9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter assesses the impacts of the Development (**Figure 1.2**) on the hydrology and hydrogeology resources of the Site. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Development:

- Construction of the Tullaghmore Wind Farm
- Operation of the Development
- Decommissioning of the Development.

The Development refers to all elements of the application for the construction and operation Tullaghmore Wind Farm (**Chapter 2: Development Description**).

Common acronyms used throughout this EIAR can be found in **Appendix 1.4.**

This chapter of the EIAR is supported by Figures provided in Volume III and the following Appendices provided in Volume IV of this EIAR:

- **Appendix 9.1** Photographic Plates
- **Appendix 9.2** Laboratory Certificates

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This CEMP will be a key construction contract document, which will ensure that all mitigation measures, which are considered necessary to protect the environment are implemented.. For the purpose of this application, a summary of the mitigation measures is included in **Appendix 15.1**.

9.1.1 Statement of Authority

This chapter of the EIAR was prepared by David Parkinson (BSc., MIEMA, CEnv) and was reviewed by Andrew Garne. David is the Principal Environmental Consultant of EcoQuest Environmental with over a decade of environmental consultancy experience in Ireland and Australia. David has completed numerous hydrological and hydrogeological impact assessments, is a Full Member of the Institute of Environmental Management and Assessment (MIEMA) and is a Chartered Environmentalist (CEnv). David's experience spans multiple industry sectors or disciplines, including numerous windfarm projects, flood alleviation schemes, infrastructure projects, transport, aviation, wastewater schemes, contaminated land and advisory on emerging contaminants. He has extensive experience in carrying out water quality assessments on major Irish rivers or their tributaries such as the Shannon, Dodder, Morell, Corrib, Broadmeadow, Finisk, Bandon and Garavogue rivers. In addition to nationwide water quality assessment experience, David has also assisted with water quality management of sensitive wetlands of international significance in Australia. David also has a background in water and wastewater chemistry laboratory analytical roles which help form the scientific basis of his environmental assessment expertise.

Andrew Garne (B.Sc., M.Sc., P.Geo) is an independent Engineering Geologist who specialises in hydrogeological, geotechnical and geological impact assessment. Andrew is a Full Member of the Institute of Geologists of Ireland (MIGI) and is a registered professional geologist (P.Geo). Andrew has worked on multiple EIAR impact assessments, including multiple windfarm developments, across the disciplines of hydrogeology, geology and soils. He also has extensive experience of windfarm peat stability assessments, geotechnical earthworks designs, geotechnical inspections and supervision, contaminated land assessments, slope stability assessments, site investigation design, procurement and supervision, soil and rock core logging, laboratory scheduling and writing of geotechnical advisory reports. Andrew has worked in tandem with David throughout the duration of this project, including in the field, at virtual meetings and through extensive collaboration. Andrew has provided and input to and has reviewed this Chapter of the EIAR.

9.1.2 Assessment Structure

In line with the EIA Directive and the Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (2022), the structure of this Hydrology and Hydrogeology chapter is as follows:

- Details of methodologies utilised for both desk and field studies
- Description of baseline conditions at the Site
- Identification and assessment of impacts to hydrology and hydrogeology associated with the Development, during the construction, operational and decommissioning phases of the Development
- Mitigation measures to avoid or reduce the impacts identified
- Identification and assessment of cumulative impacts if and where applicable
- Identification and assessment of residual impact of the Development considering mitigation measures.
- Summary of Significant Effects and Statement of Significance.

9.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

9.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential impacts of the Development on the hydrology and hydrogeology aspects of the environment at the Tullaghmore Wind Farm Site:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and on site surveys
- Undertake water balance calculation
- Undertake flood risk evaluations
- Consider hydrological or hydrogeological constraints together with development design
- Consider drainage issues, or issues with surface water runoff quality as a result of the Development, its design and methodology of construction
- Assess the combined data acquired and evaluate any likely impacts on the hydrology and hydrogeology aspects of the environment
- If impacts are identified, consider measures that would mitigate or reduce the identified impact
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

9.2.2 Relevant Legislation and Guidance

This study complies with the EIA Directive as amended which requires Environmental Impact Assessment for certain types of major development before development consent is granted. The EIA Directive as amended is transposed inter alia by the Planning and Development Act 2000 as amended and by the Planning and Development Regulations 2001 as amended.

In addition to this planning legislation, other environmental legislation relevant to hydrological and hydrogeological aspects of the environment were referred to:

- S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations 1988
- 94European Communities (Birds and Natural Habitats) (Amendment) Regulations 2013 (S.I. No. 499 of 2013)S.I. No. 41 of 1999: Protection of Groundwater Regulations 1999
- S.I. No. 439 of 2000: European Communities (Drinking Water) Regulations, 2000.S.I. No. 722 of 2003 European Communities (Water Policy) Regulations 2003

- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010
- S.I. No. 122 of 2014 European Union (Drinking Water) (No. 2) Regulations 2014;
- S.I. No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018
- European Union Water Framework Directive (2000/60/EC)
- European Union Directive 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life (The Freshwater Fish (Fishlife) Directive)
- European Union Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the "Groundwater Directive") and (2006/118/EC) (the "daughter directive").

The Water Framework Directive (WFD), which was passed by the European Union (EU) in 2000, and came into legal effect in December 2015, is wide-reaching legislation which replaces a number of the other water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive. The fundamental objective of the Water Framework Directive aims at maintaining "high status" of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least "Good" in relation to all waters by 2027 (WFD).

This study has been prepared using, inter alia, the following guidance documents, which take account of the aforementioned legislation:

- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines
- Office of Public Works (OPW) (2019), Environmental Guidance: Drainage Maintenance and Construction
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide

- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical
- Guidance
- The Galway County Development Plan (2022-2028).

The following additional sources of information have also been reviewed as part of this assessment:

- Environmental Protection Agency (2021) 3rd Cycle Draft Corrib Catchment Report
- Inland Fisheries Ireland (2018) Owenriff Fish Population Rehabilitation Plan
- Department of Housing, Planning and Local Government (2018) River Basin Management Plan for Ireland, 2018 – 2021
- Local Authority Waters Programme (2019) Failmore Priority Area for Action – Desk Study Summary 2019
- Met Eireann (2007), Technical Note 61, Estimation of Point Rainfall Frequencies, D.L. Fitzgerald, 2007
- Met Éireann (2012) A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14
- Hunter Williams, N.H., Misstear, B.D., Daly, D. and Lee, M. (2013) Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology.

9.2.3 Desk Study

A desk study consisting of a review of all available datasets, information, and literature resources relevant to the Site has been completed. The most current datasets and information maintained by the Environment Protection Agency (EPA), Geological Survey of Ireland (GSI) and the Office of Public Works (OPW) were reviewed to assist in establishing the hydrological and hydrogeological characterisation of the Site.

Relevant documents and datasets used to assist in compiling the desk study included EPA water quality data, topography maps and GSI hydrogeological data. The following full list of sources and information were utilised to establish the baseline environment:

- Department of Housing, Planning and Local Government, National River Basin Management Plan 2018-2021 https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021
- EPA Map Viewer, Water Framework Directive (WFD), surface water and hydrogeological features https://gis.epa.ie/EPAMaps/Water
- EPA HydroNet, Surface water levels, flows and groundwater levels http://www.epa.ie/hydronet/#Water%20Levels
- Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA) https://www.gov.ie/en/publication/1c7d0a-preliminary-flood-risk-assessment-pfra
- Office of Public Works (OPW), National Flood Information Portal https://www.floodinfo.ie
- Ordnance Survey Ireland, Map Viewer http://map.geohive.ie/mapviewer.html
- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer https://www.npws.ie/protected-Sites
- The Geological Survey of Ireland (GSI), groundwater data and maps https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx
- The Geological Survey of Ireland (GSI), karst features database https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-irish-karst/Pages/Karst-databases.aspx
- Myplan.ie; National Planning Application Map Viewer https://myplan.ie/national-planning-application-map-viewer
- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas https://www.seai.ie/technologies/seai-maps/wind-atlas-map/
- Met Éireann Meteorological Data https://www.met.ie/climate/available-data/historical-data
- Department of Housing, Planning and Local Government, EIA Portal https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal

9.2.4 Field Work

A preliminary field investigation and hydrological survey to inform the baseline hydrological conditions of the Site was undertaken by David Parkinson (BSc., MIEMA, CEnv) and Andrew Garne (B.Sc., M.Sc., P.Geo) on 31st August and 1st September 2020. Five subsequent rounds of field investigation surveys were conducted on 13th/14th October 2020, 4th/5th March 2021, 5th/6th October 2021, 24th January 2022 and 22nd August 2022. The field investigations consisted of the following works:

- Walkover surveys of the Site to identify and record hydrological features. The locations of surface water features including rivers, drainage patterns, ditches, wetlands, flow directions and flushes etc. were recorded.
- Field hydrochemistry measurements were recorded on surface water features at multiple locations across the Site for parameters including pH, electrical conductivity (EC), dissolved oxygen (DO), total dissolved solids (TDS) and temperature. These measurements were taken to assist in informing the origin of the surface water and also to provide an overview of the baseline water quality conditions at the Site.
- Collection of surface water samples at representative locations across the Site and transportation to an Irish National Accreditation Board (INAB) accredited for laboratory analysis.

Upon completion of the field surveys, the data collected was reviewed and mapped for further analysis against applicable water quality screening criteria. The captured field data was overlain against the publicly available datasets listed in **Section 9.2.3** such as those from the EPA, GSI, OPW, OSI and catchments.i.e. in January 2021.

9.2.5 Evaluation of Potential Effects

9.2.5.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development (EPA, 2022). The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of impacts however, in terms of qualifying significance of the receiving environment the EPA guidance also states that:

"*As surface water and groundwater are part of a constantly moving hydrological cycle, any assessment of significance will require evaluation beyond the development Site boundary.*" (EPA, 2015)

To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA) 2008, has been used in conjunction with EPA guidance. The following table presents rated categories and criteria for rating Site attributes (NRA, 2008).

Table 9.1: Criteria for Rating Site Attributes – Hydrology and Hydrogeology Specific

Importance	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	• River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European Sites' designated under the Natural Habitats Regulations, the Birds Directive or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988. • Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status.
Very High	Attribute has a high quality, significance or value on a regional or national scale	• River, wetland or surface water body ecosystem protected by national legislation – NHA status • Regionally important potable water source supplying >2500 homes Quality Class A (Biotic Index Q4, Q5) • Flood plain protecting more than 50 residential or commercial properties from flooding • Nationally important amenity Site for wide range of leisure activities • Regionally Important Aquifer with multiple wellfields • Inner source protection area for regionally important water Source.
High	Attribute has a high quality, significance or value on a local scale	• Salmon fishery • Locally important potable water source supplying >1000 homes • Quality Class B (Biotic Index Q3-4) • Flood plain protecting between 5 and 50 residential or commercial properties from flooding • Locally important amenity Site for wide range of leisure activities • Regionally Important Aquifer • Groundwater provides large proportion of baseflow to local rivers.
Medium	Attribute has a medium quality, significance or value on a local scale	• Coarse fishery • Local potable water source supplying >50 homes • Quality Class C (Biotic Index Q3, Q2- 3) • Flood plain protecting between 1 and 5 residential or commercial properties from flooding • Locally Important Aquifer • Outer source protection area for locally important water source.
Low	Attribute has a low quality, significance or value on a local scale	• Locally important amenity Site for small range of leisure activities • Local potable water source supplying < 50 homes • Quality Class D (Biotic Index Q2, Q1) • Flood plain protecting 1 residential or commercial property from flooding • Amenity Site used by small numbers of local people • Poor bedrock aquifer.

The sensitivity of the receiving hydrological and hydrogeological environment is defined by the baseline quality, as well as its potential to absorb change and for substitution, as defined in **Table 9.2** and **Figure 9.1**. The sensitivity of each receptor has been assessed using professional judgement and described with a standard semantic scale. The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the receiving aquatic and geological environment, including international and national designations, surface water, groundwater and soil quality information, waterbody status from the WFD review work undertaken to date by the EPA, consultations and professional judgement.

Table 9.2 Receptor Sensitivity Criteria

Sensitivity	Definition	Example Criteria
High	Receptor with national or international importance (i.e. SAC or SPA), a high quality and rarity on a regional or national scale and limited potential for substitution or replacement	• Surface water WFD class of "High" • European Commission (EC) designated Salmonid or Cyprinid waters • Drinking water protected area (DWPA) • Regionally important aquifer with abstractions for public drinking water supply • GSI groundwater vulnerability "Extreme" classification • Supporting a Site protected under EC habitat legislation / species protected by EC legislation • Protected bathing water area • Active floodplain • Highly Groundwater Dependent Terrestrial Ecosystems (GWDTE) • Qualifying characteristics for class 1 priority peatland habitat, all vegetation cover indicates priority peatland habitat all soils are carbon rich soils and deep peat.
Medium	Receptor with regional or county level importance with a medium quality and rarity on a regional scale and limited potential for substitution or replacement	• Surface water WFD class of "Good" or Moderate • GSI groundwater vulnerability "High" classification • Locally important aquifer • Local or regional ecological status /locally important fishery • Contains some flood alleviation features • Moderately GWDTE • Qualifying characteristics for peatland habitat, most vegetation cover indicates priority peatland habitat; all soils are carbon rich soil and deep peat.
Low	Receptor is of limited or local importance only on a Site or in proximity to a Site with low quality and rarity on a localised scale. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.	• Surface water WFD class of "Poor" • Fish only sporadically present • No abstractions for public or private water supplies. • GSI groundwater vulnerability "Low" or "Medium" classification • Aquifer importance is "Poor". • No natural flood alleviation features • Qualifying characteristics for vegetation cover does not indicate priority peatland habitat

Considering the above categories of sensitivity and associated criteria, the diagram shown in presents how comparison of the character of the predicted impact to the sensitivity of the receiving environment can determine the significance of the impact (EPA, 2022).

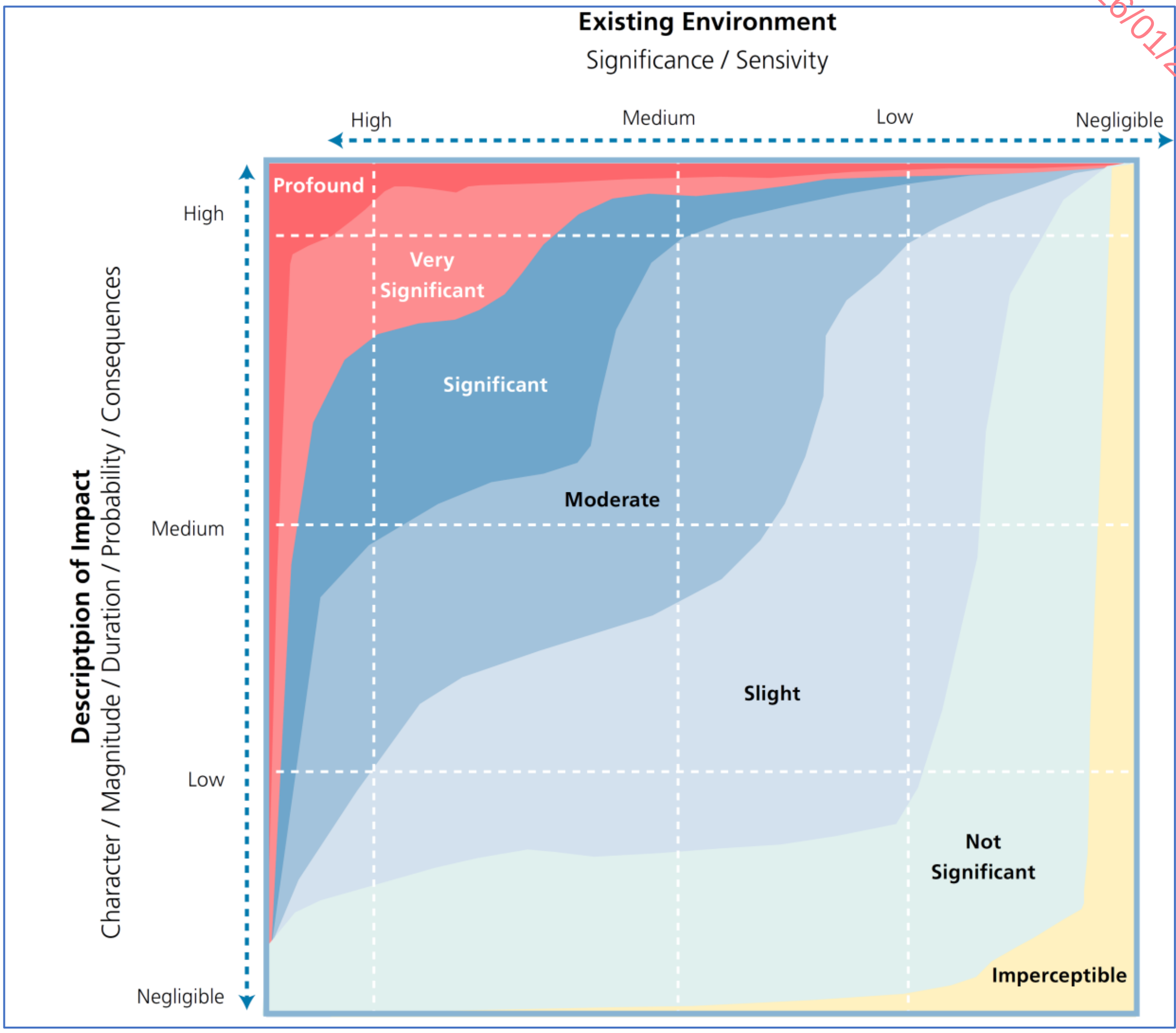


Figure 9.1: Comparison of the Character of the Predicted Impact to the Sensitivity of the Receiving Environment (EPA, 2022)

9.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in **Table 9.3** (EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example, a "*Moderate"* impact is one which is consistent with the existing or emerging trends.

Table 9.3: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An effect capable of measurement but without noticeable consequences
Not significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
Slight	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate	An effect that alters the character of the environment in a manner consistent with existing and emerging baseline trends
Significant	An effect, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Very significant	An effect which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
Profound	An effect which obliterates sensitive characteristics.

In terms of hydrology and hydrogeology, magnitude is qualified in line with relevant guidance, as presented in the following tables (NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Development, and do not provide for considering baseline trends and therefore are utilised to qualify impacts in terms of weighting impacts relative to Site attribute importance, and scale where applicable.

Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes

Magnitude of Impact	Description	Examples
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	• Loss or extensive change to a waterbody or water dependent habitat, or • Calculated risk of serious pollution incident >2% annually, or • Extensive loss of fishery
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Partial reduction in amenity value, or • Calculated risk of serious pollution incident >1% annually, or • Partial loss of fishery
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Slight reduction in amenity value, or • Calculated risk of serious pollution incident >0.5% annually, or • Minor loss of fishery
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• Calculated risk of serious pollution incident <0.5% annually

Magnitude of Impact	Description	Examples
Minor Beneficial	Results in minor improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually
Moderate Beneficial	Results in moderate improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is >1% annually
Major Beneficial	Results in major improvement of attribute quality	• Reduction in predicted peak flood level >100mm

Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	• Removal of large proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems, or • Potential high risk of pollution to groundwater from routine run-off.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Removal of moderate proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems, or • Potential medium risk of pollution to groundwater from routine run-off.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Removal of small proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems, or • Potential low risk of pollution to groundwater from routine run-off.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• Calculated risk of serious pollution incident <0.5% annually.

9.2.5.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is carried out in accordance with relevant guidance as presented in the **Table 9.6** below (NRA, 2008). This matrix qualifies the magnitude of potential effects based on weighting factors depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects **(Table 9.3: Describing the Magnitude of Impacts**) are linked directly with the development specific terms for qualifying potential impacts (**Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes**).Therefore, qualifying terms (**Table 9.6**) are used in describing potential impacts of the Development.

Table 9.6: Weighted Rating of Significant Environmental Impacts

Sensitivity (Importance of Attribute)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
High	Imperceptible	Moderate / Slight	Significant / Moderate	Profound / Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

9.2.5.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 9.7**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has addressed responses to specific issues indicated by respective consultees.

