9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter assesses the impacts of the Proposed 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 Proposed Development:

- Construction of Gortloughra Wind Farm, including:
    - Erection of eight wind turbines with an overall ground to blade tip height of 175 m. The candidate wind turbine will have a rotor diameter of 150 m and a hub height of 100 m;
    - Construction of site access roads, Turbine Hardstands and Turbine Foundations;
    - Development of a site drainage network;
    - Internal wind farm underground power and communications cabling;
    - Erection of a permanent 100 m Met Mast for monitoring wind speeds;
    - Construction of a Temporary Construction Compound for use during construction.1 no. borrow pit;
    - Biodiversity improvements including improvement of heath habitat in fenced off lands designated for Habitat Enhancement and restriction of livestock in lands to allow establishment of heath vegetation in these areas; and,
    - Recreational community improvements including the erection of 4 No. permanent information boards relating to cultural heritage and upgrades to amenity tracks across the site.
    - A 10-year planning permission and 40-year operational life from the date of commissioning of the entire wind farm is being sought. This EIAR also assesses the construction of an on-site 110 kV substation and 2 no. grid connection route (GCR) options along public roads:
    - Option A: Dunmanway 110 kV substation or
    - Option B: Carrigdangan 110 kV substation.
    - While not part of the planning consent for this planning application, this EIA also assesses the works at 18 No. locations along the Turbine Delivery Route (TDR) from the Port of Cork to Site.
- Operation of the Proposed Development
- Decommissioning of the Proposed Development (final phase).

The Project refers to all elements of the application for the construction and operation Gortloughra Windfarm (**Chapter 2: Development Description**).

Common acronyms used throughout this EIAR can be found in **Appendix 1.2** and in **Table 9.1**.

Table 9.1: Acronyms and Descriptions

Acronym	Description
AE	Actual Evapotranspiration
BOD	Biochemical Oxygen Demand
CEMP	Construction and Environmental Management Plan
CFRAM	Catchment Flood Risk Assessment and Management
CEnv	Chartered Environmentalist
CIRIA	Construction Industry Research and Information Association
COF	Confirmation of Feasibility
DO	Dissolved Oxygen
DFF	Depth Duration Frequency
EIAR	Environmental Impact Assessment Report
EPA	Environmental Protection Agency
ER	Effective Rainfall
EU	European Union
FM	Field Monitoring
FSU	Flood Studies Update
GCR	Grid Connection Route
GIS	Geographic Information System
GSI	Geological Survey of Ireland
GWBs	Groundwater Bodies
GWDTE	Groundwater Dependent Terrestrial Ecosystems
HDD	Horizontal Directional Drilling
IGI	Institute of Geologists of Ireland
INAB	Irish National Accreditation Board
IWEA	Irish Wind Energy Association
LiDAR	Light Detection and Ranging
MIGI	Member of the Institute of Geologists of Ireland
MIEMA	Member of the Institute of Environmental Management and Assessment
NHA	Natural Heritage Area
NPWS	National Parks and Wildlife Service

Acronym	Description
NRA	National Roads Authority
OD	Ordnance Datum
OPW	Office of Public Works
P.Geo	Professional Geologist
PCE	Pre-Connection Enquiry
PE	Potential Evapotranspiration
PFRA	Preliminary Flood Risk Assessment
RC	Recharge Coefficient
SAC	Special Areas of Conservation
SEAI	Sustainable Energy Authority of Ireland
SMD	Soil Moisture Deficits
SPA	Special Protection Areas
TDS	Total Dissolved Solids
TDR	Turbine Delivery Route
TSS	Total Suspended Solids
WFD	Water Framework Directive

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

- **Appendix 9.1** Photographic Plates;
- **Appendix 9.2** Laboratory Certificates; and
- **Appendix 9.3** Water Framework Directive Compliance Assessment.

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be developed into a Site-Specific Gortloughra Windfarm CEMP post consent / pre-construction once a contractor has been appointed. The CEMP will cover the construction of the Development. It will include all of the mitigation recommended within the EIAR. 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 extensive 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 and 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, Poddle, 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, 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 input to, and has reviewed, this Chapter of the EIAR.

9.1.2 Assessment Structure

In line with the revised EIA Directive and current (draft) EPA guidelines, the structure of this Hydrology and Hydrogeology chapter is as follows:

- Details of methodologies utilised for both desk and field studies, in the context of legal and planning frameworks;
- Description of Baseline conditions at the Site;
- Identification and assessment of impacts to hydrology and hydrogeology associated with the Project, during the construction, operational and Decommissioning phases of the Proposed 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 Proposed Development considering mitigation measures; and,

- 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 Project on the hydrology and hydrogeology aspects of the environment at the Site and Study Area:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and on Site surveys;
- Undertake preliminary water balance calculation;
- Undertake preliminary 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; and,
- 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;
- S.I. No. 294/1989 - European Communities (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989;
- S.I. No. 722 of 2003: European Communities (Water Policy) Regulations 2003;
- S.I. No. 684 of 2007: Waste Water Discharge (Authorisation) Regulations 2007;

- 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;
- European Communities (Assessment and Management of Flood risks) Regulation SI 122 of 2010;
- S.I. No. 499 of 2013: European Communities (Birds and Natural Habitats) (Amendment) Regulations 2013;
- S.I. No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- S.I. No. 99 of 2023: European Union (Drinking Water) Regulations 2023;
- Council Directive 74/440/EEC of 16 June 1974 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States;
- Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life;
- Council Directive 79/869/EEC of 9 October 1979 concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the Member States;
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy;
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy; and,
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.

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:

- The Cork County Development Plan (2022-2028).
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports;
- Office of Public Works (OPW) (2019), Environmental Guidance: Drainage Maintenance and Construction;
- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines;
- 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; and,
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide;

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

- Environmental Protection Agency, Cycle 3, HA 19 Lee, Cork Harbour and Youghal Bay Catchment Report, May 2024;
- Environmental Protection Agency, Cycle 3, HA 20 Bandon-Illen Catchment Report, May 2024;
- Environmental Protection Agency, Cycle 3, HA 21 Dunmanus-Bantry-Kenmare Catchment Report, May 2024;
- Department of Housing, Planning and Local Government (2018) River Basin Management Plan for Ireland, 2018 – 2021;
- Department of Housing, Local Government and Heritage (2024) River Basin Management Plan 2022 – 2027, The Water Action Plan 2024: A River Basin Management Plan;
- Local Authority Waters Programme (2021) Caha Priority Area for Action – Desk Study Summary;

- Local Authority Waters Programme (2021) Allua Priority Area for Action – Desk Study Summary;
- Met Éireann (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; and,
- Renou-Wilson, F. (2011) BOGLAND: Sustainable Management of Peatlands in Ireland (REPORT).

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. Planning applications for nearby windfarm developments have also been reviewed. The following 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[1]
- Department of Housing, Local Government and Heritage, The Water Action Plan 2024: A River Basin Management Plan for Ireland[2]
- EPA Map Viewer, Water Framework Directive (WFD), surface water and hydrogeological features[3]
- EPA HydroNet, surface water levels, flows and groundwater levels[4]
- Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA)[5]
- Office of Public Works (OPW), National Flood Information Portal[6]
- Ordnance Survey Ireland, Map Viewer[7]

[1] https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021
[2] https://www.gov.ie/en/policy-information/8da54-river-basin-management-plan-2022-2027/
[3] https://gis.epa.ie/EPAMaps/Water
[4] http://www.epa.ie/hydronet/#Water%20Levels
[5] https://www.gov.ie/en/publication/1c7d0a-preliminary-flood-risk-assessment-pfra
[6] https://www.floodinfo.ie
[7] https://www.geohive.ie/

- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer[8]
- The Geological Survey of Ireland (GSI), groundwater data and maps[9]
- The Geological Survey of Ireland (GSI), karst features database[10]
- Myplan.ie; National Planning Application Map Viewer[11]
- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas[12]
- Met Éireann Meteorological Data[13]
- Department of Housing, Local Government and Heritage, EIA Portal14
- Planning Reference: PL04.243486 Shehy More Windfarm EIAR[15]
- Planning Reference: 21/5372 Carrigarierk 2 Windfarm EIAR16

9.2.4 Field Work

Field investigation hydrological surveys to inform the Baseline hydrological conditions of the Site were undertaken by EcoQuest Environmental on 14th/15th of June 2021, 4th/5th of April 2022,13th/14th of June 2023 and 2nd/3rd of April 2024. 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; and
- 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.ie.

[8] https://www.npws.ie/protected-Sites
[9] https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx
[10] https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-irish- karst/Pages/Karst-databases.aspx
[11] https://myplan.ie/national-planning-application-map-viewer
[12] https://www.seai.ie/technologies/seai-maps/wind-atlas-map/
[13] https://www.met.ie/climate/available-data/historical-data
[14] https://housinggovie.maps.arcgis.com/apps/webappviewer
[15] http://maps.corkcoco.ie/planningenquiryv3/MainFrames.aspx
[16] https://www.carrigarierk2info.com/eiar

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 9.2: 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 Habitats Regulations 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.

