9. HYDROLOGY AND HYDROGEOLOGY

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of the Proposed Project (Proposed Wind Farm and Proposed Grid Connection) on water aspects (hydrology and hydrogeology) of the receiving environment.

For the purposes of this EIAR:

- The '**Proposed Wind Farm'** refers to the 9 no. turbines and supporting infrastructure which is the subject of this Section 37E application.
- The '**Proposed Grid Connection'** refers to the 110kV substation and supporting infrastructure which will be the subject of a separate Section 182A application.
- The '**Proposed Project'** comprises the Proposed Wind Farm and the Proposed Grid Connection, all of which are located within the EIAR Study Boundary (the '**Site**') and assessed together within this EIAR.

Please see section 1.1.1 of this EIAR for further details. A detailed description of the Proposed Project is provided in Chapter 4 section 4.3 of this EIAR.

The objectives of the assessment are:

- Produce a baseline study of the existing water environment (surface water and groundwater, i.e. natural resources) in the area of the Proposed Project;
- Identify likely significant effects of the Proposed Project on surface water and groundwater natural resources during construction, operational and decommissioning phases of the Proposed Project;
- Identify mitigation measures to avoid, reduce or offset significant negative effects;
- Assess significant residual effects; and
- Assess cumulative hydrological effects of the Proposed Project and other local developments (as described in Chapter 2; Section 2.8 of this EIAR).

The potential zone of impact of the Proposed Project on the water environment including potential cumulative effects is limited within 'the Water Study Area' as defined by the sub-catchments within which the Site is located (Suir_SC_010) and those immediately upstream and downstream (Fishmoyne_SC_010, Suir_SC_020 & Suir_SC_040). The Water Study Area is shown in **Figure 9-1** below.

9.1.2 Statement of Authority

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

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

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

Michael Gill P. Geo (B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and grid connections in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Slievecallan WF, Cahermurphy (Phase I & II) WF, Carrownagowan WF, and Croagh WF and over 100 other wind farm related projects across the country.

David Broderick P. Geo (BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 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 and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Derrykillew WF, Croagh WF, and Oweninny WF, and over 80 other wind farm related projects across the country.

Jenny Law (BSc, Msc) is an Environmental Geoscientist who has almost 2 years' experience, has been involved in the preparation of Environmental Impact Assessment Reports (EIARs) for numerous projects including wind farms and commercial housing developments. Jenny has also completed several Water Framework Directive Assessments and Flood Risk Assessments for various project types.

9.1.3 Scoping and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the List of Consultees is outlined in Section 2.6 of this EIAR. Matters raised by Consultees in their responses with respect to the water environment are summarised in

Table 9-1 below.

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

Consultee	Description	Addressed in Section
Irish Water	*"Where the development proposal has the potential to impact an Irish Water Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Irish Waters 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 ".* *"Any and all potential impacts on the nearby reservoir as public water supply water source(s) are assessed, including any impact on hydrogeology and any groundwater/ surface water interactions.".*	Section 9.3.15

Consultee	Description	Addressed in Section
	"Any potential impacts on the assimilative capacity of receiving waters in relation to Irish Water discharge outfalls including changes in dispersion / circulation characterises. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified within the report ".	
HSE	*"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. The Environmental Health Service recommends that a walk over survey of the site is undertaken in addition to a desktop analysis of Geological Survey of Ireland data in order to identify the location of private wells used for drinking water purposes".* *"Any potential significant impacts to drinking water sources should be assessed. Details of bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas should be considered when assessing potential impacts and any proposed mitigation measures".* *"Any impacts on surface water as a result of the construction of the underground cables should be identified and addressed in the EIAR".*	Section 9.3.15
Waterways Ireland	" *This is not within any Zone of Influence of our waterways so we will not be commenting*".	

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.

Regard has also been taken of the requirements of the following legislation:

- Planning and Development Acts, 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 Directive 2014/52/EU into Irish Law;
- S.I. No. 477/2011 – European Communities (Birds and Natural Habitats) Regulations 2011 which give effect to 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 of 2003 European Communities (Water Policy) Regulations, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC). Since 2000 water management in the EU has been directed by the Water Framework Directive (WFD). The key objectives of the WFD are that all water bodies in member states achieve (or retain) at least 'good' status by 2015. Water bodies comprise both surface and groundwater bodies, and the achievement of 'Good' status for these depends also on the achievement of 'good' status by dependent ecosystems. Phases of characterisation, risk assessment, monitoring and the design of programmes of measures to achieve the objectives of the WFD have either been completed or are ongoing. In 2015 it was fully replaced a number of existing water related directives, which are successively being repealed, while implementation of other Directives (such as the Habitats Directive 92/43/EEC) will form part of the achievement of implementation of the objectives of the WFD;
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive);
- S.I. No. 294/1989 of 1989: Quality of Surface Water Intended for Abstraction (Drinking Water), resulting from EU Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (as amended by 2000/60/EC in 2007);
- S.I. No.106/2007: European Communities (Drinking Water) Regulations and S.I. No. 122/2014: European Union (Drinking Water) Regulations, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the Drinking Water Directive) and WFD 2000/60/EC (the Water Framework Directive);
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended; and,
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

9.1.5 Relevant Guidance

The Hydrology and Hydrogeology chapter of the EIAR is carried out in accordance with guidance listed below:

- Environmental Protection Agency (2022) published its 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports' "(EPA, 2022)",
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Department of Environment, Heritage and Local Government (2006): Wind Energy Development Guidelines for Planning Authorities, "the 2006 WEDGs";

- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters;
- Scottish Natural Heritage (2010): Good Practice During Wind Farm Construction;
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);
- 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, 2006);
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018);
- DOE/NIEA (2015): Wind Farms and Groundwater Impacts – A guide to EIA and Planning Considerations; and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017).

9.2 Methodology

9.2.1 Desk Study

A desk study of the Site and Water Study Area was completed prior to the undertaking of field mapping, walkover assessments and investigations. The desk study involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the Site and Water Study Area. This included consultation 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 18 (Geology of Tipperary). Geological Survey of Ireland (GSI, 1996);
- Geological Survey of Ireland (2003) – Groundwater Body Initial Characterization Reports;
- OPW Flood Hazard Mapping (www.floodinfo.ie);
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.epa.ie); and,
- CFRAM Flood Risk Assessment mapping (www.floodinfo.ie).

9.2.2 Baseline Monitoring and Site Investigations

Hydrological walkover surveys, including detailed drainage mapping and baseline monitoring/sampling, was undertaken by David Broderick and Jenny Law of HES (refer to Section 9.1.2 above for qualifications and experience) on 8th November 2022, 3rd, 4th, 10th, 11th & 20th July 2023 and 29th September 2023.

A comprehensive hydrogeological dataset has been collected as part of this EIAR study. Intrusive site investigations were completed at the Site in July 2023, by Peterson Drilling Services Ltd and supervised by HES.

In summary, all site investigations to address the Hydrology and Hydrogeology chapter of the EIAR are as follows:

- Walkover surveys and hydrological mapping of the Site and Water Study Area were undertaken whereby water flow directions and drainage patterns were recorded;
- A total of 143 no. soil probes/investigations points were carried out by MKO to investigate the presence of peat at the Site;
- 23 no. of the above soil probes were carried out along the Grid Connection and end masts;
- Trial pitting (16 no.) was completed at the Site to investigate underlying mineral subsoil lithology and the subsoil-bedrock interface;
- 3 no. investigation boreholes (finished as groundwater monitoring wells) were completed by Peterson Drilling Services Ltd at the Site on 10th and 11th July 2023;
- Continuous groundwater level monitoring was completed in the monitoring wells by in-situ data loggers from 20th July to 14th November 2023;
- Field hydrochemistry measurements (electrical conductivity, pH, dissolved oxygen and temperature) and surface water flow measurements were taken to determine the origin and nature of surface water flows within and surrounding the Site;
- A total of 2 no. rounds of surface water samples were taken to determine the baseline water quality of the primary surface waters originating from and intercepted by the Site; and,
- A Stage 3 Flood Risk Assessment for the Proposed Wind Farm was completed by Fluvio R&D Limited (November 2023). Attached as **Appendix 9-1**.

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 Table 1-2 of Chapter 1 of this EIAR.

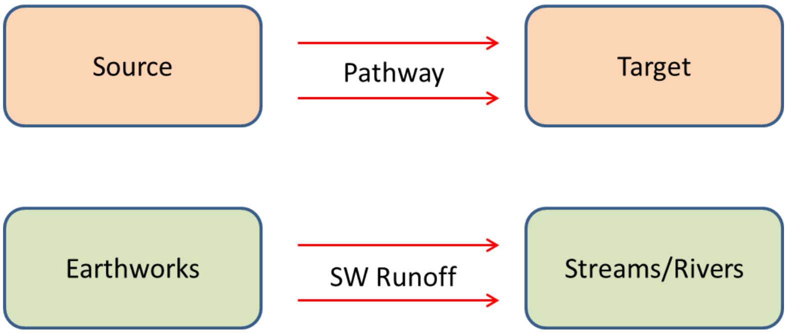
In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 9-2 are used to assess the potential effect that the Proposed Project may have on them.

Table 9-2: 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 EPA, 2022.

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

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

Using this defined approach, this impact assessment process is then applied to Proposed Project construction, 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 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 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 Water Chapter of the EIAR. The investigations carried out at the Site for the purpose of the EIAR and planning application are thorough.

9.3 Receiving Environment

9.3.1 Site Description and Topography

The Site is located approximately 2.5km northeast of the town of Templemore, Co. Tipperary and to the east of the N62 which runs northerly between Templemore and Roscrea towns.

Land coverage is predominantly agricultural fields, small scale forestry and local roads, situated within the immediate valley of the River Suir channel which flows through the Site. Isolated dwellings and farmhouses are located along the N62 to the west of the Site and along local roads to the east.

Topography at the Site is low-lying with flat to gently undulating ground. Ground elevations range from approximately 120m OD on the north to 105m OD on the south of the Site which is the direction of flow in the River Suir. In addition to an overall southerly slope, the ground also slopes gently towards the River Suir and its main tributary, the Eastwood River which flow in a southerly direction through the Site also. The main River Suir channel is located on the east of the Site while the Eastwood River is located on the west of the Site.

Temporary minor accommodating works in the form of stoning up verges and tree trimming at Junction 22 off the M7 will be required to facilitate turbine movement from the M7 to then N62. When turbine delivery is complete, these areas will be reseeded. A temporary abnormal load access road will be constructed through grassland for the delivery of larger units that comprise the turbine components. The route follows the N62 northwards for approximately 9.5km, as far as the 22nd exit on the M7 and from there to Dublin port.

The proposed enhancement of a portion of the Eastwood River within the Site will involve the restoration of a previously deepened and straightened channel to appropriate dimensions, pattern and profile and the establishment of a native woodlands buffer. The section of the river channel proposed for enhancement is approx. 240m in length. The enhancement involves creating a more meandering channel with pools and riffles.

9.3.2 Water Balance

Long term Annual Average Rainfall (AAR) (1981 - 2010) data was sourced from Met Éireann as recorded at the Templehouhy (Bord na Mona) station which is located approximately 6km southeast of the Site. The long-term average rainfall data for Templetouhy are presented in

Table 9-3.

Met Eireann modelled AAR to be 1,101mm/year for the Site.[1] This modelled value (1,101mm/year) which is higher than AAR, is used for the Site water balance calculations (Section 9.3.5 below).

Table 9-3 Local Average long-term Rainfall Data (Templetouhy G.S) (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		
Templetouhy		218,900		170,900		134		1943		1980		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
90.2	64.1	67.9	56.5	58.9	65.3	62.9	74.5	68.2	99.5	81.8	86.3	876

The closest synoptic[2] station where the average potential evapotranspiration (PE) is recorded is at Kilkenny, approximately 40km southeast of the Site. The long-term average PE for this station is 459mm/year. This value is used as a best estimate of the Site PE. Actual Evaporation (AE) at the Site is estimated as 436mm/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:

Effective rainfall (ER) = AAR – AE

= 1,101mm/year – 436mm/year

ER = 665mm/year

The Site has a range of groundwater recharge coefficient estimates by the GSI (www.gsi.ie). Based on the GSI estimated range (4 – 60%), an average of 35% recharge is taken for the Site as an overall average, reflecting the dominance of poorly draining soils at the Site.

The range accounts for *"Moderate permeability subsoil and overlain by poorly drained gley soil"* (22.5%), smaller localised areas where "*peat soils*" are mapped have the lowest recharge rates (4%), while small areas with "*Moderate permeability subsoil and overlain by well drained soil*" have the highest value (60%).

[1] *Met Eireann annual average rainfall 0981-2010 for the site available at: https://www.met.ie/cms/assets/uploads/2018/07/IE_AAR_8110_V1.txt).*
[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.

The recharge coefficient of 35% was used to calculate values for key hydrological properties/site water balance. Therefore, annual recharge (35%) and runoff rates (65%) for the Site are estimated to be 233mm/year and 432mm/year respectively.

Table 9-4 below presents return period rainfall depths for the area of the 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, 5-year, 30-year and 100-year). These extreme rainfall depths will be the basis of the Proposed Wind Farm drainage hydraulic design as described further below at Section 0.

Table 9-4 Site Return Period Rainfall depths (mm)

	Return Period (Years)			
Storm Duration	1	5	30	100
5 mins	3.6	6.0	9.9	13.5
15 mins	6.0	9.8	16.2	22.2
30 mins	7.8	12.4	20.0	26.9
1 hour	10.2	15.8	24.7	32.6
6 hours	20.4	29.4	42.7	53.8
12 hours	26.7	37.3	52.7	65.2
24 hours	34.9	47.4	65.1	79.1
2 days	42.9	56.7	75.4	90.0

9.3.3 Regional and Local Hydrology

Regionally the Site is located in the Suir WFD catchment in Hydrometric Area 16 and the Suir_010 sub-catchment which is a headwater sub-catchment of the River Suir.

Locally the Site is mapped within 2 no. WFD river sub-basins, the Suir_020 sub-basin and the Eastwood_010 sub-basin (Eastwood River). The majority of the Site lies within the Suir_020 sub-basin in the north, east and south, whilst the western portion of the Site is situated in the Eastwood_010 sub-basin.

Within the Suir_020 river sub basin the River Suir enters the Site from the north and continues southwards within the eastern portion of the Site. The Shanakill Stream enters the Site from the northeast. Within the Eastwood_010 river sub basin, the Eastwood River flows easterly, and enters the Site from the west.

The proposed underground grid connection cable route runs easterly within the southeast of the Site and into the Clonmore Stream (Suir)_010 river sub basin. The Clonmore Stream (Suir)_010 flows in a south-westerly direction and joins the River Suir within the southeast of the Site. An unnamed 2nd order tributary stream joins the Eastwood River, and at this point it continues southwards and discharges into the River Suir approximately 500m downstream of the Site. The River Suir continues south and eventually discharge into the Upper Suir Estuary approximately 56.8km southeast from the Site (as the crow flies), just west of Carrick on Suir.

To facilitate turbine delivery to the Site, minor temporary stoning up of verges at junction 22 on the M7 and the construction of a temporary abnormal load access from the L-3248 road into the Site will be required. These works are located within the Nore_SC_010 and the Suir WFD catchments, respectively.

A regional hydrology map and local hydrology map for the Site is shown as **Figure 9-1** and **Figure 9-2** respectively.