Table 9.7: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
Irish Water	Letter in response to Scoping Report Received 31 October 2021	• *"Where the development proposal has the potential to impact an IW Drinking Water Source(s) the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to IWs Drinking Water Source during construction and operational phases of the development. Hydrological / hydrogeological pathways between your Site and receiving waters should be identified."* • *"Mitigation proposed for any potential negative impacts on any water source(s), in proximity, including the environmental management plan and incident response"* • *"Any and all potential impacts on the nearby reservoir as public water supply water source(s) is assessed, including any impact on hydrogeology and any groundwater/ surface water interactions."* • *"Impacts of the development on the capacity of water services (do existing water services have the capacity to cater for the new development if required). This is confirmed by IW in the form of a Confirmation of Feasibility (COF). If a development will require a connection to either a public water supply or sewage collection system the developer is advised to submit a Pre Connection Enquiry (PCE) enquiry to IW to determine the feasibility of connection to the Irish Water network.* • *"Any up-grading of water services infrastructure that would be required to accommodate the development."* • *"In relation to a development that would discharge trade effluent – any upstream treatment or attenuation of discharges required prior to discharging to an IW collection network."* • *In relation to the management of surface water; the potential impact of surface water discharges to combined sewer networks & potential measures to minimise/stop surface waters from combined sewers*	• IW have been consulted, no known IW assets exist at the proposed Site, IW assets along the grid connection route are addressed in **Section 9.3.17**. Hydrological and hydrogeological pathways have been identified in **Sections 9.3.4** and **9.3.10** in addition to the mapping of surface water features in **Figure 9.3**. • Mitigation measures for potential impacts on water sources are contained in **Section 9.5**. • No known IW assets exist at the proposed Site, IW assets along the grid connection route are addressed in **Section 9.3.17**. Potential impacts on hydrogeology and groundwater / surface water interactions are addressed in **Section 9.3.18**. • The proposed Development will not require a new connection to a public water or wastewater supply. • The proposed development will not require any upgrading of water services. • The proposed development will not require the discharge of any trade effluent. • The proposed development will not result in discharges of surface waters to combined sewers.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *Any physical impact on IW assets – reservoir, drinking water source, treatment works, pipes, pumping stations, discharges outfalls etc. including any relocation of assets.*	• No known IW assets exist at the proposed Site, IW assets along the grid connection route are addressed in Section 9.3.17.
		• *"If you are considering a development proposal, you are advised to determine the location of public water services assets, possible connection points from your Site/lands to the public network and any drinking water abstraction catchments to ensure these are included and fully assessed in any pre planning proposals. Details, where known, can be obtained by emailing an Ordnance Survey map identifying the proposed location of your intended development to datarequests@water.ie. Other indicators or methodologies for identifying infrastructure located within your lands are the presence of registered wayleave agreements, visible manholes, vent stacks, valve chambers, marker posts etc. within the proposed Site.*	• IW have been consulted via submission of a data request to datarequests@water.ie. No known IW assets exist at the proposed Site, Galway County Council have also been consulted and have also confirmed that no known public water supplies exist within the vicinity of the Site. IW assets along the grid connection route are addressed in **Section 9.3.17**. Hydrological / hydrogeological pathways have been identified in **Sections 9.3.4** and **9.3.10** in addition to the mapping of surface water features on **Figure 9.3** in **Appendix III.**
		• *"Any potential impacts on the assimilative capacity of receiving waters in relation to IW discharge outfalls including changes in dispersion /circulation characterises. Hydrological/hydrogeological pathways between your Site and receiving waters should be identified."*	• The direct discharge of dewatered loads to surface waters will not be permitted under any circumstances as is outlined in **Section 9.5.2.2**. All discharge from the site will be via level spreaders/buffered outfalls via settlement ponds. • Hydrological / hydrogeological pathways have been identified in **Sections 9.3.4** and **9.3.10** in addition to the mapping of surface water features in **Figure 9.3**.
		• *"Any potential impact on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence / present a risk to the quality of the water abstracted by IW for public supply."*	• Water abstraction for the development will not be required. The potential for the development to present a risk to the quality of water abstracted by IW for public supply is considered to be negligible since no known IW assets exist at the proposed Site. IW assets along the grid connection route are addressed in **Section 9.3.17**.
		• *"Where a development proposes to connect to an IW network and that network either abstracts water from or discharges wastewater to a "protected"/sensitive area, consideration as to whether the integrity of the*	• The proposed development will not require a connection to an IW network.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		Site/conservation objectives of the Site would be compromised." • *"Mitigation measures in relation to any of the above ensuring a zero risk to any IW drinking water sources (Surface and Ground water)."*	• No known IW assets exist at the proposed Site, IW assets along the grid connection route are addressed in **Section 9.3.17**. Mitigation measures for potential impacts on water sources are contained in **Section 9.5**.
Health Service Executive (HSE)	Letter in response to Scoping Report 5 November 2021	• The HSE response also notes "The Environmental Health Service (EHS) recommends that "Surface and Groundwater Quality" are included and assessed in the EIAR: • The HSE response noted that the decommissioning phase and future use of the proposed Site should be assessed in the EIAR. • *"All drinking water sources, both surface water and ground water, must be identified. Public, Group Water Scheme and Private Sources and supplies should be identified. Measures to ensure that all sources and supplies are protected should be described. Site surveys should be carried out in addition to desktop analysis of GSI data. 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."* • *"The EIAR should include a detailed assessment of any likely significant cumulative impacts of the proposed development."*	• Surface and groundwater quality are assessed in **Section 9.3.8** and **Section 9.3.9** respectively. • The decommissioning phase of the proposed development is assessed in **Section 9.4.7**. • Drinking water sources, both surface and groundwater are assessed in **Section 9.3.17**. Mitigation measures to protect drinking water sources are described in **Section 9.4**. Multiple Site surveys have been carried out which are escryibed in **Section 9.2.4**, desktop analysis of GSI data is described in **Section 9.3.10**. Consideration of the bedrock, overburden, vulnerability, groundwater flows, aquifers and catchment areas is accounted for in **Sections 9.3.4, 9.3.9, 9.3.10, 9.3.11, 9.3.12 and 9.3.13**. • Cumulative impacts are assessed in **Section 9.5.6**.
Inland Fisheries Ireland (IFI)	Letter in response to Scoping Report 12 November 2021	• The IFI response noted multiple potential issues in relation to aquatic biodiversity and habitats, fish spawning and electrofishing etc. which have all been assessed in **Chapter 6: Biodiversity**. The following key points raised by IFI with relevance to this Chapter include the following: • *"Lough Corrib is renowned for its wild brown trout and salmon which ascend the tributaries of the catchment annually to spawn and utilise as nursery habitat. Prime water quality and instream habitat is key to salmonids completing this stage of their lifecycle. This is an extremely environmentally sensitive Site as the headwaters of the Owenwee River dissect the*	• The Site has been assessed in terms of being highly sensitive with hydraulic connectivity to Designated Sites which is outlined in **Section 9.3.16** and the high sensitivity classification is discussed in **Section 9.4.1**. Potential impacts on surface waters is assessed in **Section 9.4**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		middle of the proposed windfarm and also border the eastern boundary." • *"Particular attention should be paid to the hydrology of any Site where excavations including excavations for road construction are being undertaken."* • *"It is important that natural flow paths are not interrupted or diverted in such a manner as to give rise to erosion or instability of soils caused by an alteration in water movement either above or below ground."* • *"Attention should be paid to drainage during both the construction phase and the operational phase. This includes waters being pumped from foundations or other excavations. It is particularly important during the construction phase that sufficient retention time in the settlement pond is available to ensure no deleterious matter is discharged to any waters. We strongly recommend that settlement ponds are maintained, where appropriate, during the operational phase to allow for the adequate settlement of suspended solids and sediments and prevent any deleterious matter from discharging into any natural waters. In constructing and designing silt traps particular attention should be paid to rainfall levels and intensity. The silt traps should be designed to minimise the movement of silt especially during intense precipitation events where the trap maybe hydraulically overloaded. It is essential that they are located with good access to facilitate monitoring sampling and maintenance. A license to discharge to waters may be required from the local authority."* • *"We have serious concerns about the construction of roads as these will tend to provide preferential flow paths for surface waters. Considerable attention to detail must be provided in relation to the interception of surface water flows. Our concerns in relation to deleterious matter have been referred to above, but we also have concerns in relation to the flow patterns and to ensuring that normal flows are maintained both during and after construction. Situations can arise where water transportation is significantly increased in certain watercourses thereby putting additional pressures on watercourses and interfering with the sustained flow of water particularly during dry weather. This should be avoided."*	• Excavations for road construction and other excavations such at turbine locations are addressed in **Section 9.3.18.** • The retention of natural flow paths is addressed in **Section 9.3.18** and in the drainage design details outlined in the **Surface Water Management Plan** attached as **Appendix 2.1.** • An assessment of drainage during construction is contained in **Section 9.4.4.6** and an assessment of drainage during the operational phase is outlined in the drainage design details in the **Surface Water Management Plan** attached as **Appendix 2.1**. Detailed information of the proposed use of settlement ponds, and sediment fences is contained in the Construction Environmental Management Plan (CEMP). Due to the nature of the proposed development as a wind farm Site, a license to discharge to waters will not be required. • The interception of surface water flows from the proposed access roads is addressed in detail in the drainage design details outlined in the **Surface Water Management Plan** attached as **Appendix 2.1**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *"Furthermore, drainage from disturbed and stockpiled soils will have to be considered in advance. Consideration must be given to runoff/leachate from any stockpiles."* • *"Details relating to operations during the construction phase to contain pollutants should also be considered. It should be noted that cement leachate, hydrocarbon oils and other toxic poisonous materials will require full containment and should not be permitted to discharge to any waters. Please note that physical pollution of watercourses in terms of dumping of unsuitable gravel material or other construction debris in or stockpiling such materials near watercourses is not acceptable as this will interfere with the aquatic habitat."* • *"In relation to watercourse crossings please be advised that this IFI will require to be consulted well in advance in relation to all crossings of any watercourse or the use of any temporary diversions. We strongly recommend that these crossings should be kept to a minimum. We will also require that any instream structures or bridge crossings are approved by the Fisheries IFI. In particular in designing crossings the length, slope and width of any instream structure will be important. Clear span bridges are the preferred option for all crossings especially in upland areas."* • *"The EIS should indicate proposals to monitor the impact on all watercourses within the "development"."* • *"Variations in the topography that will give rise to point flows (keep flow as diffuse as possible)"* • *"In particular meticulous care should be paid to avoid interfering with the catchment and altering the direction of flow, perhaps to another catchment."* • *"Small streams in upland areas a distance of at least 15 meters should be considered as a bare minimum for a riparian zone. This should be more if the factors above are involved and will*	• Drainage and run-off from disturbed areas and stockpiles soils is addressed in **Sections 9.4.4.1 and 9.4.4.2.** • Mitigation measures to prevent potential impacts from pollutants is addressed in **Section 9.4.** • The construction of crossings is assessed in **Section 9.4.4.5** and the locations of proposed crossings have been mapped on **Figure 9.7** in **Volume III**. IFI will be further consulted at the detailed design stage so that the final structure of all required crossings is approved by IFI. Section 50 Consents Requirements for Construction/Alteration of a water course will be obtained. • The proposed monitoring programme of water quality is outlined in **Section 9.5.2.10**. • The variations in topography and associated flow paths are assessed in **Section 9.3.2** and in the drainage design details outlined in the **Surface Water Management Plan**. • The nature of the development is such that the interference with the catchment or other catchments is expected to be minimal and alteration of flow directions will not occur. • **Section 9.3.18** outlines how a self-imposed buffer zone of 50m between the proposed works and all watercourses will be implemented with the exception of where crossings are

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		require ground truthing and Site-specific survey." • *"We strongly recommend that discussions should take place with the Environmental Section of the relevant County Council with a view to obtaining a licence to discharge trade effluent from the "building Site" to waters. In this regard we consider that drainage waters particularly during the construction phase should be regarded as trade effluent. All effluent should comply with appropriate quality standards."* • *"Should works be approved a detailed method statement addressing the issues outlined above, including all mitigations measures, precautions and environmental incident procedures must be forwarded to Inland Fisheries Ireland before works commence."*	required. The 50m buffer zones have also been mapped on **Figure 9.8** in **Volume III.** • Direct discharges to surface waters of drainage water or any types of effluent will not be permitted, this policy will be enforced during the construction phase via the implementation of the CEMP. As a result, it is considered that the recommendation to seek a trade effluent discharge license does not apply to a development of this nature. This conclusion is further supported by the following statement by IFI "*The above comments and observations are generic and the specific requirements will vary with each application*." • A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. A copy of detailed method statements and a final CEMP will be provided to IFI prior to the commencement of any approved works.
National Parks and Wildlife Services (NPWS)	Letter in response to Scoping Report 19 November 2021	• "*In general, the EIAR should include sufficient project details so that the full nature and extent of the likely significant effects are clear and assessed fully in relation to, among other things, road design and construction methodology; Site drainage details, including settlement ponds."* • *"The proposed windfarm has the potential for significant changes in patterns of surface water flow and may desiccate the peat allowing pathways to open up resulting in subsurface water losses."* • *"A detailed Site drainage map will be required and should show all existing watercourses, drainage ditches, flushes, lakes or ponds; new drainage ditches; all outfall points to watercourses or lakes; and all settlement ponds."* • *"The likely impacts of grid connection on surface waters"*	• Full details on the nature of the development are outlined in **Section 9.1**. The nature and extent of the likely significant effects are described in **Section 9.4**. Site drainage details are addressed in the drainage design details outlined in the **Surface Water Management Plan**. • Changes to surface water flows will be managed by the drainage design which is outlined in the **Surface Water Management Plan**. • Detailed drainage and sensitive location maps have been prepared and are contained in **Figures 9.2, 9.3, 9.4, 9.5** and **9.7** in **Volume III.** • The likely impacts of the grid connection on surface waters has been assessed in **Section 9.4.4.10.**

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *"Flood plains, if present, should be identified in the EIAR and left undeveloped to allow for the protection of these valuable habitats and provide areas for flood water retention (green infrastructure). If applicable, the EIAR should take account of the guidelines for Planning Authorities entitled "The Planning System and Flood Risk Management" published by the Department of the Environment, Heritage and Local Government in November 2009."* • *The primary water course on Site is the Owenwee (Corrib) which has 'Good' WFD status and flows into the Lough Corrib Special Area of Conservation (SAC Site Code 004042) and Lough Corrib Special Protection Area (SPA Site Code 004042). There is potential for impact on the conservation objectives of these European Sites, particularly with respect to water-dependent species (SCIs and Qis) and wetland habitat (SCI). Consequently management of surface and sub-surface water, water tables and drainage carries an elevated risk with regard to this proposed development.*	• A comprehensive Flood Risk Identification has been completed in **Section 9.3.7** in accordance with *The Planning System and Flood Risk Management* (2009). Detailed food risk maps have been prepared and are presented in **Figures 9.11**, **9.12** and **9.13** in **Volume III.** • The potential for impacts on the conservation objectives is addressed in **Section 9.4.4.7**. Surface waters and associated sensitive receptors have been mapped and are presented in **Figure 9.5** in **Volume III.**

9.3 BASELINE DESCRIPTION

9.3.1 Introduction

Planning Permission is being sought by the Developer for the construction of 6 wind turbines, permanent met mast, on-site 38kV substation and all ancillary works.

The Project will comprise of the following main components:

- Erection of 6 no. 6.82MW wind turbines with an overall ground to blade tip height of 185m. The candidate wind turbine will have a rotor diameter of 162m and a hub height of 104m
- Construction of site access roads, crane hardstand areas and turbine foundations.
- Improvement of existing site entrance with access onto the N59
- Construction of one no. temporary construction compound with associated temporary site offices, parking areas and security fencing
- Installation of 1 no. permanent meteorological mast with a height of 104m
- Construction of new internal site access tracks and upgrade of existing Site track, to include all associated drainage
- Development of a site drainage network
- Construction of one no. permanent 38kV substation

- All associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation
- All works associated with the connection of the wind farm to the national electricity grid, which will be via 38kV underground cable connection approximately 18.65km in length to the existing ESB Screebe 110kV GIS Substation
- Biodiversity enhancement measures
- Marked walking and cycling trails along the site access roads, and associated recreation and amenity signage
- Works at 4 no. locations along the proposed turbine delivery haul route from Galway Port.

9.3.1 Site Description

The proposed wind farm Development is located near the townland of Tullaghmore, approximately 9 kilometres west of Oughterard in County Galway. The Site is located across land which is predominantly Atlantic blanket bog and mountain blanket bog (>200m in altitude) situated to the west of the Derroura Forest which is managed by Coilte. To the south of the Site is the N59 Road, Lough Bofin and the Connemara Bog Complex Special Area of Conservation (SAC). North of the Site there are additional areas of blanket bog, forestry, Curraun Lough, the Western Way long-distance walking trail and the Lough Corrib SAC. To the west/south-west of the Site flows the Owenwee River, Loughaunierin and Tawnaghbeg Lough.

The Site contains a number of small streams all of which are headwaters of the Owenwee and Owenree Rivers, the latter of which ultimately flows into Lough Corrib Upper to the north of the Site. There are no lakes located within the Site boundary where the predominant land use is agricultural grazing land for both sheep and cattle. The land within the Site boundary has also been utilised for peat extractions purposes. There are no dwellings located within the Site boundary which is characteristic of the wider rural setting. The Site is serviced by a pre-existing access road off the N59 road to along the southern Site boundary and adjacent to the Owenwee River.

The main Site extends to 161.88 hectares (ha), the majority of which is bogland used for grazing sheep and is in the ownership of three local landowners. The area designated for spoil storage and enhancement extends to 29.86ha. Therefore, the total site area is 191.74ha.

9.3.2 Topography

The topography of the Site is variable, and it is broadly surrounded by or is partially overlapping three elevated areas. These include Knockbrack to the east of the Site (299m OD (metres above Ordnance Datum)) near Lough Beg in the Derroura Forest and Cappanalaurabaun (273m OD) at the northern extent of the proposed Site. Further north beyond the Site boundary is Curraun Hill at 252m OD. The southern and western extents of the proposed Site are low lying areas ranging from 50 – 60m OD. The topography beyond the southern and western extent of the Site is characterised by low lying surface water features such as the Owenwee River, Owenree River, Lough Bofin, Loughanaduff, Loughaunierin and Tawnaghbeg Lough. The N59 road which traverses the proposed southern Site boundary is also generally low lying.

The Site is generally topographically elevated in the north / north-west and generally topographically low lying in the south and east. The steepest incline across the Site occurs at the north-western extent of the Site near the proposed T4 position. A peat stability risk assessment (PSRA) and a chapter on Lands, Soils and Geology (**Chapter 8**) have been prepared to address the potential risks associated with the positioning of project infrastructure and potential peat failures. Elevations typically range from between 100m and 200m OD across the majority of the Site with areas of relatively flat ground existing within the central areas of the Site between elevations of 110m – 150m OD. Elevation contours are included within a 3-D hydrological flow map outlined in **Figure 9.6** in **Volume III**. The proposed spoil storage area located approximately 3.4km to the west of the main site is located on relatively flat low-lying peatland at approximately 43m OD.

9.3.3 Rainfall and Evapotranspiration

Long term rainfall and evaporation data for the study area were sourced from Éireann. The World Meteorological Organisation (WMO) recommends that climate averages are computed over a 30 year period of consecutive records. This is the same frequency adopted by Met Éireann who reference the period from 1981 to 2010 (inclusive) as the baseline 30-year period for the calculation of long term averages. The closest weather station where 30-year rainfall data is available is at Cloosh Weather Station, Co. Galway, approximately 14km to the south-east of the Site. Cloosh Weather Station is located at an altitude of 101m. However, much of the Site is located on ground typically ranging from 100 – 200m in elevation. The Cloosh weather station data is therefore not considered to be an accurate reflection of the likely rainfall estimates for the Site since rainfall propensity generally increases with increasing altitude.

Met Éireann has published computer modelled "1981-2010 Rainfall Grids" estimates of monthly, seasonal and average rainfall totals (mm) with grid references for every 1 kilometre square grid in Ireland. Methods for estimating monthly rainfall amounts and temperatures for Ireland on a 1km grid were developed using point based data from approximately 500 rainfall stations and from over 80 temperature stations. The number of stations varies each year, as stations open and close. The interpolation techniques weight the surrounding measured values to derive estimates for unmeasured locations. The modelled rainfall estimates have been developed with cognisance to "*A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14, Met Éireann, Walsh S., 2012"*. Using this methodology for calculating water balance calculations is considered to be more accurate than sourcing rainfall data from the closest weather station to the Site which may not be as closely representative of the site-specific conditions. The Met Éireann 1 kilometre square grid rainfall estimate has been applied to the centre of the Site, east of the proposed T5 turbine location. A total average of 1872mm rainfall per year is estimated to occur at this location which is taken to be the best available site specific rainfall estimate for the Site and full details of this rainfall estimate are outlined in **Table 9.8**.

Table 9.8: Site Specific Average Rainfall Estimate Based on Met Éireann 1km Square Grid Modelling

1km Grid Rainfall Estimate Position (Irish National Grid)								Point Altitude Estimate		Distance from Closest Turbine		
East				North								
103000				247000				135m		428m East of T5		
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
196	143	160	109	116	116	114	159	151	206	195	208	**1872**

The closest synoptic weather station where the average potential evapotranspiration (PE) is recorded is at Mace Head, County Galway, approximately 33km south-west of the Site. However, the closet synoptic weather station where long-term-average (LTA) PE data is available is at Belmullet weather station, Co. Mayo, approximately 92km north-west of the Site. The LTA data covers a continuous 30 year period from 1981 to 2010 (inclusive) which is not available for closer synoptic weather stations such as at Mace Head, Claremorris or Athenry. The long-term average annual PE for Belmullet Weather station is 508.9mm/yr and is outlined in **Table 9.9**. This value is taken to be the best available long-term average estimate of the Site PE in the absence of long-term-average PE data being available at other weather stations closer to the Site.

Table 9.9: Potential Evapotranspiration Data (mm) for Belmullet Weather Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2021	12.4	23.9	33.2	61.5	77.4	67.7	84.1	68.0	41.1	29.3	21.9	15.0	535.5
2020	23.6	27.7	39.1	63.1	85.5	69.6	66.5	67.4	43.4	32.2	18.3	18.4	554.8
2019	16.0	23.3	39.4	58.7	78.0	79.3	76.7	68.1	45.5	33.4	16.5	18.6	553.5
2018	16.8	24.4	35.7	49.5	75.7	92.5	80.8	58.1	43.4	32.2	20.6	15.7	545.4
LTA	17.8	23.2	33.7	51.7	69.4	74.2	70.3	61.0	45.5	28.8	18.3	15.0	508.9

https://www.met.ie/climate/available-data/monthly-data

The longterm average PE for Belmullet Weather station is 508.9 mm/yr and the Actual Evapotranspiration (AE) at the Site is dependent upon the drainage of the soil. AE is limited by the amount of moisture available in the soil. Estimates of AE are derived from calculated values of PE and soil moisture deficits (SMD). Annual AE is estimated as 95% of PE to allow for seasonal moisture deficits (Hunter-Williams et al, 2013). Therefore, actual evapotranspiration at the Site is calculated to be 483.4 mm/yr which is 95% PE. The Effective Rainfall (ER) represents the water available for runoff and groundwater recharge and the annual ER for the Site is calculated via the following equation:

Effective Rainfall = Annualised Average Rainfall – Actual Evapotranspiration

1872 mm/yr – 483.4 mm/yr = 1388.5 mm/yr

It is noted that the GSI National Groundwater Recharge Map provides an alternative computer modelled method for estimating effective rainfall at any point in Ireland. The GSI Map Viewer modelling estimates effective rainfall across Ireland with a result of 1396.8 mm/yr estimated for the majority of the Site. The GSI map viewer modelled estimate for effective rainfall is only 8.3 mm/yr greater than the result from the methodology applied above which is a difference of less than 1% between the two methodologies.

According to the GSI National Groundwater Recharge Map, various recharge coefficient (RC) estimate ranges exist for the Site, including 4%, 10%, 22.5%, 60% and 85%. Peat has been chosen as the dominant hydrogeological setting and various aquifer vulnerabilities exist across the Site (i.e. moderate, high, extreme and bedrock at or near the surface). Areas of extreme aquifer vulnerability may have slightly higher recharge rates than other areas. However, at the Site, these areas are predominantly located on slopes with very poor natural drainage. A low value in the estimated GSI range of 10% has therefore been chosen to reflect the poorly draining soil types and dominant coverage of peat. The relatively high stream density and the presence of flushes and bog pools at the Site also suggests that recharge rates are comparatively low. Annual recharge and runoff rates for the Site are estimated to be 139 mm/year (10% of ER) and 1250mm/year respectively. The baseline hydrology of the Site can therefore be characterised as having a very flashy network of streams/rivers and by high surface water runoff rates. Evidence of the high surface water run off rates were visually observed during a heavy rainfall event at the Site on 6th October 2021.

Plate 9.1 when a temporary ephemeral flow path rapidly appeared as a result of high water saturation levels in the peat.

Plate 9.1: High Surface Water Run Off Rates Observed at the Site

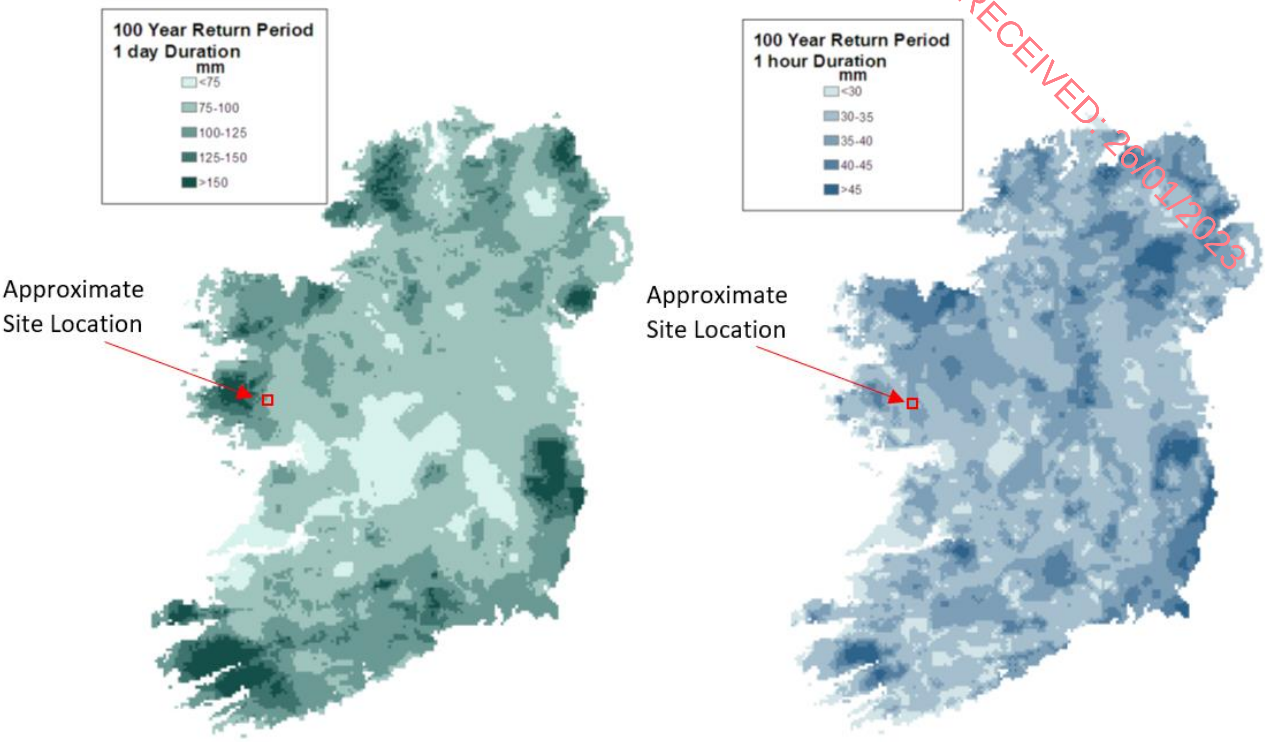
Met Éireann have undertaken a study for the Office of Public Works (OPW) through the Flood Studies Update (FSU) which provides a depth duration frequency (DFF) model. The model allows for the estimation of point rainfall frequencies across a range of durations for any location in Ireland to be predicted. The model consists of an index (median) rainfall and a log-logistic growth curve which provides a multiplier of the index rainfall. The modelling allows for the drainage system at the Site to be designed with the capacity of accommodating a rainfall event likely to be exceeded only once in a specified number of years (i.e. a return period). The proposed drainage system at the Site will be designed with the capacity to accommodate a 1 in 100-year 6-hour return period rainfall event. The modelling provides an estimation of rainfall depths at the centre of the Site for multiple storm frequency durations which are outlined in **Table 9.10**.

Table 9.10: Storm Duration and Return Period Rainfall Depths (mm) at the Site

Duration (Mins/ Hours/ Days)	Return Period Near the Centre of the Site (Irish Grid)						
	Easting: 104000			Northing: 247000			
	5 Years	10 Years	20 Years	30 Years	50 Years	75 Years	100 Years
5 mins	6.4	7.5	8.8	9.6	10.7	11.7	12.5
10 mins	8.9	10.5	12.3	13.4	15.0	16.3	17.3
15 mins	10.4	12.3	14.4	15.8	17.6	19.2	20.4
30 mins	14.0	16.5	19.1	20.8	23.1	25.1	26.6
1 hours	18.8	22.0	25.4	27.5	30.4	32.9	34.8
2 hours	25.3	29.3	33.6	36.3	39.9	43.0	45.4
3 hours	30.1	34.7	39.6	42.7	46.8	50.4	53.0
4 hours	34.0	39.2	44.6	47.9	52.5	56.3	59.3
6 hours	40.5	46.4	52.6	56.4	61.6	66.0	69.3
9 hours	48.2	54.9	62.0	66.4	72.3	77.3	81.0
12 hours	54.5	61.9	69.7	74.5	81.0	86.4	90.5
18 hours	64.8	73.4	82.2	87.7	95.0	101.2	105.8
24 hours	73.4	82.8	92.5	98.5	106.5	113.2	118.2
2 days	91.9	102.5	113.3	119.9	128.7	136.0	141.4
3 days	108.1	119.7	131.5	138.7	148.2	156.1	161.9
4 days	123.0	135.5	148.3	156.0	166.1	174.5	180.7

Site specific rainfall modelling data shown in **Table 9.8** indicates that the Site could potentially receive approximately 208mm/month of rainfall during the average wettest month (December), or approximately an average of 6.7mm of rainfall per day during the wettest month. For extreme weather events, or worst case scenarios, data from the FSU which is outlined in **Table 9.10**, indicates that the Site could potentially receive 118.2mm of rainfall per day, and potentially 34.8mm of rainfall per hour during a 100-year return period (or a 1 in 100 year storm event). The FSU modelling outlined in **Table 9.9** is consistent with the generalised graphic modelling shown in **Figure 9.2** which indicates that between 100 - 125mm of rainfall per day, and potentially between 35 - 40mm of rainfall per hour could be received by the Site during a 100-year return period.