Importance	Criteria	Typical Examples
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 9.3** and **Figure 9.1**.

Table 9.3: 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	• Surface water WFD class of "*High*" • European Commission (EC) designated Salmonid or Cyprinid waters

Sensitivity	Definition	Example Criteria
	limited potential for substitution or replacement	• 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 EU habitat legislation / species protected by EU 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.

Sensitivity	Definition	Example Criteria
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 **Figure 9.1** 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).

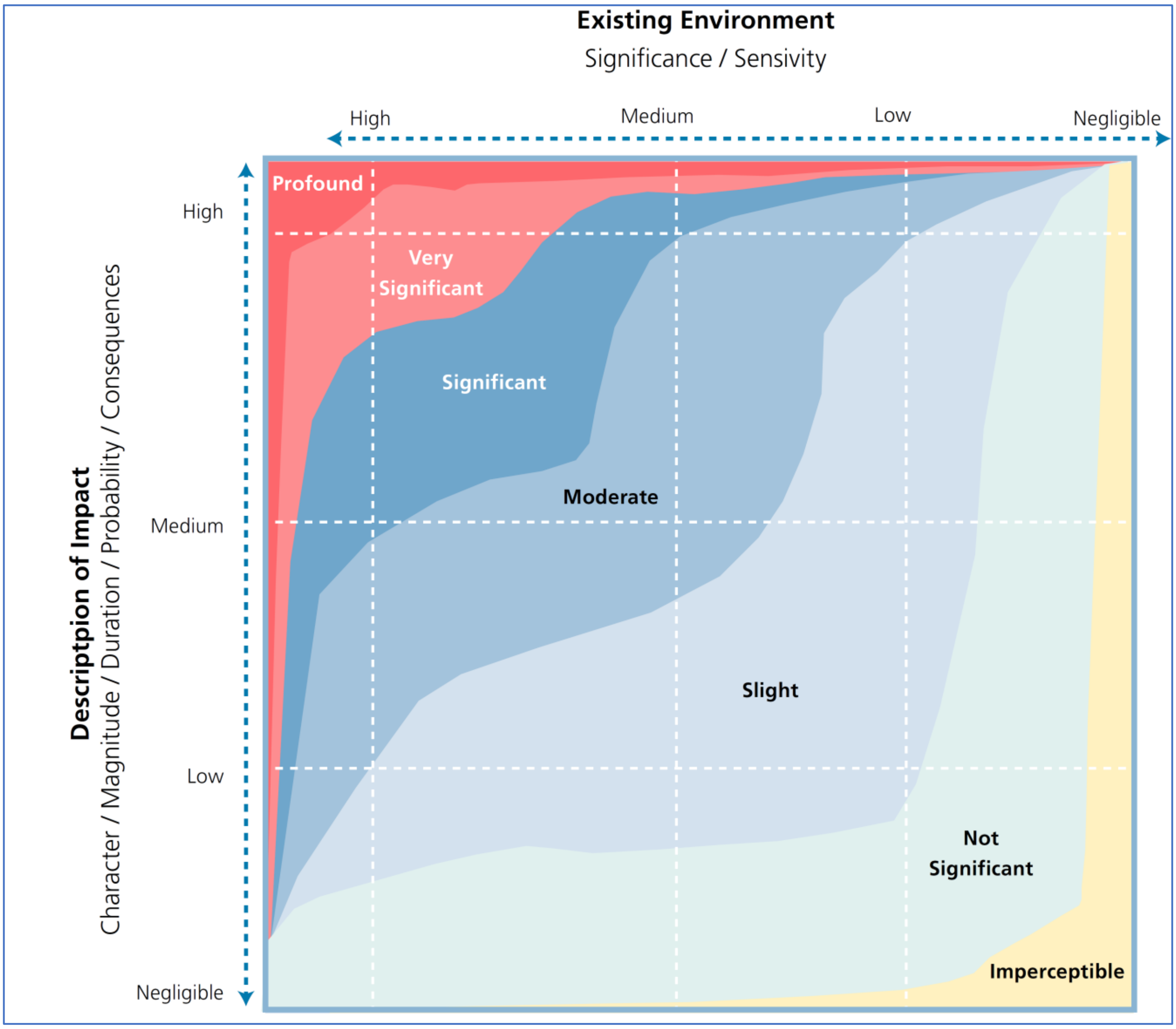


Figure 9.1: Comparison of the Character of the Predicted Impact to the Sensitivity of the Receiving Environment (EPA, 2022)

9.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Proposed Development are defined in accordance with the criteria provided by the EPA, as presented in **Table 9.4** (EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Proposed Development, and provide for considering Baseline tends, for example, a "*Moderate"* impact is one which is consistent with the existing or emerging trends.

Table 9.4: 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 Proposed 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 9.5: 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 9.6: 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 runoff.
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 runoff.
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 runoff.
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 9.7** 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 9.4: Describing the Magnitude of Impacts**) are linked directly with the development specific terms for qualifying potential impacts (**Table 9.5: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 9.6: Qualifying the Magnitude of Impact on Hydrogeological Attributes**).Therefore, qualifying terms (**Table 9.7**) are used in describing potential impacts of the Project.

Table 9.7: 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 9.8**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Proposed Development has addressed responses to specific issues indicated by respective consultees.

Table 9.8: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
Uisce Éireann	Letter in response to Scoping Report Received June 2023 Updated letter response received May 2024	• *"Where the development proposal has the potential to impact an Uisce Éireann Drinking Water Source(s) the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s) during construction and operational phases of the development. Hydrological / hydrogeological pathways between your Site and receiving waters should be identified."*	• Uisce Éireann's publicly available datasets have been consulted, no known Uisce Éireann assets exist at the proposed Site. An assessment of public and private water supplies that could potentially be impacted by the proposed Development is outlined in **Section 9.3.18**. Potential impacts on public or private water mains networks are expected to be negligible. The hydrological / hydrogeological pathways from the proposed Development and the locations of water supply zones, source protection areas, GSI mapped boreholes, wells and springs; relative to the proposed site and the grid connection route options, are mapped in **Figure 9.16** in **Volume III**. Further details on the hydrological / hydrogeological pathways from the proposed Development are outlined in the **Water Framework Directive Compliance Assessment** contained in **Appendix 9.3**.
		• *"Mitigation proposed for any potential negative impacts on any water source(s), which may be in proximity and included in the environmental management plan and incident response"*	• Mitigation measures for potential impacts on water sources are contained in **Section 9.5** and in the Construction Environmental Management Plan in **Appendix 2.1.**
		• *"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."*	• No known Uisce Éireann assets exist at the proposed Site or along the grid connection route options. Further details are provided in **Section 9.3.18**. Potential

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
			impacts on hydrogeology and groundwater / surface water interactions are addressed in **Section 9.3.19.**
		• *"Impacts of the development on the capacity of water services (i.e. do existing water services have the capacity to cater for the new development). This is confirmed by Uisce Éireann in the form of a Confirmation of Feasibility (COF). If a development requires 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 Uisce Éireann to determine the feasibility of connection to the Irish Water network. All pre-connection enquiry forms are available from https://www.water.ie/connections/connection-steps/.."*	• The Proposed Development will not require a new connection to a public water or wastewater supply.
		• *"The applicant shall identify any upgrading of water services infrastructure that would be required to accommodate the proposed development."*	• The Proposed Development will not require any upgrading of water services.
		• *"In relation to a development that would discharge trade effluent – any upstream treatment or attenuation of discharges required prior to discharging to an Uisce Éireann collection network."*	• The Proposed Development will not require the discharge of any trade effluent.
		• *"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."*	• The Proposed Development will not result in discharges of surface waters to combined sewers.
		• *"Any physical impact on Uisce Éireann assets – reservoir, drinking water source, treatment works, pipes, pumping stations, discharges outfalls etc. including any relocation of assets."*	• No known Uisce Éireann assets exist at the proposed Site, those along the grid connection route options are discussed in **Section 9.3.18**.
		• *"When considering a development proposal, the applicant is advised to determine the location of public water services assets, possible connection points from the applicant's site / lands to the public network and any drinking water abstraction*	• Uisce Éireann have been consulted via submission of a data request to datarequests@water.ie. No known Uisce Éireann assets exist at the proposed Site, no