Figure 9-1 Regional Hydrology Map

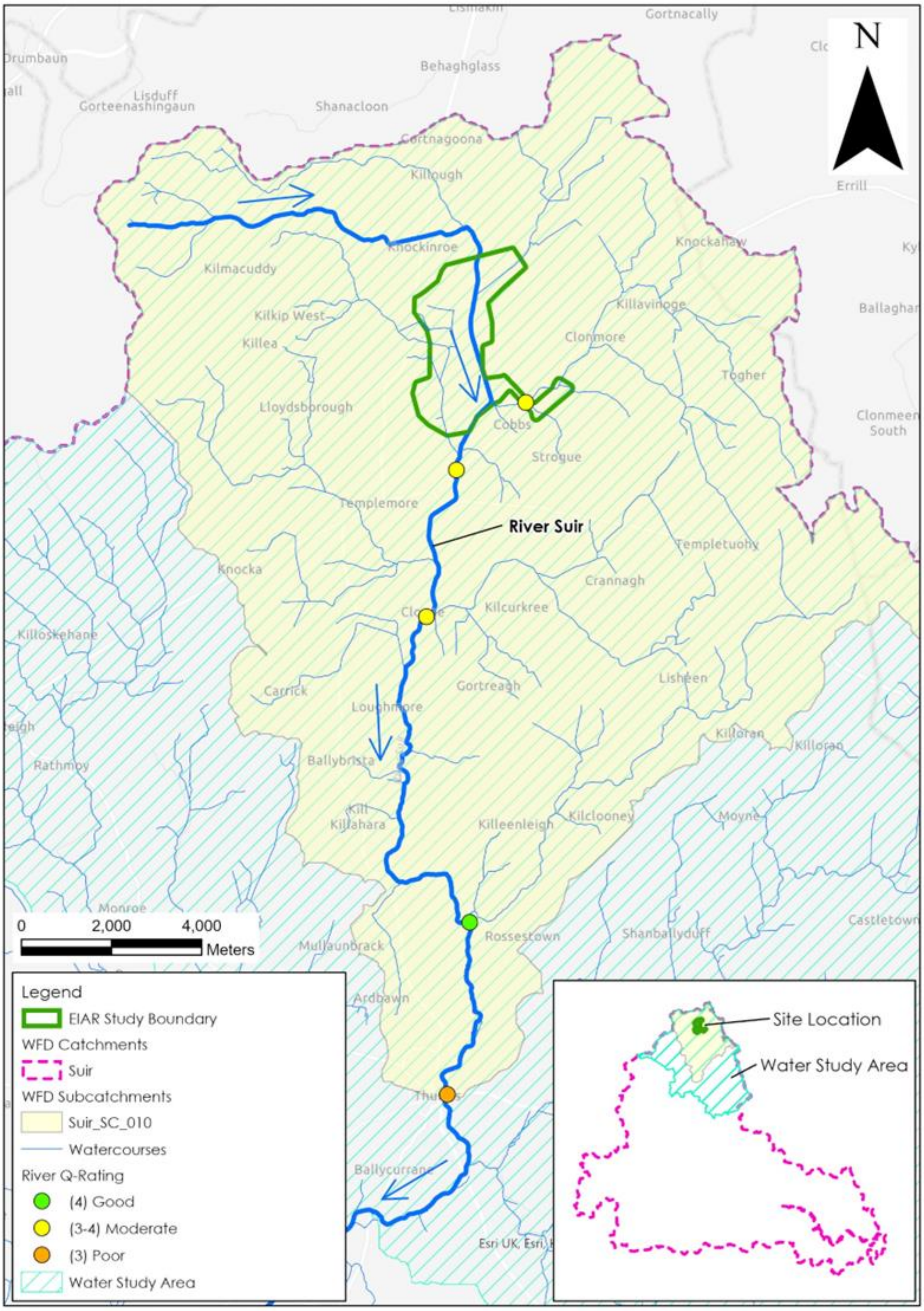
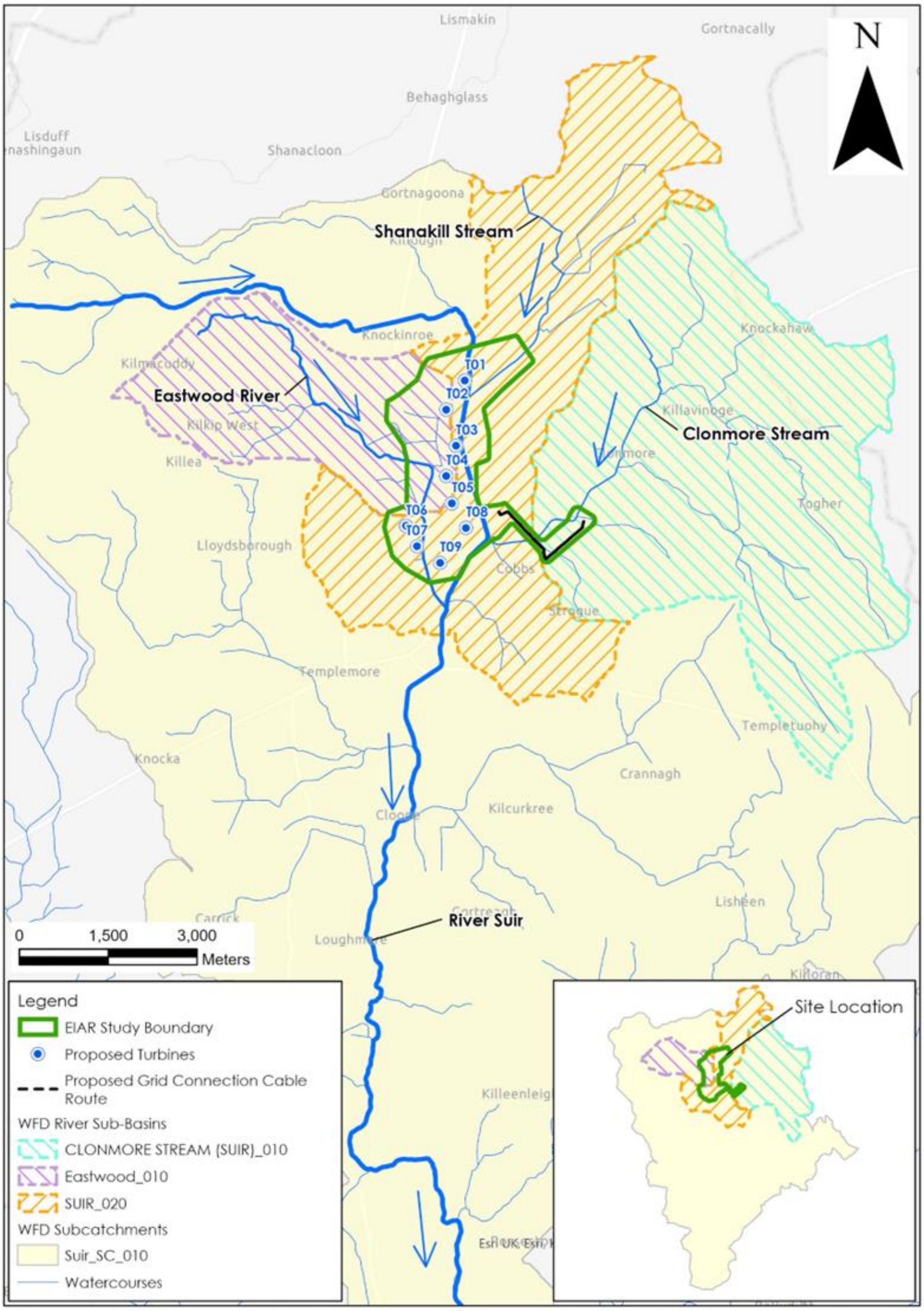


Figure 9-2 Local Hydrology Map



9.3.4 Existing Site Drainage Regime

The Site is extensively drained by a network of natural watercourse (streams & rivers) and manmade land drainage networks. All watercourses and manmade drainage networks at the Site drain into the River Suir which flows southerly through the eastern side of the Site.

Several watercourses merge with the River Suir within the Site and these include the Shankill Stream to the northeast, Clonmore Stream to the southeast and the Eastwood River to the west.

It will be required to cross 4 no. (natural) watercourse crossings within the Site to facilitate the construction of the Proposed Project.

- Eastwood River: A new clear span crossing is proposed on the Eastwood River to facilitate at a proposed new road leading to T06. Please see chapter 4 section 4.9.1.3 for construction methodology details
- River Suir: An existing bridge crossing on the River Suir located on the L-70391 to the west of the substation. It is proposed to cross this bridge via the Horizontal Directional Drilling Method. Please see Chapter 4 section 4.9.1.4 for details
- Clonmore Stream: The proposed underground grid connection cabling route runs along public roads (L-7039) and crosses the Clonmore Stream at an existing bridge on the L-7039. It is proposed to cross this bridge via the Horizontal Directional Drilling Method. Please see Chapter 4 section 4.9.1.4 and section 4.9.2.6.2 for details.
- Strogue Stream: The proposed underground grid connection cabling route crosses a 1st order tributary stream referred to as the Strogue Stream (EPA: 16S60). The crossing on the Strogue Stream is a proposed new crossing. Please see chapter 4 section 4.9.1.3 and section 4.9.2.6.1 for construction methodology details.
- In addition to the primary watercourse described above, there is also a network of drains associated with the agricultural lands and forestry. Many of the agricultural areas have field boundary drains. 16 no. new crossings will be required over field drains within the Site. Refer to the site drainage map **Figure 9-3**. Please see Chapter 4 section 4.9.2.7for construction methodology details.

The minor temporary accommodating works at junction 22 on the M7 to facilitate turbine delivery are within the Nore River catchment while the temporary abnormal load entrance is located within the Suir River catchment and either drain directly to the Suir River itself or to the Eastwood River.

Surface water flow monitoring (6 no. locations, SW1 – SW6) of the main river and streams which require crossing to facilitate new road construction was carried out on 2 no. occasions and this data is presented in **Table 9-5** below. The locations of the monitoring points are shown on **Figure 9-3**.

9.3.4.1 Grid Connection

The proposed 110kV substation is located within the Suir 020 sub basin. The underground grid connection cabling route runs from the east of the substation through a portion of agricultural land before turning south onto the L7039 for approx. 600m before entering the Clonmore Stream (Suir)_010 sub basin. The remaining underground grid connection cabling route and end masts are all located within this sub basin.

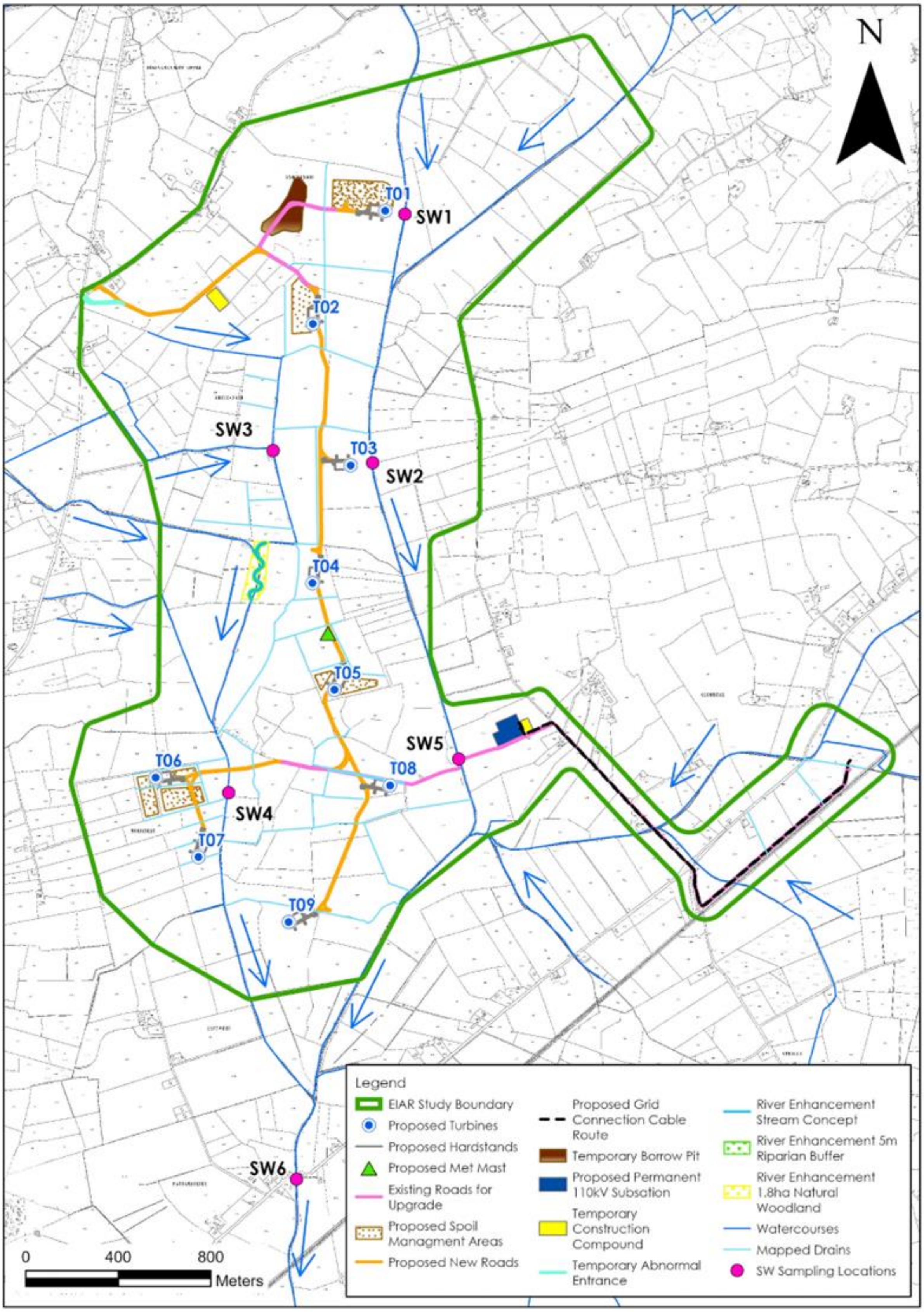
The underground grid connection cabling route crosses the Clonmore Stream at an existing bridge (to be crossed via HDD method, please see Chapter 4 section 4.9.1.4 and section 4.9.2.6.2 for details for details) and further upstream a 1st order tributary stream referred to as the Strogue Stream (EPA: 16S60). The crossing on the Strogue Stream is a proposed new crossing (please see chapter 4 section 4.9.1.3 and section 4.9.2.6.1 for details. As discussed above in section 9.3.4, manmade field drains can be found within the Site and will be crossing using the drainage crossing method described in section 4.

Surface water flows in the Clonmore Stream along the proposed underground cabling route were monitored at location SW5 (refer to **Table 9-5** below).

Table 9-5 Surface Water Flow Monitoring

Location	10/07/2023	29/09/2023
	Flow (l/sec)	Flow (l/sec)
SW1	>1000	>1000
SW2	20	30
SW3	50	65
SW4	>1000	>1000
SW5	70	980
SW6	>1000	>1000

Figure 9-3 Site Drainage Map



9.3.5 Baseline assessment of Site runoff

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

The rainfall depths used in this water balance, are long term averages. Please note the long-term averages are not used in the design of the sustainable drainage system for the Site as described in Section 9.4.1 below. The extreme rainfall depths shown in **Table 9-4** above will be the basis of the Proposed Project drainage hydraulic design as described further below at Section 0.1.

The water balance calculations are carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (**Table 9-6**). It represents, therefore, the long-term average wettest monthly scenario in terms of volumes of surface water runoff from the Site pre-Proposed Project construction. The surface water runoff co-efficient value of 65% is assumed to reflect the Site as an overall average based on the soil conditions and the existing drainage regime.

The highest long-term average monthly rainfall recorded at Templetouhy G.S over 30 years occurred in the month of January, at 97mm. The average monthly evapotranspiration for the synoptic station at Kilkenny over the same period in January was 2.4mm. 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 400,192m^3/month or 12,909m^3/day.

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

Water Balance Component	Depth (m)
Estimated Average January Rainfall (R)	0.097
Average January Potential Evapotranspiration (PE)	0.0024
(AE = PE x 0.95)	0.00228
Effective Rainfall January (ER = R - AE)	0.09472
Recharge (35% of ER)	0.0332
Runoff (65% of ER)	0.0616

Table 9-7: Baseline Runoff for the Site

Site Area (ha)	Baseline Runoff (per Wettest month (m^3)	Baseline Runoff per day (m^3) in wettest month
650	400,192	12,909

9.3.6 Flood Risk Assessment

9.3.6.1 Published Flood Mapping

9.3.6.1.1 *Proposed Wind Farm*

To identify those areas as being at risk of flooding, the OPW's Past Flood Events Maps, the National Indicative Fluvial Mapping (NIFM), CFRAM River Flood Extents, historical mapping (i.e. 6" and 25" base maps) and the GSI Groundwater Flood and Surface Water Flood Maps were consulted.

Identifiable map text on local available historical 6" or 25" mapping for the Site indicate lands "liable to flood" to the east of the River on Suir on the northeast of the Site.