Figure 9.2: One in a 100 Year Rainfall Events – Extreme Storm Events (Fitzgerald, D.L., 2007)



9.3.4 Regional and Local Hydrology

This section describes the available desktop information on the local and regional surface water hydrological environment. The European Communities Directive 2000/60/EC established a framework for community action in the field of water policy known as the Water Framework Directive (WFD). Ireland has published the draft River Basin Management Plan (2022-2027) which defines the actions that will be taken to improve water quality and achieve "good" ecological status in rivers, lakes, estuaries and coastal waters by 2027. The WFD is the overarching mechanism by which water quality management areas are divided and assessed. This section identifies the geographical distribution of WFD management areas and provides an assessment of the available water quality information relative to the proposed Site.

The proposed wind farm Site, spoil storage area and current grid connection route are located within the Corrib and Galway Bay North catchment areas in Hydrometric Area 30 and 31 respectively. The proposed wind farm Development and grid connection to Screebe are located within four WFD sub-catchments. These include the Corrib, Joyce's and Furnace subcatchments with a small section of the EIAR boundary overlapping into the Ballycuirke Lough Stream sub catchment. The Ballycuirke Lough Stream sub-catchment is listed as a Margaritifera Sensitive Area in accordance with Annex II and Annex V of the EU Habitats Directive. All of the proposed wind farm Development and grid connection options are located within the National River Basin District (RBD) as defined by the 3rd Cycle of the WFD (2022 - 2027). Figures illustrating the catchment and subcatchments areas relative to the proposed Site and grid connection are illustrated in **Volume III.**

The proposed Site and its surrounds are located upstream of Lough Corrib Upper which is located approximately 850m from the Site boundary at the closest extent near the proposed T3 turbine position. The Site has indirect hydraulic connectivity to Lough Corrib Upper via the headwaters of the Owenwee and Owenree Rivers which drain the site. Lough Corrib is the second largest lake in Ireland in terms of area (176 km^2) and is designated as the Lough Corrib SAC. The western portion of the Site is primarily hydraulically characterised by a number of unnamed rivers and streams that are headwaters of the Owenree River which ultimately discharges into Lough Corrib Upper.

The Owenwee River has an overall catchment area of 23.3km^2 and rises near the north-western portion of the Site to the east of the Derroura Forest. The Owenwee River flows in a south-westward direction before turning north-westward at Shannakinloughra and discharging into Tawnaghbeg Lough which in turn is also drained by the Owenree River. Tawnaghbeg Lough is located approximately 200m to the north-east of the larger Loughaunierin, Tawnaghbeg Lough is located approximately 400m west of the EIAR boundary. The proposed Site is not hydraulically connected to Loughaunierin via any of its rivers or streams although it is indirectly hydraulically connected to Tawnaghbeg Lough via the headwaters of the Owenwee River which drains the eastern and southern parts of the Site. Tawnaghbeg Lough measures 0.07km^2 in area and has a mean water level of 28mOD. Loughaunierin is situated approximately 1 kilometre west of the planning boundary and is designated as an area for action in the National River Basin Management Plan 2018 – 2021.

Tawnaghbeg Lough is drained by the Owenree River which continues northwards joining with an unnamed stream which drains the western extent of the Site. Further downstream along the Owenree River is a confluence with the Folore River, which includes Loughanillaun and Maumwee Lough in its catchment. Approximately 400m downstream of the confluence between the Owenree and Folore Rivers, the Owenwee River then outfalls into Lough Corrib.

A smaller unnamed lake is located adjacent to the north-western EIAR boundary, approximately 430m from the closest turbine position which is T4. Drainage mapping carried out in this area of the site did not indicate the presence of preferential flow paths from the T4 position to the unnamed lake located beyond the north-western EIAR boundary. Drainage from the proposed T4 position instead flows down a relatively steep slope to a pre-existing artificial drainage network which drains the western areas of the Site boundary. The hydrological flow paths from all turbine and handstand areas have been mapped in a 3-D hydrological flow model which is presented in **Figure 9.6** in **Volume III**.

Approximately 1.5km east of the planning boundary on the eastern side of Knockback (299 m) is the Letterfore River to which the site is not hydraulically connected. The Letterfore River continues to flow in a south-westerly direction before discharging into Lough Bofin which is located near the southern EIAR boundary. An unnamed stream which discharges from a small unnamed lake in the Derroura Forest is located approximately 225m south-east of the proposed EIAR boundary. This unnamed stream discharges into the northern extent of Lough Bofin. The primary discharge from Lough Bofin is at its southern extent via the Corrasillagh River into Lough Adrehid which then flows into Lough Agraffard. The discharge from Lough Agraffard is the Owenriff River which has a catchment area of 67.4km^2 and ultimately drains into Lough Corrib east of Oughterard. The proposed Site is not hydraulically connected to the Letterfore River, the aforementioned unnamed streams or lakes in the Derroura Forest, Lough Boffin, Corrasillagh River, Lough Adrehid nor the Owenriff River.

Beyond the north-eastern extent of the EIAR boundary exists a series of unnamed rivers, some of which merge before flowing directly into Lough Corrib Upper. Approximately 400m and 600m north of the proposed T3 turbine position, two separate unnamed rivers rise and flow in a northerly direction before discharging into Lough Corrib Upper. Approximately 400m to the northeast of the EIAR boundary an additional unnamed stream rises and flows north eastward until it intercepts another unnamed river discharging in an easterly direction from Curraun Lough. Curran Lough is a small body of water north of the Derroura Forest near the base of Curraun Hill (252 m). These combined rivers continue to flow northward until they are intercepted by another unnamed river which merge to flow in a north-easterly direction into Lough Corrib Upper. The south, south-west and south-easterly sloping topography at the site, in addition to the absence of streams or drains near the T3 position infers that the site is not hydraulically connected to the abovementioned water bodies located to the north of the EIAR boundary.

In addition to the named and unnamed rivers, streams and lakes discussed above, there are also numerous natural and artificial drainage ditches located within the proposed Site and its surrounds, examples of these are shown in **Plate 9.2**, **Plate 9.3** and **Appendix 9.1**. These channels facilitate the natural flow of surface water runoff into the streams, rivers and lakes downstream of the Site and have been mapped and presented in **Figure 9.3 in Volume III**. Within the Site EIAR boundary and further west, the blanket bog drainage channels generally flow in a south-westerly direction to merge with unnamed rivers that are headwaters of the Owenwee and Owenree Rivers. The forestry drainage network to the east is also largely influenced by the gradient and topography in the forest. The forestry plantation structure, location of firebreaks and subsoils also have a bearing on the forestry drainage network. The forestry drainage network is the main drainage vector for the hydraulic movement of water from the forest to the surrounding natural waterbodies with the Owenwee River being the major receiving water of the forestry drainage network. Pre-existing artificial drainage networks also exist within the Derroura Forest although pre-existing artificial drainage features are largely absent from the eastern extent of the site.

The proposed spoil storage area is located approximately 3.4km west of the main site and is divided into a northern and southern section. The proposed spoil storage areas are located on low lying areas of peatland containing both natural and artificial drainage ditches. To the north of the spoil storage area is Loughanillaun, which is approximately 67 hectares in area and contains multiple small islands. Loughanillaun is classified as having "*Good"* water quality under the current cycle of the WFD. Loughanillaun receives flows from the draining of multiple lakes including Maumwee Lough to the north, Lake at Shannagrena and Lough Nambrackboy both located to the east of Loughanillaun. Loughanillaun also receives flows from two small unnamed streams which intersect the northern spoil storage area. Loughanillaun is drained by the Folore River which flows in a south-easterly direction until it discharges into Lough Corrib Upper.

The proposed southern spoil storage area is located north of Ardderry Lough which is approximately 81 hectares in area and is also classified as having "*Good*" water quality under the current cycle of the WFD. Lough Shindilla, located east of Ardderry Lough, discharges via Lurgan Bridge into Ardderry Lough Lower. Ardderry Lough is divided by the R336 near Maam Cross into the lower and upper lough. Two small lakes drain into the upper lough via the N59 road, including Lurgan Lough and Ardderry Pond. Lough Ardderry Lower drains into the Screebe River which in turn flows through Lough Nahasleam, Loughaunfree and Lough Aughawoolia and into the tidal Loughahalia North and South lakes before ultimately discharging to Camus Bay at Screebe Bridge.

Appendix 2.2 contains the Grid Connection Study which confirms that the chosen gird connection route will traverse 19 existing bridge or watercourse culvert crossings with horizontal direction drilling (HDD) being required at five existing bridge locations. Two existing watercourse crossings, one culvert draining a small unnamed stream to the Owenwee River and one bridge across the Owenwee River, on the existing access track will be upgraded on the Site to allow heavy goods vehicles (HGVs) to safely cross over them. Two additional new watercourse crossings over unnamed headwaters of the Owenree River, both in the form of 4m wide bottomless culverts, will also be required for the construction of the access roads to turbine numbers T4 and T5. This will bring the total number of watercourse crossings required for the grid connection and the main site to 21. The design of the proposed bridge upgrade and the proposed culverts are shown on **Figures 2.6 (a), (b), (c)** and **(d**) respectively in **Volume III**.

The locations of all 21 watercourse crossings, both pre-existing and proposed, are outlined in **Figure 9.7** in **Volume III**. The locations of the five bridges where HDD will be required along the grid connection route are outlined on **Figure 9.9** in **Volume III**. With the exception of the five HDD bridge crossing locations, the grid connection route will be constructed via trenching adjacent to the public roadway in its entirety. The 21 water crossings at the main site and along the grid connection route includes 17 rivers or small streams and 4 lakes. The type of crossing and the approximate centre point coordinates for each crossing along the grid connection route is outlined in **Table 9.11.**

Table 9.11: Grid Connection Watercourse Crossings and Coordinates

Crossing Number	Crossing Type	Proposed Works	Approximate Centre Coordinates of Crossings (Irish National Grid)	
			Easting	Northing
1	River	New Culvert	102218	247244
2	River	New Culvert	102667	246979
3	River	New Culvert	102963	245451
4	River	Existing Bridge Upgrade	102563	245219
5	River	No Change	101216	245541
6	River	No Change	100312	245866
7	Lake	No Change	98554	246026
8	Lake	No Change	98395	246067
9	River	No Change	97616	246058
10	River	No Change	97498	245706
11	Lake	No Change	97460	244358
12	River	No Change	97472	244141
13	River	No Change	97436	243437
14	River	No Change	97091	242367
15	River	No Change	97324	242086
16	River	No Change	97727	241235
17	River	No Change	97602	241006
18	River	No Change	97358	240147
19	River	No Change	97193	238916
20	Lake	No Change	95887	238206
21	River	No Change	95113	238256

9.3.2 Wind Farm Site Drainage

Plate 9.2: Example of Natural Drainage Channels at the Site

Plate 9.3: Example of Right-Angle Artificial Drainage Channels at the Site

9.3.5 Water Balance Assessment

A water balance assessment has been carried out for the Site which is outlined in **Table 9.12**. The water balance assessment utilises site specific rainfall estimates for the highest average monthly rainfall (December) at the Site. Combined with long-term potential evapotranspiration (PE) data, GSI recharge coefficient estimates, associated runoff estimates, and Site area(m^2) input variables; the assessment provides an estimate of the average volume of surface water expected to occur during the average December period. The water balance assessment is carried out for the estimated baseline runoff conditions and the estimated post Development conditions at the Site. A comparison is made between these two results to predict the estimated changes that the development will have on surface water runoff rates at the Site during the average wettest month of the year.

The Met Éireann 1981-2010 one km^2 grid estimates provide modelled average rainfall totals near the centre of the site as is outlined in **Table 9.8** with a result of 208mm estimated for the average December month. The minimum December potential evapotranspiration during the same period of 1981-2010 at Belmullet Weather Station occurred in December 2010 at 5.1mm PE, this has been adopted as a conservative estimate for PE. A range of GSI recharge coefficient and runoff estimates exist for the site with 10% and 90% respectively being adopted as site wide averages. The water balance assessment conservatively estimates that the volume of surface water runoff at the Site during the average wettest month would be 295,981 m^3/month or 9,548 m^3/month day. For the post development runoff scenario, the water balance assessment conservatively assumes that all hardstand areas and access roads would be fully impermeable. This is most unlikely to be the case in reality and can be considered as a worst-case scenario. Assuming fully impermeable road and hardstand surfaces are in place as a worst-case scenario, the surface water runoff at the site is estimated to increase by 0.38% when compared to the pre-Development baseline runoff rates which is considered to be a negligible increase in terms of potential downstream impacts.

9.3.6 Assessment of Changes in Site Run-off Volumes

Table 9.12: Preliminary Water Balance Analysis

Variable	Data Description	Site Assessment	Units
Average Wettest Month (December) Estimated Water Balance			
Site Specific Average Wettest Monthly Rainfall Total (R)	Met Éireann 1981-2010 1 km² Grid Estimates of Wettest Monthly Average Rainfall Totals (December)(R)	208	mm
December Minimum Potential Evapotranspiration (PE)	Belmullet 30 Year December Minimum (1981-2010) (December 2010)	5.1	mm
Minimum December Actual Evapotranspiration (AE = PE x 0.95)	AE = PE*0.95	4.84	mm
Max Effective Rainfall (December) (ER = R - AE)	R - AE	203	mm
Range of GSI Recharge Coefficient Estimates (RC) for the Site (4%, 10%, 22.5%, 60% and 85%)	A low value in the estimated GSI ranges (10%) has been adopted as a side wide average to reflect the poorly draining soil types and dominant coverage of peat.	10	%
Estimated Recharge Coefficient	10% of ER	20.3	mm
Estimated Runoff	90% of ER	182.8	mm
Average Wettest Month (December) Runoff Estimates			
Site Area	EIAR Chapter 2 Description of Development	1,618,800	m²
Baseline Wettest Month Monthly Runoff	Estimated Average Monthly Baseline Runoff During Wettest Month	295,981	m³/month
Baseline Wettest Month Daily Runoff	Estimated Average Daily Baseline Runoff During Wettest Month	9,548	m³/day
Estimated Changes to Baseline Runoff Post Development During the Average Wettest Month			
Hardstand Development Area (DA)	EIAR Chapter 2 Description of Development	54,965	m²
100% Runoff Scenario from Hardstand Area	DA*ER/1000	11,166	m³
90% Runoff Scenario from Hardstand Area	DA*(ER*0.9)/1000	10,050	m³
Net Monthly Runoff Increase	Estimated Monthly Runoff Increase Versus Baseline Conditions	1,117	m³/month
Net Daily Runoff Increase	Estimated Daily Runoff Increase Versus Baseline Conditions	36	m³/day
Percentage Runoff Increase	Percentage Runoff Increase Compared to Baseline Conditions	0.38	%

9.3.7 Flood Risk Identification

Flood risk identification is the first stage in a flood risk assessment (FRA) process that is required to be carried out for proposed developments in accordance with The Planning System and Flood Risk Management - Guidelines for Planning Authorities (DHPLG/OPW, 2009).

The scope of this flood risk identification includes both the proposed wind farm Site and the proposed grid connection route. Flood risk identification was conducted in order to assess the potential flood risks posed to the Development and to downstream receptors. A review of historic flooding within the study area has been undertaken. Multiples sources were consulted to identify the areas being potentially at risk of flooding, including the following:

- Catchments.ie (www.catchments.ie)
- Office of Public Works (OPW) Catchment Flood Risk Assessment and Management (CFRAM)
- National Flood Hazard Mapping (www.floodmaps.ie)
- Department of Environment, Community and Local Government on-line planning mapping (www.myplan.ie)
- The Planning System and Flood Risk Management - Guidelines for Planning Authorities (DHPLG/OPW, 2009)
- Ordnance Survey Ireland, Map Viewer http://map.geohive.ie/mapviewer.html

The OPW's interactive flood maps and Catchment Flood Risk Assessment and Management (CFRAM) are currently the main source of reference for flood risk identification in Ireland. The interactive maps are indicative flood risk maps and the interactive National Indicative Fluvial Mapping (NIFM) supersede the Preliminary Flood Risk Assessment (PFRA) maps. The Past Flood Events dataset has been reviewed on the OPW's website at www.floodinfo.ie. This dataset includes records of all available flood events held by the OPW, local authorities and other national organisations such as the EPA, Teagasc and the Department of Communications, Climate Action and Environment (DCCAE). No historical single or recurring flood events have been recorded within the EIAR Site boundary. Four recurring flood events have been recorded along the existing roadway which the proposed grid connection will traverse. Details of these recurring flood events is outlined in **Table 9.13** and their locations relative to the proposed Site and grid connection route are also mapped on **Figure 9.11** in **Volume III**. Two additional recurring flood events have also been recorded more than 3km upstream and east of the proposed southern Site boundary to the west of Lough Adrehid adjacent to the Owenriff River near Derryerglinna.

The closest mapped flood event to the Site is a recurring flood event at Bunnakill, approximately 290m west of the southern EIAR Boundary along the N59 road and down gradient of the proposed Site. This recurring flood event occurs approximately 1.4km south-west of the closest proposed turbine position (T6). This recurring flooding occurs as a result of low-lying land in the area with the road liable to flood after heavy rain and it is therefore a recurring pluvial (rainfall) flood event. Rainfall run-off from the proposed development will be captured for attenuation in the Sites designed drainage system, which will include settlement ponds that will be designed for a 1 in 200-year 30-minute return period rainfall event. The settlement ponds will be strategically located at turbine bases and/or hardstand areas which will facilitate the treatment of run-off water through the settling out of sediments before eventual discharge to the existing bog drainage environment.

The proposed drainage system will result in increased attenuation of rainwater during heavy rainfall events prior to ultimately being discharged to the surrounding bog environment for natural recharge. Natural recharge will occur via seepage to groundwater, diverted to topographically low points such as drains via the undulating topography across the 1.4km distance or absorbed by the extensive vegetation. The proposed Development will therefore not exacerbate the pre-existing and recurring pluvial flood event due to an absence of direct pathways between the Site and the identified recurring flood event locations.

Three other recurring floods have been recorded along the proposed grid connection route. The proposed route would consist of trenching for underground cables which will be restored with like-for-like surfaces in addition to HDD at 5 bridge crossing locations. Any trenching works which will be carried out will be temporary in nature with no additional hardstand being proposed. As a result, runoff characteristics will be effectively unchanged when compared to the existing surfaces along the proposed route. The proposed grid connection route will therefore not change flood risk potential upstream or downstream of the proposed grid connection.

Table 9.13: Recurring Floods Recorded Along the Proposed Grid Connection Route.

Flood ID	Flood Location Description	Flood Type	Flood Source	Distance to Project Location
2049	N59 Road at Bunnakill	Recurring	Low Lying Land	190m west of the EIAR boundary along the N59 road.
1787	Near Quarry, Screebe, Maam Cross	Recurring	River	4.8km south-west of the EIAR boundary and along the R336 Road which the grid connection will traverse.
1800	Screebe, Near Quarry	Recurring	River	5.2km south-west of the EIAR boundary and along the R336 Road which the grid connection will traverse.

Flood ID	Flood Location Description	Flood Type	Flood Source	Distance to Project Location
1782	R340 near lodge	Recurring	Coastal/Estuarine Waters	9.3km south-west of the EIAR boundary and along the R336 Road which the grid connection will traverse.
2047	Owenriff Leam 1	Recurring	River	3.6km east of EIAR boundary and west of Lough Adrehid along the Owenriff River.
2048	Owenriff Leam 2	Recurring	River	3.2km east of EIAR boundary and west of Lough Adrehid along the Owenriff River.

The NIFM interactive maps have also been consulted with reference to fluvial (rivers and streams) flooding for both current day and future case scenarios. The medium and low probability present day scenarios relate to an annual exceedance probability (AEP) of 1% and 0.1% respectively. The medium and low probability present day scenarios reflect the odds of a theoretical extreme flood event occurring in a given year being 1:100 and 1:1000 respectively. There are no 1% or 0.1% AEP fluvial flood events predicted within the Site boundary for the present-day scenario. A possible 1% AEP fluvial flood event is mapped downstream of the Site adjacent to the Owenwee River east of Loughaunierin for the low probability present day scenario. However, the extent of the river which forms part of the eastern Site boundary is not predicted to flood in a 1% nor a 0.1% AEP present day scenario fluvial flood event. Given that the proposed drainage system outlined in the **Surface Water Management Plan** attached to **Appendix 2.1.** will result in increased attenuation of rainwater during heavy rainfall events, the potential risk of exacerbating a theoretical 1% or 0.1% AEP fluvial flood downstream of the proposed Site is expected to be negligible.

In an assessment of potential future flooding impacts on the proposed Development, the NIFM's "*High-End Future Scenario*" which models a 30% increase in rainfall resulting from climate change has been adopted as precautionary approach. The medium probability scenarios (AEP of 1%) has been reviewed at the Site for additional conservatism. There are no 1% AEP extreme fluvial flood events modelled within the Site boundary for the high-end future scenario. Similar to the modelled present-day scenario, stretches of the Owenwee River downstream of the Site east of Loughaunierin are predicted to flood during the medium probability high end future scenario flood events. The predicted extent of this High-End Future Scenario has been mapped on Figure 9.12 in Volume III.

The extent of the Owenwee River which makes up the eastern Site boundary is not predicted to flood during either of the high-end future scenario flood events. Similar to the current day scenario, the proposed drainage system outlined in the **Surface Water Management Plan** attached as **Appendix 2.1** will result in increased attenuation of rainwater during heavy rainfall events. Surface water runoff from the developed areas of the

Site will be directed to a stormwater drainage system designed in accordance with the principles of Sustainable Drainage Systems (SuDS). The management of surface water runoff will limit discharge from the Site to greenfield runoff rates. The potential risk of exacerbating theoretical downstream high end future scenario fluvial flood events is therefore expected to be negligible.

The Geological Survey of Ireland (GSI) groundwater flooding probability maps were also reviewed at https://www.floodinfo.ie/map/floodmaps/. There are no low, medium or high probability instances of groundwater flooding predicted to occur at the proposed Site or along the proposed grid connection route. The closest area to the Site which is mapped for potential groundwater flooding impacts is located approximately 17km to the east of the Site near Carrowmoreknock, County Galway. Ordnance Survey Ireland's (OSI's) National Townland and Historical 6 and 25 inch maps were also consulted for potential evidence of historical references to flooding at the Site. These historical maps do not provide any references to lands within or adjacent to the Site boundary being prone to flooding.

The OPW's database on Arterial Drainage Schemes (ADS) benefiting areas associated with the schemes constructed under the Arterial Drainage Acts 1945 & 1995 was also reviewed. The benefited lands database identifies land that was drained as part of the Arterial Drainage Schemes, which typically was performed to improve land for agricultural purposes. The benefitting lands database can be indicative of land that has historically been subject to flooding or which had poor drainage. There are no mapped OPW benefited lands located within the proposed Site boundary or along the proposed grid connection route. The closest mapped benefited lands to the proposed Site is located near Derryherbert close to where the Owenree River flows into Lough Corrib Upper. Drainage from the Site is not predicated to have any influence on the benefitted lands at this downstream location due to the absence of proximity to the Site and the attenuation of water during periods of heavy rainfall which is incorporated into the drainage design contained in the **Surface Water Management Plan** attached as **Appendix 2.1**.

In addition to the proposed drainage design, a fundamental component of the Sites flood mitigation strategy will be achieved via mitigation through avoidance. All proposed design elements such as access roads, turbine locations, construction compound, substation, met mast etc. will all be positioned a minimum distance of 50m away from the Site's rivers and streams wherever possible. The pre-existing Site access road which would be utilised to facilitate the construction phase is located north of the N59 road and is currently positioned adjacent to the Owenwee River. The Site access road will have only limited use during the operational phase due to the nature of the proposed Development. The Owenwee River is generally located at the lowest elevation across the Site and it is not predicted to flood during any of the current or future scenario extreme fluvial flood events. No significant risk of flooding has been identified within the project area due to the elevated nature of the Site relative to the surrounding area.

The flood risk identification has not identified any flood risk at the Site and the potential for exacerbating existing recurring flood events along the grid connection route is considered to be negligible. The drainage design will ensure that surface water run-off from the Site will not increase the risk of flooding to downstream receptors. Mitigation by avoidance through design will also alleviate the risk of any potential flood risks. Having assessed the potential risks in the context of the Development and in accordance with the guidelines, there is no requirement to proceed further in the staged process of the flood risk assessment.

9.3.8 Surface Water Hydrochemistry

The Environmental Protection Agency (EPA) conducts an ongoing monitoring programme as part of Ireland's requirements under the WFD. The monitoring programme involves assessment of river water quality and trends with respect to ecological criteria and to physico-chemical water quality standards. All of Ireland's major rivers and their more important tributaries are included within the programme. As part of the physico-chemical monitoring programme, approximately 1,500 rivers are assessed annually. The monitoring programme includes an assessment of biotic indices (biological quality ratings ranging from 1-5) known as Q-Values. Historical and ongoing monitoring data from two EPA monitoring points exists for the Owenwee (Corrib) River.

The most recent assessment of the Owenwee River by the EPA was carried out on 14th August 2018 which indicates that the river has a Q-Value of 4 or "Good" with the latest result noting "Continuing satisfactory at Good ecological quality in this Lough Corrib tributary". Details of the closest EPA monitoring points on the Owenwee River relative to the Site and the latest Q-Values are outlined in **Table 9.14**.

Table 9.14: EPA Monitoring Points and Latest Available Q-Values

Station ID	RS30O030100	RS30O030180
Station Name	Owenwee (Corrib) - Bridge S.E. of Bofin Lodge	200m d/s Tawnaghbeg Lough
WFD Waterbody Code	IE_WE_30O030180	IE_WE_30O030180
Type	River	River
Latest Monitoring Year	1989	2021
Latest Status	High	Good
Latest Q-Value	4 - 5	4

Station ID	RS30O030100	RS30O030180
Distance from the Proposed EIAR Boundary	17 metres	468 metres
Easting	102296	101455
Northing	245118	246784
Local Authority	Galway County Council	Galway County Council

Loughanillaun is located to the north of the proposed spoil storage area which is situated approximately 3.4km west of the main Site. Samples are collected from the western shore of Loughanillaun for analysis multiple times per year by Galway County Council at Monitoring Station Code LS300014313600020. Loughanillaun is approximately 67 hectares in area, contains multiple small islands and is classified as having "Good" water quality under the current cycle of the WFD. Loughanillaun is designated as a high-status objective lake under the Water Framework Directive. The protection and restoration of high-status water bodies is a priority under Ireland's River Basin Management Plan (RBMP). Loughanillaun is currently categorised as being "At Risk" of failing to meet its high-status Water Framework Directive (WFD) objective by 2027. Two unnamed streams flow into the southern extent of Loughanillaun and are located within the footprint of the spoil storage area. These two streams are both categorised as "Good" water quality and categorised as being *"Not at Risk"* of failing to meet their water quality objectives under the Water Framework Directive (WFD) by 2027.