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		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 the applicant's intended development to datarequests@water.ie"	known public water supplies exist within the vicinity of the Site, those along the grid connection route options are discussed in **Section 9.3.18**. Hydrological / hydrogeological pathways have been identified in **Sections 9.3.10** and **9.3.11** in addition to the mapping of surface water features on **Figure 9.3** in **Volume III.**
		• *"Any potential impacts on the assimilative capacity of receiving waters in relation to Uisce Éireann 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 0, 9.3.10** and **9.3.11** in addition to the mapping of surface water features in **Figure 9.3** in **Volume III**.
		• *"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 Uisce Éireann for public supply."*	• Water abstraction for the Proposed Development will not be required. The potential for the Proposed Development to present a risk to the quality of water abstracted by Uisce Éireann for public supply is considered to be negligible since no known Uisce Éireann assets exist at the Site, those along the grid connection route options are assessed in **Section 9.3.18**.
		• *"Where a development proposes to connect to an Uisce Éireann network and that network either abstracts water from or discharges wastewater to a "protected"/sensitive area,*	• The Proposed Development will not require a connection to an Uisce Éireann network.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		consideration as to whether the integrity of the Site/conservation objectives of the Site would be compromised." • *"Mitigation measures in relation to any of the above ensuring a zero risk to any Irish Water drinking water sources (Surface and Ground water)."*	 • No known Uisce Éireann assets exist at the Site, those along the grid connection route options are addressed in **Section 9.3.18.** Mitigation measures for potential impacts on water sources are contained in **Section 9.5**.
Cork County Council	Letter in response to Scoping Report Received 11 April 2022	• The response received from Cork County Council did not identify any specific issues relating to hydrology or hydrogeology.	• Not Applicable.
Irish Peatland Conservation Council (IPCC)	Letter in response to Scoping Report Received 22 February 2022	• *"The IPCC would advise any developer planning construction in, or within close proximity to peatland habitat to be familiar with the Environmental Protection Agency funded project BOGLAND (www.ucd.ie/bogland).This project recommends the best practice guidelines to ensure no damaging development occurs on, or affects peat soils and peatlands of conservation value."* • *"The Irish Peatland Conservation Council have identified a number of designated sites within the proximity of the proposed windfarm which need to be given due attention in ascertaining the impacts to biodiversity from the proposed project. In particular, developments have the potential to disrupt the hydrology of peatland and even small impacts to the water table may have disastrous consequences for specialised peatland species that live within minimal ranges of chemical and hydrological limits, such as the Vertigo whorl snails. Developers need to ensure that their project in no way affects the integrity of the habitats and qualifying interests including species of the designated sites."*	• This Project has been reviewed and the applicable best practice techniques are incorporated into **Section 9.5.** • Designated sites are assessed in **Sections 9.3.17** and **9.4.4.7.** The locations of designated sites relative to the Site and proposed grid connection route options are mapped on **Figure 9.5** in **Volume III**. Potential impacts on biodiversity are assessed in **Chapter 6:Biodiversity**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *"In 2018 in the UK 39 of 57 Special Areas of Conservation listed on the APIS website (http://www.apis.ac.uk) exceeded the Critical Load Threshold for nitrogen. This is having negative impacts on the vegetation of the designated habitats. There are various sources of excess nitrogen such as construction (e.g. roads, developments), urban waste water (pollution) and agriculture (e.g. fertilizer/piggerys) and can enter a habitat via wet or dry deposition. The proposed development needs to account for nitrogen within pre-planning coupled with a nitrogen monitoring agenda which could highlight possible pathways of nutrient enrichment. Peatlands are naturally nutrient poor and the excessive loads can decimate botanical species."* • *"Ireland has legal obligations under the WFD to ensure that all rivers and lakes are of "Good Ecological Status" by 2027. Please ensure that the proposed development will not adversely impact on the water quality and lower Ireland's standing with our legal obligations in protecting our waterways. Silt runoff and chemical/construction pollution can be disastrous for aquatic wildlife and this should also be factored into the management and construction plans of the proposed development. IE_SW_20B020200 and IE_SW_19L030200 are of good quality and their status needs to be protected from the development. IE_SW_21O070200, IE_SW_20C010400 and IE_SW_21O040400 are all of high quality and their status also needs to be protected from the development."*	• Total nitrogen, nitrite as NO_2 and Nitrate as NO_3 have all formed part of the water quality monitoring programme as is discussed in **Section 9.3.9** where possible pathways for nutrient enrichment is also addressed. The same parameters would continue to be monitored during the operational phase of the water quality monitoring programmes as discussed in **Section 9.5.2.10**. • There are no lakes located within the proposed Site boundary nor adjacent to the proposed Grid Connection route options as can be seen on **Figure 9.3** in **Volume III**. All rivers and streams within and adjacent to the Site Redlin Boundary have been mapped in addition to those located along the proposed Grid Connection route options. Mitigation measures for potential impacts on water sources are contained in **Section 9.59.5**. A water quality monitoring programme has been carried out as is discussed in **Section 9.3.9**. A **Water Framework Directive Compliance Assessment** has also been prepared and is attached to **Appendix 9.3.** With the implementation of the proposed mitigation measures, a deterioration in WFD status is not anticipated in any waterbody.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *"Wetland Surveys Ireland (www.wetlandsurveysireland.com) have identified a number of wetlands which have had or need to have an ecological survey to ascertain the biodiversity and ecological value within them"*	• The potential wetlands identified at the Site by Wetland Surveys Ireland are assessed in **Chapter 6: Biodiversity**.
Geological Survey of Ireland (GSI)	Letter in response to Scoping Report Received 18 January 2022	• *"Please find attached a list of our publicly available datasets that may be useful to the environmental assessment and planning process. We recommend that you review this list and refer to any datasets you consider relevant to your assessment"* • *"Proposed developments need to consider any potential impact on specific groundwater abstractions and on groundwater resources in general. We recommend using the groundwater maps on our Map viewer, which should include: wells; drinking water source protection areas; the national map suite - aquifer, groundwater vulnerability, groundwater recharge and subsoil permeability maps."* • *"The Groundwater Vulnerability map indicates 'High' and 'Extreme' groundwater vulnerability within the area covered. We would therefore recommend use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability in your assessments, as any groundwater-surface water interactions that might occur would be greater in these areas."*	• All relevant GSI datasets have been thoroughly investigated, assessed and mapped, including aquifer vulnerability mapping (**Figure 9.14)**, groundwater body mapping (**Figure 9.15**), wells, springs, boreholes and source protection areas (**Figure 9.16**). The GSI Map Viewer has been reviewed and referenced for groundwater recharge and subsoil permeability in carrying out the water balance calculations in **Section 9.3.7.** • Groundwater abstraction and resources has been assessed in **Section 9.3.11** (Wells) and in **Section 9.3.18** (Water Resources). Mitigation measures for the protection of groundwater are outlined in **Section 9.5.2.8**. The GSI Map Viewer has been reviewed and referenced for groundwater recharge and subsoil permeability in carrying out the water balance calculations in **Section 9.3.7**. • GSI data has been utilised to produce the groundwater vulnerability map as shown on **Figure 9.14** in **Volume III** and groundwater vulnerability is assessed in **Section 9.3.12**.

Consultee	Type and Date	Summary of Consultee Response With Relevance to This Chapter	Addressed
		• *"The Groundwater Protection Response overview and link to the main report is here: https://www.gsi.ie/en-ie/programmes-and-projects/groundwater-and-geothermal-unit/projects/protecting-drinking-water/what-is-drinking-water-protection/county-groundwater-protection-schemes/Pages/default.aspx"*	• The link provided by GSI has been reviewed. A Groundwater Protection Scheme Report for both west and north Cork were not available at the time of preparing this chapter. Inner and outer source protection areas in the region have been identified and are mapped as shown on **Figure 9.16 in Volume III** with an assessment also provided in **Section 9.3.18**.
		• *"Geological Survey Ireland also engaged in a national project on Groundwater Flooding. The data from this project may be useful in relation to Flood Risk Assessment (FRA) and management plans, and is described in more detail under 'Groundwater' above."*	• The GSI groundwater flooding data has been reviewed and assessed as part of the flood risk identification outlined in **Section 9.3.8**.

9.3 BASELINE DESCRIPTION

9.3.1 Introduction

The Proposed Development is outlined in detail in **Section 2.1** of **Chapter 2: Project Description**.

9.3.2 Site Description

The Proposed Development is located to the east of the townland of Gortloughra, approximately 9 kilometres north-west of Kealkill in west County Cork at the southern extent of the Shehy Mountains. The site is broadly split into a northern and a southern portion which are divided by the highest peak on the site, Shehy More at 546m OD (metres above Ordnance Datum). The Site is located across approximately 117.21 hectares of land which is under the ownership of third parties and the principal land use in the general area is comprised of agricultural sheep grazing, farmland and open mountain heath. The Site is located within the townlands of an tSeithe Bheag (Shehy Beg), (Muscraí Gaeltacht), Gortloughra, Cloghboola and Inchinroe. To the south and south-east of the Site are the townlands of Shanacrane West and Tooren respectively. To the north of the Site there are additional areas of blanket bog, forestry, Douce Mountain, Lough Nambrackderg, the pre-existing Shehy More Windfarm and the townlands of Shehy More, Cloghboola, Derryriordane South and Inchiroe. To the east of the Site Redline Boundary is the townland of Coolmountain and additional areas of forestry. To the west and south-west of the Site Redline Boundary are the townlands of Gortloughra, Coomclogh, Glanycrney, the Cousane Gap and the R585 road. The wider area surrounding the Site is rural in nature with low intensity agriculture in the form of pastoral grassland, peat harvesting and commercial forestry plantations being the predominant land use.