The OPW Past Flood Events Maps have no records of recurring or historic flood instances within the Site or in the surrounding lands (refer to **Figure 9-4**).

The closest mapped past flood event to the Site is in Templemore town and it relates to a single event dating back to the November 2000 floods that affected the town. A separate recurring event relates to the Mall River at Templemore town where the river floods land and roads approximately every two years. There is no Proposed Project infrastructure in the Mall River catchment.

No CFRAM River Flood Extents mapping has been completed for the stetch of the River Suir at the Site. River Flood Extents is available for the River Suir immediately downstream of the Site.

National Indicative Fluvial Mapping (NIFM) is available for the Site and the present-day scenario shows larges areas of the site within 100-year and 1000-year flood zones which affects some of Proposed Project infrastructure locations. The present-day scenario flood mapping does not vary significantly from the future scenarios for the Site. Refer to **Figure 9-5** below for the NIFM present day scenario.

Proposed turbine locations mapped inside the 100-year flood zone include T3, T4 and T9. Only 1 no. additional turbine is located in the 1000-year flood and that is T7. The largest sections of proposed access roads affected by the NIFM flood zones is the proposed road between turbine location T8 and T9 as well the proposed access road from turbine location T8 linking turbines T6 and T7.

All other key Proposed Project infrastructure such as the borrow pit, temporary construction compound and spoil management areas are located outside of mapped NIFM flood zones and are therefore located in Flood Zone C (Low Risk).

The GSI Winter 2015/2016 Surface Water Flood Map shows surface water flood extents for this winter flood event. This flood event is recognised as being the largest flood event on record in many areas. Large areas of the southern part of the Site were affected by the 2015/2016 floods, but only one turbine location (T9) was affected by the 2015/2016 floods.

9.3.6.1.2 *Proposed Grid Connection*

National Indicative Fluvial Mapping (NIFM) for the area of the Proposed Grid Connection infrastructure shows that the proposed 2 no. end masts and approximately 200m of proposed access roads along the underground cabling route are within 100-year flood zones. There is no significant difference in the mapped extent of the 100-year and 1000-year flood in the area of the Proposed Grid Connection infrastructure.

The proposed 110kV substation and the remainder of the underground cabling route are not located in any NIFM mapped fluvial flood zone and is therefore in Flood Zone C (Low Risk).

Based on the GSI Winter 2015/2016 Surface Water Flood Map, the lands where the proposed end masts are located were also affected by the 2015/2016 floods.

Figure 9-4 OPW Past Flood Event Mapping

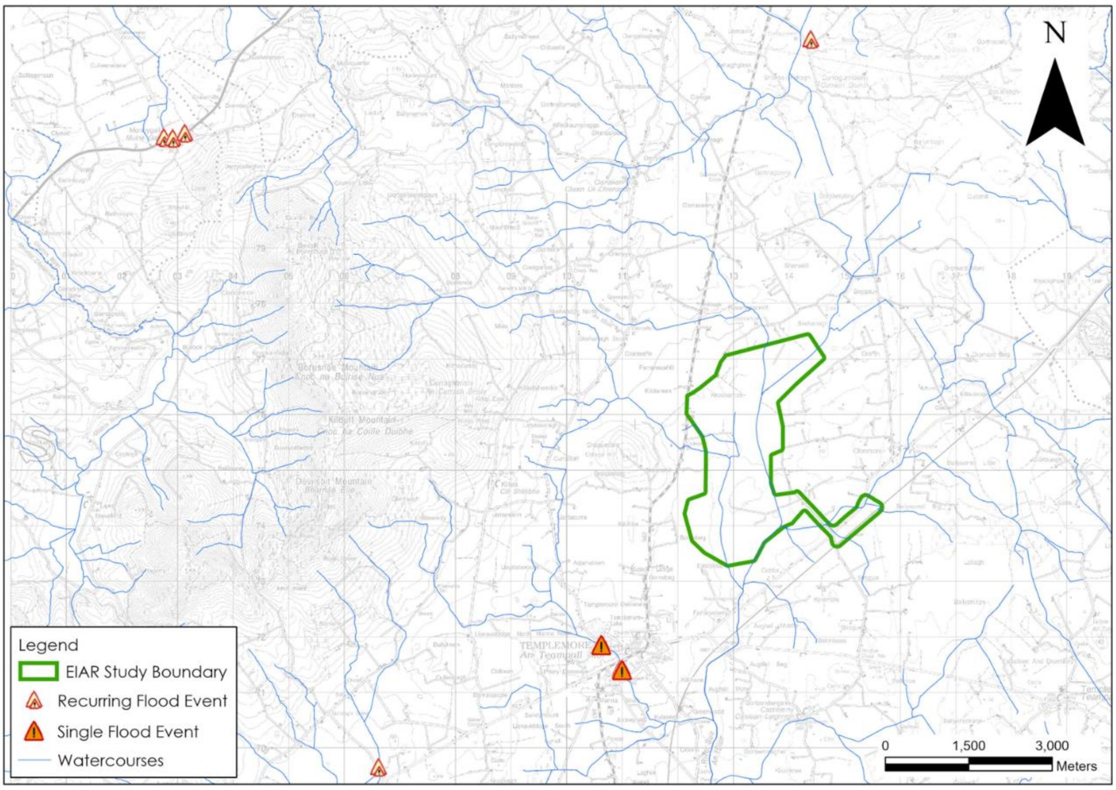
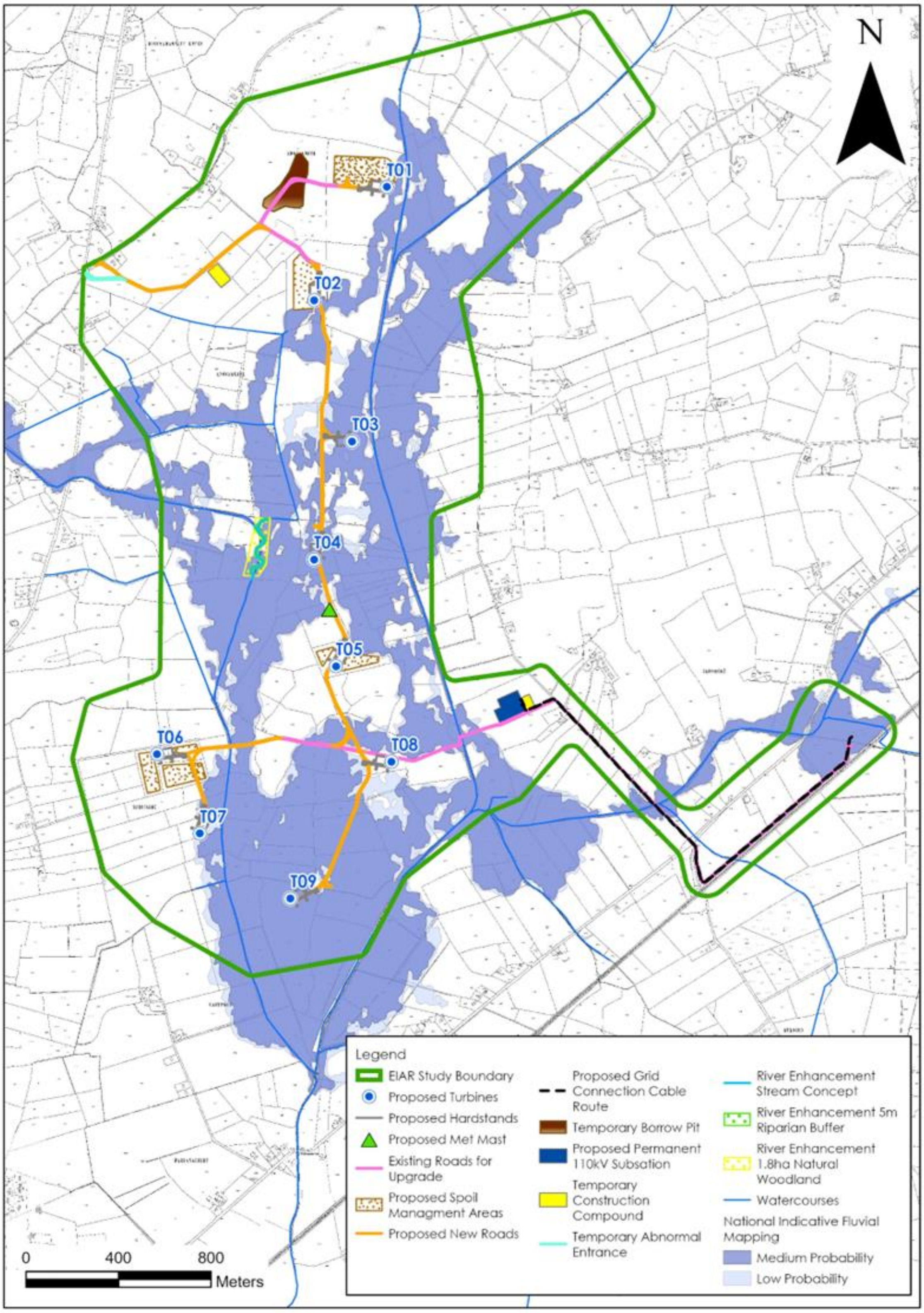


Figure 9-5 NIFM Present Day Scenario.



9.3.6.2 Site Specific Flood Risk Assessment

This section is a summary of the Stage 3 Flood Risk Assessment (including flood modelling) prepared by FLUVIO R&D Limited for the Proposed Wind Farm site. The Flood Risk Assessment report is attached as **Appendix 9-1**.

The assessment involved a detailed river channel and bridge/culvert topographic survey along with use of aerial acquired Lidar data to develop a digital elevation model of the river and floodplain at the Site.

Flood level modelling was undertaken using HEC-RAS™[3] open channel flow software. HEC-RAS is a 2-dimensional flow model which can calculate channel water depth/level using parameters such as flood volumes, channel dimensions, slope and friction coefficients (Mannings n number). To investigate the potential for flooding within the Site, modelling of design flood volumes (i.e. 100-yr and 1000-yr) was undertaken for the watercourses and flood plains with allowance for climate change (20%).

A model was created for existing Greenfield Scenario and also for the Developed Scenario (constructed windfarm scenario).

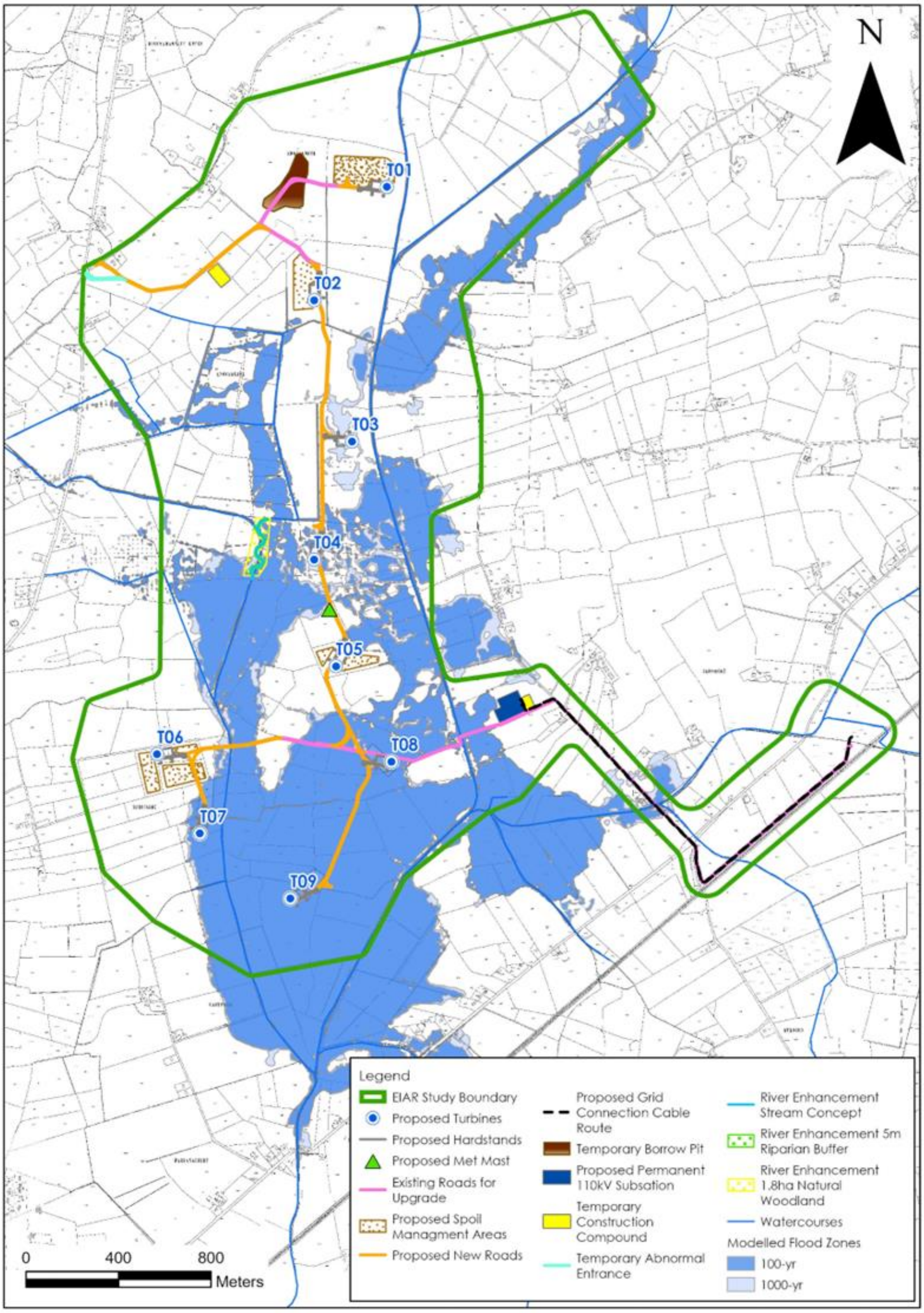
Summary model results for the Greenfield Scenario are as follows (refer to **Figure 9-6** below):

- The 100-year flood level for the Proposed Wind Farm site ranges from approximately 110m OD (upstream) and 108m OD (downstream);
- The 1000-year flood level for the Proposed Wind Farm site ranges from 110m OD (upstream and 108.2m OD (downstream);
- Proposed turbine locations T3, T4, T7, T8 and T9 are mapped inside the 100-year flood zone;
- The 100-year flood depth (m) at the affected turbine locations range from 0.01m (T3) to 1.25m (T7);
- The 1000-year flood depth (m) at the affected turbine locations range from 0.07m (T3) to 1.42m (T7);
- Sections of proposed access roads linking T5, T6, T7, T8 and T9 are also inside the 100-year/1000-year flood zone; and,
- All other key Proposed Project infrastructure such as the 110kV substation, site compound, borrow pit and spoil management areas are outside the modelled 100-year and 1000-year flood zones and are therefore located in Flood Zone C (Low Risk).

Summary results for the Developed Scenario (constructed windfarm scenario) are shown in Section 9.5.3.3 below as this is the assessed effect of constructing the above outlined Proposed Wind Farm infrastructure in fluvial flood zones.

[3] HEC-RAS – Hydrologic Engineering Centre – River Analysis System

Figure 9-6 Modelled Flood Zones (FLUVIO R&D Limited)



9.3.7 Surface Water Quality

Biological Q-rating[4] data for EPA monitoring points in the local catchments downstream of the Site are shown in **Table 9-8** below.

Most recent data available (2020) show that the Q-rating for the Suir River is 'Moderate' immediately upstream and downstream of the Site while the Q-rating for the Clonmore Stream (Suir)_010 is also "Moderate" status. There are no Q-value monitoring locations along the Eastwood_010 river waterbody.

Table 9-8: EPA Water Quality Monitoring Q-Rating Values

Waterbody	Station ID	Easting	Northing	EPA Q-Rating Status
CLONMORE STREAM (SUIR)_010	Br u/s Suir R confl	214632	174016	(3-4) Moderate
SUIR_020	Knocknageragh Br	213093	172520	(3-4) Moderate
SUIR_030	Penane Br	212428	169262	(3-4) Moderate
SUIR_050	Rossestown Br	213385	162473	(4) Good
SUIR_060	Thurles Br	212889	158652	(3) Poor

2 no. rounds of surface water sampling and field hydrochemistry (measurements of electrical conductivity (µS/cm), pH (pH units) and dissolved oxygen (%) were taken at 6 no. locations (SW1 – SW6) within surface watercourses downstream of the Site (refer to **Figure 9-3** for locations). Sampling and field monitoring was conducted on 10th July and 29th September 2023.