The proposed southern spoil storage area is located north of Ardderry Lough which is approximately 81 hectares in area and is also classified as having "*Good"* water quality under the current cycle of the WFD. Ardderry Lough is divided by the R336 near Maam Cross into the lower and upper lough. At the southern extent of Ardderry Lough Upper, sampling and analysis is also carried out multiple times per year by Galway County Council at Monitoring Station Code LS31000r411200010. Ardderry Lough is currently categorised as being "*Not at Risk*" of failing to meet its high-status Water Framework Directive (WFD) objective by 2027.

To assist in further characterising the watercourses surrounding the proposed Site and spoil storage area, five rounds of water quality monitoring for were carried out. The monitoring rounds included analysis of parameters requiring laboratory analyses and field hydrochemistry measurements on unstable parameters including pH, dissolved oxygen (DO), electrical conductivity, total dissolved solids (TDS) and temperature. The five water quality monitoring rounds were conducted across the following dates.

Table 9.15: Water Quality Monitoring Rounds and Dates

Monitoring Round	Monitoring Dates
Round 1	31st of August and 1st of September 2020
Round 2	13th and 14th of October 2020
Round 3	4th and 5th of March 2021
Round 4	5th and 6th of October 2021
Round 5	22nd of August 2022

At the early stages of the project development, the proposed wind farm Site encompassed a much wider geographical area than the final proposed six turbine design layout. Multiple additional turbine locations were initially being considered for positioning in the Derroura Forest to the east of the Site. As the scale of the project was gradually reduced to a six turbine development, the quantity and positioning of water quality monitoring locations were amended accordingly (Refer to **Chapter 3: Alternatives Considered**). In total, 21 different water quality monitoring locations were analysed throughout the monitoring programme for a wide variety of laboratory and field measured parameters. Although some of the water quality monitoring locations ultimately became less representative due to significant design changes and moving of proposed turbine positions, the inclusion of all captured data does provide a wholistic overview of the wider regional water quality. The field monitoring locations which are considered to be less representative than the finalised monitoring locations are denoted by an asterisk (*) in the results tables below for the purposes of differentiation. The water quality monitoring locations have been mapped and are shown on **Figure 9.4** in **Volume III** with those located within, adjacent to and downstream of the EIAR boundary considered to have more relevance to the assessment than some of the original locations to the east of the Site in the Derroura Forest.

The spoil storage area, to the west of the main site, was added to the monitoring programme in August 2022 when this area was identified as potentially being suitable for the long-term storage of excavated material from the main site. The spoil storage area is located on an area of low lying bogland which is bound by Loughanillaun to the north and Ardderry Lough to the south. There are also a number of artificial drainage ditches and two mapped small streams located within the northern extent of the spoil storage area. Samples were collected for field and laboratory analyses from both Loughanillaun and Ardderry Lough. The easterly unmapped stream at the spoil storage area was also sampled analysed for field based parameters to assist in characterising the baseline water quality conditions in this area.

A number of water quality parameters are physically or chemically unstable and must be analysed in-situ immediately after collection with a field monitoring multi-parameter meter.

The pH values across the Site ranged from between pH 4.89 during monitoring round 2 to pH 7.93 during monitoring round 3. The majority of the pH concentrations recorded were relatively pH neutral or slightly acidic. Slightly acidic conditions were consistently recorded at locations such as FM2 and FM7 where relatively low pH concentrations ranged from pH 4.89 to pH 5.50 across the four monitoring rounds. A slightly acidic pH concentration of 5.65 was also recorded at the easterly unnamed stream within the spoil storage area where cutaway bog was observed. Slightly acidic pH concentrations are not uncommon in waterbodies of a catchment containing underlying granite bedrock, acidic peatland soils and dense conifer forestry.

Electrical conductivity is a measure of the ability of an aqueous solution to carry an electrical current. Conductivity is useful as a general measure of water quality, it is primarily used as an indicator of saline intrusion although it also increases if contamination by most ionic species is present in a water body. There are no nationally recognised environmental quality standards (EQS) for electrical conductivity in surface waters with an EQS of 2,500 μS/cm being the upper acceptable concentration for drinking water. Significantly elevated electrical conductivity can indicate that unknown pollutions have entered the waterbody. Conductivity values recorded across the five monitoring rounds ranged from between 32 μS/cm during monitoring round 2 to 245 μS/cm during monitoring round 1. The relatively low electrical conductivity values recorded during the four monitoring rounds did not indicate the presence of polluted surface waters.

Concentrations of total dissolved solids (TDS) ranged from 23 mg/L at FM2 during monitoring round 2 to 171 mg/L during monitoring round 1. TDS are made up of inorganic salts, as well as a small amount of organic matter and are linked to electrical conductivity as a general indicating measure of the presence of pollutants in surface waters. TDS originate from a number of sources, both natural and as a result of human activities such as agricultural, urban runoff, wastewater discharges, industrial wastewater and salt that is used to de-ice roads. Total dissolved solids in rivers can range from between 20 – 20,000 mg/L and higher TDS results can often indicate that the water is saline. If the concentration of TDS in water is elevated, it can reduce the clarity of the water, contributing to a decrease in photosynthesis, compounds react with heavy metals, and cause an increase in water temperature. TDS concentrations are also used as an indicator of the aesthetic characteristics of the water and as an indicator of the number of very small particles. As a result of the very low concentrations of TDS recorded at each sample location across the four monitoring rounds, the presence of dissolved pollutants was not indicative at any of the monitoring locations.

With the exception of the two lake samples and the easterly unnamed stream, all located within or adjacent to the spoil storage area, dissolved oxygen (DO) concentrations otherwise ranged from 9.10 mg/L during monitoring round 3 to 12.22 mg/L also during monitoring round 3. These include all results at the main site or areas which once formed part of the footprint of the main site in addition to some downstream sampling points. At the easterly unnamed stream of the spoil storage area, a low dissolved oxygen concentration of 4.13 mg/L was recorded during monitoring round 5. More elevated DO concentrations of 7.26 mg/L and 6.94 mg/L were recorded in Loughanillaun and Ardderry Lough respectively during monitoring round 5. All of the DO concentrations recorded at the watercourses within and adjacent to the spoil storage area were considerably lower than those recorded at the main site. Water runoff from peatlands contain dissolved organic matter (DOM) which is principally composed of natural acids and proteins produced by the specialist peat forming plant species unique to bog ecosystems. It is the organic forms of carbon, nitrogen and phosphates contained in DOM that are responsible for the characteristic yellow/brown colour of peatland water which typically have low levels of dissolved oxygen than non-peatland based surface waters. In simple terms, the chemical degradation of the peat in the water can deplete the oxygen saturation.

Water temperature influences DO concentrations in a river or stream, DO generally increases as the water temperature decreases. The flow rate or movement of water in a river or stream can also impact upon the DO concentration. Rapidly moving water, such as in rivers or streams, tends to contain higher DO concentrations since the movement of the water allows for a greater mixing of air whereas stagnant water typically contains lower DO concentrations. Lakes generally contain lower DO concentrations due to their relatively stagnant nature. Lower concentrations of DO in stagnant water is also due to the enhanced consumption of dissolved oxygen by plants and microbial life. With the exception of all monitoring locations within or adjacent to the spoil storage area, all of the recorded DO concentrations at each monitoring location across the five monitoring rounds were within the ≥ 8 mg/L guide range for cyprinid waters and within the ≥ 9 mg/L guide range for salmonid waters as set out in the EC Directive 2006/44/EC.

Surface water temperatures ranged from between 4.73°C during monitoring round 3 to 17.82°C during monitoring round 1. Increases in surface water temperature resulting from human activities may exceed the thermal tolerances of aquatic biota that are adapted to colder environments. The EC Directive 2006/44/EC screening criteria for temperature relates to thermal discharges to waters with the capacity to increase the surface water temperate by a maximum of 1.5°C. The proposed Development is not expected to require any thermal discharge activities and this screening criteria is therefore of limited value. The significant temperature differential of 13.09°C between the maximum and the minimum results across the 5 monitoring rounds is representative of natural seasonal surface water temperature fluctuations with air temperature being the dominant factor in influencing seasonal surface water temperatures.

Table 9.16: Field Hydrochemistry Results from Monitoring Round 1

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @ 20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	1/09/2020	6.51	64	45	10.69	14.82
FM2	1/09/2020	4.96	60	42	9.87	16.04
FM3	1/09/2020	6.01	65	46	9.9	14.66
FM4	1/09/2020	6.06	75	52	9.31	17.82
FM5	31/08/2020	7.51	126	88	9.85	14.82
FM6	31/08/2020	7.79	111	77	9.47	15.58
FM7*	31/08/2020	5.04	245	171	11.34	13.95
FM8*	1/09/2020	6.43	72	51	9.68	16.39
FM9*	1/09/2020	7.41	116	81	10.11	14.46
FM10*	1/09/2020	6.32	66	46	9.79	15.19
FM11*	1/09/2020	6.36	70	49	10.02	14.52
FM12*	31/08/2020	7.61	164	115	11.19	13.51
FM13*	1/09/2020	7.58	164	115	9.97	15.29
FM14*	31/08/2020	7.75	174	122	10.21	14.48
FM15*	31/08/2020	7.80	154	107	11.28	13.64
FM16*	31/08/2020	7.04	109	112	9.77	14.91

* Monitoring location is considered to be less representative of the reduced and finalised design layout

Table 9.17: Field Hydrochemistry Results from Monitoring Round 2

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	14/10/2020	6.62	64	45	11.03	11.57
FM2	13/10/2020	4.89	32	23	11.21	10.04
FM3	13/10/2020	6.03	61	43	10.98	11.15
FM4	13/10/2020	6.00	60	42	11.37	10.49
FM5	13/10/2020	7.27	94	66	10.71	11.57
FM6	13/10/2020	7.04	82	58	11.46	10.34
FM7*	13/10/2020	5.14	52	37	9.15	10.38
FM8*	14/10/2020	6.25	85	59	10.59	9.32
FM9*	14/10/2020	7.29	133	93	11.34	9.73
FM10*	14/10/2020	6.68	75	53	11.05	9.24
FM11*	14/10/2020	5.38	41	29	10.55	9.28
FM12*	14/10/2020	7.53	159	111	11.31	8.91
FM13*	13/10/2020	7.53	137	96	11.41	10.93
FM14*	14/10/2020	7.02	89	62	11.15	9.97
FM15*	14/10/2020	7.46	123	86	11.33	9.77
FM16*	14/10/2020	7.48	50	35	11.57	9.66
FM17	13/10/2020	7.65	139	97	11.46	10.65

* Monitoring location is considered to be less representative of the reduced and finalised design layout

Table 9.18: Field Hydrochemistry Results from Monitoring Round 3

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	4/03/2021	7.42	66	46	11.05	6.14
FM2	4/03/2021	5.50	58	41	10.35	6.78
FM3	4/03/2021	6.93	69	48	10.38	6.09
FM4	4/03/2021	6.73	87	61	9.10	7.93
FM5	4/03/2021	7.73	125	88	11.09	6.34
FM6	4/03/2021	7.81	112	78	11.34	5.92
FM7*	4/03/2021	5.21	96	67	9.71	5.48
FM8*	5/03/2021	5.72	60	42	11.42	5.66
FM9*	5/03/2021	7.74	103	72	12.21	6.32
FM10*	5/03/2021	7.32	65	45	12.10	5.12
FM11*	5/03/2021	6.97	64	45	11.62	5.15
FM12*	5/03/2021	7.93	141	99	12.22	5.39
FM13*	5/03/2021	7.64	231	162	12.03	5.41
FM14*	4/03/2021	7.37	60	42	11.25	5.25
FM15*	4/03/2021	7.84	126	88	11.46	4.73
FM16*	4/03/2021	7.84	86	60	11.52	4.75
FM17	4/03/2021	7.69	140	98	11.12	5.75

* Monitoring location is considered to be less representative of the reduced and finalised design layout

Table 9.19: Field Hydrochemistry Results from Monitoring Round 4

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM1	5/10/2021	5.79	50	35	11.19	12.03
FM3	5/10/2021	5.9	61	43	11.15	10.08
FM4	5/10/2021	6.19	53	37	10.45	14.09
FM5	5/10/2021	7.29	104	72	11.15	9.32
FM6	5/10/2021	7.48	73	51	10.96	11.99
FM7	5/10/2021	5.15	51	36	10.9	11.86
FM17	5/10/2021	6.83	63	44	11.73	9.96
FM18	5/10/2021	5.76	48	34	10.68	13.06

Table 9.20: Field Hydrochemistry Results from Monitoring Round 5 (Spoil Storage Area Only)

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM19	22/08/2022	7.06	144	101	7.26	17.12
FM20	22/08/2022	5.65	87	61	4.13	16.17
FM21	22/08/2022	7.40	144	101	6.94	17.79

A total of 30 surface water samples were also collected at multiple locations for laboratory analysis on a broad range of parameters during the five monitoring rounds. Copies of the laboratory certificates from each round of monitoring are contained in **Volume IV**. The results from the laboratory analysis from the five monitoring rounds are compared to various screening criteria in **Table 9.21**, **Table 9.22**, **Table 9.23, Table 9.24, and Table 9.25** below. The sample locations have been mapped and are shown on **Figure 9.4** in **Volume III**.

Biochemical Oxygen Demand (BOD) concentrations were below the laboratory limit of detection (<1 mg/L) in all samples with the exception of SW1 during monitoring round 1 where a concentration of 1 mg/L BOD was recorded. This single laboratory detection at monitoring location SW1 for BOD was below the "Good" status and "High" status threshold limits for BOD as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*.

Total suspended solids (TSS) were reported below the laboratory limit of detection (<2 mg/L) in 26 out of 30 samples analysed across the five monitoring rounds. A maximum concentration of 13 mg/L TSS was recorded at monitoring location SW7 during monitoring round 2. This result is below the threshold value of 25 mg/L TSS for both salmonid and cyprinid species as set out in EC Directive 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life.

Concentrations of total nitrogen were below the laboratory limit of detection (0.5 mg/L) in 26 out of the 28 samples analysed across the five monitoring rounds. A maximum concentration of 0.765 mg/L was recorded at location SW1 during monitoring round 1. There are no applicable EQS against which to compare the total nitrogen results. However, given that there were only two low concentration detections recorded across the four monitoring rounds, total nitrogen was not considered to be elevated at any of the monitoring locations. Concentrations of nitrate were below the laboratory limit of detection (0.44 mg/L) in 28 out of the 30 samples analysed across the four monitoring rounds. A maximum concentration of 0.482 mg/L for nitrate was recorded at monitoring location SW2 during monitoring round 3 which is below the 50 mg/L threshold value set out in the *European Union Drinking Water Regulations 2014.* For nitrite, all results were below the laboratory limit of detection in all 30 samples analysed.

Concentrations of total phosphorus were below the laboratory limit of detection (0.05 mg/L) in 27 out of the 30 samples analysed across the five monitoring rounds. A maximum concentration of 0.06 mg/L for total phosphorous was recorded at monitoring location SW6 during monitoring round 2. There are no applicable screening criteria for rivers against which to compare this maximum result although it is considered to be a low concentration of total phosphorous. Orthophosphate concentrations were below the laboratory limit of detection (0.01 mg/L) in all river/stream samples with the exception of monitoring round 1 where orthophosphate was detected in 5 out of 6 samples. Three of these five detections during monitoring round one exceeded the "Good" status criteria as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009* whilst two of the results were below the "Good" status criteria. All five of the detectable orthophosphate concentrations during monitoring round one exceeded the "High" status threshold as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Orthophosphate was also detected in both of the lake samples during monitoring round 5 at 0.033 mg/L in Loughanillaun and 0.015 mg/L in Ardderry Lough. The orthophosphate result from Loughanillaun (SW13) did not meet the "*High*" status threshold although it did meet the "*Good*" status threshold for orthophosphate. The concentration of orthophosphate recorded in Ardderry Lough (SW14) did meet both the "*Good*" and "*High*" status criteria as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Chloride concentrations ranged from between 10.9 mg/L to 23.2 mg/L. The maximum detected concentration for chloride did not exceed the 250 mg/L threshold value set out in the *European Union Drinking Water Regulations 2014*. The ammonia as N concentrations were detected above the laboratory limit of reporting (0.005 mg/L) in 17 of the samples across the monitoring rounds. The maximum recorded ammonia concentration was 0.034 mg/L at SW1 during monitoring round 2. All of the recorded ammonia as N concentrations were below both the "*Good*" status and "*High*" status thresholds of 0.065 mg/L and 0.04 mg/L respectively as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Due to the differing water chemistry and environmental conditions found in lakes, other parameters such as colour and chlorophyll *a* underwent laboratory analyses on the Loughanillaun (SW13) and Ardderry Lough (SW14) samples. Water colour can change the quantity and quality (wavelengths) of light in water, as well as reducing its overall depth of penetration. It is associated with transparency and phytoplankton biomass (chlorophyll *a*). Colour concentrations generally increase as the dissolved organic carbon (DOC) concentrations increase. Increased colour in a water body decreases light penetration and reduces the area of macrophyte (aquatic plants) habitat, particularly at the lower euphotic depths. Higher colour concentrations in a waterbody also generally result in increased growth of angiosperms over charophytes in hard water lakes.

The primary source of increased colour in Ireland is peatland disturbance, forestry streams can often also appear dark or brownish-yellow. Run-off of heavy rainfall also enables the transport of organic material, nutrients and minerals into lakes and rivers. Lakes associated with wetlands also generally have a higher colour concentration. No habitat-specific or national standards for water colour exist. A study of 199 Irish lakes in 2000 produced a range for colour of between 5 – 258 mg/l Pt/Co and a median colour concentrations in Irish lakes of 38 mg/l Pt/Co (Free et al., 2000). Colour concentrations of 42.3 mg/l Pt/Co and 63.3 mg/l Pt/Co were recorded within Loughanillaun (SW13) and Ardderry Lough respectively. The colour concentrations from each of the lake water samples were greater than the national median (38 mg/l Pt/Co) lake concentration recorded in the year 2000 national survey. However, the results were considerably below the maximum value (258 mg/l Pt/Co) recorded during the year 2000 national survey.

Chlorophyll *a* is a specific form of chlorophyll used in oxygenic photosynthesises and is the pigment that makes plants and algae green. It is analysed in surface water samples to determine the amount of algae that may be present in a water body. Natural seasonal variations in algal concentrations occurs in Irish lakes. In the spring, water is generally more transparent and there are additional nutrients available due to the spring turnover although surface water temperatures remain cooler which limits algal growth. As the water warms throughout the summer, algae can grow to higher concentrations. Algal blooms can also form as a result of excess discharge of nutrients such as nitrogen and phosphorous to water bodies which can be exacerbated by heavy rainfall when run-off rates are increased.

The Surface Water Regulations 2009 (S.I. 272 of 2009) sets out chlorophyll *a* threshold limits for various types of lakes. For the purpose of this assessment, both Loughanillaun and Ardderry Lough are considered to be representative of a Type 4 lakes (i.e. low alkalinity (≤ 20 mg/1 $CaCO_3$), deep (≥ 4m) and large (≥50 ha). The concentration of chlorophyll *a* recorded in Loughanillaun was 1.07 µg/L whereas the concentration of chlorophyll *a* recorded in Ardderry Lough was below the laboratory limit of reporting of less than 1 µg/L. Both of these results were within "*Good - Moderate*" upper threshold of 9 µg/L and were also within the "*High - Good*" upper threshold of 6 µg/L as set out in *S.I. No. 272/2009 — European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Table 9.21: Surface Water Results from Round 1 Monitoring on 31 August 2020

Parameter	Sample ID						EC Directive 2006/44/EC		EC Directives 75/440/EEC 79/869/EEC	EC Directive 98/83/EC	EC Directives 2000/60/EC 2008/105/EC	EC Directive 78/659/EEC
	SW1	SW2	SW3	SW4	SW5	SW6	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU Drinking Water Regs 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	1	<1	<1	<1	<1	<1	≤6	≤3	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	<2	<2	<2	<2	<2	<2	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	0.765	0.560	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-
Chloride (mg/L)	22.9	15.4	15	18.6	15.6	16.8	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	0.148	0.031	0.055	0.101	0.029	<0.01	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.028	<0.005	<0.005	<0.005	0.01	0.005	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Table 9.22: Surface Water Results from Round 2 Monitoring on 13 October 2020

Parameter	Sample ID							EC Directive 2006/44/EC		EC Directives 74/440/EEC 79/869/EEC	EC Directive 98/83/EC	EC Directives 2000/60/EC 2008/105/EC	EC Directive 78/659/EEC
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU Drinking Water Regs 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	<1	<1	<1	<1	<1	<1	<1	≤6	≤3	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	5	<2	<2	<2	<2	<2	13	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.05	-	-	-	-	-	-
Chloride (mg/L)	23.2	16.8	15.3	17.3	14.9	15	12.9	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.034	0.005	0.005	0.007	0.015	0.014	0.011	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Table 9.23: Surface Water Results from Round 3 Monitoring on 4 March 2021

Parameter	Sample ID								EC Directive 2006/44/EC		EC Directives 74/440/EEC 79/869/EEC	EC Directive 98/83/EC	EC Directives 2000/60/EC 2008/105/EC	EC Directive 78/659/EEC
	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW9	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU Drinking Water Regs 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	<1	<1	<1	<1	<1	<1	<1	<1	≤6	≤3	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	<2	<2	<2	<2	<2	<2	3	5	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-
Chloride (mg/L)	20	15	14	15.6	15.6	15.6	12.6	14.2	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<0.44	0.482	<0.44	<0.44	<0.44	<0.44	0.446	<0.44	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosphate as PO_4-P (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.033	0.005	<0.005	0.006	0.01	0.012	0.009	0.031	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Notes: Sample location SW8 was dry, a sample could not be collected for analysis. Sample location SW9 was added to the monitoring programme following design layout changes.

Table 9.24: Surface Water Results from Round 4 Monitoring on 5 October 2021

Parameter	Sample ID							EC Directive 2006/44/EC		EC Directives 74/440/EEC 79/869/EEC	EC Directive 98/83/EC	EC Directives 2000/60/EC 2008/105/EC	EC Directive 78/659/EEC
	SW4	SW5	SW6	SW7	SW9	SW11	SW12	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU Drinking Water Regs 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	<1	<1	<1	<1	<1	<1	<1	≤6	≤3	A1 and A2 Waters = 5 A3 Waters= 7	-	High ≤ 1.3 mean Good ≤ 1.5 mean	≤5
Total Suspended Solids (mg/L)	<2	<2	<2	<2	<2	<2	<2	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-
Chloride (mg/L)	12.4	12.2	13.9	10.9	12.4	11	11.9	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Notes: Sample locations SW1, SW2 and SW3 were removed from the monitoring programme due to design layout changes and sample locations SW11 and SW12 were added. Sample location SW8 was again dry and a sample could not be collected for analysis.

Table 9.25 Surface Water Results from Round 5 Monitoring on 22 August 2022 (Lake Samples Only)

Parameter	Sample ID		EC Directive 2006/44/EC		EC Directives 74/440/EEC 79/869/EEC	EC Directive 98/83/EC	EC Directives 2000/60/EC 2008/105/EC	EC Directive 78/659/EEC
	SW13	SW14	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU Drinking Water Regs 2014	EC Environmental Objectives Surface Water Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Colour (mg/l Pt/Co)	42.3	63.3	-	-	20	Acceptable to consumers and no abnormal change	-	-
Total Suspended Solids (mg/L)	≤2	≤2	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<0.5	<0.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	<0.05	<0.05	-	-	-	-	-	-
Chlorophyll *a* (μg/L)	1.07	< 1	-	-	-	-	High – Good ≤ 6 Good – Moderate ≤ 9	-
Nitrate as NO_3 (mg/L)	<0.44	<0.44	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.017	<0.017	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	0.033	0.015	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035 Good ≤ 0.065	- -

9.3.9 Hydrogeology

The underlying bedrock within the EIAR Site boundary is considerably varied and has been mapped as containing a mixture of Ordovician age igneous and metamorphic rocks with the following formations:

- Oughterard Granite consisting of medium/coarse non-porphyritic granite
- Lakes marble formation (Precambrian Marbles) consisting of marbles, metavolcanics, schists and grits
- Streamstown schist formation consisting of psammitic pelitic and semi-pelitic schists
- Bennabeola quartzite formation consisting of pale quartzites, grits and graphtic top
- Ballynakill schist formation consisting of aluminous schist, quartzite and pebble beds.

The bedrock formations underlying the Site are predominantly classified as by the GSI as Poor Aquifers (Pl: which is generally unproductive except for local zones). The granites, together with the Lower Palaeozoic and Precambrian rocks that underlie most of the region are characterised by low fissure permeability. The hydrogeological significance of quaternary sediments is highly variable and is largely a function of their permeability, thickness and extent. The Site is intersected by a north-west to south-east trending fault which intersects or possibly through, the proposed location of turbine T5 (see **Chapter 8: Soils and Geology**). There are no known karst features recorded in close proximity to the Site. The closet evidence of karstification to the Site is recorded within a borehole located approximately 7.5km to south-east in the townland of Carrowmanagh, Oughterard.