The townlands along which the two grid connection options transverse include:

- **Option A (Dunmanway):** an tSeithe Bheag (Shehy Beg), Gortloughra, Inchinroe, Cloghboola, Cornery, Garraí na Tórnóra (Garryantornora), Tuairín na Lobhar (Tooreenalour), Gort na Carraige (Gortnacarriga), Moneylea, Coolcaum, Coolmountain, Tullagh, Moneyreague, Togher, Cooranig, Keelaraheen, Neaskin, Ardcahan, Knockduff, Gurteennasowna and Ballyhalwick.
- **Option B (Carrigdangan):** an tSeithe Bheag (Shehy Beg), Gortloughra, Inchinroe, Cloghboola, Cornery, Garraí na Tórnóra (Garryantornora), Tuairín na Lobhar (Tooreenalour), Gort na Carraige (Gortnacarriga), Cooragreenane, Coolroe West, Gortnahoughtee, Derryleigh, Gortatanavally, Carrigdangan and Johnstown.

Sixteen mapped rivers or small streams were originally identified that were located either within or adjacent to the Redline Boundary at various stages of the Project design. A significant reduction in size of the Redline Boundary total area occurred during the Project design phase. This resulted in only four mapped rivers or small streams intersecting the finalised Redline Boundary. Multiple interconnecting artificial and natural drainage channels have also been surveyed at the Site, many of these ultimately connect to the larger mapped rivers and streams. Given this considerable surface water interconnectivity, and the potential for sediment laden run-off to migrate down gradient towards lower altitude watercourses, all of the sixteen mapped rivers or small streams that were originally identified have been considered in this chapter, noting that twelve of these watercourses are now located outside of the Redline Boundary.

Eight streams were identified to the north of the summit of Shehy More, these watercourses are located either within or downstream of the northern portion of the Site. These watercourses are all tributaries of the Gortloughra River, which in turn is a tributary of the Owvane River. The Owvane River flows in a south-westerly direction to the north of Kealkill before ultimately draining into Bantry Bay at Ballylickey.

Eight streams were also identified to the south of the summit of Shehy More, these watercourses are located either within or downstream of the southern portion of the Site. These watercourses are all tributaries of the River Bandon which flows to Dunmanway, before turning eastward towards the villages of Ballineen and Enniskean. It then makes its way through the centre of Bandon town, and on to Innishannon and Kilmacsimon, before draining into Kinsale Harbour.

There are no lakes within the Redline Boundary, the closest lake to the Site is Lough Nambrackderg, which is located approximately 850m northeast of the Redline Boundary at the closet extent within the pre-existing Shehy More windfarm site. There are a small number of dwellings and farm buildings located beyond the Redline Boundary which is characteristic of the wider rural setting, there are no buildings or dwellings located within the Redline Boundary. The northern portion of the site is accessible via the L8544 local road which also forms part of the Beara Gougane Barra Cycle Route, a long-distance route from Cork City to the Beara Peninsula. The southern portion of the site is accessible via the L-95853 local road from the R585 regional road, though it is not proposed to access the Site using this road.

9.3.3 Topography

The Site forms part of the southern fringes of the Shehy Mountains and is therefore generally elevated in nature. The highest peak at the Site is Shehy More (546m OD) which broadly divides the northern and southern sections of the Site. To the north of the Site is Douce Mountain (474m OD), in between Douce Mountain and Shehy More is a valley through which the L8544 local road traverses and which forms part of the northernmost extent of the Site. The northern portion of the site ranges in elevation from 200m OD with increasing steeper inclines existing to the south as far as the summit of Shehy More at 546m OD. 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.

The southern face of Shehy More is also steep with elevations reducing rapidly from 546m OD to 400m OD across an approximate lateral distance of 300m. The southernmost extent of the Site ranges in elevation from approximately 250 – 300m OD. Further south beyond the Redline Boundary, the topography is generally flat in the townland of Shanecrane East at an elevation of approximately 120m.To the west of the Site, beyond the Redline Boundary is Carrigmount with an elevation of 342m OD. To the east and south-east of the Site there are peaks ranging in elevation from 312m OD, 332m OD and 375m OD and the Cousane Gap through which the R585 regional road traverses. Elevation contours are included within a 3-D hydrological flow map outlined in **Figure 9.6** which is presented in **Volume III**.

9.3.4 Rainfall and Evapotranspiration

Long term rainfall and evaporation data for the study area were sourced from Met 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 proposed site is located in between three weather stations which include the following:

Table 9.9: Rainfall Data Available in the Vicinity of the Proposed Site

Station Name	Approximate Distance from Site	Year Opened	Year Closed	Elevation (m OD)
Coomclogh	1.4 Km southwest of the Site	1993	N/A	240
M.Ballingeary,	3.4 Km north of the Site	1948	N/A	323

Station Name	Approximate Distance from Site	Year Opened	Year Closed	Elevation (m OD)
M.Inchigeelagh,	4.4 km northeast of the Site	1948	N/A	299

There is considerable variation in the elevations of the weather stations outlined in **Table 9.9**. Many areas of the Site are located on ground exceeding 300m in elevation. The weather stations outlined in **Table 9.8** are therefore not considered to be an accurate reflection of the likely rainfall estimates for the Site since rainfall propensity generally increases with increasing altitude. This phenomenon occurs due to orographic uplift, a process in which moist air masses are forced to rise over higher terrain, such as hills or mountains. As the air rises, it cools and condenses, leading to precipitation. Therefore, utilising historic climate data from the localised weather stations listed in **Table 9.9** is not considered to be the most reliable methodology that is currently available for estimating rainfall levels at the Site.

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 1-kilometre 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, particularly with respect to higher altitude sites such as that of the proposed Development.

Four Met Éireann 1-kilometre square grid rainfall estimates are available for areas within or in close proximity to the Redline Boundary with the average of these four values being adopted for the purpose of site specific rainfall calculations. A total average of 2,237 mm rainfall per year is estimated to occur on average at the site 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 9.10**.

Table 9.10: Site Specific Average Rainfall Estimate Based on Met Éireann 1km Square Grid Modelling

Point ID	1km Grid Rainfall Position (ING)		Altitude Estimate (m OD)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
	East	North														
11,868	114,000	60,000	350m	266	195	182	137	133	127	118	156	168	247	230	243	2,203
12,169	115,000	60,000	520m	290	216	199	144	141	132	126	169	186	275	249	265	2,392
12,469	116,000	60,000	360m	263	192	178	133	131	124	116	149	164	243	226	241	2,161
12,168	115,000	59,000	370m	266	193	179	135	133	127	119	156	169	247	229	242	2,196
			Site Averages	**271**	**199**	**185**	**137**	**135**	**128**	**120**	**158**	**172**	**253**	**234**	**248**	**2,237**

The closest synoptic weather station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, approximately 52km east of the Site. The long-term-average (LTA) PE data covers a continuous 30-year period from 1981 to 2010 (inclusive). The long-term average annual PE for Cork Airport station is 516.3 mm/yr and is outlined in **Table 9.11**. This value is taken to be the best available long-term-average estimate of the Site PE.

Table 9.11 Potential Evapotranspiration Data (mm) for Cork Airport Weather Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2023	12.5	19.6	29.7	47.6	87.8	91.4	79.0	67.4	45.5	21.7	15.4	12.1	529.7
2022	13.9	20.6	43.4	58.0	76.3	79.3	93.6	96.6	49.9	25.7	12.7	10.7	580.7
2021	11.4	17.0	32.5	59.9	70.2	88.3	94.3	72.1	42.9	24.9	15.4	12.4	541.3
2020	10.7	19.6	36.1	57.4	83.9	78.4	85.3	70.0	47.5	28.2	11.9	11.0	540.0
2019	13.0	16.0	35.3	51.6	81.0	79.4	87.6	67.7	47.0	27.1	13.9	11.5	531.1
LTA	12.8	20.1	32.1	52.5	71.2	81.7	81.3	69.1	46.1	24.7	13.8	10.9	**516.3**

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

Whilst the long-term average PE for Cork Airport station is 516.3 mm/yr, Actual Evapotranspiration (AE) at the Site will be dependent upon a number of factors, including 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 P.E. to allow for seasonal moisture deficits (Hunter-Williams et al, 2013). Therefore, actual evapotranspiration at the Site is calculated to be 490.4 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:

Annualised Average Rainfall – Actual Evapotranspiration = Effective Rainfall

2237 mm/yr – 490.4 mm/yr = 1746.5 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 1751.6 mm/yr being the estimated total across the majority of the area at the Site. This GSI map viewer modelled estimate for effective rainfall is only 5.1 mm/yr greater than the result from the methodology applied above, which is a difference of only 0.29% between the two methodologies.

According to the GSI National Groundwater Recharge Map, the recharge coefficient (RC) estimated ranges for the Site include 22.5% and 85% across the majority of the site. Peat and poorly drained soils form the dominant hydrogeological setting. The aquifer vulnerability across the Site is predominantly categorised as "*rock at or near the surface*" and "*extreme*" by GSI. Areas of aquifer vulnerability classified as "*rock at or near the surface*" may have slightly higher recharge rates than areas categorised as "*extreme*". However, at the Site, these areas are predominantly located on slopes or in areas with very poor natural drainage. The lowest value in the available range (22.5%) has therefore been chosen to reflect the poorly draining soil types and the presence of peaty soils at the Site. The relatively high stream density and the presence of wetlands at the Site also suggests that recharge rates are comparatively low. Annual recharge and runoff rates for the Site are estimated to be 393 mm/year (22.5% of ER) and 1354 mm/year respectively. The Baseline hydrology of the Site can therefore be characterised as having a flashy network of streams/rivers and by high surface water runoff rates.