Field hydrochemistry results recorded during sampling events are presented in **Table 9-9** below.

Table 9-9: Field Hydrochemistry

Location	EC (µS/cm)		pH		Dissolved Oxygen %	
	10/07/2023	29/09/2023	10/07/2023	29/09/2023	10/07/2023	29/09/2023
SW1	520	510	7.8	7.7	89.9	84.2
SW2	343	350	7.8	7.7	86.2	87
SW3	720	710	7.3	7.4	83	85
SW4	579	570	7.7	7.6	86	85.5
SW5	398	350	7.7	7.7	80.1	82
SW6	471	425	7.6	7.6	86	81

Electrical conductivity (EC) values at the monitoring locations range from 343 - 720 µS/cm, which is normal background for a catchment having alkaline soils, subsoils and calcareous bedrock.

All pH values are above 7.0, indicating surface waters which are alkaline. The recorded pH of the surface waters is typical for the calcareous geology of the area.

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

Dissolved oxygen saturation ranged between 81 and 89.9%. The dissolved oxygen levels would be normal for a Good to High Status and exceed the required dissolved lower limit of 80% (Surface Water Regulations S.I. No. 272/2009).

Surface water samples (2 rounds) were also taken at the 6 no. monitoring locations for laboratory analysis. Results of the laboratory analysis are shown alongside relevant water quality regulations in **Table** 9-10 and **Table 9-11** below. Original laboratory reports are attached as **Appendix 9-2**.

Table 9-10: Round1 Analytical Results of HES Surface Water Samples (10/07/2023)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	27	15	12	8	16	91
Ammonia (mg/L)	≤0.065 to ≤ 0.04(*)	0.13	0.08	0.21	0.05	0.08	0.08
Nitrite NO_2 (mg/L)	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	0.03	0.03	<0.02	0.03	0.03	0.04
Nitrate - NO_3 (mg/L)	-	<5	<5	<5	<5	<5	5.1
Nitrogen (mg/L)	-	2.0	2.1	1.6	1.6	1.9	2.7
Phosphorus (mg/L)	-	0.11	0.18	0.10	0.12	0.11	0.18
Chloride (mg/L)	-	17.4	13.2	25.6	15.7	13.6	14.7
BOD	≤ 1.3 to ≤ 1.5(*)	2	3	3	2	2	3

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

Table 9-11: Round 2 of Analytical Results of HES Surface Water Samples (29/09/2023)

Parameter	EQS	Sample ID					
		SW1	SW2	SW3	SW4	SW5	SW6
Total Suspended Solids (mg/L)	25(+)	12	6	<5	11	5	9
Ammonia (mg/L)	≤0.065 to ≤ 0.04(*)	0.03	0.03	0.04	<0.02	0.03	0.03
Nitrite NO_2 (mg/L)	-	<0.01	<0.01	0.01	<0.01	0.01	0.01
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	0.04	0.02
Nitrate - NO_3 (mg/L)	-	4.9	<4.43	11.1	5.3	4.87	5.75
Nitrogen (mg/L)	-	1.5	<1.0	2.6	1.3	1.7	1.9
Phosphorus (mg/L)	-	0.15	0.10	0.10	0.15	0.19	0.14
Chloride (mg/L)	-	14.5	11.2	15.4	11.6	12.1	12.3
BOD	≤ 1.3 to ≤ 1.5(*)	1	1	<1	2	2	2

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

Total suspended solids (TSS) ranged between <5 and 91mg/L with 2 no. exceedances regarding S.I. No. 293/1988 which occurred at SW1 and SW6 on the River Suir on 10th July 2023 (Round 1/R1). The majority of the sampling results for TSS were between 10 and 20mg/L.

Ammonia ranged between <0.02 and 0.21mg/L. The highest level was recorded during R1 sampling at SW3 on the Eastwood River which drains the western side of the Site. With regard S.I. No. 272/2009, all sampling locations exceed the “Good” status threshold on at least one sampling occasion with the exception of SW4.

BOD exceeded both the “Good” and “High” status with regard S.I. No. 272/2009 at sample locations SW4 to SW6 on both sampling occasions. Results for SW1 to SW3 in sampling round R2 were ≤1mg/L which achieved “High” status, but in R2 SW1 to SW3 exceeded the “Good” status.

Ortho-phosphate ranged between <0.02 and 0.04mg/L with the majority of sampling below the “Good” status threshold. “High” status was also achieved on at least one sampling occasion with the exception of SW5 on the Clonmore Stream.

Results for nitrate, nitrite, nitrogen and phosphorous were generally low and at a level close to the respective laboratory detection limits (i.e. low nutrient levels).

9.3.8 Hydrogeology

9.3.8.1 Desk Study

The Site is located in the Templemore Ground Water Body (GWB) (IE_SE_G_131) where the WFD description is “poorly productive bedrock”. The majority of the GWB comprises Locally Important Aquifers. The overall groundwater flow direction is southerly with discharge into the River Suir and its tributaries. Discharge occurs via springs, which flow towards the surface water bodies or via baseflow directly into the rivers (GSI, 2004).

The majority of groundwater flow in this GWB is considered to take place in the upper weathered zone (3m). Below this the amount of groundwater flow decreases gradually with depths and large flows are not expected below 10m except in isolated open fractures (GSI, 2004).

The Ballysteen Formation (Dinantian Lower Impure Limestones), which are mapped to underlie the majority of the Site are classified by the GSI (www.gsi.ie) as a Locally Important Aquifer (LI), having bedrock which is moderately productive only in local zones. The Waulstorian limestones (Dinantian Pure Unbedded Limestones) on the northwest of the Site are also classified LI.

The band of the Lisduff Oolite Member (Dinantian Pure Bedded Limestones) mapped across the centre of the Site is classified as a Locally Important Aquifer (Lm), bedrock which is generally moderately productive.

There are no GSI mapped karst features in the area of the Site.

9.3.8.2 Site Specific Hydrogeological Investigations

Trial pitting (16 no.) and investigation drilling (3 no. boreholes) was carried out at the Site in July 2023. Refer to **Appendix 8-1** for trial pit logs and **Appendix 8-2** (Refer to Chapter 8 Land, Soils and Geology for logs and further information and analysis).

Investigation drilling (constructed as monitoring wells) was carried out by Peterson Drilling Services Ltd on 10th & 11th July 2023. Boreholes (3 no. in total) were drilled at the proposed borrow pit (BH01), turbine location T2 (BH02) and turbine location T8 (BH03).

The site investigations encountered alluvial deposits (mainly SAND dominated with various amounts of gravel, clay & silt) at the 6 no. turbine locations (T1, T2, T3, T4, T5 & T8) and limestone tills at turbine locations T6 and T7, the substation and construction compound. Turbine T9 location was not accessible for trial pit or drilling investigations due to the existing forestry plantation at this location.

The depth of overburden encountered during the site investigations ranged from 0.2m to 8.8m. Overburden depths are greatest closet to the River Suir channel which flows down the eastern portion of the Site. BH02 (@T2) and BH03 (@T8), which are the closest turbines to the River Suir, are approximately 0.3km and 0.35km from the river channel where the respective depths of alluvial deposits are 8.8m and 4.8m.

Overburden depths appear to become shallower with distance from River Suir channel, as seen at T6 and T7 which are the furthest (westerly) turbines from the River Suir channel. Respective overburden depths at T6 and T7 are 1.1m and 1.8m. Also, the alluvial deposits do not extend westerly as far as turbines T6 and T7.

The deeper alluvial deposits at turbines locations T1, T2, T3 and T8 are groundwater saturated, where moderate to large groundwater inflows were recorded at a depth approximately 2m below ground level during the trial pitting. Very minor groundwater inflows were recorded at turbine T4 at a depth approximately 2.1m below ground level and the trial pit at T5 was dry. Only surface water seepages were noted from the limestone tills at T6 and T7.

Limestone bedrock was encountered in the 3 no. boreholes and at all 7 no. trial pits that met bedrock. Dark grey limestone was reported in BH2 (turbine T2) and BH3 (turbine T8) which is consistent with Ballysteen Formation mapped geology. Light grey limestone was noted in BH1 (borrow pit) which is consistent with Waulsortian mapped geology.

The light grey limestone at BH1 was highly weathered in the upper 1m, then very competent to 5mbgl, and below 5mbgl clay filled fractures were frequent. Large groundwater inflows were recorded between 7.5 and 9mbgl.

The bedrock encountered in BH2 and BH3 was very strong with rare to occasional fractures with no major groundwater inflows.

9.3.8.2.1 Groundwater Level Monitoring

Continuous groundwater level monitoring was carried out in 2 no. of the boreholes (BH1 & BH2) between 20th July and 14th November 2023. BH1 and BH2 are located at the proposed borrow pit and at proposed turbine location T2 respectively.

Manual dip measurements were carried out in all 3 no. boreholes during this period and the levels are shown in **Table 9-12** below.

Summary data of the continuous groundwater level monitoring in BH1 and BH2 are shown in **Table 9-13** below and groundwater level plots are shown in **Figure 9-7** and **Figure 9-8** below.

The proposed borrow pit is located on elevated ground (up to approximately 118.5m OD) on the northwest of the Site where depth to bedrock is shallow (0.6 – 0.9m). Groundwater levels over the monitoring period in BH1 ranged between 6.42mbgl (110.58m OD) and 4.39mbgl (112.61m OD) over the monitoring period.

Groundwater levels in BH2 (turbine T2), where 8.8m of alluvial deposits are present, ranged between 1.23mbgl (108.77m OD) and 0.24mbgl (109.76m OD) over the monitoring period.

Further south in the Site at proposed turbine T8, groundwater is shallower where groundwater level depths were measured within 0.5m of ground level (108m OD) in alluvial deposits over the monitoring period.

The groundwater level measurements show an overall southerly flow direction which is the direction of flow of the River Suir. Groundwater flow is expected to discharge the River Suir.

Table 9-12: Manual Groundwater Level Measurements

BH ID	G.L (m OD)	Top of Bedrock (m OD)	20/07/2023		29/09/2023		14/11/2023	
			mbgl	m OD	mbgl	m OD	mbgl	m OD
BH1	117	116.6	5.69	111.31	5.11	111.89	4.89	112.103
BH2	110	101.2	0.87	109.13	0.72	109.28	0.57	109.43
BH3	108	103.2	0.43	107.57	0.09	107.91	0.031	107.97

Table 9-13: Summary of Continuous Groundwater Level Monitoring

BH ID	G.L (m OD)	Top of Bedrock (m OD)	Minimum WL		Maximum WL	
			mbgl	m OD	mbgl	mOD
BH1	117	116.6	6.42	110.58	4.39	112.61
BH2	110	101.2	1.23	108.77	0.24	109.76

Figure 9-7 Groundwater Level Monitoring at BH1 (Proposed Borrow Pit Location)

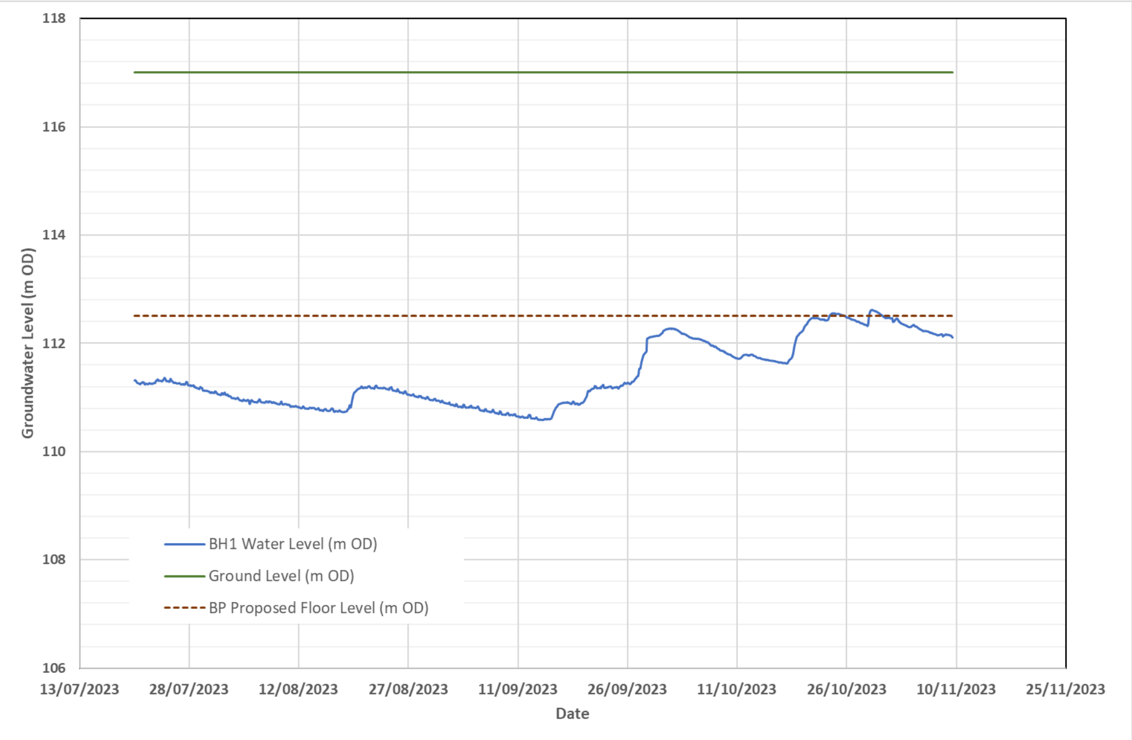
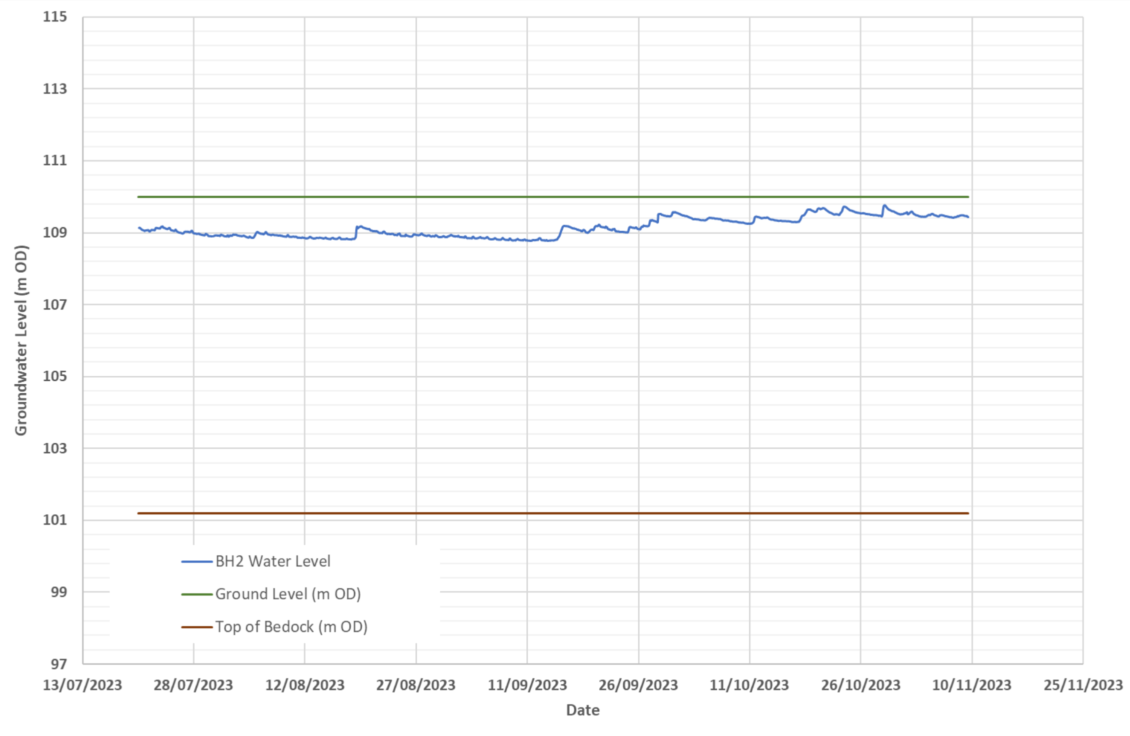


Figure 9-8 Groundwater Level Monitoring at BH2 (Proposed Turbine T2 Location)



9.3.9 Groundwater Vulnerability

Groundwater Vulnerability is a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability is mapped by the GSI using the criteria shown in **Table 9-14** below.