The Maam-Clonbur groundwater body (GWB) (IE_WE_G_006) underlies the EIAR Site boundary and northern extent of the proposed spoil storage area. It is classified as being composed primarily of low transmissivity rocks with low permeability bedrock. The Maam-Clonbur GWB is designated as a Registered Protected Area (RPA) as this GWB intersects with WFD designated salmonid waters under S*.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988*. Most of the groundwater flux is in the uppermost part of the aquifer, comprising a broken and weathered zone typically less than 3m thick, a zone of interconnected fissuring typically less than 10m thick and a zone of isolated fissuring typically less than 150m thick. Groundwater flows are expected to be concentrated in fractured and weathered zones and in the vicinity of fault zones. Flow paths are likely to be short, between 30-300m with groundwater discharging rapidly to nearby streams and small springs. Baseflow contributions to rivers and streams is likely to be relatively low. The groundwater flow direction is expected to generally follow the topography with the overall flow direction being eastwards. (*Maam_ Clonbur GWB: Summary of Initial Characterisation, GSI, 2004*).

The Oughterard Marbles GWB (IE_WE_G_009) underlies multiple areas beyond the EIAR Site boundary and contains many similar characteristics to the Maam-Clonbur GWB. The Oughterard Marbles GWB is also classified as being composed primarily of low transmissivity rocks with low permeability subsoil and bedrock. Most of the groundwater flux is in the uppermost part of the aquifer, comprising a broken and weathered zone typically less than 3m thick, a zone of interconnected fissuring 10 - 15m thick and a zone of isolated fissuring typically less than 150m thick. In the absence of inter-granular permeability, groundwater flow is expected to be concentrated in upper fractured and weathered zones, which may have some degree of karstification. Flow paths are likely to be up to 150m with groundwater discharging rapidly to nearby streams and small springs. Flow directions are expected to be generally to the east towards Lough Corrib. *(Oughterard Marbles GWB: Summary of Initial Characterisation, GSI, 2004).*

A small section of the grid connection route is underlain by the Oughterard Marbles GWB with the majority of the route being underlain by the Spiddal GWB and also the Recess Marbles GWB to a lesser extent. The southern extent of the spoil storage area is also underlain by the Recess Marbles GWB. The Spiddal GWB is a Registered Protected Area (RPA) for Shellfish as this GWB intersects with Designated Shellfish Zones under S.I. No. 55/2009 European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009. Due to the shallow depths of trenching along the proposed grid connection route along the pre-existing road to Screebe, potential impacts on groundwater are expected to be negligible. Potential impacts on groundwater from the proposed wind farm Site are discussed in detail in subsequent sections of this Chapter.

9.3.10 Wells

Mapping and searches of the EPA WFD and GSI well databases confirms that there are no known groundwater abstraction wells located within 5km of the EIAR boundary. The closet known groundwater well is located 10km to the south-east of the Site boundary near Oughterard.

A GSI study on the Geology of Connemara and South Mayo (GSI 1995) notes that this region of Ireland is amongst the worst from the point of view of groundwater potential. Most of the rocks have a low permeability and a poor aquifer potential. Groundwater is not a major source of drinking water for public supplies, although given the rural location, many private wells may be in use. In addition, all Water Framework Directive (WFD) Groundwater bodies have been identified as Drinking Water Protected Areas (DWPA) due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD. The DWPA designation applies to all groundwater bodies nationally nationwide regardless of the productivity status of the underlying aquifer.

The Maam-Clonbur groundwater body (GWB) (IE_WE_G_006) underlies the EIAR Site boundary with the Oughterard Marbles GWB (IE_WE_G_009) situated within areas surrounding the EIAR Site boundary. The GSI note both of these aquifers are amongst the least productive in the country with 99% of the 524 km^2 Maam-Clonbur GWB being classified as a poor bedrock aquifer (PI). It is classified as having poor bedrock that is generally unproductive except for local zones. This type of bedrock aquifer is capable of supplying small abstractions such as domestic supplies, or small group schemes. Given that the existing GSI groundwater well database is an incomplete dataset, it should be assumed for the purpose of conservatism that all dwellings located in close proximity to the EIAR Site boundary have the potential to maintain a groundwater well for abstraction. Discussions with local landowners have also confirmed that private wells are in use by residents in the area for the abstraction of water for drinking water purposes. Potential risks to groundwater quality and drinking waters sources are discussed in **Section 9.4.4.9**.

9.3.11 Groundwater Vulnerability

Groundwater vulnerability is a measure of the inherent geological and hydrogeological characteristics which determine the ease at which groundwater may potentially become contaminated via human activities at the surface. The vulnerability of groundwater is dependent upon multiple factors. These include the intrinsic toxicity of the contaminants in question, the quantity of contaminants that can reach the groundwater, the rate at which contaminants can flow to the groundwater and the attenuating capacity of the subsoils and bedrock through which the water travels.

The GSI groundwater vulnerability rating for the aquifer within the EIAR Site boundary ranges from "*Extreme*" and "*Rock at or Near the Surface*" in the northern section of the Site to predominantly "*Extreme*", "*High*" and "*Moderate*" vulnerability in the south and west of the Site. The GSI groundwater vulnerability rating for the aquifer underlying the proposed spoil storage area is predominantly classified as *"High*". The high and extreme vulnerability classifications are reflective of the considerably variable and often shallow depths of subsoil and blanket peat in the area. The GSI aquifer vulnerability classifications broadly aligns with changes in elevation across the main Site with higher altitude areas in the north and north-east generally being characterised as more vulnerable than less elevated areas in the south and west. The high and extreme vulnerability classifications across the Site indicate that the combined thickness of blanket peat and mineral subsoils in these areas ranges from 0 – 5m as is outlined in **Table 9.26** below. The extreme and high vulnerability classifications are also consistent with bedrock outcrops at the surface and the shallow blanket peat which is dominant across the Site. Extensive peat probing at the Site confirmed that the depth to the top rock ranged from depths of between in 0 - 5.7m. This is consistent with the GSI groundwater vulnerability classification for the Site of Extreme, High and Moderate.

The granites, Lower Palaeozoic and Precambrian bedrock that underlie the Site are characterised by a low fissure permeability. Blanket peat and poorly draining soils are also low permeability materials which are dominant within the EIAR Site boundary. These low permeability materials protect underlying groundwater and restricts recharge. Where sufficiently thick, such low permeability materials may confine groundwater. Flow paths are expected to be short with groundwater discharging rapidly to nearby streams and small springs, thus restricting the potential for signification groundwater flux to the uppermost part of the aquifer. In the event that contaminants were to be accidentally released on Site, it is expected that their mobility within the groundwater would be limited and would remain relatively localised to the source of contamination. It is more likely that contaminants released at the surface would flow to nearby watercourses within surface runoff than to groundwater. As a result, surface waters such as rivers, lakes, streams and drains are likely to have a higher vulnerability to potential contamination at the Site than groundwater. The GSI mapped groundwater vulnerability for the Site is shown in **Figure 9.14** in **Volume III.**

Table 9.26: Groundwater Vulnerability Classes

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil permeability (type) and thickness			Unsaturated zone	Karst features
	High permeability (sand/gravel)	Moderate permeability (e.g. sandy till)	Low permeability (e.g. clayey till, clay, peat)	Sand/gravel aquifers only	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0m – 10.0m	3.0m – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0m – 10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Source: Strive Report Series No. 6, Water Framework Directive – Recharge and Groundwater Vulnerability, Environmental Protection Agency, 2008

Similar to the proposed wind farm Site, a range of GSI groundwater vulnerability classification have been mapped along the proposed grid connection route to Screebe 110kV ESB Substation. The majority of the proposed grid connection route is underlain by aquifer vulnerabilities classified as "Extreme" and "Moderate" with multiple "*Rock at or Near the Surface"* also mapped along the proposed route. These groundwater vulnerability classifications are consistent with those mapped in the wider Connemara region. Shallow trenching which will be backfilled is expected to be required for the proposed grid connection in addition to HDD at five bridge locations along the route. The shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden.

Horizontal directional drilling (HDD) is the method of cable installation which will be used at five bridge crossings along the grid connection route at the locations outlined on Figure 9.9 in **Volume III**. Horizontal directional drilling is a drilling technique whereby a hole is drilled under a feature so that the cable installation avoids disturbance of the feature, in this case the features are watercourses adjacent to five existing bridges. This methodology requires the excavation of two pits; a launch pit and a reception pit. Approximate dimensions for the excavations would be 4m long x 3m wide x 2m deep. Sides of the drive pits will be battered with no requirement for sheet piling. HDD involves drilling of a pilot hole from a drilling machine positioned at one side of the obstacle to be crossed. A pipe is inserted into the drilled hole which acts as a duct through which the cable is pulled. The horizontal directional drilling will require a drilling fluid to cool and lubricate the drill head. The drilling fluid used during the works will be Clearbore which is a polymer-based product that is designed to instantly break down and become chemically inert in the presence of small quantities of calcium hypochlorite. Clearbore is not toxic to aquatic organisms and is biodegradable. Typical depths for horizontal directional drilling will be in the range of between 5m to 10m although the actual depth will ultimately be determined by the ground profile at each HDD location.

During the HDD process, there is potential for groundwater to be encountered. There is also potential for sediment laden run-off to arise from the entry pit excavation works. The loss of drilling fluid can occur as a result of the geological formation that is being drilled through. A brecciated or fractured formation will result in the loss of drilling fluid through cracks, voids and fractures. Potential receptors include Ardderry Lough, Lough Shindilla, the Screeb River, Lough Nahasleam, Loughaunfree, Lough Aughawoolia, Lough Ahalia South and Camus Bay. If a frac-out occurs, there will be a loss in drilling pressure, this is a signal to the operator that an issue has arose with the drilling process. Clearbore drilling fluid is used to minimise the risk to the environment in the case of a frac-out. There is therefore an unlikely risk of frac-out occurring during the HDD process which could result in contamination of the surrounding watercourses with drilling fluids. Mitigation measures to minimise potential risks to surface water and groundwater quality are outlined in **Section 9.5**. Guidance and mitigation measures recommended by Inland Fisheries Ireland (IFI) during the consultation process have been incorporated into the design of the proposed crossings. As a result, potential impacts on groundwater or surface water along the proposed grid connection route is expected to be negligible.

9.3.12 Groundwater Levels

Blanket bog which is the dominant surface layer at the Site normally forms in areas where the underlying bedrock is effectively impermeable such as the granite and quartzite at the proposed Site. In such instances, the overlying bog typically forms part of a fully saturated perched aquifer system. In most areas of the Site, the groundwater level is generally either at or just below (typically within 10cm) the surface particularly during the wetter winter months but also throughout most of the year due to the high rainfall levels which occur at the Site. The presence of groundwater at or very near the surface was observed when gouge cores were advanced at each of the turbine locations, gouge coring at turbine locations is discussed in **Chapter 8: Soils and Geology.** The installation of piezometers are therefore not considered necessary at this stage of the projects development due to the groundwater level being predominantly at the surface.

9.3.13 Groundwater Hydrochemistry

There is no groundwater hydrochemistry data available for the proposed wind farm Site and only limited GSI groundwater hydrochemistry data is available for the wider region. Groundwater quality monitoring is generally not conducted for proposed wind farm developments due to the limited excavation nature of such developments. Impacts on groundwater quality are also generally not expected to occur from such developments. Oughterard granite bedrock underlies much of the EIAR Site boundary and from the available GSI data for granite rocks across the country, alkalinities typically range from 43 – 298 mg/L ($CaCO_3$) with a median value of 184 mg/L ($CaCO_3$). Total Hardness in granite rocks across the country ranges from 103 – 304 mg/l with a median 178 mg/l and conductivity ranges from 317 – 1017 µS/cm with a median of 461 µS/cm.

Precambrian marbles also underly the EIAR Site boundary and much of the proposed grid connection route which at a national classification level have alkalinity concentrations in the range of 112 – 428 mg/L ($CaCO_3$) with a mean value of 274 mg/L ($CaCO_3$). Total Hardness in Precambrian marbles across the country ranges from 180 – 436 mg/l with a mean of 311 mg/l and conductivity ranges from 414 – 814 µS/cm with a mean of 667 µS/cm (GSI, 2004). Only shallow trenching which will be backfilled is expected to be required for the proposed grid connection, the shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden. As a result, potential impacts on groundwater along the proposed grid connection route is expected to be negligible. Mitigation measures to minimise potential risks to groundwater quality are outlined in **Section 9.5**.

9.3.14 Water Framework Directive Water Body Status & Objectives

The Water Framework Directive (WFD) surface water body status (2013 – 2018) and the associated objectives assigned for the surface water network both within and surrounding the Site have been reviewed. The wider Corrib Catchment is amongst the largest catchment areas in Ireland spanning over 3,100km^2. The WFD status of river water bodies associated with the Corrib Catchment ranges from "*High*" to "*Bad*" with the majority of river water bodies ranging from "*Good*" to "*Moderate*". Surface water bodies assigned "*Bad*" status are limited to portions of the headwaters and main channel of the Owenriff River which flows through Oughterard to the east of the Site. All of the streams which drain the proposed Site are headwaters of the Owenwee and Owenree Rivers and all have a WFD Status of "*Good*". Lough Bofin which is located south of the Site on the southern extent of the N59 road has a WFD status of "*High*" and Lough Corrib Upper into which the Owenree River drains has a WFD status of "*Good*".

Surface water bodies with good or high status have an overall objective to retain this status, that is that no deterioration in water quality is the objective for these water bodies. Surface water bodies assigned "*Moderate*" status are "*At Risk*" of not meeting objectives whereby the object is to restore the status to at least "*Good*" status by 2027 under the third cycle of the Water Framework Directive. All of the streams which drain the Site and the Owenwee and Owenree Rivers are assigned as "*Not at Risk*" of meeting at least "*Good*" status by 2027. Similarly, Lough Bofin and Lough Corrib are also assigned as "*Not at Risk*" of meeting at least "*Good*" status by 2027.

Loughanillaun located to the north of the proposed spoil storage area is classified as having "*Good*" water quality under the current cycle of the WFD. Loughanillaun is designated as a high-status objective lake under the Water Framework Directive. The protection and restoration of high-status water bodies is a priority under Ireland's River Basin Management Plan (RBMP). Loughanillaun is currently categorised as being "*At Risk*" of failing to meet its high-status Water Framework Directive (WFD) objective by 2027. Two unnamed streams flow into the southern extent of Loughanillaun and are located within the footprint of the spoil storage area. These two streams are both categorised as "*Good*" water quality and categorised as being "*Not at Risk*" of failing to meet their water quality objectives under the Water Framework Directive (WFD) by 2027. The proposed southern spoil storage area is located north of Ardderry Lough which is also classified as having "*Good*" water quality under the current cycle of the WFD. Ardderry Lough is currently categorised as being "*Not at Risk*" of failing to meet its high-status Water Framework Directive (WFD) objective by 2027.

9.3.15 Groundwater Body Status

The Maam-Clonbur, Recess and Oughterard Marbles groundwater bodies which underly the EIAR Site boundary, spoil storage area and the wider region have been assigned "*Good Status*" under the Water Framework Directive (WFD). This classification is based on an assessment of the chemical and quantitative status of the GWB. The Spiddal groundwater bodies which underlie sections of the proposed grid connection route to Screebe has also both been assigned "*Good Status*" under the WFD. The status is derived from representative monitoring points selected specifically for the WFD groundwater monitoring programme. All of the GWB's underlying the Site, spoil storage area and the proposed grid connection route have been categorised as "*Not at Risk*" of failing to meet their WFD objectives by 2027.

The risk of not meeting WFD objectives is determined by assessment of monitoring data, data on the pressures and data on the measures that have been implemented. Groundwater bodies that are "*At Risk*" are prioritised for implementation of additional measures and resources to mitigate potential impacts, the implementation of such additional measures do not apply to the GWBs underlying the proposed Site or the proposed gird connection route.

9.3.16 Designated Sites & Habitats

Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), referred to as "*European Sites*" or "*Natura 2000 Sites*", are the means by which European legislation protects threatened or rare habitats and species. Candidate Sites (i.e. cSAC or cSPA) have the same level of protection as fully designated Sites under Irish Law. Candidate Sites are those that are currently under consideration by the Commission of the European Union for SAC or SPA status in accordance with the Habitats Directive. Natural heritage areas (NHAs) are designated areas that are protected under the Wildlife Act 2000 for areas considered important for the habitats present or which hold species of plants and animals whose habitat needs protection. Proposed natural heritage areas (pNHAs) are Sites not yet offered the same statutory protection as NHAs but which may become NHAs in due course and are Sites of significance for wildlife and habitats.

The proposed Site and spoil storage area are not located within a designated area of conservation. To the north of the proposed Site is the Lough Corrib SAC, SPA and pNHA. Lough Corrib is the second largest lake in Ireland covering an area of approximately 18,240 hectares. It is renowned for its wild brown trout and salmon that ascend tributaries of the catchment annually to spawn and utilise it as a nursery habitat. The proposed Site boundary is located approximately 750m to the south of Lough Corrib Upper at the closest extent. The vast majority of the Site drains to or contains headwaters of the Owenwee and Owenree Rivers, the latter of which ultimately drains to Lough Corrib Upper. Lough Corrib has multiple qualifying interests that ensure its status as a designated Site. Examples of qualifying interests for Lough Corrib include "*Oligotrophic Waters Containing very few minerals*", "*Freshwater Pearl Mussel (Margaritifera margaritifera)", "Atlantic Salmon (Salmo salar)"* and "*Otter (Lutra lutra)".*

The proposed Site is situated north of the Connemara Bog Complex SAC and pNHA. The Connemara Bog Complex SAC is a large site encompassing the majority of the south Connemara lowlands in Co. Galway. The Site supports a wide range of habitats, including extensive tracts of western blanket bog, which form the core interest, as well as areas of heath, fen, woodlands, lakes, rivers and coastal habitats. The proposed grid connection route which follows the pre-existing road alignment to Screebe, Co. Galway, passes through the Connemara Bog Complex SAC and pNHA. The proposed grid connection route also borders the Maumturk Mountains SAC and pNHA at its north-westerly extent as it follows the pre-existing road alignment. The proposed spoil storage area also borders the Maumturk Mountains SAC and pNHA at the southern extent of Loughanillaun. The pre-existing substation at Screebe is not located within a designated area of conservation, it is located to the north of the Kilkieran Bay and Islands SAC and it is located to the north-east of the Glencoh Rock pNHA. Kilkieran Bay to the south of the pre-existing substation is also a registered protected area for shellfish in accordance with the Water Framework Directive (WFD).

The Ballycuirke Lough Stream sub-catchment which bounds the southern extent of the proposed Site is listed as a Margaritifera Sensitive Area in accordance with the EU Habitats Directive. The majority of rivers and streams which flow into Lough Corrib are designated on the Register of Protected Areas (RPAs) as WFD river waterbodies intersecting with WFD Designated Salmonid Waters under S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988. These surface waters include the rivers and streams located to the north and north-east of the Site that flow directly into Lough Corrib Upper . There are no rivers which intersect the proposed grid connection route that are listed on the RPA as WFD river waterbodies intersecting with WFD Designated Salmonid Waters under S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988. There are no rivers located within 5km of the Site that are designated as a RPA for shellfish although three rivers which are designated as RPAs for shellfish do intersect the pre-existing road along which the proposed grid connection route to Screebe will traverse.

The proposed Development is located within the Failmore Priority Area for Action (PAA) which is made up of one river and four lake waterbodies covering an area of approximately 50km^2 in Connemara. The Failmore Priority Area for Action (PAA) is one of the 189 PAAs selected nationally as set out in The River Basin Management Plan for Ireland 2018 – 2021 (RBMP) for the protection and management of water quality in rivers, lakes, estuaries, groundwater, and coastal waters. The reasons why this area was selected as a PAA are given as follows in the RBMP 2018 – 2021 Areas for Action – Reasons for Selection:

- Test case for examining deteriorated water bodies in areas of low human activity
- One deteriorated High Ecological Status objective river water body
- Two deteriorated High Ecological Status lake water bodies
- Headwaters flow into the Corrib.

Loughaunierin is the closest waterbody in the Failmore PAA to the proposed Development and is located approximately 1km southwest of the Site. The Local Authority Waters Programme (LAWPRO), Failmore Priority Area for Action Desk Study Summary 2019 notes that the main pressure on Loughaunierin is land drainage. Aerial photographs show what appear to be several drains in the peatland area surrounding the lake which are leading into the lakes. The study also notes that there are areas of peat cutting near Loughaunierin which may be affecting its ecological status. As is discussed in **Section 9.3.4**, the proposed Site is not hydraulically connected to Loughaunierin via the surface waters which drain the Site.

The Maam-Clonbur groundwater body (GWB) (IE_WE_G_006) underlies the proposed Site boundary and is classified as being composed primarily of low transmissivity rocks with low permeability bedrock. The Maam-Clonbur GWB is designated as a Registered Protected Area (RPA) Salmonid Water Regulations. The Spiddal GWB which underlies the majority of the proposed grid connection route is a Registered Protected Area (RPA) for Shellfish. In addition, all Water Framework Directive (WFD) GWBs nationally have been identified as Drinking Water Protected Areas (DWPA) due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD. The catchment locations surrounding the Site area mapped in **Figure 9.9** and the Designates Sites in the wider region are mapped in **Figure 9.5,** both of these figures are contained in **Volume III.**

9.3.17 Water Resources

There are nine surface waterbodies in the wider Corrib catchment identified as Drinking Water Protected Areas (DWPA) based on water abstraction data on the abstraction register.

The closest surface water DWPA to the Site is Lough Corrib, a designated WFD drinking water lake. The Site boundary is located approximately 720m to the south of Lough Corrib Upper at the closest extent. Lough Corrib is an important public water source for the population of Galway City and other areas of County Galway. The rivers and streams which drain the Site are all headwaters of the Owenwee and Owenree Rivers, the latter of which ultimately flows into Lough Corrib Upper. Lough Corrib Upper is located approximately 1.5km downstream from the Site boundary at the closest extent via an unnamed headwater of the Owenree River and ultimately the Owenree River itself. A number of rivers which flow into Lough Corrib are listed on the Register of Protected Aras (RPA) for Drinking Water Rivers. However, none of the rivers which drain the Site are a RPA for Drinking Water Rivers. There are no RPA Drinking Water Rivers located withing 5km of the Site or the proposed grid connection route to Screebe 110kV Substation.

The EPA maintains a register of water abstractions in accordance with the *European Union (Water Policy) (Abstraction Registration) Regulations 2018 (S.I. No. 261 of 2018)*. All persons that abstract a volume of 25 cubic metres (25,000 litres) per day or more from rivers, lakes and groundwater are required to register. The EPA does not publish a detailed public abstraction register as it may contain personal or commercially sensitive information or other information that could jeopardise the security of water supplies. A limited publicly available version of the abstraction register is available from the EPA upon request which has been carried out. The data received does not include information on water abstractions where the abstraction purpose has been identified as being for drinking water. Additionally, grid references are rounded to the nearest kilometre to protect the identity of individual households and businesses, who may also use the abstracted water for private domestic use. The publicly available abstraction register does not include any abstractions for any purpose within 10km of either the Site or the proposed grid connection route.

There are no dwellings located within the Site boundary nor within the proposed spoil storage area. Consultation with Irish Water and the local authority has confirmed that there are no public water supplies (PWS) in existence in the area surrounding the Site. Discussions with local landowners have indicated that at least one property in the wider area downstream of the Site utilises the Owenwee River for domestic consumption purposes and one additional property utilises a filtration system to abstract water from the Owenwee River for drinking water purposes. There are no National Federation of Group Water Schemes (NFGWS) located in the vicinity of the Site nor in the vicinity of the proposed grid connection route. The closet NFGWS to the Site is located approximately 17km to the east of the Site near Carrowmoreknock, County Galway.

The proposed Site is located within the Electoral Division (ED) of Letterfore which contained 45 households according to the 2016 census. A review of the 2016 census data for the ED of Letterfore has been carried out to establish the percentage of the 45 households in the ED that source their water from either public or private sources. Privately sourced water supplies accounted for 77.8% of respondents within the ED in 2016 with the remainder consisting of public and private group scheme water supplies.

Galway County Council were also consulted for information pertaining to public and private water supplies. The Council confirmed that a public water main (Irish Water) exists along the existing road that the grid connection route will follow. Council records indicate that the water main is present along the R336 road from south of Aughawoolia Lough, continuing onto the R340 road past Screebe and towards Glencoh, County Galway. The water main is enclosed and protected in a pipe. Underground service searches will be carried prior to any trenching works that will be required along this section of the route to ensure that impacts on the water main are avoided. As a result, potential impacts on the water main are expected to be negligible.

9.3.18 Receptor Sensitivity

All water based receptors associated with the Development, such as streams, rivers, lakes and groundwater, are considered to be highly sensitive in accordance with the criteria set out in **Table 9.2**. A key basis for this consideration is due to the hydrological connectivity of the water bodies at the Site to the Lough Corrib via headwaters of the Owenwee and Owenree Rivers. Lough Corrib is also important as a drinking water source for Galway and it is utilised by wild brown trout and salmon as a nursery. The characterisation of the local water courses as highly sensitive is further indicated by the "*Good*" WFD status of local rivers such as the Owenwee and Owenree Rivers, the "*High*" WFD status of local lakes such as Lough Bofin and the connectivity to down-gradient designations (sensitive protected areas), associated sensitive habitats and species associated with same. Ultimately, all surface water and groundwater associated with the Site are considered sensitive and must be protected as per numerous legislative instruments relating to same. However, risk to receptors must consider both the hazard and likelihood of adversely impacting on any given sensitive receptor, and therefore parameters such as distance from the potential source of hazard to receptor, pathway directness and/or connectivity, and assimilative capacity of the receiving water body should also be considered.