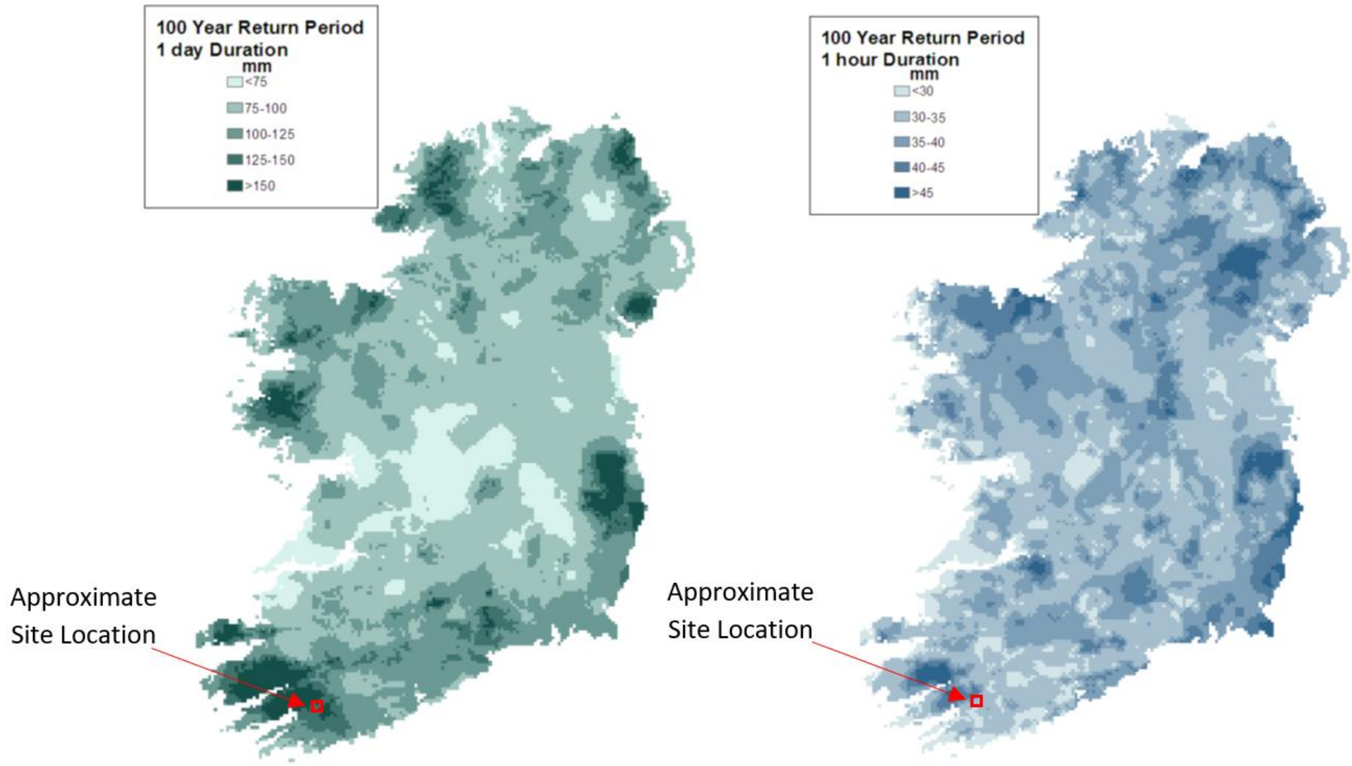
Met Éireann have undertaken a study for the Office of Public Works (OPW) through the Flood Studies Update (FSU) which provides a depth duration frequency (DFF) model. The model allows for the estimation of point rainfall frequencies across a range of durations for any location in Ireland to be predicted. 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). Requirements for attenuation may vary but in general best practice is to attenuate the 1 in 100-year storm with a 6-hour duration. The proposed drainage system at the Site will therefore be designed with the capacity to accommodate the 1 in 100-year storm with a 6-hour duration. Settlement ponds at the Site will be designed with the capacity to accommodate the 1 in 200-year storm with a 30 minute duration. The modelling provides an estimation of rainfall depths at the Site for multiple storm frequency durations which are outlined in **Table 9.12**.

Table 9.12: Storm Duration and Return Period Rainfall Depths (mm) at the Site

Duration (Mins/ Hours/ Days)	Return Period at the Site (Irish Grid) Easting: 115132, Northing: 059538								
	5 Years	10 Years	20 Years	30 Years	50 Years	75 Years	100 Years	150 Years	200 Years
5 mins	6.0	6.8	7.7	8.2	9.0	9.6	10.0	10.7	11.2
10 mins	8.3	9.5	10.7	11.5	12.5	13.4	14.0	15.0	15.7
15 mins	9.8	11.2	12.6	13.5	14.7	15.7	16.5	17.6	18.4
30 mins	13.7	15.6	17.6	18.8	20.5	21.9	23.0	24.5	25.7
1 hours	19.1	21.8	24.5	26.3	28.6	30.6	32.0	34.2	35.9
2 hours	26.6	30.3	34.2	36.6	39.9	42.6	44.7	47.7	50.0
3 hours	32.3	36.9	41.6	44.5	48.5	51.8	54.3	58.0	60.8
4 hours	37.1	42.3	47.7	51.1	55.6	59.5	62.3	66.6	69.8
6 hours	45.1	51.4	58.0	62.1	67.6	72.2	75.7	80.9	84.8
9 hours	54.8	62.5	70.5	75.4	82.1	87.8	92.0	98.3	103.0
12 hours	62.9	71.7	80.9	86.6	94.3	100.8	105.6	112.8	118.2
18 hours	76.4	87.1	98.3	105.2	114.5	122.4	128.3	137.1	143.6
24 hours	87.7	100.0	112.8	120.8	131.5	140.5	147.3	157.3	164.9
2 days	108.8	122.4	136.6	145.3	156.8	166.5	173.8	184.5	192.4
3 days	126.7	141.6	156.9	166.2	178.6	189.0	196.7	208.0	216.4
4 days	142.9	158.9	175.2	185.1	198.3	209.2	217.3	229.2	238.1

Site specific rainfall modelling data shown in **Table 9.10** indicates that the Site could potentially receive approximately 271 mm/month of rainfall during the average wettest month (January), or approximately an average of 8.7 mm 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 9.12**, indicates that the Site could potentially receive 147.3mm of rainfall per day, and potentially 32 mm 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 125 – 150 mm of rainfall per day, and potentially between 30 – 35mm 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)



9.3.5 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 River Basin Management Plan 2022-2027 (The Water Action Plan 2024: A River Basin Management Plan for Ireland) which defines the actions that will be taken to improve water quality and achieve "*Good*" ecological status in rivers, lakes, estuaries and coastal waters. 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 Site, both Grid Connection route options, and the TDR are located within three separate catchment areas, including the Lee, Cork Harbour and Youghal Bay Catchment Area, the Bandon-Illen Catchment Area and the Dunmanus-Bantry-Kenmare Catchment Area in Hydrometric Areas 19, 20 and 21 respectively. The Proposed Development and Grid Connection route options are located within three WFD sub-catchments. These include the Lee[Cork]_SC_010 sub-catchment, the Bandon_SC_010 sub-catchment and the Coomhola_SC_010 sub catchment. These sub-catchments are geographically spread across three Margaritifera Sensitive Areas in accordance with Annex II and Annex V of the EU Habitats Directive. These include the Lee Upper, Bandon/Caha and the Owvane Margaritifera Sensitive Areas. All of the Proposed Development and Grid Connection options are located within the National River Basin District (RBD) as defined by the current cycle of the WFD. Maps illustrating the catchment and subcatchments areas relative to the Site and Grid Connection route options are illustrated on **Figure 9.9** and **Figure 9.10** respectively in **Volume III.**

There are no Special Areas of Conservation (SACs) or Special Protection Areas (SPAs), collectively referred to as Natura 2000 sites, within the Site nor in close proximity to the Site. The Bandon River SAC is located approximately 7.3km south-east of the Site. There is tenuous surface water connectivity between the Site and Bandon River SAC via the tributaries of the Bandon River which drain the Site. Derryclogher (Knockboy) Bog SAC is located approximately 8.5km west of the Site and is not hydrologically connected to the site. The Site is located approximately 5.5km southwest of the Conigar Bog Natural Heritage Area (NHA). The Conigar Bog NHA is located upstream of the Site via multiple different rivers, any potential hydrological connectivity between the Site and Conigar Bog NHA is therefore very tenuous.