The mapped vulnerability rating of the aquifer at the Site is predominantly "Moderate" with the areas to the north and the very southeast classified as "High". This reflects the varying types and depth of soil and underlying mineral subsoil over bedrock.

Based on the site investigations carried out at the Site, the alluvial deposits were generally SAND dominant and therefore mainly of Moderate permeability while the limestone tills have an estimated Low – Moderate permeability.

The depth of overburden encountered during the site investigations ranged from 0.2m to 8.8m which is a vulnerability rating of Extreme to High based on GSI criteria. The site investigations identified no areas of Moderate vulnerability.

The groundwater vulnerability rating at the location of proposed turbines T1, T2, T3 and T8 is High, while all other proposed turbine locations (except T9 where subsoils depths were not confirmed) are located in areas of Extreme groundwater vulnerability.

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

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

Table 9-14: GSI Groundwater Vulnerability Rating Criteria

9.3.10 Groundwater Hydrochemistry

There are no groundwater quality data for the Site. The WFD status for the local groundwater body in terms of water quality is "Good" and therefore this is assumed to be the baseline condition for groundwater in the area of the Proposed Project.

According to the GSI, there is limited hydrochemical data for the Templemore GWB. Electrical Conductivity values range from 273 to 683 uS/cm with most values tending to be around 300uS/cm. Values for hardness are variable but generally the water appears to be slightly hard to hard.

9.3.11 Water Framework Directive Water Body Status & Objectives

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

- Ensure full compliance with relevant EU legislation;
- Build on the achievements of the 2^{nd} Cycle;
- Prevent deterioration and maintain a 'high' status where it already exists;
- Protect, enhance and restore all waters with aim to achieve at least good status by 2027;
- Ensure waters in protected areas meet requirements; and,
- Implement targeted actions and pilot schemes in focused sub-catchments aimed at restoring impacted waters and protecting waters from deterioration.

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

Strict mitigation measures (refer to Section 9.5 below) in relation to maintaining a high quality of surface water runoff from the Proposed Project and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the Site will be at least maintained (see below for WFD water body status and objectives) regardless of their existing status and the Proposed Project will not prevent waterbodies from achieving Good Status

A full WFD Compliance Assessment is included as **Appendix 9-3**.

9.3.12 WFD Groundwater Bodies

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

The Templemore GWB (IE_SE_G_131) underlies the Site. The GWB is currently assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

9.3.13 Surface Water Body Status

The Site is drained by the Suir_020 river water body in the east which achieved "Poor" status under the WFD 2016-2021 cycle. The western portion of the Site is drained by the Eastwood_010 river waterbody which achieved "Moderate" status.

The Proposed Grid Connection infrastructure is mapped to cross the Clonmore Stream (Suir)_010 which achieved "Moderate" status. Downstream from the Proposed Project the Suir_030 river waterbody also achieved "Moderate" status.

In terms of the WFD Risk third cycle, all the watercourses that drain the eastern portion of Site (Suir_020 and Clonmore Stream (Suir)_010) were assigned "At Risk". The Eastwood_010 river waterbody mapped in the western portion of the Site is currently under review with regards its risk status. The downstream Suir_030 is assigned "At Risk" meaning there is a risk for this waterbody of failing to meet their Water Framework Directive (WFD) objectives by 2027.

A full WFD Compliance Assessment is included as **Appendix 9-3**.

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 (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs). A designated site map for the area is shown as **Figure 9-9**.

The Site is not located within any designated conservation site.

The nearest designated site is the Templemore Wood pNHA (Site Code: 000942) which is located directly north of Templemore town, approximately 2km southwest of the Site.

The Kilduff, Devilsbit Mountain pNHA and SAC (Site Code: 000934) is located approximately 5.3km west from the Site. Nore Valley Bogs NHA (001853) is located approximately 7.5km to the north of the Site.

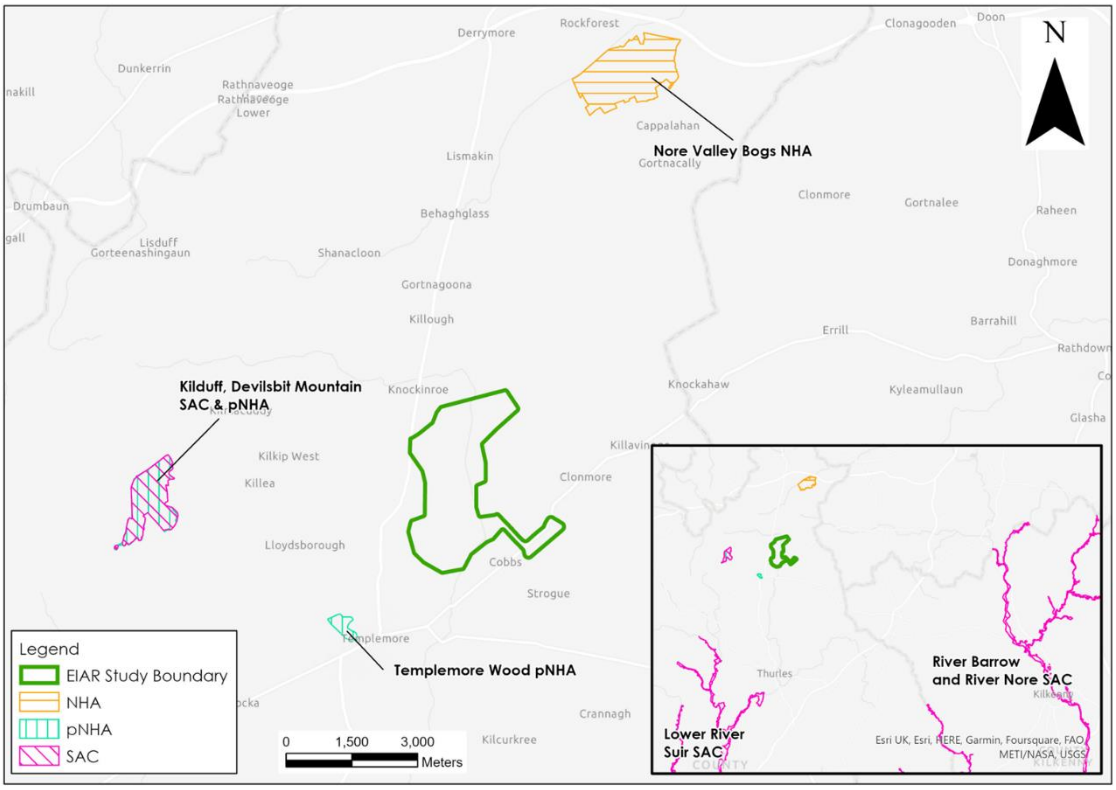
The Lower River Suir SAC (Site Code: 002137) is located ~22km downstream of the Site along the Suir River. Further downstream the River Suir discharges into the River Barrow and River Nore SAC (Site Code: 002162) >100km downstream of the Site.

A summary of designated sites in close proximity to and downstream of the Site are summarised below in **Table 9-15**.

Table 9-15: Summary of Distances and Connectivity to Designated Sites

Designated Site	Minimum Distance to Site from EIAR Boundary	Hydrological connectivity to Designated/European Sites	Groundwater connectivity to Designated / European Sites
Templemore Wood pNHA	2km SW	No, there is no hydrological connectivity to the pNHA as surface water flow at the Project Site is towards the River Suir	No connectivity as groundwater flow at the Site is southerly towards the River Suir
Kilduff, Devilsbit Mountain SAC/ pNHA	5.3km W	No, there is no hydrological connectivity to the SAC / pNHA as surface water flow at the Project Site is towards the River Suir	No connectivity as groundwater flow at the Site is southerly towards the River Suir
Nore Valley Bogs NHA	7.5km N	No, there is no hydrological connectivity to the NHA as surface water flow at the Project Site is towards the River Suir	No connectivity as groundwater flow at the Site is southerly towards the River Suir
Lower River Suir SAC	17km	Yes, there is direct surface water connectivity from the development to the SAC via the River Suir.	Yes (indirect), Groundwater flow from the Site is expected to discharge locally to streams and rivers crossing the aquifer such as the River Suir.
River Barrow and River Nore SAC	18km	Yes, there is connectivity from the development to the SAC via the River Suir.	Yes (indirect), Groundwater flow from the Site is expected to discharge into the River Suir and then downstream River Barrow
Cabragh Wetlands pNHA [001934]	24.1km	Typically No, as drainage from the wetland is generally towards the River Suir and not vice versa. However, during extreme flood events, the River Suir may flood the wetland area	No, as the Proposed Project Site is too remote to have groundwater connectivity.

Figure 9-9 Designated Site Map



9.3.15 Water Resources

9.3.15.1 Groundwater

The GSI do not map the presence of any National Federation registered Group Water Scheme (GWS) or Public Water Scheme (PWS) sources or an associated groundwater Source Protection Areas (SPA) within the Site or in neighbouring lands (www.gsi.ie).

The closest SPA to the Site is related to the Templemore PWS (ref; 2800PUB1013), located approximately 0.7km to the west. The source comprises of up to 2 no. production wells located at Curraduff townland which are located 2km to the west of the Site.

In addition, SPAs associated with Castleiney A GWS and Curacuneen GWS groundwater sources are located 2.8km to the southwest and 4.5km to the north of the Site respectively.

A search of private well locations was undertaken using the GSI well database (www.gsi.ie). There are wells mapped (with poor accuracy) along public roads to the east and west of the Site. Considering the proven southerly groundwater flow direction, and with groundwater ultimately discharging into the River Suir, these GSI mapped wells are unlikely to be located down-gradient of the Site.

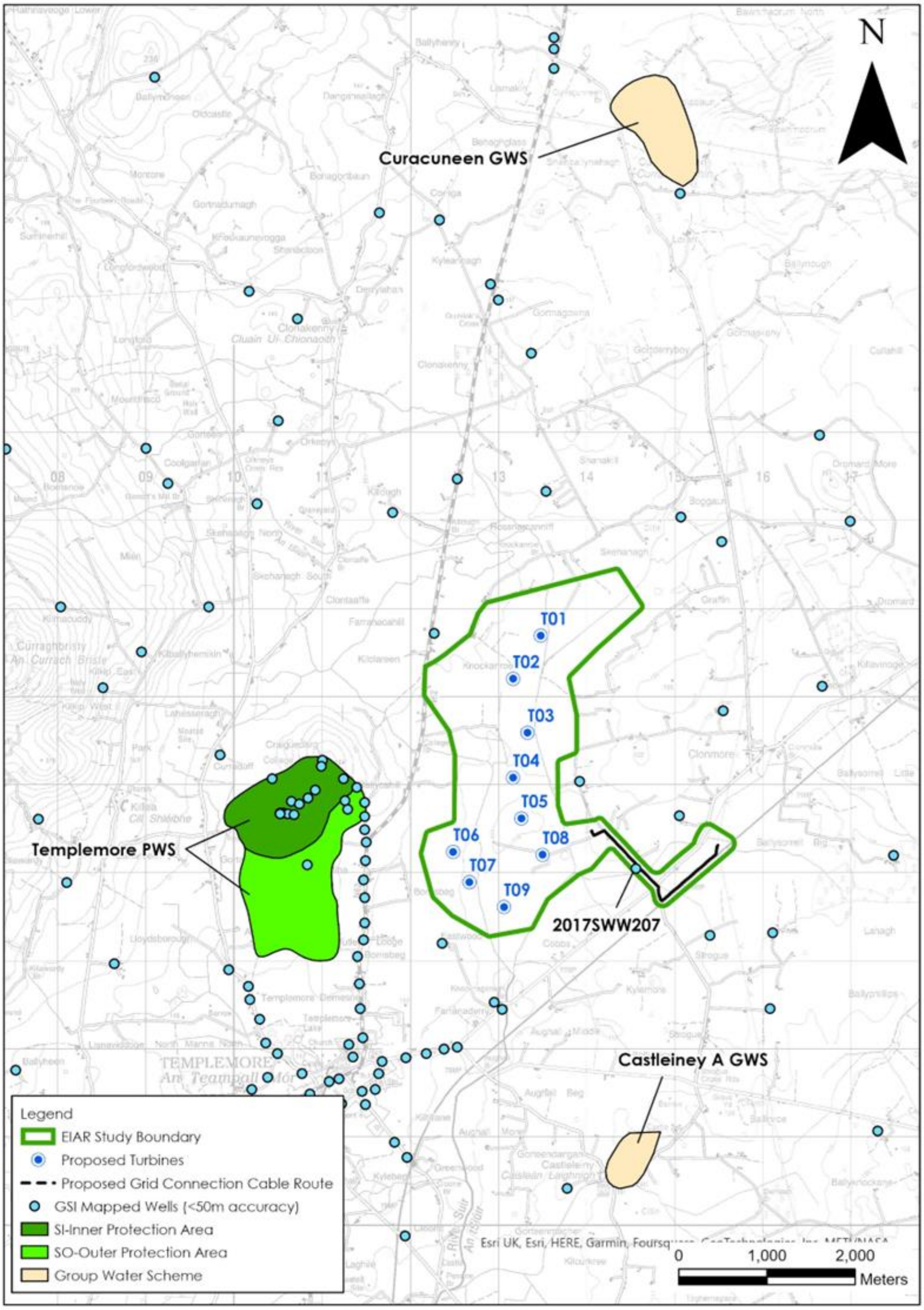
HES has also completed an assessment below of private wells in the lands surrounding the Proposed Wind Farm only (due to the shallow nature of the works and the proposed underground cabling route largely along public roads, effects on private wells along the Proposed Grid Connection is not likely).

In order to be conservative and following the worst-case assumption, it has been assumed that all dwellings in the surrounding lands have a private groundwater well. Private houses are mainly scattered along public roads to the east, west and southwest of the Site. Due to the southerly groundwater flow direction towards the River Suir, any potential wells located at these houses are unlikely to be down-gradient of the Site.

Due to the likely absence of groundwater flowpaths between the Site and local groundwater supplies, water supply wells have been ruled out for further assessment below.

Templemore PWS SPA, GSI mapped wells and private dwelling houses are shown on **Figure 9-10** below.

Figure 9-10 SPAs, GSI Mapped Wells and Private Dwellings



9.3.15.2 Surface Water Resources

There are no SWBs in the vicinity of the Site which are identified as Drinking Water Protected Areas (DWPAs). The nearest downstream DWPA is the Suir_140 river waterbody approximately 60km downstream of the Site.

9.3.16 Receptor Sensitivity

This section discusses the sensitivity and importance of the receiving water environment in terms of the Proposed Project and identified those sensitive receptors which will be carried forward into the impact assessment.

Due to the nature of Wind Farm developments and associated Grid Connection infrastructure being near surface construction activities, impacts on groundwater are generally not significant and surface water is generally the main sensitive receptor assessed during impact assessments. The primary risks to groundwater at the Site would be from cementitious materials, hydrocarbon spillage and leakages, potential piling and borrow pit works. These potential common effects are assessed in **Section 9.5** below.

Some of these (cementitious materials, hydrocarbon spillage and leakages, potential piling works) are common potential impacts on all construction sites (such as road works, industrial sites and quarries). All potential contamination sources are to be carefully managed at the Site during the construction and operational phases of the development and mitigation measures are proposed below (Section 9.5) to deal with these potential effects.

Based on criteria set out in

above, the Locally Important Aquifer can be classed as “Sensitive” to pollution as the aquifer is moderately productive in local zones and could potentially be supplying the several wells mapped by the GSI in the vicinity of the Site. The majority of the Site is covered in poorly draining soil which in turn is underlain by tills or deep alluvial deposits (of only moderate permeability) and these layers act as a protective cover to the underlying bedrock aquifer. Any contaminants which may be accidentally released on-site are more likely to travel to nearby drains, streams and rivers within surface runoff. The relatively high density of manmade drainage at the Site is also suggestive of relatively high runoff rates.