In terms of surface water sensitivity, as is noted in **Section 9.3.11**, the vast majority of potential contaminants or adverse impacts would likely infiltrate to surface water bodies rather than to groundwater bodies. However, sensitive receptors are of variable distance to proposed turbine locations as is discussed in **Section 9.3.4**, and the pathways are of variable condition for each proposed turbine location and/or any part of the Development. Extensive surface water mitigation measures are outlined in **Section 9.5** to ensure protection of all downstream receiving water bodies. Mitigation measures will ensure that surface water runoff from the Site, and the proposed spoil storage area, will be of a high quality and will therefore not impact on the quality of downstream receiving waters. The proposed drainage design for the Site and spoil storage area will mimic the existing hydrological regime and will therefore significantly reduce potential changes to flow volumes leaving these areas.

A 50m buffer zone from all waterbodies will be maintained during the construction phase. The only exception to this rule will be where upgrades to pre-existing access roads that are already located within the 50m buffer zone are required or where unavoidable stream crossings are required. The vast majority of the proposed development areas are located greater than 50m distance away from watercourses that are considered to be sensitive to pollution. The significant buffer zone distance of 50m from sensitive watercourses will ensure that sensitive water courses will not be impacted as a result of excavations or other construction works such the construction of access roads. The buffer zone will also ensure adequate space is available for the proposed drainage mitigation measures to be suitably constructed up gradient of natural drainage features at the Site and spoil storage areas. This approach will allow for attenuation of surface water runoff to be diffuse and effective. In instances where implementation of a 50m buffer zone is unavoidable, such as at crossings or at upgrades to pre-existing roads, the use of sediment fences or straw bales will be implemented to reduce the potential for surface water run-off to sensitive watercourses. The proposed 50m buffer zone relative to the surface waters at the Site is mapped in **Figure 9.8** in **Volume III.** It is noted through consultation with Inland Fisheries Ireland outlined in **Table 9.7** that their recommendation is for a minimum 15m buffer zone to be implemented. Implementation of a 50m buffer zone can therefore be considered to be a conservative approach.

The nature of the proposed Development as a wind farm will necessitate near surface construction activities which would generally result in negligible groundwater impacts. Although all groundwater associated with the Site is protected as a source of drinking water, the bedrock aquifer underlying the Site and surrounding area is a poor aquifer except for local zones (PI), which can be expressed as an aquifer with poor production and low connectivity. As previously noted, this region of Ireland is amongst the worst from the point of view of groundwater potential. Most of the rocks have a low permeability and a poor aquifer potential. Groundwater is not a major source of drinking water for public supplies and therefore the risk of potential adverse impacts will be highly limited to localised zones. Furthermore, it is considered that the majority of any potential contaminants such as fuel/chemical spills or seepage from cementitious materials would likely infiltrate to surface water systems rather than recharge via percolation into groundwater. These potential impacts are common to all construction Sites. All potential contamination sources will be carefully managed during the construction and operational phases. Mitigation measures are proposed in **Section 9.5** to ensure that such potential impacts are appropriately managed. Based on the above factors and on the sensitivity criteria outlined in and **Table 9.2**, groundwater at the Site and spoil storage area can be classed as low sensitivity from potential adverse effects.

9.3.19 Haul Route

It is proposed that the turbine nacelles, tower hubs and rotor blades will be landed in Galway Port. From there, they will be transported to the Site via the R336 to Maam Cross and then the N59 east to the upgraded site entrance. There will be few changes to the existing public roads with the exception of temporary widening at 4 locations on the haul route to allow a load bearing surface and temporary changes to two roundabouts along the haul route. None of the temporary widening areas are located in close proximity to watercourses with the closest being located approximately 35m west of an unnamed tributary of the Screebe River adjacent to the R336 road west of the townland of Knockaphreaghaun. No additional bridges or temporary crossings will be constructed to facilitate these deliveries along the proposed haul route to the Site. Potential impacts on surface waters and groundwater resulting from use of the pre-existing road network to allow for deliveries to the Site are expected to be negligible. The proposed haul route is shown on **Figure 2.4** in **Chapter 2: Project Description**. There are four areas on the haul route that will require works in third party lands. These are shown on **Table 2.5** in **Chapter 2**.

9.3.20 Other Infrastructure - Borehole/s

Drilling of boreholes in general is not considered to have potentially significant impacts on groundwater. Furthermore, the proposed Development will not require the installation of boreholes for groundwater extraction purposes during the construction or operation phase. There is no potential for the Development to impact on groundwater due to drilling of boreholes for extraction purposes.

EIA Reports should be compliant but also proportional to the nature, scale and significance of effects. With reference to **Chapter 8: Soils and Geology**, drilling of boreholes and mechanical geotechnical testing have not been carried out as part of this assessment as these types of analyses are not considered proportional to the nature, location and size of the project and the limited significance of its effects on the surrounding hydrogeological environment. However, a detailed Site investigation (DSI) will be carried out at the pre-construction phase which will include drilling of boreholes and geotechnical testing of the underlying bedrock.

9.4 POTENTIAL EFFECTS AND MITIGATION MEASURES

9.4.1 Assessing the Magnitude of Potential Effects – Surface Water

The receiving environment in terms of **SURFACE WATER** associated with the Development is considered as being of **Very High Importance** and **Highly Sensitive**, and therefore classification of any potential impacts associated with the Development will be limited to Magnitudes associated with Very High Importance, as presented in the following table.

Table 9.27: Weighted Rating of Significant Environmental Impacts – Surface Water Systems – Limited to Very High

Sensitivity (Importance of Attribute/s)	Magnitude of Impact			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound

In terms of determining and assessing the magnitude of impacts on surface water features, categories of magnitude relate to the potential effect on the status of the attribute, that is; the attribute driving the classification of sensitivity such as the WFD status , and condition of the surface water feature/s, the risk of not reaching WFD objectives and the potential for the surface water system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.2 Assessing the Magnitude of Potential Effects – Groundwater

The receiving environment in terms of **GROUNDWATER** associated with the Development is considered as being of **Low Importance** and **Low to Medium Sensitivity**, and therefore classification of any potential impacts associated with the Development will be limited to

Magnitudes associated with Medium Importance as a conservative approach which is presented in the following table.

Table 9.28: Weighted Rating of Significant Environmental Impacts – Groundwater Systems – Limited to Medium

Sensitivity (Importance of Attribute/s)	Magnitude of Impact			
	Negligible (Imperceptible)	Small Adverse (Slight)	Moderate Adverse (Moderate)	Large Adverse (Significant to Profound)
Medium	Imperceptible	Slight	Moderate	Significant

In terms of determining and assessing the magnitude of impacts on groundwater features, categories of magnitude relate to the potential effect on the status of the attribute, i.e. the attribute driving the classification of sensitivity is the aquifer potential classification and use as a drinking water source, the proximity of the Site to groundwater wells, condition of the groundwater feature/s, the risk of not reaching WFD objectives, the GSI groundwater vulnerability classification and the potential for the groundwater system to support, or function as part of designated and protected areas (SAC, SPA, NHA etc).

9.4.3 Do Nothing Impact

If the proposed wind farm development does not proceed, current land use practices such as agricultural grazing and peat extraction will continue. There are no significant impacts to the hydrological and hydrogeological environment in the do nothing scenario.

9.4.4 Construction Phase Potential Effects

9.4.4.1 Assessment of Effects - Increased Hydraulic Loading

The proposed wind farm Development has the potential to result in increased rates of runoff during the construction phase relative to baseline conditions. Such an increase in surface water runoff from the proposed Development has the potential to result in increased hydraulic loading to the receiving drainage network and ultimately to the surface water network at the Site. Preliminary water balance calculations indicate that the Development will lead to a net increase of surface water runoff of approximately 1,117 m^3/month (or 0.38 % relative to the area of the Site) during the average wettest month of the year (December). This calculation, as shown in **Table 9.12**, assumes that all road and hardstand surfaces would be fully impermeable as a precautionary scenario which is unlikely to be considered as an option during the detailed design phase. Therefore, the real world runoff scenario is likely to result in a net increase of less than 0.38%. This is considered to be a likely, negative, imperceptible or not significant, imperceptible weighted significance, permanent impact of the Development. The increase in hardstand area associated with the Development will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered a likely, negative, imperceptible or not significant, Imperceptible weighted significance, permanent impact of the Development.

9.4.4.2 Assessment of Effects - Earthworks

The construction phase of the proposed Development will involve the following excavations activities which may have the potential to adversely impact on surface water and groundwater:

- Construction of Site Access Tracks and amenity roads
- Upgrading of the main pre-existing Site access track off the N59 road
- Temporary construction compound
- Turbine foundations and hardstand areas
- Foundations for the proposed substation
- Foundations for the proposed met mast
- Trenching for underground electrical cabling, including along the proposed grid connection route.
- Temporary and permanent stockpiling of peat, subsoils and bedrock.

All of the abovementioned excavations which will be required will necessitate the removal of vegetation, the excavation of peat and mineral subsoils. Such excavations and associated ground disturbance may increase the risk of either point source or diffuse sediment laden run-off to sensitive receptors via drainage channels and discharge routes. The proposed earthworks therefore have the potential to result in the release of elevated suspended solids to surface waters, particularly during prolonged heavy rainfall events. The release of elevated suspended solids to watercourses would adversely affect water quality and potentially negatively affect aquatic habitats or fish stocks downstream of the discharge source point if not mitigated against. The most vulnerable areas to surface water quality deterioration through the release of elevated suspended solids are considered to be:

- Proposed track crossing points of streams
- Turbine hardstand and infrastructure development, particularly at moderate to high gradient slopes to existing waterways
- Upgrading of the pre-existing Site access track which is located north of the N59 road and adjacent to the Owenwee River.
- The permanent placement of spoil at the proposed spoil storage areas which are located south of Loughanillaun and north of Ardderry Lough.

The potential release of elevated suspended solids to surface waters is considered to be a direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance, impact of the Development. This potential impact is considered to be in contrast to baseline conditions, with the exception of where peat extraction activities have the potential to result in increased sediment laden run-off, although it is also temporary. Although this impact is likely to be temporary, considering the mobility characteristics of surface waters to downstream receptors, it is not considered reversible. However, with appropriate mitigation measures in place and via the implementation of environmental engineering controls, this impact will be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this chapter.

Potential localised peat stability issues, and erosion or degradation of peat such as by vehicular movements have the potential to increase the potential for entrainment of suspended solids in surface water runoff, impact or obstruct established drainage networks, and increase the amount of excavation works required generally which in turn increases the potential for standard effects associated with earthworks. This is considered an unlikely, direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance impact on receiving surface waters, assuming mitigation measures described in **Chapter 8: Soils and Geology** and in this Chapter are implemented and adhered to. This potential impact is considered to be in contrast to baseline conditions, with the exception of where peat extraction activities have already occurred which could have resulted in the potential entrainment of suspended solids in surface water runoff, but is also temporary.

A potential worst-case scenario associated with earthworks activities is the potential for significant stability issues leading to mass peat movement or landslides. As discussed in **Chapter 8: Soils and Geology** and the associated Peat Stability Risk Assessment, the risk of significant stability issues leading to mass movement or landslides has been assessed in the Peat Stability Risk Assessment prepared by Andrew Garne Geotechnical Services. In the event of such an occurrence, there is the potential to greatly increase entrainment of suspended solids in surface water runoff, impact or obstruct established drainage or surface water networks. Such an occurrence could potentially adversely impact upon sensitive aspects of the environment, and increase the amount of excavation works required, including for emergency remediation, which in turn would increase the potential for standard effects associated with earthworks. This is considered an unlikely, indirect, negative, potentially profound, potentially Profound weighted significance impact. This potential impact is considered to be in contrast baseline conditions and also potentially permanent.

Table 9.29: Impact Summary – Earthworks

Impact Description	Type	Quality	Significance	Weighted Significance	Context	Probability	Duration / Frequency	Reversible
Entrainment of suspended solids during earthworks	Direct	Negative	Moderate to Significant	Significant / Profound	Contrast to baseline	Likely	Temporary	No but can be minimised
Increased entrainment of contaminants and other impacts arising due to localised stability issues	Direct	Negative	Moderate to Significant	Significant / Profound	Contrast to baseline	Unlikely[1]	Temporary	No but can be minimised
Catastrophic impacts arising from significant stability issues (Landslide – worst case)	Indirect	Negative	Potentially Profound	Potentially Profound	Contrast to baseline	Unlikely[2]	Permanent	No

[1] Assuming mitigation measures described in **Chapter 8: Soils and Geology** and in this chapter are implemented and adhered to, localised stability issues are unlikely to give rise to impacts on surface water networks associated with the proposed development.

[2] With reference to **Appendix 8.1 Peat Stability Risk Assessment** and **Chapter 8: Soils and Geology**, the risk of mass movement of peat is considered to be low. **Section 8.3.10** of **Chapter 8** notes that the risk of a peat slide occurring at the proposed locations of turbine T2, turbine T5 and the substation are considered to be "Low", while the risk of a peat slide occurring at the remaining four turbine locations is considered to be negligible due to a recoded peat depth of less than 0.5m. The risk of a slide occurring along the proposed grid route is also considered to be negligible due to a combination of low slopes and generally thin or absent peat in addition to the grid route being located within existing roads and pavements.

9.4.4.2.1 Monitoring

Monitoring of peat, subsoils, bedrock and material management during the construction phase of the Development will be fundamentally important in ensuring that potential suspended solid entrainment in surface waters is minimised. With comprehensive planning and preparation, and implementation of relevant mitigation measures contained in the CEMP appended to the EIAR in **Appendix 2.1**, the potential for elevated suspended solids to be released to surface waters via runoff is likely to be minimal. Monitoring of surface water quality is discussed in greater detail in **Section 9.5.2.10** of this chapter.

9.4.4.3 Assessment of Effects – Excavation Dewatering

The dewatering of excavations during construction is likely to have significant adverse effects on surface water runoff quality in the absence of mitigation measures. Should dewatering of open excavations, Turbine Foundations etc. be required, the receiving engineered drainage and attenuation features will likely receive water discharges elevated in suspended solids. The potential overflow of such sediment laden water into the receiving downstream surface waters is considered to be a likely, direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance of the Development. This impact is considered to be in contrast to baseline conditions although it is also temporary. Although temporary, considering the mobility characteristics associated with flowing surface waters, it is not considered reversible. However, with the implementation of appropriate mitigation measures and environmental engineering controls, this potential impact can be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this report.

Potential dewatering through drainage in advance of excavation activities, or dewatering via pumping during excavation activities, will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered to be a likely, negative, slight, Slight weighted significance, localised impact of the Development which is in contrast to the baseline conditions. The potential effects on groundwater during the proposed operational phase of the development is considered to be negligible to low. Contaminated land has not been identified at the Site or spoil storage areas and therefore the potential for sources of contamination other than elevated suspended solids to be released to surface waters through dewatering activities is not anticipated.

9.4.4.4 Diversion and Enhancement of Drainage

The Development will result in the diversion, alteration and/or enhancement of the existing drainage networks at the Site during the construction of the project relative to baseline conditions. The existing drainage network at the Site is mapped and presented in **Figure 9.3** in **Volume III.** Considering that pre-existing natural and artificially established drainage networks are present at the Site, the diversion, enhancement or introduction of additional drainage features is considered a likely, negative, moderate, localised impact of the Development which conforms to baseline conditions. However, there are potential risks associated with the earthworks required to carry out such drainage works. The potential impacts of excavations are addressed in **Section 9.4.4.2** and in **Chapter 8: Soils and Geology.**

9.4.4.5 Watercourse Crossings

At the Site, two new watercourse crossings in the form of 4m wide bottomless culverts will be constructed as part of facilitating access across small unnamed headwaters of the Owenree River and on to the proposed turbines T4 and T5. A third 4m wide bottomless culvert will replace an existing small culvert already in place along the unpaved access track from the main site to the N59 Road which drains a small unnamed stream to the Owenwee River. An existing bridge, also located along the unpaved access track leading from the main site to the N59 Road will also be upgraded to facilitate the movement of heavy goods vehicles. The design of the required bridge upgrade and the required culverts are shown on **Figures 2.6 (a), (b), (c)** and **(d**) respectively in **Volume III**, the locations of the proposed crossings are mapped in **Figure 9.7** in **Volume III.** It is noted that the small stream which will require crossing for access to the T4 turbine position was consistently dry during the water quality monitoring rounds discussed in **Section 9.3.8** and it is therefore considered to be an ephemeral stream which may not be in flow during the time at which the construction of a crossing is required. For the purposes of conservatism and the adoption of the precautionary principle, it has been assumed that this ephemeral stream will be flowing at the time when a crossing is being constructed to access the T4 turbine position.

Construction of any new watercourse crossing will have an inherent risk of resulting in adverse impacts to surface waters due to the required ground disturbance through excavations and the movement of heavy plant machinery and the proximity to the primary sensitive receptor which is the watercourse itself. Pre-existing crossings in the form of bridges and culverts across the Owenwee River are in place along the existing access track at the eastern extent of the redline boundary. Therefore, the introduction of the proposed new watercourse crossings is considered to conform with baseline conditions at the Site. In relation to the proposed grid connection, spoil storage areas and haulage route, no new watercourse crossings / culverts will be constructed.

Release of elevated suspended solids to surface waters due to excavations or other earthworks etc., or the accidental release of any form of anthropogenic contaminant such as fuels or chemicals during construction of new watercourse crossings are both potential significant adverse effects. This is considered a likely, negative, significant, but temporary impact of the Development which contrasts to baseline conditions. The impacts relating to the release of contaminants during earthworks is addressed in **Section 9.4.4.2** of this Chapter.

Poor planning, design and construction methodology of new watercourse crossings can potentially result in significant changes in flow, erosion and deposition patterns and rates associated with the surface water feature. This in turn can potentially lead to flow being restricted leading to increased risk of flooding locally. In the absence of mitigation measures, these impacts are considered a likely, negative, significant, Profound weighted significance, localised impact of the Development which contrasts to baseline conditions.

9.4.4.6 Potential Effects on Surface Water and Groundwater Quality

9.4.4.6.1 Assessment of effects - release of suspended solids

The proposed Development has the potential to result in the release of suspended solids during the construction phase of the project relative to baseline conditions. Runoff of suspended solids will increase turbidity concentrations in surface waters which can smother spawning grounds, reduce light penetration for flora growth, block fish gills, and promote algal growth in surface waters.

Nutrients associated with the solids entrained in run-off such as phosphorus, nitrogen and other potential contaminants such as hydrocarbons can lead to eutrophication of the water environment and eventually to fish-kills due to lowering of the dissolved oxygen concentration. Freshwater Pearl Mussels are particularly sensitive to changes in water quality, and in particular elevated suspended solids. **Chapter 6: Biodiversity** of this EIAR outlines further information on the Freshwater Pearl Mussels and other ecological sensitivities.

In addition to potentially direct adverse impacts on ecological sensitivities down-gradient of the Site, runoff of suspended solids will potentially impact on the WFD status and objectives associated with the surface water networks both within and downstream of the proposed development. Considering the good quality of the baseline surface waters draining from the Site and the spoil storage areas, in addition to the sensitivity and 'Very High' importance of the associated surface water networks, any introduction of contaminants is considered an adverse impact of high significance. The release of suspended solids is considered a direct, negative, potentially moderate to significant, potentially Significant / Profound weighted significance impact of the Development. This impact is considered to be in contrast to baseline conditions but also temporary in nature. Considering the long ranging mobility of surface waters, this potential impact is not considered reversible. However, with the implementation of mitigation measures and appropriate environmental engineering controls, this impact can be reduced to within water quality regulatory limits.

It is considered that the release of suspended soils does not have significant potential to adversely impact on groundwater due to the natural process of filtration associated with percolation of water through soils. This principle is particularly pertinent at a Site of this nature where a combination of low permeability subsoils beneath the peat and low recharge rates at the Site are anticipated.

9.4.4.6.2 Assessment of effects – release of hydrocarbons and storage

Hydrocarbons are a pollutant risk due to their inherent toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and do not readily dissolve in polar solvents such as water. Most hydrocarbons are light non-aqueous phase liquids (L-NAPL's) that they are less dense than water. If hydrocarbons are accidentally released to water, they will therefore float on the water's surface. Hydrocarbons adsorb onto the majority of natural solid objects they come in contact with, such as peat, soil, vegetation and animals. Hydrocarbons will burn most living organic tissue they come in contact with due to their volatile chemistry. Hydrocarbons also represent a nutrient supply for adapted micro-organisms, this process in turn can rapidly deplete dissolved oxygen and thus result in fish kills or mortality of water based vertebrate and invertebrate life.

During the construction phase, vehicles and plant associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon spillages and leaks from fuels and oils. The risk is increased when regular refuelling is required which in turn implies the requirement of a designated refuelling area which will likely require fuel storage on Site. Alternatively, the fuel could be supplied by fuel tanker scheduled to refuel the plant and equipment directly.

Hydrocarbons or any other forms of toxic chemicals such as paints or adhesives etc. accidentally released to the environment will likely be intercepted by drainage and surface water networks at the Site. The low permeability subsoils beneath the peat and low recharge rates at the Site will inhibit the spatial distribution and temporal variation of hydrocarbon mass and concentration should an accidental spill occur. This results in limited potential for contaminant movement through peatland. Therefore, the risk to subsoils / peat is limited, and in turn the risk to groundwater at a significant scale is also limited.

With regards to surface waters at the Site and spoil storage areas, an accidental hydrocarbon spillage is considered a likely, negative, significant to potentially profound, Profound weighted significance, medium to long term impact of the Development, which is in contrast to baseline conditions.

In terms of groundwater associated with the Site and spoil storage areas, an accidental hydrocarbon spillage is considered to be a likely, negative, significant, Significant weighted significance, localised medium to long term impact of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

9.4.4.6.3 Assessment of effects – release of wastewater sanitation contaminants

The Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto peat/soils and ultimately into surface waters during the construction phase of the project. The installation of permanent sanitation facilities at the Site will not be required for the operational phase of the proposed Development.

Sanitation facilities such as portaloos used during the construction phase will be self-contained and supplied with water by tank trucks. Portaloos will contain water storage tanks and separate wastewater storage tanks which will be routinely emptied by vacuum removal for off Site disposal via a tank truck. Accidental release of wastewater to surface waters would likely result in an increase in biochemical oxygen demand (BOD) which in turn would lower the dissolved oxygen concentration and adversely impact on aquatic life. Wastewater sanitation chemicals are also pollutant risks due to their inherent toxicity to aquatic flora and fauna and their potential to adversely impact on the productivity or status of surface water systems. The level of risk posed by such temporary facilities is dependent upon the following key factors:

- The location of the proposed temporary sanitation facilities relative to sensitive receptors
- The condition, emptying schedule and maintenance of the facilities
- The level of toxicity of the chemical agents used to aquatic flora and fauna.

A potential worst case scenario(s) associated with wastewater sanitation is the potential for wastewater or sanitation chemicals to accidentally spill or leaking and to be intercepted by surface water drainage features, ultimately discharging to surface waters. This is considered to be an unlikely, negative, significant, Profound weighted significance, medium to long term impact of the Development, which is in contrast to baseline.

With the implementation of appropriate mitigation measures, these potential risks can be significantly reduced.

9.4.4.6.4 Assessment of effects – construction or cementitious materials

The construction phase of the Development has the potential to result in the accidental spillage or deposition of construction waste into peatland or soils. This in turn has the potential for waste materials to leach out toward preferential drainage flow paths that may ultimately be connected to the surrounding surface water network.

The accidental leaching of cementitious wastes such as concrete, lean mix or cement etc., can result in an adverse change to hydrochemistry which can adversely impact on sensitive aquatic flora fauna. Cementitious materials are highly alkaline and if accidentally released to surface waters can significantly elevate the pH concentration above the tolerance range of fish such as cyprinid and salmonid species. Freshly poured or wet concrete has greater potential to leach out towards preferential flow paths when compared to set concrete which is considered inert in comparison, the risk from wet concrete is further increased during periods of heavy rainfall. Surface water runoff that comes into contact with concrete will be impacted to a lesser extent than water percolating through lean mix concrete which will be impacted significantly. Regardless of the nature of the construction waste in question, the deposition of any construction materials or waste deposited at the Site that does not form part of the constructed development, even if inert, is considered contamination.

The accidental spillage or deposition of construction materials such as wet or lean mix concrete which is intercepted by drainage or surface water networks is considered a direct, negative, moderate to significant, Significant / Profound weighted significance, temporary to medium term impact of the Development, which is in contrast to baseline.

With the implementation of appropriate mitigation measures and environmental engineering controls described in 9.5, these potential risks can be significantly reduced and are considered unlikely.

9.4.4.7 Potential Effects on Hydrologically Connected Designated Sites

The proposed Site and spoil storage areas are situated up stream of the following Designated Sites which are discussed in detail in **Section 9.3.16**:

- Lough Corrib SAC, SPA and pNHA
- Connemara Bog Complex SAC and pNHA
- Maumturk Mountains SAC and pNHA

The southern extent of the Site is also bound by the Ballycuirke Lough Stream sub-catchment which is listed as a Margaritifera Sensitive Area in accordance with the EU

Habitats Directive. The proposed spoil storage areas and grid connection route also border the Maumturk Mountains SAC and pNHA. The pre-existing substation at Screebe is not located within a designated area of conservation, it is located to the north of the Kilkieran Bay and Islands SAC and it is located to the north-east of the Glencoh Rock pNHA.

Any accidental release of potential contaminants to the environment as a result of the Development will likely be intercepted by the drainage and surface water network at the Site. Therefore, any contaminants released will subsequently impact on a designated site. Contaminants which are intercepted by the surface water network may also be carried further downstream towards other designated sites. The potential of the Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered to be a negative, significant to profound, Significant / Profound weighted significance, potentially temporary to long-term impact of the Development which is in contrast to the baseline.