The Site is intersected by four EPA mapped rivers or small streams, with sixteen rivers or small streams being located either within or in relative proximity to the Redline Boundary. Many of these streams merge to form larger channels. These small channels have been numbered 1 – 16 for the purpose of ease of identification and are shown on **Figure 9.3** and **Figure 9.4** in **Volume III**. The Site also contains multiple unmapped small natural and artificial drainage channels. Eight EPA mapped channels located north of the summit of Shehy More (Streams 1 - 8), are tributaries of the Gortloughra River which in turn is a tributary of the Owvane River, which is also referred to as the "*Ouvane River*". The Gortloughra River has the EPA name designation of "*Inchiroe*" and has a stream order of 3. The Gortloughra River flows for approximately 2km west of the Site until it merges with the Owvane River. The Owvane River has the EPA name designation of "*Owvane (Cork)*" and has a stream order of 4. The Owvane River flows in a south-westerly direction to the north of Kealkill before ultimately draining into Bantry Bay at Ballylickey.

Eight small channels are located south of the summit of Shey More (Channels 9 – 16, inclusive), all of which are tributaries of the River Bandon. Six of these small channels have a stream order of 1 and are unnamed streams. Two of these channels have a stream order of 2 and have the EPA names of "*Shehy_Beg*" and "*Shanacrane_East*". Six channels located in the south-eastern area of the Site all merge into the "*Shehy_Beg*" River to the south-east of the Site in the townland of Tooreen. The Shehy Beg River ultimately merges with the Bandon River, approximately 4km to the south-east of the Redline Boundary. Two channels drain the south-west portion of the Site, namely the "*Shanacrane_East*" and a small unnamed stream. Both of these streams ultimately merge and continue as the EPA named "*Shanacrane_East*" which merges with the Bandon River approximately 3.8km southwest of the Redline Boundary. The Bandon River then continues to flow in a south-easterly direction, through the Bandon River SAC and east of Dunmanway before turning eastward towards the villages of Ballineen and Enniskean. It then flows through the centre of Bandon town, and on to Innishannon and Kilmacsimon, before draining into Kinsale Harbour.

Approximately 300m east of the Redline Boundary, within the existing Shehy More Windfarm site, is the EPA named "*Cloghboola 19*" stream which flows in a north-easterly direction into Lough Nambrackderg, which is also located within the existing Shehy More Windfarm site. Lough Nambrackderg drains in a north-westerly direction via the EPA named "*Cloghboola 19*" stream which merges with the Sruhaunphadeen stream. The Sruhaunphadeen stream in turn merges with the Bealaphadeen Stream, which ultimately flows into Lough Allua, approximately 5km northeast of the Site. Approximately 200m north of the Site, within the existing Shehy More Windfarm site, an area of forestry plantation exists containing three channels which flow in a northerly direction to merge with another unnamed stream which ultimately merges with the Sruhaunphadeen Stream. Approximately 350m northwest of the of the Site boundary, three unnamed channels rise and merge to form Channel 6 which flows in a southerly direction before turning west and merging with the Gortloughra River.

Approximately 780m northwest of the Site, at the southern base of Douce Mountain, an unnamed stream (Channel 8) rises and flows in a southerly direction before turning west and merging with the Gortloughra River. Approximately 80m and 140m west of Channel 2, beyond the north-western Site, two additional unnamed streams (Channels 3 and 4 respectively) flow in a northerly direction, near parallel to Channel 2, into which they merge, before Channel 2 in turn merges with Channels 5, 7 and ultimately the Gortloughra River.
In addition to the named and unnamed rivers, streams and lake discussed above, there are also numerous natural and artificial drainage ditches located within the Site and its surrounds, examples of these are shown in **Plate 9.1**, **Plate 9.2** and **Appendix 9.1**. The pre-existing artificial drainage network is more prominent in the northern portion of the Site than in the southern portion of the Site. The natural and artificial drainage channels facilitate

the flow of surface water runoff into the streams and rivers located downstream of the Site. Light Detection and Ranging (LiDAR) data has been utilised along with Geographic Information System (GIS) software to map the most prominent of the unmapped streams at the Site. Ground truthing surveys at the Site, and the use of satellite imagery were both used to confirm the accuracy of the LiDAR mapping with GIS software. The LiDAR modelling returned several thousand drainage flow paths, or very small channels within the Site. The most prominent of these are presented on **Figures 9.3 and 9.6** in **Volume III**. **Figure 9.6** in **Volume III** outlines a three-dimensional hydrological model of the Site with respect to the main design elements.

Within the northern portion of the Site, the drainage channels are heavily influenced by the topography and generally flow in a westerly or northerly direction to merge with unnamed channels that are tributaries of the Gortloughra River. Within the southern portion of the Site, the drainage channels generally flow in a southerly or easterly direction to generally mimic the land gradient and merge with the various rivers and unnamed streams that are tributaries of the Bandon River further south.

There are no lakes within the Site, the closest lake to the Site is Lough Nambrackderg, which is located approximately 850m northeast of the Site at the closet extent and is located within the pre-existing Shehy More windfarm site.

The Grid Connection route option to Carrigdangan substation follows the road network and would traverse across eighteen watercourses along the road network, two mapped watercourses within the Redline Boundary, and four field surveyed drainage channels within the Redline Boundary. The Grid Connection route option to Dunmanway substation follows the road network to Dunmanway and would traverse across thirty-three watercourses along the road network, two mapped watercourses within the EIAR boundary, and four field surveyed drainage channels within the Redline Boundary.

To facilitate the installation of either Grid Connection route option and upgrading of the Site access tracks, one new bridge would be constructed within the Redline Boundary, to the southwest of T06. Five existing culverts would be upgraded and three new culvers would be installed at the main Site. A maximum of 6 drainage channels would also require slight diversions to be implemented at the main site to allow for the access tracks, Turbine Hardstand areas and borrow pit to be constructed. These locations are shown on **Figure 9.7A** in **Volume III**.

The road network between the Site entrance and the townland of Gortnacarriga is proposed to be utilised for both grid connection route options, at this point the grid connection route options diverge towards either Dunmanway or Carrigdangan substations. There are eight watercourses located along this stretch of road network that is common to both grid connection route options (between the main Site and the townland of Gortnacarriga). Horizontal directional drilling (HDD) could potentially be required at all thirty-three crossing locations along the Dunmanway option as a conservative assumption. For the purpose of conservatism, it is also assumed that all eighteen crossings along the Carrigdangan option could potentially also require HDD to be carried out. The locations where HDD may potentially be required along both grid connection route options are shown on **Figure 9.7B** in **Volume III**.

In terms of the Turbine Delivery Route (TDR), which is from the Port of Cork to the northern entrance of the Site, the route crosses multiple mapped rivers and streams with minor works being carried out or laydown areas being utilised at a total of 49 individual locations. The type of minor works that would be required along the TDR include temporary road widening for overrun areas, areas to be cleared for oversail areas, vegetation clearance, checking the width of access roads and the use of fields as blade laydown areas. The locations of watercourse relative to the TDR are shown on **Figures 9.17** to **9.65** in **Volume III**.

9.3.6 Wind Farm Site Drainage

Plate 9.1: Example of Natural Drainage Channel

Plate 9.2: Examples of Excavated Artificial Drainage Channels

9.3.7 Water Balance Assessment

A water balance assessment has been carried out for the Site which is outlined in **Table 9.13**. The water balance assessment utilises site specific rainfall estimates for the highest average monthly rainfall (January) at the Site. Combined with long-term potential evapotranspiration (PE) data from Met Éireann, 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 January 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 Proposed 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 at the Site as is outlined in **Table 9.9** with a result of 271mm estimated for the average month of January. The closest synoptic weather station where the average potential evapotranspiration (PE) is recorded is at Cork Airport, approximately 52km east of the Site. The long term minimum monthly PE data from Cork Airport synoptic weather station has therefore been adopted as being the most representative available PE data for the Site. The minimum January potential evapotranspiration during the same period of 1981-2010 at Cork Airport Weather Station occurred in January 2010 at 7.8 mm PE, this has been adopted as a conservative estimate for PE. As these datasets represent the worst-case scenario, they have been conservatively used to estimate runoff volumes from the Site.

The surface water runoff coefficient for the Site will be variable and dependent on a range of factors such as the antecedent conditions, rainfall intensity, rainfall duration, slope, vegetation type and subsoil type etc. In winter, when wetter conditions prevail, a greater proportion of runoff is likely to occur, than that which occurs in summer for a similar rainfall event. Peat catchments are susceptible to high rates of runoff. May et al. (2005) found that over 90% of the total flow in a peat catchment in the west of Ireland originated from precipitation and was mainly in the form of surface runoff. Given that peat does contribute to the hydrogeological setting across the Site, and peat is usually saturated, in addition to the generally sloping topography, a surface water runoff co-efficient of 77.5% has been conservatively estimated for the Site.

A range of GSI recharge coefficient and runoff estimates exist for the Site with 22.5% being adopted as a site wide average. The water balance assessment conservatively estimates that the volume of surface water runoff at the Site during the average wettest month would be 228,226 m^3/month or 7,362 m^3/day. For the post development runoff scenario, the water balance assessment conservatively assumes that all hardstand areas and access tracks 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 constructed as a worst-case scenario, the surface water runoff at the site is estimated to increase by 3.26% when compared to the pre-Development baseline runoff rates which is considered to be a slight increase in terms of potential downstream impacts.