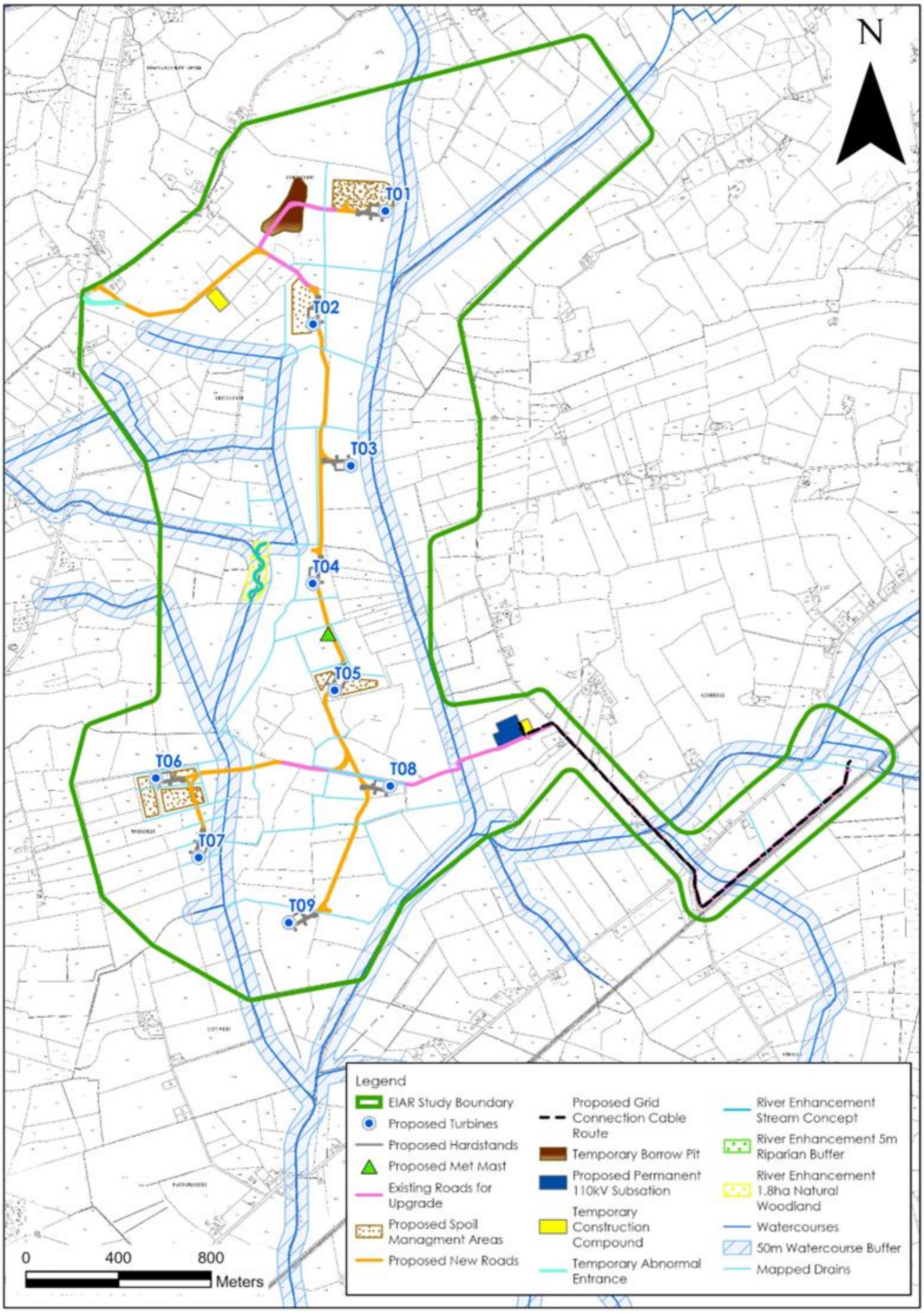
Surface waters such as the River Suir, the Eastwood River and the Clonmore Stream can be considered Very Sensitive to potential contamination due to their fisheries potential and because all the above watercourses drain to downstream Lower River Suir SAC and River Barrow and River Nore SAC, as listed in **Table 9-15** above. Based on this assessment the only designated sites with the potential to be affected are the Lower River Suir SAC the River Barrow and River Nore SAC.

Comprehensive surface water mitigation and controls are outlined below to ensure protection of all downstream receiving waters. Mitigation measures will ensure that surface runoff from the developed areas of the Site will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the Site will mimic the existing drainage regime.

A hydrological constraints map for the Site is shown as **Figure 9-11**. A self-imposed 50m buffer from streams and rivers was applied during the constraints mapping and will be maintained during the construction phase. All proposed infrastructure, with the exception of watercourses crossings, are located outside of the 50m buffer zones.

Proposed Infrastructure which is within a 50m distance from the hydrologically very sensitive rivers and streams onsite must be considered throughout the construction and mitigation processes so that treatment of surface runoff is effective before it reaches local watercourses.

Figure 9-11 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 the temporary construction compound, which will involve minor regrading of soil/subsoil and the emplacement of the construction compound. Welfare facilities will be provided at the primary temporary construction compound. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licenced contractor.
- Construction of the site access tracks will use the excavate and replace technique. This will involve the use of aggregate from the proposed borrow pit and imported from local quarries where required.
- Construction of the 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 stream works 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 and water tankered to site where required. Bottled water will be used for potable supply.
- Construction of 9 no. turbine foundations, which will be a combination of piled foundation and gravity foundation design;
- Due to deep groundwater saturated alluvial deposits at turbine T1, T2, T3 & T8, piling is being is assessed as an alternative option to gravity based;
- In terms of excavation volumes and spoil storage requirements, its assumed gravity bases will be used at all turbines locations as this generates the greatest volume of spoil for storage;
- Cabling between turbine locations and the onsite substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling;
- Opening of a temporary borrow pit which has been designed in a manner to avoid dewatering (i.e. no excavations below the groundwater table);
- Construction of 1 no. new watercourse crossing (clearspan bridge design) on the Eastwood River, Horizontal Directional Drilling under bridge over the River Suir on L-70391, crossing of several manmade field drains;
- Tree felling (4.22ha) for the purposes of turbine and access road construction clearance which will be carried out under felling licence; and,
- The enhancement of a portion of the Eastwood River within the Site will involve the restoration of a previously deepened and straightened channel to appropriate dimensions, pattern and profile and the establishment of a native woodlands buffer.

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

- Approx 2km of an underground cabling route between the proposed 110kV substation and the Ikerrin to Thurles OHL 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 2 no. end masts an associated foundations at the Ikerrin to Thurles OHL connection;

- 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;
- New access road following the off-road sections of the proposed underground cabling route through agricultural lands; and,
- Construction of 1 no. new watercourse crossing (clear span design) on the Strogue Stream, Horizontal Directional Drilling under 1 no. existing bridge crossing on the Clonmore and crossing of manmade field drains.

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 existing 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 new proposed silt traps and settlement ponds (or stilling ponds) prior to controlled diffuse release into the existing drainage network. There will be no direct discharges to surface waters or the existing drains.

During the construction phase, all runoff from works areas (i.e. dirty water) will be slowed down and treated to a high quality prior to being released. A schematic of the proposed site drainage management is shown as **Figure 9-12** below. A detailed drainage plan showing the layout of the proposed drainage design elements for the Proposed Wind Farm is shown in **Appendix 4-1a** of the EIAR. The drainage design for the Proposed Grid Connection is shown in Appendix 4-5 of this EIAR.

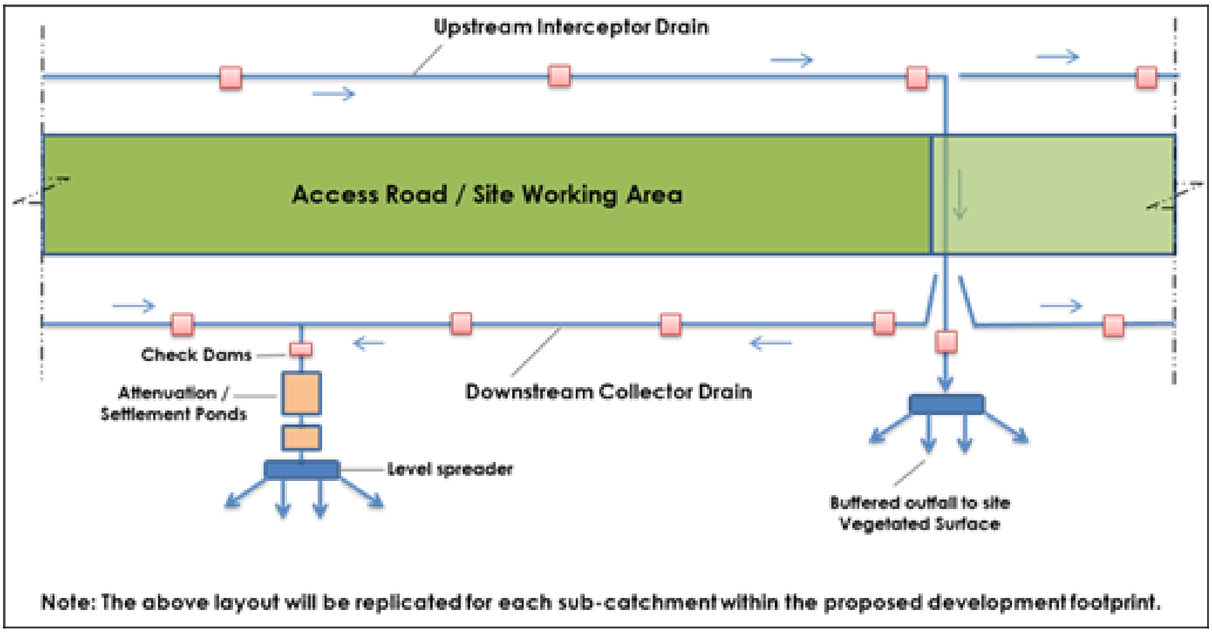


Figure 9-12 Schematic of Proposed Site Drainage Management

9.4.2 Development Interaction with the Land Drainage Network

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

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

9.5 Likely Significant Effects and Associated Mitigation Measures

9.5.1 Do -Nothing Effect

If the Proposed Project were not to proceed, the existing land use practices including agricultural activities and forestry will continue at the Site. Forestry will be felled as forestry compartments reach maturity. Re-planting of these commercial forestry areas with coniferous plantation is likely to occur. Land drainage carried out in areas of the Site will continue to function and may be extended in some areas.

If the Proposed Project were not to proceed, the opportunity to capture part of Tipperary's valuable renewable energy resource would be lost, as would the opportunity to contribute to meeting Government and EU targets for the production and consumption of electricity from renewable resources and the reduction of greenhouse gas emissions.

If the Proposed Project were not to proceed, the opportunity to retore a segment of the Eastwood River by improving channel stability, instream habitat and establishing a natural wooded riparian buffer would be lost. Please see Appendix 6-4 Biodiversity Management and Enhancement Plan for details

9.5.2 Construction Phase - Likely Significant Effects and Mitigation Measures

9.5.2.1 Clear Felling of Forestry, Woodland and Linear Vegetation

Tree felling is a minor component of the Proposed Wind Farm with approx. 4.22ha felling proposed. In addition to the felling, 1.8km of linear vegetation will be removed to facilitate the infrastructure footprint.

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

Potential effects during tree felling occurs mainly from:

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

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters (Eastwood River and Suir River) and associated dependant ecosystems.

Pre-Mitigation Potential Impact: Indirect, negative, moderate, temporary, likely effect.

Proposed Mitigation Measures:

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:

- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations and Water Protection Guidelines;
- Coillte (2009): Methodology for Clear Felling Harvesting Operations; and,
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

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 9-16**.

Table 9-16 : 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 construction phase a self-imposed conservative buffer zone of 50 metres will be maintained for all streams. These buffer zones are shown on **Figure 9-11**. No tree felling is required inside the delineated 50m buffer zones.

The large distance between the majority of the proposed felling areas and sensitive aquatic zones means that potential poor quality runoff from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes.

Mitigation by Design:

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

- Machine combinations (i.e. handheld or mechanical) will be chosen which are most suitable for ground conditions and which will minimise soils disturbance;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;
- Ditches which drain from the proposed area to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute

angle to the contour (~0.3%-3% gradient), to minimise flow velocities. Main drains to take the discharge from collector drains will include water drops and rock armour, as required, where there are steep gradients, and 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. All new silt traps will be constructed on even ground and not on sloping ground;
- 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 before 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 will 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;
- Direct crossing of streams with machinery will not be permitted;
- 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 will be carried out during pre-felling inspections and after:

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;
- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspections the main drainage ditches will be identified. Ideally the pre-felling inspection will be carried out during rainfall;
- Following tree felling all main drains will be inspected to ensure that they are functioning;
- Extraction tracks within 10m of drains will be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the Site, if impeded by silt or debris, will be unblocked; and,

- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring:

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

Details of the proposed water quality monitoring are outlined in the Construction Environment Management Plan (CEMP) Appendix 4-3.

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

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

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

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

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

9.5.2.2 Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Site construction phase activities including access road construction, turbine base/hardstanding construction, construction compound, met mast construction, borrow pit opening and River Restoration works will require varying degrees of earthworks resulting in excavation of soil and mineral subsoil where present. The main earthworks along the Grid Connection will be related to the cabling, substation, access road and end masts. Potential sources of sediment-laden water include:

- Drainage and seepage water resulting from excavations;

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

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

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Eastwood River and River Suir) and associated dependent ecosystems.

Pre-Mitigation Potential Impact: Negative, significant, indirect, temporary, likely effect.

Proposed Mitigation by Avoidance:

The key mitigation measure during the construction phase is the avoidance of sensitive hydrological features where possible, by application of suitable buffer zones (i.e. 50m to main watercourses). All of the key infrastructure elements of the Proposed Project areas are located significantly away from the delineated 50m watercourse buffer zones with the exception of the horizontal directional drilling underground cabling crossing at the existing watercourse crossing on the River Suir and new watercourse crossing on the Eastwood River. Additional control measures, which are outlined further on in this section, will be undertaken at these locations.

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

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

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.
- In-Line controls:
  - Interceptor drains, vee-drains, oversized swales, erosion and velocity control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt bags, silt fences, sedimats, filter fabrics, and collection sumps, temporary sumps, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems.
- Treatment systems:
  - Temporary sumps and ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as Siltbuster, and/or other similar/equivalent or appropriate systems.

It should be noted for this Site that an extensive network of drains already exists, 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 existing water treatment elements, such as in line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

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

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the Proposed 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 settlement ponds and buffered outfalls onto vegetated surfaces;
- Buffered outfalls which will be numerous over the Site will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the Site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded, widening will be targeted to the opposite side of the road. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

It should be noted that 10% (~930m) of the Proposed Project roads already exist (as farm tracks) and are proposed for upgrade. The upgrading of these roads, albeit presents a potential short-term potential non-significant effect on surface water quality during construction, will be a positive effect in the long-term with regard to improved drainage controls. In addition to this, approx. 1.1km of the L-70391 local road which runs through the Site will be upgraded and 870m of the L7039 will be resurfaced, both of which will be used for the operational phase.

Pre-commencement Temporary Drainage Works

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

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

These details are included in the drainage plans attached as **Appendix 4-1a.**

Silt Fences:

Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids such as those present in the subsoils/sandstone tills that overlie the

Site. This will act to prevent entry to water courses of sand and gravel sized sediment, released from excavation of mineral sub-soils of glacial and glacio-fluvial origin, and entrained in surface water runoff. Inspection and maintenance of these of these structures during construction phase is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase. Double silt fences will be placed within drains down-gradient of all construction areas inside the 50m 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 Pond Design:

The Proposed Project footprint has been divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 50-year return period rainfall event were calculated for various catchment areas in order to size the settlement ponds (Refer to **Table 9-17**).