However, with the implementation of appropriate mitigation measures and environmental engineering controls, these potential risks can be significantly reduced and are considered unlikely. Furthermore, considering the geographical scale of Lough Corrib as the second largest lake in Ireland (18,240ha), the assimilative capacity of the surface water systems will buffer against any potential contaminants introduced. In the event of accidental release of contaminants to surface waters at the Site, they will become more diluted in receiving waterbodies as the distance from the Site increases. This principle does not lessen potential adverse impacts in the immediate vicinity and it does not reduce the need for robust mitigation measures to be implemented.

9.4.4.8 Drilling of Boreholes and Extraction of Groundwater

The bedrock formations underlying the Site and spoil storage areas are predominantly classified by the GSI as Poor Aquifers (Pl: which is generally unproductive except for local zones). Poor aquifers will have moderate to low well yields of less than 100m^3 per day. Drilling of boreholes in general is not considered to have potentially significant impacts on groundwater. Extraction of groundwater is considered to have potentially significant impacts on groundwater and on associated sensitive receptors. The proposed Development will not require the installation of boreholes for groundwater extraction purposes during the construction or operation phase. All fresh water required during the construction phase of the project will be delivered to the Site via tank trucks. Therefore, there is no potential for the Development to impact on groundwater due to drilling of boreholes for extraction purposes.

9.4.4.9 Potential Effects on Local Groundwater Supplies (Wells)

Given the incomplete nature of the GSI well database and the rural location, it has been assumed for the purpose of conservatism that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography. In other words, the groundwater flow paths are expected to be from topographic high points to lower elevated discharge points at streams, flushes, bog pools, lakes and rivers. Utilising this conceptual model of groundwater flow, dwellings that are located down gradient of the Site can be identified as potential receptors. The groundwater flow direction in the area of the Site is expected to be predominantly in a west to south-west direction. There are no dwellings located withing the redline Site boundary, 29 dwellings are located within 2km of the Site including a small number of dwellings to the west and south-west of the redline boundary in the townlands of Derrybeg, Tawnaghbeg and Tullaghboy. However, the closest dwelling to a proposed turbine position (T4) is situated approximately 770m to the south-west. Similarly, the closest dwellings to the proposed substation and meteorological mast are located approximately 425m and 280m respectively to the southwest of these structures. It is anticipated that any potential groundwater impacts will have significantly attenuated across these distances in the underlying poorly productive aquifer.

Piling works will not be carried out at turbine positions due to the presence of shallow rock across much of the Site. Excavations will be advanced to approximately 3m and mass reinforced concrete gravity bases will be constructed. Minimal excavation dewatering is expected to be required at turbine positions or hardstand locations. Excavations will occur in a low permeability environment which will have a containment effect on the localised groundwater. The potential for any possible contaminants to leach or migrate across long distances or to alter the localised groundwater chemistry will therefore be limited. Excavations are not expected to be required at the spoil storage areas where only the placement of spoil is expected to be carried out. A combination of low permeability subsoils beneath the peat, the temporary nature of the construction works, low recharge rates at the Site and the absence of proximity to the nearest dwellings is expected to result in a likely, neutral to negative, slight to moderate significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

9.4.4.10 Potential Groundwater and Surface Water Effects due to the Grid Connection Cable Works

Galway County Council and the GSI well database has indicated that there are no mapped or known wells located along or within the vicinity of the proposed grid connection route. However, given the incomplete nature of the GSI well database and the rural location, it is considered that private wells are in use along the proposed grid connection route to Screebe. Shallow trenching which will be backfilled is expected to be required for the proposed grid connection, the shallow trenching will not breach the groundwater table. Horizontal directional drilling will be required adjacent to five bridge locations along the grid connection route. In the unlikely event that a brecciated or fractured formation were to occur, it could potentially result in the loss of drilling fluid through cracks, voids and fractures. However, if a frac-out occurs, there will be a loss in drilling pressure, this is a signal to the operator that an issue has arose with the drilling process and the drilling would be immediately ceased. The method for reducing the drilling fluid losses and thereby control the consumption of water and drilling fluid products is to identify the point of losses and seal the area off. Clearbore drilling fluid will be used during the drilling process which is not toxic to aquatic organisms and is biodegradable which further reduces the potential for adverse impacts in the event of frac-out occurring.

Due to the vast majority of the gird connection requiring shallow trenching that will be backfilled, the temporary nature of the construction works, the established HDD technique with controls and non toxic fluids is expected to result in a neutral to negative, slight to moderate significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

9.4.4.11 Potential Groundwater and Surface Water Effects due to Internal Cable Works at the Site

The internal cable works at the main site will follow the hardstand and road alignment and will be predominantly buried within shallow cable tranches. It has been assumed for the purpose of conservatism that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography. Utilising this conceptual model of groundwater flow, dwellings that are located down gradient of the Site can be identified as potential receptors. The groundwater flow direction in the area of the Site is expected to be predominantly in a west to south-west direction. There are no dwellings located within the redline Site boundary, 29 dwellings are located within 2km of the Site including a small number of dwellings to the west and south-west of the redline boundary in the townlands of Derrybeg, Tawnaghbeg and Tullaghboy. However, the closest dwelling to a proposed turbine position (T4) is situated approximately 770m to the south-west, it is anticipated that any potential groundwater impacts will have significantly attenuated across this distance in the underlying poorly productive aquifer.

At two proposed watercourse crossing locations spanning the access roads to turbines T4/T5 and along the main site access road adjoining the N59 Road, internal cables will be entrained within the culvert crossing structures at these locations and are not expected to have an adverse impact on surface water quality. Due to the alignment of the internal cable works with the proposed site access roads, the shallow trenching, the absence of proximal groundwater wells and the sealed nature of the internal cable works at the two proposed crossings, internal cable works are expected to result in a neutral to, slight significance, localised impact of the Development which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced to Imperceptible to Slight.

9.4.5 Reinstatement of Redundant Access Track, Hardstand Areas and Borrow Pits

Site Access tracks and Turbine Hardstand areas, such as Site compound areas that will be utilised for the construction phase of the proposed Development will become redundant following the completion of construction activities at the Site. Redundant access tracks and hardstand areas will require the removal of the top layer of hardstand and temporary access tracks. The underlying peat or soil will not be significantly exposed during such top layer surface removals. Any excess peat from the top layer removals will be transported to the designated Spoil Storage Area.

Depositing of acrotelm (or vegetated peat) over the areas in question will be carried out following the removal of the surface layers. Catotelm peat will not be used to reinstate redundant Turbine Hardstand areas or Site Access Tracks as it is prone to rapid erosion. There is potential for elevated suspended solids to become entrained by surface water runoff during the reinstatement of such areas. Any impacts to the receiving hydrological and hydrogeological environment during reinstatement are likely to be slight and infrequent with the implementation of the mitigation measures and precautions described in this report. Reinstatement of redundant infrastructure following the Development construction phase is considered a positive, or beneficial impact of the Development. Although reinstatement will not revert the areas in question to pre-existing baseline conditions, it will serve as a foundation for the promotion and establishment of new blanket bog and associated ecological and biodiversity benefits.

9.4.6 Operational Phase Effects

The replacement of the vegetated surface at the Site with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. The completed Site footprint will comprise of Turbine Hardstand areas, Site Access Tracks, Sub-station and Met Mast. The spoil storage area has been designed to ensure that all spoil placement areas are setback a minimum distance of 50m from all identified watercourses.

During prolonged heavy rainfall events, additional surface water runoff at increased flow velocity could increase hydraulic loading. This in turn has the potential to result in enhanced erosion of watercourses and adverse impact on aquatic ecosystems. However, with the implementation of the proposed drainage design discussed in the **Surface Water Management Plan** attached as **Appendix 2.1.**, it is anticipated that such potential impacts are expected to be an imperceptible to slight, neutral, permanent impact during the operational phase. Nevertheless, the mitigation measures described in this report will be implemented in full as applicable.

9.4.7 Decommissioning Phase

Decommissioning of the Development will result in the cessation of renewable energy generation at the end of the operational life of the wind farm with the removal of various infrastructural elements. The decommissioning phase will involve the removal of the above ground elements of the wind farm which will require:

- De-energising of the Site via a high voltage (HV) disconnection followed by low voltage (LV) disconnection of turbines
- Removal of the substation building
- Controlled dismantling of turbine components such as blades, tower and nacelle
- Controlled removal of the met mast
- Removal of de-energised underground cables, electrical control systems and ducts.

It is anticipated that the following elements of the wind farm will be left in place after decommissioning:

- The reinforced concrete turbine foundations
- The turbine hardstanding areas adjacent to the turbines
- The site access roads
- The hardstanding area for the substation
- The site drainage network.

There will not be a requirement for additional drainage measures to be implemented during the decommissioning phase of the proposed Development. With the passage of time, the constructed drainage network will likely become full of deposited sediment and revegetation will naturally occur which will render the drainage system less effective over time. The Site will therefore revert over time to a more natural drainage regime that is similar to its current baseline environment. Given the relatively long operational lifespan of wind farms, the groundwater levels on the Site will have stabilised at a new equilibrium steady state condition when the decommissioning phase is required. As the efficiency of the drainage network is reduced over time, a gradual restoration of groundwater levels on the Site will occur. The works to be completed during the decommissioning phase are expected to result in an imperceptible to slight, neutral, permanent impact on the hydrological and hydrogeological setting surrounding the Site.

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

The Development has associated potential impacts as described in the previous sections of this report. The following sections outline mitigation measures to be implemented during the design, construction, operational and decommissioning phases of the Development. Potential residual effects after mitigation measures are implemented are also described in the following sections.

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

The fundamental mitigation measure to be implemented during each stage of the proposed Development will be avoidance of sensitive hydrological or hydrogeological receptors wherever possible, this key principle is referred to as "mitigation by avoidance". This principle has been adopted during the design of the turbine and associated infrastructure layout across multiple design iterations. Hydrological constraints maps have been developed which identified areas of the Site where surface water and drainage constraints resulted in areas of the Site being deemed less suitable for development. The multiple constraints maps are presented in **Volume III**. The identified constraints have been extensively discussed in consultation with the design team. The final Site layout plan has been identified as the optimal layout design available for protecting the existing hydrological regime of the Site, while at the same time incorporating and overlaying engineering and other environmental constraints.

9.5.1.2 Constraints

As part of mitigation by avoidance principles applied during the design phase of the Development, a self-imposed 50m buffer zone around surface waters and significant drainage features was implemented. The 50m buffer zone is intended to inform the design process by minimising or avoiding the risk to surface water receptors and by restricting construction disturbance to outside these zones. The buffer zone will in turn provide enhanced potential for filtering capacity of runoff and will protect riparian zone vegetation. The implementation of 50m surface water buffer zones is not a legislative requirement, particularly for unmapped surface water features. However, it has been employed for identifying areas of the Development which pose an elevated risk in terms of sensitive surface water receptors. It should also be noted that consultation with IFI regarding the proposed Development has indicated that at least 15m should be considered as a bare minimum for a riparian zone. A self-imposed 50m buffer zone can therefore be considered to be a highly conservative approach.

The layout of the Development itself is inherently restricted due to the proposed infrastructure requirements, such as the proposed turbines require a minimum distance from each other to ensure the potential for wind turbulence impacting on downwind locations is minimised. The vast majority of the proposed Development features will be situated outside of the 50m buffer zone, with the exception of the following unique and unavoidable circumstances:

- The pre-existing Site access road, its associated bridge and culvert crossings, to the north of the N59 road, which will require upgrading, is already located inside a 50m buffer zone of the Owenwee River
- The proposed hardstand area for the T5 turbine position will from part of a crossing of an unnamed upland stream
- The Site access road to the proposed T4 turbine position will require a crossing of an unnamed ephemeral stream which was dry on multiple occasions during the water quality monitoring rounds.
- Temporary haul road widening area located approximately 35m west of an unnamed tributary of the Screebe River adjacent to the R336 road, west of the townland of Knockaphreaghaun.

The principle of mitigation by avoidance during the design phase has been implemented to the fullest practical extent. However, additional consideration and planning measures as described in **Section 9.5.2.7** will be required for the abovementioned areas which could not be designed for positioning outside of the 50m surface water buffer zone. The almost right-angled nature of the upland stream near the proposed T5 position, which flows from north to south-west in a downgradient arc is restrictive by nature. The flow path of this unnamed stream dissects large sections of the Site compared to other unnamed streams which discharge rapidly in a near straight line uniform fashion to the Owenwee and Owenree Rivers.

During the Site surveys discussed in **Section 9.2.4**, multiple natural and artificial drainage features were observed, surveyed and have been mapped on **Figure 9.3** in **Volume III**. Some of these drainage features are relatively well connected to the mapped surface water network, especially at lower altitude areas of the Site. Given the pre-existing access track and established drainage network at the Site, and the limited nature of the Development in terms of utilising the existing infrastructure (i.e. as a predominantly rural greenfield Site), some construction activities will invariably be required in close proximity to surface waters, including within the 50m buffer zone.

Careful consideration and special attention to planning is required for the identified locations within the surface water 50m buffer zone as described in **Section 9.5.2.7**. The **Surface Water Management Plan** attached as **Appendix 2.1** details multiple mitigation measures for works proposed within the 50m buffer zone. Each proposed construction location will possess unique characteristics and will require assessment on a case by case basis to ensure adequate measures are implemented. Method statements and the proposed design of any road crossings as described in **Section 9.5.2.7** will also require agreement from Inland Fisheries Ireland (IFI) in advance of construction which invariably must be constructed within the 50m buffer zone as explained above.

9.5.2 Construction Phase

9.5.2.1 Earthworks Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from earthworks and management of spoil include the following:

- Management of excavated material will adhere to the measures related to the management of temporary stockpiles outlined in **Chapter 8: Soils and Geology**
- No permanent or semi-permanent stockpiles will remain on the Site during the construction or operational phase of the Development. Spoil to be taken off site to the designated spoil storage area near Maam Cross
- Suitable locations for temporary stockpiles will be identified on an individual basis. The suitability of any particular location will consider Site specific characteristics, including;
    - The location of drainage networks in the vicinity
    - The slope incline and topography of the downgradient area
    - Any other relevant characteristics which are likely to facilitate or increase the potential for entrainment by surface water runoff.
- Construction activities will not be carried out during periods of sustained significant rainfall events, or directly after such events. This will allow sufficient time for work areas to drain excessive surface water loading and discharge rates to be reduced

- Following heavy rainfall events, and before construction works recommence, the Site will be inspected and any required corrective measures implemented
- An emergency response plan will be developed for the construction phase of the project. The plan, at a minimum, will involve 24-hour advance meteorological forecasting linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded such as a very heavy rainfall at >25mm/hr, planned responses will be undertaken. These responses will include cessation of construction until the storm event, including storm runoff has ceased
- Sediment fencing will be erected along proximal and paralleling areas of watercourses, channels and drains spanned by the works to reduce the potential for sediment laden run-off to reach sensitive receptors
- No direct flow paths between stockpiles and watercourses will be permitted at the Site
- Excavated material will be backfilled are transported to the spoil storage area as soon as is reasonably practicable to prevent long duration storage at the Site which increases the risk of adverse effects on aquatic environments
- All mitigation measures related to surface water quality described throughout **Section 9.5** will be implemented before excavation works commence.

9.5.2.2 Excavation Dewatering Proposed Mitigation Measures

Mitigation measures to reduce the potential for adverse impacts arising from dewatering activities include the following:

- Management of excavations will adhere to the measures outlined in **Chapter 8: Soils and Geology**. Areas of peat and subsoils to be excavated will be drained ahead of excavation works. This will reduce the volumes of water encountered during excavation works and will therefore reduce the volume of water that is required to be dewatered whilst excavations are being carried out.
- Engineered drainage and attenuation features outlined in the **Surface Water Management Plan** attached as **Appendix 2.1** will be established ahead of excavation works
- Dewatering pumping rates will be controlled by an inline gate valve or similar infrastructure which will facilitate a reduction of loading on the receiving environment, thus enhancing the attenuation and settlement of suspended solids
- The direct discharge of dewatered loads to surface waters will not be permitted under any circumstances
- All dewatering will follow a strict procedure of pumping to a settlement tank and then to a dewatering bag, or settlement ponds prior to discharging to receiving environment for overland flow

- Geofabric lined settlement ponds will buffer the run-off discharging from the drainage system which will reduce the hydraulic loading to watercourses. Settlement ponds will be designed to reduce flow velocity to 0.3m/s at which velocity silt settlement generally occurs. In areas of the Site where the placement of settlement ponds is not feasible, other mitigation measures described below will be implemented
- Check Dams will be constructed across drains and will reduce the velocity of run-off which will in turn promote settlement of solids upstream of potential surface water receivers. An additional benefit of check dams is that they will reduce the potential for erosion of drains. Rock filter bunds may be used for check dams, wood or hay bales can also be used if properly anchored. It is recommended that multiple check dams are installed, particularly in areas immediately down gradient of construction areas
- Overland flow paths of the final dewatered discharge will be maximised to the greatest practical extent to avoid prematurely draining to drainage channels or surface waters. This approach will allow for enhanced settling out of suspended solids entrained in the run-off
- All pumps, tanks, settlement ponds, dewatering bags and check dams used in the dewatering process will be regularly inspected and maintained as necessary to ensure surface water run-off is appropriately treated
- Sediment fencing will be installed up gradient of water courses which may receive the final overland flow
- The final treated dewatered discharge will be directed towards heavily vegetated areas to allow for further natural filtration of suspended solids
- A programme of water quality monitoring will be implemented during the construction phase which is outlined in detail in **Section 9.5.2.10**
- No extracted or pumped water will be discharge directly to the surface water network associated with the Site (this is in accordance with the Local Government (Water Pollution) Act 1977 as amended)
- Any discharges of sediment treated water should meet the requirements of the Surface Water Regulations 2009, as amended.

9.5.2.3 Release and Transport of Suspended Solids Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts from the release of suspended solids to the surface waters will be implemented:

- Collector drains and soil berms will be implemented to direct and divert surface water runoff from construction areas such as temporary stockpiles into established settlement ponds, buffered discharge points and other surface water runoff control infrastructure. This planning and placement of these control measures will be of fundamental importance, especially for the areas where works within the 50m buffer zone will be unavoidable which is discussed in **Section 9.5.1.2**

- Sediment control fences will be implemented significantly upgradient of potential receiving waters and as part of the drainage network. Sediment control fences will also be established upgradient of the Sites pre-existing natural and artificial drains in addition to degraded areas of peat that are likely to receive surface water runoff. This practice will reduce the potential for elevated suspended solids entrained in surface water runoff to discharge to surface waters
- Multiple silt fences will be used in drains discharging to the surface water network. This will be especially important for the areas where works within the 50m buffer zone will be unavoidable which is discussed in **Section 9.5.1.2**
- The drainage, attenuation and other surface water runoff management systems will be installed prior to the commencement of construction activities. Whenever possible, drainage and attenuation control measures will be installed during seasonally dry conditions to limit the potential for sediment laden run-off to discharge to surface waters during the installation of these measures
- Surface water runoff will be discharged to land via buffered drainage outfalls that will contain hardcore material of similar composition to the geology of the bedrock at the Site. This mitigation measure will promote the capture and retention of suspended sediment
- Buffered drainage outfalls also promote sediment percolation through vegetation in the buffer zone, reducing sediment loading to adjacent watercourses and avoiding direct discharge to the watercourse
- Buffered drainage outfalls will be placed outside of the 50m buffer zone and will not be positioned in areas with extensive erosion and degradation
- A relatively high number of discharge points will be established to decrease the loading on any one particular outfall
- Discharging at regular intervals mimics the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points
- A Site specific CEMP appended to the EIAR in **Appendix 2.1** has been developed which mandates regular inspections and maintenance of pollution control measures. Contingency measures outlining urgent protocols to repair or backup any breaches of designed mitigation measuresare also be incorporated into the Site specific CEMP
- In the event that mitigation measures are failing to reduce suspended solids to acceptable levels, construction works will cease until remediation works are completed
- Fine solids or colloidal particles are very slow to settle out of waters, coagulant or flocculant will be used to promote the settlement of finer solids prior to discharging to

surface water networks. Flocculant gel blocks can be placed in drainage channels, these are passive systems that are self-dosing, self-limiting and are environmentally friendly. Flocculant gel blocks bind elevated levels of silt and associated contaminants into masses that are easily separated, captured and then removed from the water

- Surface water runoff controls will be checked and maintained on a regular basis and as soon as any signs of deterioration become visible. Check dams and settlement ponds will be maintained and emptied on a regular basis and as soon as any signs of deterioration become visible.

The adoption of precautionary principles and the implementation of mitigation measures listed above will ensure that the risk of elevated suspended solids to surface waters is low. This in turn will ensure that potential risks to sensitive receptors is also low. Nevertheless, should a significant discharge of suspended solids to surface waters occur, the absence of immediate proximity to designated sites and the assimilative capacity of the localised surface waters will act as a natural hydrological buffer in terms of suspended solids loading. Should such a discharge occur, the dilution and retention time of suspended solids in the localised surface water network will reduce potential impacts on highly sensitive downstream designated sites. It should be noted that this natural mitigation measure is not to be adopted as a first principle and will not be relied upon to prevent adverse impacts on designated sites, it will be rather a last line of defence.

A detailed design of required drainage, collector drainage, stilling ponds and other listed mitigation infrastructure is contained in the **Surface Water Management Plan** in **Appendix 2.1**. Unsuitable and particularly sensitive areas are identified and presented in various figures contained in **Volume III**.

9.5.2.4 Horizontal Directional Drilling Mitigation Measures

The following mitigation measures to reduce potential impacts associated with horizontal directional drilling will be implemented:

- Clearbore, which is not toxic to aquatic organisms and is biodegradable will be the drilling fluid used.
- Mud mixing will be monitored to suit the ground conditions encountered and will initially be based on a mud programme developed by the specialised HDD Contractor, the drilling fluid supplier and an Environmental Clerk of Works.
- The drilling fluids will be constantly monitored, any changes required to the mix will be performed on site by specialised HDD Contractor upon consultation with the drilling fluid supplier and Environmental Clerk of Works.

- Mud testing equipment will be available at all times during drilling operations to monitor key mud parameters.
- All equipment will be carefully checked on a daily basis by the Site Supervisor prior to use to ensure plant and machinery is in good working order with no leaks or potential for spillages.
- Spill kits, including an appropriate hydrocarbon boom will be available on the site in the event of any unforeseen hydrocarbon spillages and all staff shall be trained in their use.
- All plant, materials and wastes will be removed from site following the HDD works.
- The launch pit will be reinstated to the original land surface condition and the normal duct trench will continue from this point.
- Should any dewatering be required, it will be carried out in accordance with the site-specific CEMP.
- Test pits and boreholes will not be located directly on, or extend through, the proposed alignment, as these weak points may serve as conduits where inadvertent fluid returns or frac outs occur. At least a 3m offset will be provided between the boreholes and pipe alignment.

9.5.2.5 Release of Hydrocarbons Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts from the environmental release of hydrocarbons and other harmful chemicals to the surface waters will be implemented:

- Refuelling of vehicles will be carried out off site to the greatest practical extent. This refuelling policy will mitigate the potential for impacts by avoidance. Due to the remote location and nature of the Site, it is unlikely that implementation of this refuelling policy will be practical in all circumstances. In instances where refuelling of vehicles on Site is unavoidable, a designated and controlled refuelling area will be established at the Site. The designated refuelling area will enable low risk refuelling and storage practices to be carried out during the works. The designated refuelling area will contain the following attributes and mitigation measures as a minimum requirement:
  - The designated refuelling area will be located a minimum distance of 50m from any surface waters or Site drainage features
  - The designated refuelling area will be bunded to 110% volume capacity of fuels stored at the Site
  - The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund
  - Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis

- Any oil contaminated water will be disposed of at an appropriate oil recovery plant or licensed tip site
- Any minor spillage during this process will be cleaned up immediately
- Vehicles will not be left unattended whilst refuelling
- All machinery will be checked regularly for any leaks or signs of wear and tear
- Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner.

Notwithstanding the management of refuelling and fuel storage at the designated refuelling area, the potential risk of hydrocarbon spills from plant and equipment or other general chemical spills at other areas of the Site remains. To mitigate against potential spills at other areas of the Site, the following mitigation measures will be implemented:

- Oil absorbent booms and spill kits will be available adjacent to all surface water features associated with the Development. The controls will be positioned downstream of each construction area and at principal surface water drainage features. Oil booms deployed will have sufficient absorbency relative to the potential hazard
- Spill kits will also be available at construction areas such as at turbine erection locations, the temporary site compound, on-site substation, spoils storage areas and met mast location etc.
- Spill kits will contain a minimum of oil absorbent pads, oil absorbent booms, oil absorbent granules, and heavy-duty refuse bags for collection and appropriate disposal of contaminated matter
- Should an accidental spill occur during the construction or operational phase of the Development, such incidents will be addressed immediately, this will include the cessation of works in the area of the spillage until the issue has been resolved
- Spill kits will be kept in each vehicle at the Site and will be readily available to all operators
- No materials, contaminated or otherwise will be left on the Site
- Suitable receptacles for hydrocarbon contaminated materials will also be available at the Site
- A detailed spill response plan forms part of the Site specific CEMP appended to **Appendix 2.1** of this EIAR.

Implementation of the above mitigation measures will significantly reduce the risk of hydrocarbon contamination being released to the surface water network. Nevertheless, the potential risk cannot be entirely eradicated. Therefore, precautionary measures and emergency response protocols will be established and are included in the Site specific CEMP appended to the EIAR in **Appendix 2.1**.