Table 9.13: Preliminary Water Balance Analysis

Variable	Data Description	Site Assessment	Units
Average Wettest Month (January) Estimated Water Balance			
Site Specific Average Wettest Monthly Rainfall Total (R)	Met Éireann 1981-2010 1 km^2 Grid Estimates of Wettest Monthly Average Rainfall Totals (January)(R)	271	mm
January Minimum Potential Evapotranspiration (PE)	Cork Airport 30 Year January Minimum PE (1981-2010) (January 2010)	7.8	mm
Minimum October Actual Evapotranspiration (AE = PE x 0.95)	AE = PE*0.95 (Hunter-Williams et al, 2013)	7.41	mm
Max Effective Rainfall (October) (ER = R - AE)	R - AE	263.59	mm
Range of GSI Recharge Coefficient Estimates (RC) for the Site (22.5% and 85%)	The lowest value in the GSI range (22.5%) has been adopted as a site wide average to reflect the presence of peat at the site and the National Soils Hydrology Map classification for the majority of the site as being poorly drained.	22.5	%
Estimated Recharge Coefficient	22.5% of ER	59.1	mm
Estimated Runoff	77.5% of ER	203.5	mm
Average Wettest Month (January) Runoff Estimates			
Site Area	EIAR Boundary File GIS Geometry Calculation	1,117,210	m^2
Baseline Wettest Month Monthly Runoff	Estimated Average Monthly Baseline Runoff During Wettest Month	228,226	m^3/month
Baseline Wettest Month Daily Runoff	Estimated Average Daily Baseline Runoff During Wettest Month	7,362	m^3/day
Estimated Changes to Baseline Runoff Post Development During the Average Wettest Month (October)			
Hardstand Development Area (DA)	EIAR Chapter 2 Description of Development (Sum of all Hardstand Areas)	125,298	m^2

Variable	Data Description	Site Assessment	Units
100% Runoff Scenario from Hardstand Area	DA*ER/1000	33,027	m^3
77.5% Runoff Scenario from Hardstand Area	DA*(ER*0.75)/1000	25,596	m^3
Net Monthly Runoff Increase	Estimated Monthly Runoff Increase Versus Baseline Conditions	7,431	m^3/month
Net Daily Runoff Increase	Estimated Daily Runoff Increase Versus Baseline Conditions	240	m^3/day
Percentage Runoff Increase	Percentage Runoff Increase Compared to Baseline Conditions	3.26	%

9.3.8 Flood Risk Identification

Flood risk identification is the first stage is 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. The scope of this flood risk identification includes both the Site and the proposed Grid Connection route options. Flood risk identification was conducted in order to assess the potential flood risks posed to the Proposed 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 the Environment, Climate and Communications.

No historical single or recurring flood events have been recorded within the Redline Boundary. The closest recurring flood event to the Site is mapped as the "*Sruhaunphadeen Derrynagree*" recurring flood event which occurs in a rural area approximately 1.8km north of the Site. This recurring flood event is located approximately 50m below the lowest altitude of the Site and has been recorded through mapping produced by Coillte identifying a number of areas prone to flooding in Cork. An additional recurring flood event has also been mapped by Coillte at Derragh Bridge, south of Shanacrane East along the R585 Road, approximately 2.2km south-east of the Site. The recurring flood event at Derragh Bridge is located at an altitude approximately 200m lower than that of the southern Site boundary. Given the distance of these recurring flood events to the Site and their occurrence at much lower altitudes than the Site, potential impacts from these flood events on the Proposed Development are expected to be negligible. Furthermore, given the considerable distance from the Site to these recurring flood events, and the minimal surface water runoff increase that is expected to occur as a result of the Proposed Development, the Proposed Development is not anticipated to exacerbate the existing potential for flooding at these locations.

Both Grid Connection route options to Carrigdangan and Dunmanway Substations would progress from the northern extent of the main Site onto the L-8544 local road in a north-easterly direction until the two route options diverge near the townland of Gortnacarriga. For the Carrigdangan Grid Connection route option, no single or recurring past flood events have been recorded either on or in close proximity to the road network along which this Grid Connection route option would follow. The closet recorded flood events to this Grid Connection route option is the "*Sruhaunphadeen Derrynagree*" recurring flood event described above, which is also the closest recurring flood event to the mains Site. The "*Sruhaunphadeen Derrynagree"* recurring flood event is located approximately 890m northwest of the L-8544 local road along which both Grid Connection options would traverse, although it is located at an altitude of approximately 90m lower than the L-8544 local road at the closet extent. Any potential impacts from the *Sruhaunphadeen Derrynagree"* recurring flood event on either of the Grid Connection route options is expected to be negligible.

For the Carrigdangan Grid Connection route option, approximately 1.7km south of the route, both a recurring and single flood event are recorded in the townland of Knockariblihane. The single flood event in this area last occurred at Inchigeelagh Junction, on the R585 regional road, on September 11th, 2015. The flood source is not identified on the OPW database for this flood event with only limited details being available for this flood event. The recurring flood event in this area occurs approximately 340m northeast of a single flood event in this area which is described as the "*Caha Knockariblihane recurring*" flood event where the flood source is a "*River*", which is presumably the Caha River which flows past this location. The immediate area surrounding the Carrigdangan Substation is not recorded to have been impacted by any historical flood events.

For the Dunmanway Grid Connection route option, one single flood event has been recorded at Ardcahan Bridge when the Bandon River flooded in February 1991, approximately 220m southwest of the existing roadway which this Grid Connection route option would traverse. OPW photographic records also exist for a flood event on 19th February 2002, at Inchicuhan Crossroads along which this Grid Connection route option would traverse and also at Ardcahan Bridge. The cause of this flooding in February 2002 is noted to be the Caha River and not the Bandon River which caused the February 1991 flooding. Since two separate rivers were the cause of these two flood events, this is presumably the rationale as to why the Ardcahan Bridge flooding has not been mapped as a recurring flood event on the OPW Past Flood Event database although it is noted that it has been known to become flooded more than once.

Further north of Ardcahan Bridge, along the R587 road which the Dunmanway Grid Connection route option would traverse, a flood event occurred on 2nd February 2021. This event has been recorded on the OPW flood database as "*Flooding at Dunmanway/Enniskeane*" with the source of this flood event being attributed to a river. Although details of the river in question are not provided on the OPW database, it is notable that two rivers are located in close proximity to the R587 road at this location, namely the Caha River and a tributary of the Caha River with the EPA name of "*Ardachan*". It is possible that either or both of these rivers resulted in the flooding along this stretch of the R587 road in February 2021. Approximately 900m further northwest of this single flood event, a recurring flood event of the Caha River is recorded as "*Caha River Neaskin*". This location is approximately 240m west of this Grid Connection route option along the R587 road at the closest extent. Approximately 370m further north along the R587 road, another single flood event is recorded as "*Flooding at Ardachan*" where a flood event occurred on 11th September 2015. A river was the source of this flood event and although the details of the river in question are not provided on the OPW database, two rivers exist in close proximity to this location. These are the Caha River and a tributary of the Caha River with the EPA name of "*Aultagh*". Similar to the flood event described above at Ardachan in February 2021, it is possible that either or both of these rivers resulted in the flooding along this stretch of the R587 road in September 2015.

South of Keelaraheen, approximately 500m south of the L-8551-15 local road along which the Dunmanway grid connection route would traverse, a recuring flood event has also been recorded along the Bandon River. This recuring flood event has also been recorded by Coillte and is located on land approximately 10m lower in altitude than the L-8551-15 local road along which this Grid Connection route option would traverse. The Bandon River has also flooded in east Dunmanway in October 1996 along the R586 near "*The Long Bridge*". This location is approximately 500m west of the substation near Ballyhawlwick, Dunmanway, where this Grid Connection route option would terminate. The immediate area surrounding the substation at Dunmanway is not recorded as having been impacted by the 1996 flood event nor any other flood events.

Regardless of which Grid Connection route option is chosen, the Grid Connection route would consist of underground trenching along public roads which will be restored with like-for-like surfaces. 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 chosen route. The proposed Grid Connection route will therefore not change flood risk potential upstream or downstream of the proposed Grid Connection.

In terms of the TDR, a review of past flood events along the road network from the Port of Cork to the Site has been carried out. A single flood event recorded as "*Inchigeelagh 15/01/11*" on the L-4608 local road occurred near the townland of Cappanclare in January 2011. The cause of this single flood event was reported to be overtopping of the River Lee, which is located to the north of this section of road. An additional single flood event recorded as "*Flooding at Inchigeelagh Junction on 11/09/2015*" occurred in September 2015, only limited information regarding this event is available on the OPW floodinfo website. The flood source for this event is not listed, it could have resulted from overtopping of the nearby Caha River, although this is not stated on the OPW database. Only short duration minor works consisting of checking of the road with for oversail and overrun widening areas, and/or vegetation clearing will be carried out in the vicinity of these locations. The use of the road network for the purpose of TDR is expected to have a negligible impact on potential flooding at these locations and on the vehicles/personnel that will temporarily be utilising the road network.