Table 9-17 : Settlement Pond Design

Pond Size W [m] x L [m] x D [m]			Catchment Size (m^2)		
Return Period	*50 yrs*	Storm Duration	500	1000	2000
6hr retention for coarse silt		6 hrs	2.8 x 9 x 1 m	4 x 13 x 1 m	5.7 x 18 x 1 m
11hr retention for medium silt		12 hrs	3.2 x 10 x 1 m	4.5 x 14 x 1 m	6.4 x 20 x 1 m
24hr retention for fine silt		24 hrs	3.5 x 11 x 1 m	5 x 16 x 1 m	7 x 22 x 1 m

Level Spreaders and Vegetation Filters:

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

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

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

Water Treatment Train:

A final line of defence will be provided by a water treatment train such as a "Siltbuster". If the discharge water from construction areas fails to be of a high quality during regular inspections, then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply for all of the construction phase.

Pre-emptive Site Drainage Management

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

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

- General Forecasts: Available on a national, regional and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3-hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;
- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3-hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24-hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

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

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

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

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

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

Management of Runoff from Spoil Storage Areas

It is proposed that excavated soil/subsoil (spoil) will be used to reinstate the proposed borrow pit and any excess spoil will be placed in dedicated spoil management areas. The borrow pit and spoil management areas are located outside the 50m stream buffer zone (refer to **Figure 9-11**).

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

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

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

Timing of Site Construction Works:

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

Monitoring:

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

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

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

Allowance for Climate Change

Climate Change rainfall projections are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the Proposed Project, as the turbines have a life span of 30- 35 years. It is likely that the long-term effects of climate change on rainfall patterns will not be observed during the lifetime of the Proposed Project. As outlined in the above sections settlement ponds have been designed for a 1 in 10 year return flow. This approach is conservative given that the Proposed Project will likely be built over a much shorter period (18-24 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

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

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

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

9.5.2.3 Potential Impacts on Groundwater Levels during Excavation Works

Potential dewatering of the borrow pit (as required) and other deep excavations (i.e. turbine bases) have the potential to impact on local groundwater levels and flows. However, due to the Proposed Project design measures outlined below no significant effects are likely.

No groundwater level impacts are predicted from the construction of the Proposed Grid Connection infrastructure due to the shallow nature of the excavations (i.e. 0 -~1.3m).

Pathway: Groundwater flowpaths

Receptor: Groundwater levels and flows within the underlying GWBs (Templemore GWB).

Pre-Mitigation Potential Impact: Direct, slight, brief, likely effect on groundwater levels and flows.

Impact Assessment/Mitigation Measures:

The deepest excavation works will be centred around the turbine foundations and borrow pit.

During the early design phase, site investigations and groundwater level monitoring were carried out at the area of the proposed borrow pit to establish the depth of unsaturated bedrock that could be extracted above the underlying groundwater table.

The proposed final extraction depth/floor level at the proposed borrow pit is 112.5m OD. Groundwater level monitoring shows that the groundwater level at the proposed borrow pit is generally below 112.5m OD. There were brief spikes in water levels above 112.5m OD due to very heavy rainfall events that were experienced during October/November 2023.

The maximum recorded groundwater level was 112.61m OD which is approximately 0.10m above the proposed borrow pit floor level. In the rare event of the base of the borrow pit being flooded to a level of 112.61m OD during its operation, there will be <u>no requirement</u> to pump water (i.e. dewater) due to the shallow depth of water which will only be present temporarily.

In addition, the edge of the borrow pit (i.e. existing greenfield surrounding ground level) will be at a minimum 0.7m above the base of the borrow pit, therefore there will be no potential for groundwater to escape from the borrow pit and flow onto adjacent ground.

Therefore, the proposed borrow pit will have no potential to affect local groundwater levels as no groundwater dewatering will be required. Refer to **Figure 9-7** above for groundwater level monitoring at the proposed borrow pit.

Trial pitting and boreholes were carried out at the proposed turbines locations to determine ground conditions for design purposes.

During the trial pitting, relatively shallow bedrock was proven at proposed turbine locations T4 (2.3m), T5 (1.4m), T6 (1.1m) and T7 (1.8m). The subsoils encountered at these locations was unsaturated with very minor seepages recorded.

Investigation drilling was required to determine the depth of deep alluvial subsoils in the area of proposed turbine locations T1, T2, T3 and T8. The drilling encountered groundwater saturated alluvial deposits between 4.8 and 8.8m in depth. High to moderate groundwater inflows were recorded from the alluvial deposits which were non-cohesive and flowing.

In order to avoid excavation and dewatering of alluvial deposits, it is proposed that a piled foundation design will be considered at turbine locations T1, T2, T3 and T8. Ground conditions at proposed turbine location T9 will be determined by additional site investigations at the detailed design phase. If deep, groundwater saturated alluvial deposits are present at T9, the piled turbine base option will also be considered. Piling of Turbine T9 (along with T1, T2, T3 and T8) is assessed in Section 9.5.2.14 below.

Mitigation by Best Practice

Environmental management guidelines from the EPA quarry 2006 guidance document – *"Environmental Management in the Extractive Industry"* in relation to groundwater issues at the borrow pit will be implemented during the construction phase.

Post-Mitigation Residual Impact: Due to the Proposed Project design measures, groundwater level drawdown residual effect will be negative, imperceptible, direct, brief, likely impact on groundwater levels.

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

9.5.2.4 Excavation Pumping/Drainage and Potential Impacts on Surface Water Quality

Some minor shallow groundwater/surface water seepages will likely occur during the excavations, and this will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the Site and therefore pollution issues arising from such sources will not occur.

Pathway: Overland flow and site drainage network.

Receptor: Down-gradient surface water bodies (Eastwood River, River Suir, Clonmore Stream and Strogue Stream).

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

Proposed Mitigation Measures:

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

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place;
- If required, pumping of excavation inflows will prevent build-up of water in the excavation;

- The interceptor drainage will be discharged to the site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters;
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit or silt bag;
- The borrow pit settlement ponds have been designed to allow a 24hr retention time as per EPA guidance (2006) which is highest level of protection recommended by the EPA with regard to retention time;
- 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 the Environmental Clerk of Works will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken; and,
- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

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

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

9.5.2.5 Potential Release of Hydrocarbons during Construction

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

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater (Templemore GWB) and surface water (Eastwood River, River Suir, and Clonmore and Strogue Streams).

Pre-Mitigation Potential Impact:

Indirect, negative, moderate, short term, likely impact to local groundwater quality.

Indirect, negative, significant, short term, likely 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 mobile double skinned fuel bowser. The fuel bowser will be parked on a level area on-site when not in use. All

refuelling will be carried out outside designated watercourse buffer zones. Only designated trained and competent operatives will be authorised to refuel plant on-site. Mobile measures such as drip trays and fuel absorbent mats will used during refuelling operations as required. All plant and machinery will be equipped with fuel absorbent material and pads to deal with any event of accidental spillage.
- Onsite refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building (at the substation) will be bunded appropriately to 110% of the volume of oils that will be stored, and to prevent leakage of any associated oils to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages is included within the Construction and Environmental Management Plan (Appendix 4-3). Spill kits will be available to deal with any accidental spillage in and outside the re-fuelling area.

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

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

9.5.2.6 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from on-site temporary wastewater treatment systems could have the potential to impact on groundwater and surface water quality. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater quality (Templemore GWB) and surface water quality (Eastwood River, River Suir and Clonmore Stream).

Pre-mitigation Effect: Negative, significant, indirect, temporary, unlikely effect to surface water quality. Negative, slight, indirect, temporary, unlikely effect to local groundwater.

Proposed Mitigation Measures:

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

Post-Mitigation Residual Effect: During the construction phase no water or wastewater for sanitation will be sourced on the Site, nor discharged to the Site, therefore no residual effects will occur.

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

9.5.2.7 Release of Cement-Based Products

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. 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 (Eastwood River, River Suir and Clonmore Stream).

Pre-Mitigation Effect: Indirect, negative, moderate, short term, likely effect to surface waters.

Proposed Mitigation Measures:

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

Post-Mitigation Residual Effect: The potential for the release of cement-based products or concrete 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 concrete truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect will be - negative, imperceptible, indirect, short term, unlikely impact to surface water and groundwater quality.

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

9.5.2.8 Morphological Changes to Surface Water Courses & Drainage Patterns at the Site

Diversion, horizontal directional drilling, 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.

It is proposed that only 1 no. new stream crossing (Eastwood River) and will be required to facilitate the wind farm site infrastructure and one clear span on the Strogue to facilitate the underground grid connection cabling route.

There is a total of 16 no. proposed drain crossings along the proposed wind farm infrastructure.

In addition, access roads constructed in flood zones can result in alteration of drainage patterns.

Pathway: Site drainage network.

Receptor: Surface water flows (Eastwood River and River Suir and Clonmore and Strogue Streams).

Pre-Mitigation Potential Effect: Negative, direct, slight, long term, likely effect.

Proposed Mitigation Measures

- All proposed new watercourse crossings will be bottomless or clear span culverts and the existing banks will remain undisturbed. No in-stream excavation works are proposed and therefore there will be no direct impact on the stream at the proposed crossing location;
- All proposed drain crossing culverts will be minimum 900mm in diameter;
- New access roads in mapped flood zones will be placed close to ground level to maintain the hydrology of the Site. Culverts will be placed along access roads accordingly (i.e. low points and depressions) to facilitate drainage of flood waters;
- All guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland[5] is incorporated into the design of the proposed crossings;
- As a further precaution, near stream construction work, will only be carried out during the period permitted by Inland Fisheries Ireland for in-stream works according to the Eastern Regional Fisheries Board (2004) guidance document "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites", i.e., May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses (any deviation from this will be done in discussion with the IFI);
- Where works are necessary inside the 50m buffer double row silt fences will be emplaced immediately down-gradient of the construction area for the duration of the construction phase; 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.

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

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

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

9.5.2.9 Potential Effects on Hydrologically Connected Designated Sites

The Site is not located within any designated site. Local designated sites include the Templemore Wood pNHA and Kilduff, Devilsbit Mountain pNHA and SAC. The setback distances and up-gradient location of these designated sites relative to the Site means hydrological and hydrogeological effects will not occur.

Hydraulically connected designated sites downstream of the Proposed Project include the Lower River Suir SAC and the River Barrow and River Nore SAC.

Cabragh Wetlands pNHA is also potentially located downstream of the Site. However, drainage from the wetland is generally towards the River Suir and not vice versa. However, during extreme flood events, the River Suir may flood the wetland area for a brief period.

All Designated Sites are located greater than 20km downstream of the Proposed Project. However, taking a precautionary approach there is the potential for significant impacts on the Lower River Suir SAC and Cabragh Wetlands pNHA via surface water deterioration prior to implementation of mitigation.

Pathway: Surface water flowpaths.

Receptor: Down-gradient water quality and designated sites (Lower River Suir SAC, River Barrow and River Nore SAC and Cabragh Wetlands pNHA).

Pre-Mitigation Potential Effect: Indirect, negative, imperceptible, short term, likely effect.

Impact Assessment & Proposed Mitigation Measures:

Mitigation measures for surface water quality protection during construction are summarised again below: (Please refer to Section 9.5.2.2 above for the full description of these measures).

- The proposed mitigation measures which will include 50m buffer zones for avoidance of sensitive hydrological features;
- Pre-construction drainage control measures;
- Robust drainage control measures (i.e. interceptor drains, swales, settlement ponds) 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 and cement based compounds.

As stated in Section 9.5.2.2 above, there could potentially be an "imperceptible, short term, likely impact" 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 downstream designated sites will not occur.

Post-Mitigation Residual Effect: No effects.

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

9.5.2.10 Site Entrance and Turbine Delivery Works

Minor temporary accommodating works are required for turbine delivery works at junction 22 of the M7. A temporary entrance will be constructed off the L-3248, adjacent to the N62 in the northwest of the Site. A second construction entrance will be constructed off the L-3248, approximately 70m northeast of the N62. This entrance will be used as the main entrance for construction traffic and staff vehicles.

These Site Entrances and minor temporary accommodating works at junction 22 are described in Section 4.5 of the EIAR.

Pathway: Surface water flowpaths.

Receptor: Down-gradient surface water quality (Eastwood River and River Suir).

Pre-Mitigation Potential Effect: Indirect, negative, slight, short term, likely effect.

Proposed Mitigation Measures:

No significant effects will occur for the following reasons:

- All works are relatively minor and localised and cover very small areas; and,
- Excavation/earthworks will all be small scale.

Nevertheless, the "Pre-commencement Temporary Drainage Works" described in 9.5.2.2 will be employed at all the Site Entrances.

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

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

9.5.2.11 Use of Siltbuster and Impacts on Downstream Surface Water Quality

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

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

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of siltbuster systems from northwest Mayo is provided in **Figure 9-13**. 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).

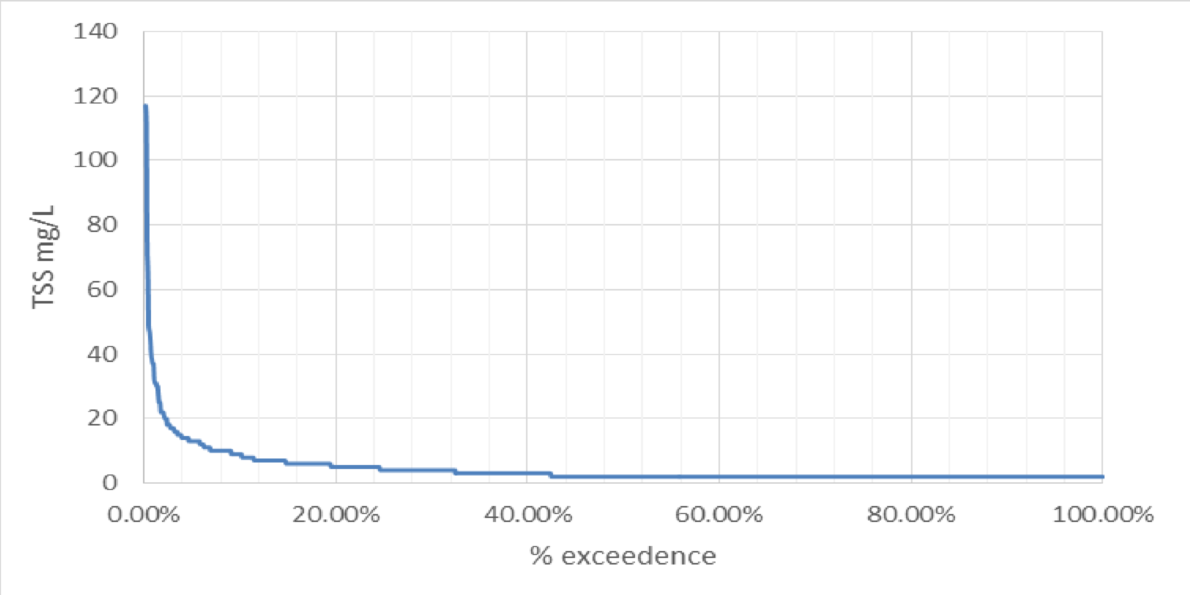


Figure 9-13 TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Down-gradient rivers (Eastwood River and River Suir) and designated sites and associated dependent ecosystems.

Pre-Mitigation Potential Effects: Negative, slight, indirect, temporary, likely effect.

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.

9.5.2.12 Potential Impacts on Surface Water and Groundwater WFD Status

The Templemore GWB underlies the Site (including the Proposed Wind Farm and proposed Grid Connection Infrastructure). This GWB is currently assigned 'Good Status', which is defined based on the quantitative status and chemical status of the GWB.

The Suir_020 surface water body achieved 'Poor' status under the WFD 2016-2021. Both the Eastwood_010 and the Clonmore Stream_010 achieved 'Moderate' status.

Effects on surface water and groundwater quality as a result of the Proposed Project have the potential to negatively effect the WFD status.

Pathway: Surface water and groundwater flowpaths.

Receptor: WFD status of downstream surface water bodies (Eastwood River, River Suir and Clonmore Stream) and GWBs (Templemore GWB).

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

Impact Assessment & Proposed Mitigation Measures:

This section is a summary of the WFD Assessment undertaken for the Site. The full WFD Assessment report is attached **Appendix 9-3**.

of The purpose of these objectives is that surface waters and groundwater, 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. Also, the development will not prevent the local waterbodies or groundwater bodies from achieving 'Good' or 'High' status.

