Proposed Project footprint with regard the overall Site area, the naturally high runoff rates, the avoidance of fluvial flood zones (see Section 9.3.6) and with the implementation of the proposed mitigation measures, the increased flood risk associated with the Proposed Project is imperceptible.

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. A portion of the Proposed Project site is located inside the Mid Galway PWS and Barnaderg GWS SPA, but investigations have been carried out to assess the risk (see Section 9.5.2.1) posed by the Proposed Project. 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 Development, summarised in Section 9.3.6. The lack of Proposed Development 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 and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

9.5.7 Cumulative Effects (Proposed Project)

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

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the local hydrogeological setting (i.e. low permeability peat

and glacial tills) and the near-surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are assessed as not likely.

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

The cumulative Water Study area is delineated by the catchment of the Clare River which has an area of approximately 1,030km^2. Downstream of the Clare River catchment (i.e. Lough Corrib itself) no cumulative hydrological effects are likely due to the combined large upstream catchment area of Lough Corrib (i.e. approximately 3,100km^2) and the very high dilution effects afforded by such a large regional catchment, subsequent large surface water flows and the natural attenuation afforded by Lough Corrib water body itself.

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

- A hydrological cumulative impact assessment is carried out on the whole Clare River catchment for large projects such as other wind farm developments and large-scale infrastructure developments only. Other smaller developments have been excluded at this regional scale as cumulative effects are likely to be less than perceptible at this (regional) scale.
- The cumulative study area for assessing small projects (i.e. agricultural, forestry and smaller planning applications) only include sub-basins of the Grange River and Abbert River catchments in which the Proposed Project is directly located.

9.5.7.1 Cumulative Effects with Agriculture

According to Corine land cover mapping (www.epa.ie) (2018) the Clare River catchment is a 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.

9.5.7.2 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.

Given that most of the main forestry plantations are located a significant distance from the Proposed Project site, the likelihood of significant potential effects occurring is very small.

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

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

9.5.7.3 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 Development. Nevertheless, the mitigation measures detailed for the construction, operational, and decommissioning phases of the Proposed Development will ensure the protection of downstream surface water quality.

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

9.5.7.4 Cumulative Effects with One Off Housing Developments

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

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

9.5.7.5 Cumulative Effects with Other Wind Farms

In addition to the Proposed Project Wind Farm, 4 no. other wind farms have been identified within the Clare River catchment/cumulative study area (refer to **Table 9-19**). Within these existing and proposed wind farms there are a total of 15 no. turbines potentially situated within the River Clare catchment/ cumulative study area.

The total number of wind turbines that could potentially be operating in the cumulative study area is 24 no. (9 no. from Proposed project Wind Farm site and 15 no. turbines from the other wind farms.

The total area of the River Clare catchment is c. 1,000km^2 which equates to 1 no. turbine per approximately 42km^2 which is considered not significant in terms of likely cumulative hydrological effects on the River Clare.

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

Therefore, due to the dispersed nature/setback distance of the other wind farms along with the implementation of the proposed mitigation measures for the Proposed Project (listed in **Table 9-20**) there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Proposed Project and other wind farms within the cumulative study area.

Table 9-20: List of Other Wind Farm Developments Assessed for Hydrological Cumulative Effects

Catchment	Wind Energy Development (Status)	Total Turbine No.	Turbine No. in Clare Catchment
Clare River	Clonberne WF (proposed)	11	11
	Laurclavagh WF (proposed)	8	1
	Clonlusk WF (existing)	2	2
	Cloonascragh WF (Permitted)	1	1
Totals		**22**	**15**