9.5.2.6 Construction and Cementitious Materials Proposed Mitigation Measures

The following mitigation measures to reduce potential impacts posed by the use of concrete and the associated effects on surface water in the receiving environment are proposed:

- The procurement, transport and use of any cement or concrete will be planned fully in advance and supervised by appropriately qualified personnel at all times
- Vehicles transporting cement or concrete to the Site will be visually inspected for signs of excess cementitious material prior to being granted access to the Site. This will prevent the likelihood of cementitious material being accidentally deposited on the Site Access Tracks or elsewhere at the Site.
- Drivers of such vehicles will be instructed to ensure that all vehicles are washed down in a controlled environment prior to the departure of the source site, such as at concrete batching plants
- Precast concrete will be used wherever possible, although the use of pre-cast concrete is not viable option for large structures such as Turbine foundations and so concrete will be delivered to the Site
- Concrete will not be poured during periods of rainfall or if any kind of precipitation is forecast. This policy will limit the potential for freshly poured concrete to adversely impact on surface water runoff.
- Raw or uncured waste concrete will be disposed of by removal from the Site
- Washout of concrete trucks shall be strictly confined to the batching facility and shall not be located within the vicinity of watercourses or drainage channels. Only the chutes will be cleaned prior to departure from Site and this will take place at a designated area at the Temporary Site Compound
- Spill kits will be readily available to Site personnel, and any spillages or deposits will be cleaned up as soon as possible and disposed of appropriately
- Pouring of concrete into standing water within excavations will be avoided
- Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place
- Any surplus concrete will not be stored or deposited anywhere on Site and will be returned to the source location or disposed of appropriately at a suitably licensed facility
- Any required shuttering installed to contain the concrete during pouring will be fully secured around its perimeter to minimise any potential for leaks.

9.5.2.7 Watercourse Crossings Proposed Mitigation Measures

At the Site, two new watercourse crossings in the form of 4m wide bottomless culverts will be constructed as part of facilitating access to the proposed turbines T4 and T5. Both of the required crossings are across small streams that are headwaters of the Owenree River. A third 4m wide bottomless culvert will replace an existing small culvert along the existing site access road at the eastern extent of the site where a small unnamed stream drains into the Owenwee River. On the same unpaved road which adjoins the N59 Road, a pre-existing bridge over the Owenwee River will also be upgraded to facilitate the movement of heavy goods vehicles. The locations of the proposed crossings are mapped on **Figure 9.7** in **Volume III**. It is noted that the small stream which will require crossing for access to the T4 turbine position was consistently dry during the water quality monitoring rounds discussed in **Section 9.3.8** and it is therefore considered to be an ephemeral stream which may not be in flow during the time at which the construction of a crossing is required. However, detailed planning and consideration as described below, to ensure potential impacts are assessed adequately and in turn mitigated against will be implemented for these locations.

A detailed design stage assessment in terms of bridge or culvert design will be carried out that will have cognisance to both locations including the characteristics of water flow at both locations. The current design of the proposed bridge upgrade and the proposed culverts are shown on **Figures 2.6 (a), (b), (c)** and **(d**) respectively in **Volume III**. The following mitigation measures will be implemented as minimum requirements to ensure any potential impacts of the proposed watercourse crossings are minimised:

- The final design of the proposed crossings and a method statement for the proposed construction will be agreed in advance with Inland Fisheries Ireland (IFI)
- The culverts will be bottomless which will allow for all forms of aquatic life to safely pass underneath without obstruction
- This design of all crossings will adhere to relevant available guidance and will be reviewed through consultation with the OPW which will mitigate against any significant impact on surface water flow and in turn the risk of localised or downstream flooding
- Crossings will be designed to minimise in so far as practical and to the extent deemed acceptable by the competent authority, the disturbance or alteration of water flow, erosion and sedimentation patterns and rates
- A Construction Environmental Management Plan has been prepared and is appended to the EIAR in **Appendix 2.1**. Adherence to this plan will be mandatory throughout the construction of the watercourse crossings.

- Vehicles and plant used in the construction of the proposed crossings will only be refuelled at the Sites bunded and designated refuelling area, no refuelling will be permitted within 50m of any watercourse at the Site
- To mitigate against the potential risk of accidental leaks or spillages from plant and equipment, an emergency response plan for such incidents is contained in the CEMP appended to the EIAR in **Appendix 2.1**. Multiple spill kits will be maintained on the Site at all times within the cabs of vehicles and placed strategically at environmentally sensitive locations across the Site. Spill kits will be routinely inspected to ensure that they are fully stocked with oil absorbent booms and pads at all times. Oil absorbent booms will be installed downstream of channel crossing work areas within 25m of the works location prior to the commencement of works.

Section 50 of the European Communities (Assessment and Management of Flood risks) Regulation SI 122 of 2010 states; *"No Person, including a body corporate, shall construct any new bridge or alter, reconstruct, or restore any existing bridge over any watercourse without the Consent of the Commissioners or otherwise than in accordance with plans previously approved of by the Commissioners*". The same regulations also state that the word "bridge" includes a culvert or other like structure. The OPW is the agency in Ireland responsible for the implementation of the regulations and consent to construct all crossings will firstly be sought from the OPW via their application process. This OPW application and consent process will mitigate against the potential for the design of the crossings to result in significant adverse impacts on the surface water network at the Site. Relevant guidance documents will also be consulted, and applicable mitigation measures incorporated at the detailed design stage of the proposed crossings with a view to mitigating and reducing any potential impact on the receiving watercourse. The following is a non-exhaustive list of relevant guidance documents:

- OPW (2013) Construction, Replacement, or Alteration of Bridges and Culverts, A Guide to Applying for Consent under Section 50 of the Arterial Drainage Act, 1945
- OPW (2019), Environmental Guidance: Drainage Maintenance and Construction
- Inland Fisheries Ireland (IFI) (2016) Guidelines on the Protection of Fisheries During Construction Works in and Adjacent to Waters
- National Roads Authority (NRA) (2008) Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes
- Scottish Environment Protection Agency (SEPA) (2010) Engineering in the water environment: good practice guide – River Crossings.

9.5.2.8 Groundwater Contamination Proposed Mitigation Measures

A combination of the underlying bedrock geology, the associated poor aquifer potential, low permeability subsoils beneath the peat and low recharge rates has resulted in the risk posed to groundwater quality by the Development being considered as low risk. Nevertheless, mitigation measures to reduce potential risks to groundwater will be implemented. A primary risk to the underlying groundwater quality would be through the accidental release of hydrocarbons from fuels or oils during the construction phase of the Development. In order to mitigate against potential groundwater contamination by hydrocarbons, implementation of the following mitigation measures is proposed:

- In the first instance, no fuel storage will occur at the Site whenever feasible and refuelling of plant and equipment will occur off site at a controlled fuelling station
- In instances where on Site refuelling is unavoidable, then the bunded on Site designated refuelling area must be used. The designated refuelling area must be bunded to 110% volume capacity of fuels stored at the Site
- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund
- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis
- Any oil contaminated water will be disposed of at an appropriate oil recovery plant or licensed tip Site
- Any minor spillage during this process will be cleaned up immediately
- Vehicles will not be left unattended whilst refuelling
- A Site specific CEMP appended to the EIAR in **Appendix 2.1** will be enforced to ensure that equipment, materials and chemical storage areas are inspected and maintained as required on a regular basis.

The following mitigation measures are proposed in relation to non-hydrocarbon potential contamination of groundwater:

- All other liquid based chemicals such as paints, thinners, primers and cleaning products etc. will be stored in locked and labelled bunded chemical storage units
- Temporary sanitation facilities such as portaloos used during the construction phase will be self-contained and supplied with water by tank trucks. Portaloos will contain water storage tanks and separate wastewater storage tanks which will be routinely emptied by vacuum removal for offsite disposal via a tank truck. All temporary sanitation facilities will be removed from the Site following the completion of the construction phase

- The controlled attenuation of suspended solids in settlement ponds and check dams etc. will result in inorganic nutrients (if present in elevated concentrations) such as phosphorus and nitrogen being absorbed and retained by the solids in the water column. This will allow for a reduction of peak inorganic discharges in a controlled and stable run off rate. It is noted that the presence of elevated contaminants were not detected during any of the four surface water quality monitoring rounds which are discussed in **Section 9.3.8**
- It is considered that there is a low risk of mobilising trace metals that may naturally be present in low concentrations in the baseline environment. The potential for mobilising trace metals is most likely to result from enhanced water percolation associated with excavated bedrock substrate. To mitigate against this potential impact, water quality will be monitored for trace metal concentrations prior to, during and after the construction phase
- The potential for livestock such as cattle and sheep which have been observed grazing at the Site to cause bacteriological contamination of groundwater will be controlled through the implementation of strict grazing control zones, Site perimeter fencing and exclusion zones around all open excavations.

9.5.2.9 Groundwater Extraction Proposed Mitigation Measures

The extraction of groundwater from boreholes for the purpose of potable water supply will not be required for either the construction or operational phase of the project. As a result, no potential effects are anticipated from the extraction of groundwater as a potable water supply.

9.5.2.10 Water Quality Monitoring

The following Site monitoring recommendations will be implemented to mitigate against potential impacts on the surface water and groundwater receiving environment:

- A programme of water quality monitoring outlining the selected parameters and monitoring frequency should be agreed with Inland Fisheries Ireland and Galway County Council prior to the commencement of construction
- In order to assist in the detection of any deviations from the baseline hydrochemistry conditions at the Site, regular periodic monitoring of the Sites surface waters will be carried out prior to and during construction
- It is proposed that a programme of operational phase water quality monitoring is also implemented at a monitoring frequency agreed with the competent authority in order to aid the detection of any potential operational phase impacts on surface water quality

- As a minimum requirement, field measured parameters such as pH, conductivity, total dissolved solids (TDS), temperature, dissolved oxygen (DO) and turbidity will be included in the water quality monitoring programme. The results should be compared to the applicable EQS to determine if adverse impacts on water quality are occurring
- Water quality will be monitored for trace metal concentrations prior to, during and after the construction phase
- Water quality monitoring locations will include both upstream and downstream points relative to the works locations. The locations of the water quality monitoring points will be flexible and will be moved as the construction phase progresses so that monitoring points remain representative of the most likely construction impact receptor points
- The watercourses within and adjacent to the proposed spoil storage area will be included within the water quality monitoring programme
- The downstream monitoring locations will be positioned as close as possible downstream of the works location and another positioned further downstream. This approach will allow for an assessment of the dilution of potential contaminations (if present) as the distance from the point of diffuse source location increases
- Watercourses which do not have year round flows such as artificial drains, ditches or ephemeral streams will be avoided as water quality monitoring locations
- During the construction phase, daily visual inspections of excavations, dewatering procedure, settlement ponds, silt traps, buffered outfalls and drainage channels etc. will be carried out by a suitably qualified person. Any excess build-up of sediment at settlement ponds, drains or at any other drainage features that may decrease the effectiveness of the drainage feature will be promptly removed
- During the construction phase of the Development, all development areas will be monitored on a daily basis for evidence of groundwater seepage, water ponding and wetting of previously dry spots
- Following the completion of the construction phase, inspection of silt traps, buffered outfalls and drainage channels will be periodically inspected during maintenance visits to the Site when the operational phase water quality monitoring will also be carried out
- During both the construction and operational phases of the Development, the proposed watercourse crossings discussed in **Section 9.5.2.7** will be monitored daily during construction and during each Site visit during the operational phase. The water course crossings will be monitored in terms of their impacts (if any) on the receiving watercourses and in terms of their structural integrity to identify any signs of erosion or potential for sediment release

- It is proposed that a handheld turbidity meter is available at the Site to accurately measure the quality of water discharging from the Site. The meter will be maintained and calibrated frequently.
- A detailed inspection and monitoring regime to be agreed with Inland Fisheries Ireland and Galway County Council will be outlined in the Site specific Construction Environmental Management Plan (CEMP).
- Any discharges of sediment treated water should meet the requirements of the Surface Water Regulations 2009, as amended.

9.5.2.11 Emergency Response

Mitigation measures outlined in the previous sections of this chapter will significantly reduce the potential for contamination of surface water or groundwater associated with the Development. Nevertheless, as is the case with all construction projects, a risk of accidental chemical spillages, sediment overloading of control measures or leaks of contaminants from plant or equipment remains a possibility. Emergency response procedures to potential contamination incidents are contained in the site specific CEMP appended to the EIAR in **Appendix 2.1** and will be implemented at the Site prior to the commencement of the construction phase. The following is a non-exhaustive list of potential emergencies and respective emergency responses:

- Spill or leak of hazardous substances (less than 20 litres);
  - All spill incidents will be dealt with immediately as they arise
  - Spill kits will be prepared and available in vehicles associated with the construction phase of the Development
  - Spill kits will also be prepared and made available at primary work areas such as at proposed turbine, hardstand, substation, met mast and construction compound locations
  - Disposal receptacles for hydrocarbon contaminated materials will also be available at the Site
- Major spill of hazardous or toxic substance off Site or to environmentally sensitive areas;
  - Immediate escalation measures will be implemented for all major spill events
  - Escalation measures may include installation of temporary sumps or drains to control the flow or migration of hydrocarbons or other chemicals
  - Attempts to be made to limit or contain the spill using sandbags to construct a bund wall, use of absorbent material, temporary sealing of cracks or leaks in containers, use of geotextile or silt fencing to contain the spill

- Excavation and disposal of contaminated material will be immediately carried out following any such incidents
- Evacuation procedures will be implemented to remove non-essential personnel from the area
- Data gathering and an investigation will commence immediately after the emergency is contained
- If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer must have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill
- All major spills of this nature will be reported to the competent authority immediately following such instances.

- Flooding of low lying areas of the Site;
  - Immediately remove all chemicals, fuels and other hazardous substances from low lying areas of the Site
  - Immediately remove plant and equipment from low lying areas
  - Recover materials washed from Site including sediment and other waste
  - Review and address the potential for excess water entering the Site
  - Review and maintain erosion and sedimentation controls.
- Spills of cementitious material;
  - Cement / concrete contamination incidents will be cleaned up immediately as they arise
  - Spill kits will also be established at key construction areas and they will also be readily available in the cabs of plant and equipment
  - Suitable receptacles for cementitious materials will also be available at the Site.

Emergency responses, including methodologies and all relevant contact details are specified in the Site specific CEMP appended to the EIAR in **Appendix 2.1**.

9.5.2.12 Construction Phase Residual Impacts

The residual impact on the surface water receiving environment resulting from the construction phase of the Development is anticipated to be a limited temporary decrease in water quality. A limited temporary decrease in water quality may arise due to a release of suspended solids and sediments to surface waters during excavations at the Site. The potential for release of elevated suspended solids is likely to be exacerbated following heavy rainfall events which occur after sustained dry periods. Any localised reduction in water quality is likely to be mitigated against by the extensive control measures outlined in this chapter and also by natural dilution as distance from the point or diffuse source of contamination increases with distance from the Site.

Mitigation by avoidance and the implementation of physical control measures will ensure that contaminant concentrations, particularly elevated suspended solids entrained in run-off are reduced to below the relevant legislative screening criteria and adopted EQS. The overall impact is anticipated to be a direct, negative, imperceptible, Imperceptible weighted significance and temporary.

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures

The proposed Development will lead to an increase in impermeable surface area through the construction of hard stand areas within the Site. This in turn will lead to an increase in hydraulic loading by surface water runoff. However, preliminary water balance calculations indicate that the worst-case net increase in surface water runoff volumes will be approximately 1,117m^3/month, or 0.38% relative to the area of the Site, therefore this is considered an imperceptible, or not significant impact.

As a consequence of the estimated low significance of the impact of hydraulic loading during the operational phase, mitigation measures to facilitate a reduction in surface water runoff are limited to ensuring that pre-existing and newly established drainage infrastructure is sufficiently maintained for the discharge rates associated with all areas of the Site. Any and all blockages which may adversely impact upon the drainage regime at the Site will be immediately removed during the operational phase of the proposed Development. No other additional impacts are anticipated during the operational phase of the Development.

9.5.3.2 Operational Phase Residual Impacts

The residual impact on the receiving surface water environment during the operational phase of the Development is anticipated to be an increase in runoff of rainwater and an increase in drainage discharge. This is anticipated to occur as a result of the construction of mostly impermeable hardstand areas at the Site. Depending on the exact area of the Site in question, the finalised drainage design may result in some areas becoming more saturated, particularly at lower elevations, whilst other predominantly upland areas may result in a net drying effect being observed. This is considered a direct, neutral, localised impact of the Development, which contrasts to the baseline conditions.

9.5.4 Development Decommissioning and Restoration Phase/s

9.5.4.1 Decommissioning of Infrastructure

As discussed in **Section 9.4.7**, no new impacts on the surface water and groundwater receiving environment are anticipated during the decommissioning phase of the project. The decommissioning phase of the project will result in the removal of Site infrastructure such as wind turbines and the Met Mast etc. No new additional mitigation measures are required for the decommissioning phase of the proposed Development. The decommissioning phase and associated removal of major infrastructure components is anticipated to result in similar potential risks to surface water and groundwater as those that will be encountered during the construction phase of the proposed Development.

The excavation of peat or soil is not expected to be required during the decommissioning phase. In addition, the movement of plant, vehicles and equipment is not expected to be required during the decommissioning phase since all of the project's hardstand areas will be pre-existing by the time the decommissioning phase is being carried out. As a result, the risk of elevated suspended solids being discharged in surface water run-off to the downstream receiving environmental is expected to be low. However, the potential risk remains for spills of fuels hazardous chemicals which is a common risk to all developments. The mitigation measures outlined in this chapter will be implemented during the decommissioning phase to reduce the potential for such impacts.

9.5.4.2 Reinstatement of Redundant Access Track and Hardstand Areas

Reinstatement of redundant Site Access Tracks and Turbine Hardstand areas during the decommissioning phase has the potential to result in soil creep, associated erosion and potential entrainment of elevated suspended solids in surface water run-off. This in turn has the potential to impact on the receiving surface water environment. The potential for such impacts are likely to be increased at areas of the Site where steep slopes are present. As a result, additional care and attention to detail is required as follows:

- Mitigation measures described in this chapter to reduce the potential for run-off of elevated suspended solids will be implemented
- Sediment fences will be implemented along the perimeter of all access tracks and hardstand areas during the reinstatement works
- Additional precautions such as the implementation of check dams, secured straw bales, sandbags, or settlement ponds will be implemented at areas where surface water runoff is likely to be intercepted by both natural and artificial drainage features

- Any drains or outfalls which have the potential to draw water from reinstatement areas, or promote preferential surface water runoff flow paths through reinstatement areas will be removed, blocked or decommissioned as required
- The mitigation measures for the preparation of the hardstand area surfaces prior to material being deposited discussed in **Chapter 8: Soils and Geology** will be implemented
- Monitoring and maintenance of the reinstated areas will be conducted regularly following the initial stages of establishment to ensure that the potential for excessive surface water runoff eroding deposited material along preferential pathways is minimised.

9.5.4.3 Reinstatement Residual Impacts

It is anticipated that the appropriate reinstatement of redundant Site Access Track and hardstand areas will result in a net beneficial impact. This will be achieved through passive continuous improvements at the areas in question. Over time, the reinstated areas will become revegetated and will recover to become similar in appearance to the surroundings of the wider Site. The reinstatement of the Site areas will likely result in enhanced water storage at the Site. This will occur through the reintroduction of permeable layers at former hardstand areas which will in turn promote the filtration of potentially contaminated surface water runoff which may originate from reinstated areas. Therefore, the residual impact of reinstatement at Site Access Tracks and former Turbine Hardstand areas is considered to be a positive, localised and permanent impact of the proposed Development.

9.5.5 Decommissioning and Restoration Phase – Physical Infrastructure

Restoration of physical infrastructure at the Site following the decommissioning phase has the potential to cause adverse impacts on the receiving hydrological and hydrogeological receiving environment. It is recommended that a benefit analysis should be carried out to determine the overall positive outcomes against any potential adverse effects prior to such activities being permitted. The assessment of all restoration activities will require an analysis across multiple other environmental disciplines (i.e. ecology, noise and human beings etc.) with the overall synergistic effects requiring evaluation. It is noted that the blanket bog and associated ecological environment surrounding the Site will also become altered over time across the operational lifetime of the proposed Development. It is therefore recommended that the potential for restoration activities following the decommissioning phase of the Development is evaluated in detail following the completion of the decommissioning phase.

9.5.6 Cumulative Effects

The only other major development or proposed development within 10km is a permission to restore a disused railway station at Maam Cross and convert it into a railway heritage museum with re-laid railway track, rebuilding a signal cabin, refurbishment of goods store and loading bank, water tower and passenger platforms, car parking and portaloo toilet facilities. This proposed development is located approximately 3.8km to the west of the Development to the east of the R336. Other developments in the area are generally for one off housing developments.

With respect to hydrology, the effects of the Development are considered to contribute to and add to the cumulative nature of adverse impacts imposed on the surface water network in the catchments associated with the Development. However, considering the pre-existing "Good" and "High" WFD status of the surface waters surrounding the proposed Development, especially the headwaters of the Owenwee/Owenree Rivers, and the generally high quality baseline water quality results outlined in **Section 9.3.8**, the potential for the Development to have adverse cumulative impacts on hydrology is limited to the construction phase. In further consideration of the wider Corrib and Galway Bay North (grid connection) catchment areas, the associated large volumes of water, particularly in Lough Corrib and its associated assimilative capacity, the control measures which will be put in place, the Development is not considered likely to significantly contribute to cumulative effects in terms of water quality nor flood risk.

With respect to hydrogeology, and the potential effects of the Development having been assessed as likely being localised due to the overlying peat, slow recharge rates, high run-off rates and poor yielding underlying groundwater aquifer except for local zones, the Development is not considered to significantly contribute to cumulative effects.

9.6 SUMMARY OF SIGNIFICANT EFFECTS

During both the construction and operational phases of the proposed Development, activities will take place at the Site that will have the potential to significantly affect the hydrological regime or water quality at the Site or its vicinity. These significant potential impacts generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cementitious substances, with hydrocarbons or chemicals spills to surface waters having the most potential for impact.

The implementation of mitigation through avoidance principles, pollution control measures, surface water drainage measures and other preventative measures have been incorporated into the project design in order to minimise potential significant adverse impacts on water quality at the Site. A self-imposed 50m stream buffer zone will be implemented at the Site wherever possible which will largely result in the avoidance of sensitive hydrological features. Direct discharges to surface waters of dewatered loads will not be permitted under any circumstances. This in turn will reduce the potential for adverse impacts on downstream designated Sites.

The drainage plan for the Site will be a key method through which sediment runoff arising from construction activities will be reduced and through which runoff rates will be controlled. Implementation of the control measures outlined in this EIAR are considered to result in a likely, neutral to negative, imperceptible to slight significance, Imperceptible weighted significance impact of the Development which conforms to the baseline conditions when considering areas of pre-existing peat cutting agricultural land uses. There will be minor localised changes to how water flows at the Site, this is considered a likely, neutral to negative, slight to moderate significance, localised impact of the Development which conforms to the baseline.

9.7 REFERENCES

- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines
- Office of Public Works (OPW) (2019), Environmental Guidance: Drainage Maintenance and Construction
- The Galway County Development Plan (2022-2028)
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- National Roads Authority (NRA) (2008) Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes

- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- GSI (2004) Maam_ Clonbur GWB: Summary of Initial Characterisation
- GSI (2004) Oughterard Marbles GWB: Summary of Initial Characterisation
- Environmental Protection Agency (2021) 3rd Cycle Draft Corrib Catchment Report
- Inland Fisheries Ireland (2018) Owenriff Fish Population Rehabilitation Plan
- Department of Housing, Planning and Local Government (2018) River Basin Management Plan for Ireland, 2018 – 2021
- Local Authority Waters Programme (2019) Failmore Priority Area for Action – Desk Study Summary 2019
- Met Eireann (2007), Technical Note 61, Estimation of Point Rainfall Frequencies, D.L. Fitzgerald, 2007
- Met Éireann (2012) A Summary of Climate Averages 1981-2010 for Ireland, Climatological Note No.14
- Hunter Williams, N.H., Misstear, B.D., Daly, D. and Lee, M. (2013) Development of a national groundwater recharge map for the Republic of Ireland. Quarterly Journal of Engineering Geology and Hydrogeology
- Fitzgerald, D.L. (2007) Estimation of Point Rainfall Frequencies. Met Eireann
- Office of Public Works (OPW) (2009) The Planning Systems and Flood Risk Management: Guidelines for Planning Authorities
- Scottish National Heritage (SNH) (2013) A Handbook on Environmental Impact Assessment
- Scottish Environment Protection Agency (SEPA) (2010) Engineering in the Water Environment: Good Practice Guide – River Crossings
- EPA (2008) Strive Report Series No. 6, Water Framework Directive – Recharge and Groundwater Vulnerability
- Roscommon National Roads Design Office (NRDO) (2012) N59 Maam Cross to Oughterard Proposed Road Development Environmental Impact Statement
- Department of Housing, Planning and Local Government, National River Basin Management Plan 2018-2021 (https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021)
- EPA Map Viewer, Water Framework Directive (WFD), surface water and hydrogeological features (https://gis.epa.ie/EPAMaps/Water)
- EPA HydroNet, Surface water levels, flows and groundwater levels (http://www.epa.ie/hydronet/#Water%20Levels)
- Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA)

(https://www.gov.ie/en/publication/1c7d0a-preliminary-flood-risk-assessment-pfra)

- OPW, National Flood Information Portal (https://www.floodinfo.ie)
- Ordnance Survey Ireland, Map Viewer (http://map.geohive.ie/mapviewer.html)
- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer (https://www.npws.ie/protected-Sites)
- The Geological Survey of Ireland (GSI), groundwater data and maps (https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx)
- The Geological Survey of Ireland (GSI), karst features database (https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-irish-karst/Pages/Karst-databases.aspx)
- Myplan.ie; National Planning Application Map Viewer (https://myplan.ie/national-planning-application-map-viewer)
- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas (https://www.seai.ie/technologies/seai-maps/wind-atlas-map/)
- Met Éireann Meteorological Data (https://www.met.ie/climate/available-data/historical-data)
- Department of Housing, Planning and Local Government, EIA Portal (https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal)
- Catchments.ie (https://www.catchments.ie/)