Strict mitigation measures (refer to Section 9.5.2 and 9.5.3) in relation to maintaining a high quality of surface water runoff from the development and groundwater protection will ensure that the status of both surface water and groundwater bodies in the vicinity of the Site will be maintained.

Post-Mitigation Residual Effect: No effects on WFD status of surface water or groundwater bodies.

Significance of Effects: No significant effects on WFD status of surface water or groundwater bodies will occur.

9.5.2.13 Potential Effects of the Earthworks Works at Watercourse Crossings

The Proposed Wind Farm requires crossing the Eastwood River east of T6 via a new clear span crossing and directional drilling under a bridge crossing on the River Suir to facilitate IPP cabling connection to the proposed 110kV substation. In addition to this several field drains will require culverting.

The Proposed Grid Connection includes an approx. 2km underground grid connection cabling route which requires crossing the Clonmore Stream via directional drilling and the Strogue Stream via a new clearspan crossing. In addition to this, 3 field drains will require culverting.

Pathway: Surface water flow paths/groundwater paths.

Receptor: Down-gradient water quality (Eastwood River, Clonmore Stream and River Suir)

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

Proposed Mitigation Measures:

Pre-commencement Temporary Drainage Works:

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

- All existing roadside drains (where present) that intercept the proposed works area will be temporarily blocked down-gradient of the works using check dams/silt traps;
- Culverts, manholes and other drainage inlets (where present) will also be temporarily blocked;
- A double silt fence perimeter will be placed along the road verge on the down-slope side of works areas that are located inside the watercourse 50m buffer zone.

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;
- 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,
- The area around the Clear Bore™ (or similar alternative) batching, pumping and recycling plants will be bunded using terram and sandbags in order to contain any spillages;
- Accidental spillage of fluids will be cleaned up immediately and transported off site for disposal at a licensed facility; and,
- Adequately sized skips will be used for temporary storage of drilling arisings during directional drilling works. This will ensure containment of drilling arisings and drilling flush.

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 is considered to be negative, imperceptible, direct, long term, likely effect.

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

9.5.2.14 Potential hydrogeological Effects Associated with Piled Foundations

Due to the presence of deep, saturated fluvial deposits at proposed turbine's locations T1, T2, T3 and T8 (and possibly T9), piled foundation are being assessed as a possible solution.

- Piled foundation with a configuration of up to 20 no. 900 mm cylindrical bored piles. These piles could extend to a depth of between 5 to ~18 metres below ground level.

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

- Creation of preferential pathways, through lower permeability subsurface layers (silts and clays), to allow downward flow into the underlying bedrock aquifer; and,
- Creation of a blockage to local or regional groundwater flow within the underlying aquifer due to placement of pile clusters.

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

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

Receptors: Groundwater quality in the underlying Templemore GWBs

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

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

<u>Scenario 1: Creating a Pathway for Downward Flow</u>
To ensure downward flow of potential pollutants from the piling works does not occur, a bentonite seal will be used in a starter pit for each bored pile, and the mitigation measures outlined above will be implemented. The concrete added to the bored pile will seal the pile annulus. As a result, the potential for either piling work option to create pathways for downward flow of water or pollutants that could affect groundwater quality in the underlying aquifer is imperceptible.

<u>Scenario 2: Blocking Local or Regional Groundwater Flow</u>

For example, if a piling array of 20 no. 900mm piles is applied at each turbine base (T1, T2, T3, T8 and T9), this combined area of piling footprint amounts to ~63.5m^2, or 12.7m^2 per turbine base. Each turbine base is 500m – 800m apart. The area of the piles bored into the ground is distributed over a very large area, and that area only amounts to 0.75% of the development footprint, or <0.001% of the Site area. Also, none of the proposed piles would penetrate any great distance into the underlying bedrock aquifer, as they will likely find sufficient resistance upon reaching the top of bedrock. At such wide separation distance, the ability of clusters of piles, with a plan area of ~12.7m^2 per turbine, to alter or affect local or regional groundwater flow is imperceptible.

Proposed Mitigation Measures:

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

- Mitigation measures for sediment control are detailed in Section 9.5.2.1.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in Section 9.5.2.5.
- Mitigation measures for the control of cement-based products during construction works are detailed in Section 9.5.2.7.

Proposed mitigation measures relative to piling works will comprise:

- Strict QA/QC procedures for piling works will be followed;
- Piles will be kept vertical during piling works;
- Good workmanship will be employed during all piling works; and,
- Where required use bentonite seal to prevent upward/downward movement of surface water/groundwater.

Post-Mitigation Residual Effects: The piling works likely to be required at some of the proposed turbine locations, potentially pose a threat to groundwater quality in the underlying regional groundwater system. The potential effects will not arise at the proposed site due to a combination of the prevailing ground conditions, groundwater conditions, and proposed mitigation measures, outlined above, that will ensure the potential pathways for interaction of shallow and deeper groundwaters are prevented from occurring.

In addition, due to the small footprint of proposed pile clusters, and the significant spacing between turbine bases where pile clusters are proposed, the potential for such pile clusters to block regional groundwater flow is imperceptible at that scale. The proposed piled foundations therefore have no potential to change the WFD status or impact the WFD objectives of the underlying Templemore GWB. The residual effect will be a negative, imperceptible, indirect, short term, unlikely effect on groundwater flow, and ground quality/ water hydrochemistry.

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

9.5.2.15 Potential Water Quality and Morphological/Hydrological Effects Associated with River Channel Restoration

The enhancement of a portion of the Eastwood River within the Site will involve the restoration of a previously deepened and straightened channel to appropriate dimensions, pattern and profile and the establishment of a native woodlands buffer. Therefore, with regard watercourse morphology and hydrology, the effects will be positive. The proposed works are described in Chapter 4 section 4.3.1.9 of the EIAR.

The primary potential negative effects will be water quality (suspended solids) during the construction phase and this relates to the proposed excavation works required for the channel realignment.

Pathways: Surface water flowpaths and channel realignment works.

Receptors: Surface water quality and watercourse hydrology/morphology.

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

Positive, moderate, direct, permanent, likely effect on watercourse hydrology/morphology.

Proposed Mitigation:

No mitigation is required with regard hydrology/morphology as the overall effects of the enhancement works is positive.

The following measures will be employed to reduce release of sediment to downstream waters:

- All stream work to be performed "in the dry" either by pump-around or stream diversion with silt curtain;
- Impervious dikes or sand bags are to be used to isolate work from stream flow;
- The contractor shall not disturb more area than can be stabilised the same working day;
- Maintenance of stream flow operation shall be incidental to the work. This includes pumps and hoses;
- Pumps and hoses shall be of sufficient size to dewater the work area;
- Graded stream banks shall be stabilised, with matting, prior to predicted rain fall events;
- Silt bags and stilling basins shall be used to collect silt and sediment from work area dewatering;
- coir fibre matting shall be installed on the outside of all meander bends where shear stress is likely to be highest, and in other locations where erosion control may be necessary;
- Live willow cuttings (live stakes) shall be installed through the coir fibre matting along both sides of the stream channel following the installation of coir fibre matting to provide bank stability through the establishment of fast-growing native willows; and,
- Installation of cross vanes to prevent erosion of the river banks.

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 is considered to be negative, slight, direct, short term, likely effect on surface water quality.

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

9.5.3 Operational Phase – Likely Impacts and Mitigation Measures

9.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the watercourses. This could potentially increase runoff from the Site and increase flood risk downstream of the Proposed Project.

However, it is conservatively assumed in this assessment that the proposed access roads and hardstands are impermeable. The assessed footprint comprises turbine and met mast bases and hardstandings, access roads, site entrance, 110kV substation and end masts. During storm rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

Pathway: Site drainage network.

Receptor: Surface waters (Eastwood River, River Suir and Clonmore Stream) and dependent ecosystems.

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

Effects Assessment:

The emplacement of the proposed permanent development 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 2,808 m^3/month (**Table 9-18**). This represents a potential increase of approximately 0.7% in the average daily/monthly volume of runoff from the Site area in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the Site being developed, the proposed total permanent development footprint being approximately 8.47ha, representing 1.3% of the Site (650ha).

Table 9-18: Baseline Site Runoff V Development Runoff

Site Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)	Hardstanding Area 65% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
400,192	12,909	84,700	8,023	5,215	2,808	90.6	0.7

The additional volume is low due to the fact that the runoff potential from the Site is relatively high (65%). Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as access tracks will be constructed of permeable stone aggregate. The increase in runoff from the Proposed Project will, therefore, be imperceptible This is even before mitigation measures will be put in place.

Proposed Mitigation by Design:

The operational phase drainage system of the Proposed Project will be installed and constructed in conjunction with the road and hardstanding construction work as described below and as shown on the Drainage drawings submitted with this planning application (**Appendix 4-1a**):

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access roads and turbine hardstanding areas of the Site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed in the surface layer of the road to divert any runoff off the road into swales/road side drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;

- Settlement ponds, emplaced downstream of road swale sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses;
- Regular culverts will be placed along access roads in areas prone to flooding; and,
- Settlement ponds have been designed in consideration of the greenfield runoff rate.

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

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

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

9.5.3.2 Runoff Resulting in Suspended Solids Entrainment in Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of site entrances, internal roads and hardstand areas. These works 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 (Eastwood River, River Suir and Clonmore Stream) and associated dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect.

Proposed Mitigation Measures:

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

It is proposed that bedrock won from the on-site borrow pit (i.e. limestone) 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 the borrow pit or local quarries.

Mitigation measures for control of hydrocarbons during maintenance works as described in Section 9.5.2.5.

Post-Mitigation Residual Effects: With the implementation of the proposed drainage measures as outlined above, and based on the post-mitigation assessment of runoff, residual effects 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 Increased Flood Risk due to Infrastructure in Fluvial Flood Zones

A Stage 3 flood risk assessment carried out for the Site determined that proposed turbine locations T3, T4, T7, T8 and T9 are mapped inside the 100 and 1000-year flood zones. In addition, sections of proposed access roads linking T5, T6, T7, T8 and T9 are also inside the 100-year and 1000-year flood zones. The grid connection end masts and a section of the grid itself are also inside the 100-year and 1000-year flood zones, however due to the underground nature of the grid connection and above ground structure of the end masts, they will have no potential to increase flood risk.

All other key Proposed Project infrastructure such as the 110kV substation, site compounds, borrow pit and spoil management areas are outside the modelled 100-year and 1000-year flood zones and are therefore located in Flood Zone C (Low Risk).

Construction in fluvial flood zones has the potential to increase flood risk due to floodplain storage reduction and alteration of drainage patterns.

Pathways: Drainage and surface water discharge routes.

Receptors: Proposed wind farm infrastructure as well as upstream and downstream receptors (i.e. property and people).

Pre-Mitigation Potential Effect: Negative, moderate, direct, long term, likely effect on Proposed Project infrastructure.

Negative, imperceptible, indirect, long term, likely effect on downstream receptors (i.e. property and people).

Impact assessment /Proposed Mitigation Measures:

<u>Proposed Flood Resilience Measures</u>

Measures to reduce flood risk with regard the Proposed Project include:

- Turbine bases T3, T4, T7, T8 and T9 will have finished floor levels +500mm above the 1000-year flood level;

- Proposed new roads in flood zones will be kept close to existing ground level to avoid alteration of surface water flows and reduced potential road damage during flood events; and,
- For the proposed new Eastwood River Crossing and upgrade of the existing crossing on the River Suir a Section 50 consent will be sought under Section 50 of the Arterial Drainage Act, 1945 to install a new culvert/bridge with the hydraulic capacity to accommodate a 100-year flood flows while maintaining at least a 300mm freeboard above the flood level.

Effect on Flood Levels due to the Proposed Project Infrastructure/Flood Resilience Proposal

The flood model was run for the Developed Scenario (constructed windfarm scenario) to assess the effects of the proposed infrastructure on flood levels and flood flows:

- There is a modelled 0.01m water level rise in the 100-year flood level and no change in the 1000-year flood level for the Developed Scenario;
- The resulting change in the 100-year and 1000-year flood zone extent at the Site is imperceptible;
- The proposed channel restoration works in the Eastwood River will have no negative effect on flood risk;
- Effects on flood flow velocity through the Site were also assessed to be imperceptible; and,
- There are no flood level effects upstream or downstream of the Site;

Other than the Proposed Project drainage control measures/SuDs, no additional mitigation measures are with regard flood risk.

Post-Mitigation Residual Effects: Negative, slight, direct, brief, likely effect on Proposed Project infrastructure.

Negative, imperceptible, indirect, brief, likely effect on flood risk and downstream receptors (i.e. property and people).

Significance of Effects: For the reasons outlined above, no significant effects with regard flood risk.

9.5.3.4 Assessment of Effects on WFD Objectives

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

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

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

9.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures

The potential impacts associated with decommissioning of the Proposed Project will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. A description of the decommissioning works is contained in Chapter 4 section 4.11 of this EIAR and in the Decommissioning Plan (Appendix 4-4).

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 foundation areas. This will be done by covering with vegetation to encourage vegetation growth and reduce run-off and sedimentation.

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

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

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

Turbine and mast foundations will remain underground and will be covered with earth and allowed to revegetate. Leaving the foundations in-situ is considered a more environmentally prudent option, as to remove that volume of reinforced concrete from the ground could result in significant environment nuisances.

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".*

The Proposed Grid Connection (110kV substation, Underground Cabling, access road and end masts) will not be decommissioned, as it will form part of the national electricity grid.

No significant effects on the hydrological and hydrogeological environment will occur during the decommissioning stage of the Proposed Project.

9.5.5 Assessment of Potential Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. There are no mapped public or group water scheme groundwater protection zones in the area of the Site. 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 detailed Stage 3 Flood Risk Assessment has been carried out for the Proposed Project, summarised in Section 9.5.2 and Section 9.5.3.3. This Flood Risk Assessment, 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 insignificant. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

9.5.6 Cumulative Hydrological Effects

9.5.6.1 Introduction

This section presents an assessment of the potential cumulative effects associated with the Proposed Project and other developments (existing, permitted and proposed) on the hydrological and hydrogeological environment. Please see Chapter 2 Section 2.8 for details on the Cumulative Assessment methodology for the EIAR.

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. groundwater flow towards the nearby River Suir that flows through the Site) and the near surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Proposed Project are not likely to extend beyond the Site.

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 lesser degree with less ground disturbance.

9.5.6.2 Cumulative Study Area

The potential zone of impact of the Proposed Project on the water environment including potential cumulative effects is limited within the Water Study Area is defined by the sub-catchments within which the Site is located (Suir_SC_010) and those immediately downstream (Fishmoyne_SC_010, Suir_SC_020 & Suir_SC_040). The Site is located in the Suir_SC_010 which is the furthest upstream sub-catchment. The proposed TDR accommodation works in the River Nore catchment are very minor and will not contribute to cumulative effects.

The area of the Water Study Area is approximately 570km^2 and extends approximately 25km downstream of the Site. The Water Study Area is shown in **Figure 9-1** above.

There will be no potential for cumulative effects beyond this Water Study Area due to increases in flow volumes (as the catchment area increases) and increasing distance from the Proposed Project.

9.5.6.3 Cumulative Effects with Agriculture

The Site is situated in the Suir_010 sub-catchment. According to Corine land cover mapping (www.epa.ie) (2018) the Suir_010 sub-catchment is a largely agricultural catchment.

Agriculture is the largest pressure on water quality in Ireland and has been listed as a significant pressure on the Suir_010 SWB in the vicinity of the Site. 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.

9.5.6.4 Cumulative Effects with Commercial Forestry

According to Corine land cover mapping (www.epa.ie) (2018) coniferous forestry plantations are not extensive within the Water Study Area, with the closest plantations located on the eastern slopes of the Kilduff Mountains, approximately 7km to the west of the Site.

The Kilduff Mountains are drained by the headwater streams of the River Suir including the Eastwood River. The most common water quality problems arising from forestry relate to the release of sediment and nutrients to the aquatic environment, and impacts from acidification. Forestry may also give rise to modified stream flow regimes caused by associated land drainage.

Given that most of the main forestry plantations are located a significant distance from the Site, the likelihood of significant potential effects occurring is low. Nevertheless, given that the Site and these forested areas drain to the River Suir, the potential cumulative effects on downstream water quality and quantity need to be assessed.

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

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

9.5.6.5 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