An additional single flood event recorded as "*Flooding at Crookstown June 28th 2012*" is also recorded on the OPW flood database. In this instance, the flood source is recorded as being the "*River Bridge / Brouen River*". No works will be carried out in the vicinity of this recorded flood event location, use of the road network for the purpose of TDR is expected to have a negligible impact on flooding at this location.

A blade laydown area, to the east of Cookstown, is the furthest east between the Site and the Port of Cork where any works will be required along the TDR. No single flood or recurring flood east of this location have been considered further since use of the wider road network for the purposes of the TDR is not expected to have any impacts on potential flooding or on the vehicles/personnel that would be temporarily utilising the public road network.

Rainfall runoff from the Site will be captured for attenuation in the Site's designed drainage system, which will include settlement ponds. The settlement ponds will be strategically located at turbine bases and/or hardstand areas which will facilitate the treatment of runoff water through the settling out of sediments before eventual discharge to the existing 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 environment for natural recharge. Natural recharge will occur via seepage to groundwater, diverted to topographically low points such as drains via the undulating topography or absorbed by the natural vegetation. The Proposed Development will therefore not exacerbate the identified pre-existing single or recurring flood event due to an absence of direct pathways between the Site and the identified flood event locations. Details of these flood events is outlined in **Table 9.14** and their locations relative to the Site and Grid Connection route options are also mapped on **Figure 9.11** in **Volume III**.

Table 9.14: Regional Flood Events Recorded

Flood ID	Flood Location Description	Flood Type	Flood Source	Approximate Distance to Project Location
2839	Sruhaunphadeen Derrynagree	Recurring	River	1.8km north of the Redline Boundary and 890m northwest of both Grid Connection route options
2887	Derragh Bridge	Recurring	River	2km southeast of the Redline Boundary
13956	Inchigeelagh Junction	Single	Null	1.7km south of the Carrigdangan Grid Connection route option
2892	Caha Knockariblihane	Recurring	River	1.8km south of the Carrigdangan Grid Connection route option
2836	Bandon Keelaraheen	Recurring	River	500m south of the Dunmanway Grid Connection route option

Flood ID	Flood Location Description	Flood Type	Flood Source	Approximate Distance to Project Location
10281	Caha River, Ardcahan Bridge Feb 2002	Single Event	River	Inchicuhan Cross Roads (along Grid Connection route) and Ardcahan Bridge (220m southwest of the Dunmanway Grid Connection route option)
608	Bandon Dunmanway October 1996	Single Event	River	500m west of the substation near Ballyhawlwick, Dunmanway
14061	Flooding at Dunmanway/Enniskeane, Feb 2021	Single Event	River	Along the R587 road which the Dunmanway Grid Connection route option
2893	Caha River Neaskin	Recurring	River	240m west of the Dunmanway Grid Connection route option
13957	Flooding at Ardcahan, September 2015	Single Event	River	70m northwest of the the Dunmanway Grid Connection route option
11302	Inchigeelagh 15/01/11	Single Event	River	Along the TDR on the L-4608 local road near the townland of Cappanclare
13956	Flooding at Inchigeelagh Junction on 11/09/2015	Single Event	Not Stated	Along the TDR on the R585 near the townland of Inchincurka
11740	Flooding at Crookstown June 28th 2012	Single Event	River	Along the TDR on the R585 at Crookstown

The NIFM interactive maps have also been consulted with reference to fluvial sourced (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 for the present-day scenario.

A possible 0.1% and 1% AEP fluvial flood event is mapped downstream of the Site adjacent to the EPA named "*Shanacrane_East"* River for the medium and low probability present day scenario. The location of these modelled possible flood events are approximately 650m south of the Site at an elevation of approximately 230m below the lowest point on the southern Site boundary. An additional 0.1% and 1% AEP fluvial flood event is modelled downstream of the Site adjacent to the Shehy Beg River for the medium and low probability present day scenarios. The closet distance of this potential flood extent for the present-day scenario to the southern Site boundary is 1.8km. This modelled potential flood event is located approximately 230m below the lowest point of the southern Site boundary.

Approximately 1.6km west of the northern Site boundary, a possible 0.1% and 1% AEP fluvial flood event is modelled downstream of the Site adjacent to the Gortloughra River. In both of these potential flood modelled scenarios, the elevation of the flood extent is approximately 80m below that of the lowest elevation on the northern Site boundary. Approximately 1.9km north of the Site, along the Sruhaunphadeen Stream, which is not hydrologically connected to the Site via a mapped watercourse, a possible 0.1% and 1% AEP fluvial flood event for the present-day scenario has also been modelled. The elevation of these potential flood events are approximately 100m below the lowest point of the northern Site boundary.

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 Site for the present-day scenarios is expected to be negligible. The predicted extent of the current day scenario fluvial flood events surrounding the site and the Grid Connection route options have been mapped in **Figure 9.13** in **Volume III**.

In terms of the Carrigdangan Grid Connection route option, there are no potential 1% or 0.1% AEP fluvial flood events modelled to occur along this Grid Connection route option with the closest potential event modelled to occur approximately 130m north of the L-8540 Local Road at the townland of Gortaknockane. This event is located at 10m lower in altitude than the L-8540 Local Road, potential impacts on the Carrigdangan Grid Connection route option from this event are expected to be negligible.

In terms of the Grid Connection route option to Dunmanway, the Caha River is the primary source of potential 1% or 0.1% AEP fluvial flood events that could potentially occur along the road network during the present-day scenario. Potential 1% or 0.1% AEP fluvial flood events that could potentially occur at or near the townlands of Lackabaun, Tullagh, Farrannahineeny, Dromlough, Aultaghreagh, Aultagh, Gortanure, and Ardachan. To a much lesser extent, the Bandon River also represents a source of potential 1% or 0.1% AEP fluvial flood events that could potentially occur along the road network during the present-day scenario near the townlands of Knockduff and Gurteennasowna.

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 a 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 for the high-end future scenario. Similar to the modelled present-day scenario, stretches of the Shanacrane East River, Shehy Beg River, Caha River, Gortloughra River and the Sruhaunphadeen Stream are all predicted to flood during the medium probability high end future scenario flood events. The extent of these potential future modelled scenarios are all similar in area to the present day scenario and are not expected to impact on the proposed development site.

Similar to the current day scenario, 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. 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 predicted extent of this High-End Future Scenario has been mapped in **Figure 9.12** in **Volume III.**

Regardless of which Grid Connection route option is chosen, works along the Grid Connection route will be of short duration and temporary in nature. Trenching works required to facilitate the installation of the Grid Connection route will be backfilled resulting in no notable changes of the road network. As a result, any potential changes to the fluvial flood risk along the road network for the present-day or "*High-End Future Scenarios"* are expected to be negligible.

In terms of the TDR, multiple sections of the existing public road network are modelled to flood during both the present day and high-end future scenarios. These locations include along the R585 near the areas of Inchincurka, Farranmareen, Bealnablath, Bellmount

Lower and Crookstown. Additional present day and high-end future scenarios are also modelled to occur along the N22 national road further east towards Cork City. Only very short duration minor works will occur along the TDR. Any potential impacts on the present day or high-end future flood scenarios at these locations, and on the vehicles/personnel that will temporarily utilise the TDR are 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 Site or along either of the Grid Connection route options or the TDR. The closet area to the Site which is mapped for potential groundwater flooding impacts is located approximately 52 km to the northeast of the Site near Cecilstown, County Cork. 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 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 Site or along either of the Grid Connection route options. In terms of the TDR, some OPW benefitted lands have been identified along the N22 National Road near the townlands of Currahaly, Greenfiled, Maglin, Currahee n, Garranedarragh and Inchisarsfiled, although no works on the TDR will occur in these areas, potential flood impacts are therefore expected to be negligible.

The closest mapped constructed flood embankment to the Site is located along the Bandon River near Dunmanway, approximately 10km south-east of the Site. 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 as is outlined in the **Surface Water Management Plan** attached to **Appendix 2.1**.

In addition to the proposed drainage design, a fundamental component of the Site's flood mitigation strategy will be achieved via mitigation through avoidance wherever possible. All proposed design elements such as access tracks, turbine locations, Temporary Construction Compound, Onsite Substation and Control Buildings, Met Mast and borrow pit etc. will all be positioned a minimum distance of 50m away from the Site's rivers and streams wherever possible.

Similarly, at the Site, the pre-existing unpaved tracks traverse over several rivers and small drains which flow through culverts beneath the unpaved tracks at the Site. In addition to the pre-existing crossings at the Site, new access tracks will also be constructed to facilitate access to turbine and Turbine Hardstand positions. The newly constructed access tracks will not cross any additional EPA mapped rivers or streams which have been deliberately avoided through the design process. There are numerous small man-made and natural drainage channels at the Site which are identified on **Figure 9.7A** in **Volume III**. Due to the large quantity of small drains existing at the Site, the turbine access track layout could not avoid intersecting several drainage channels at the Site. Many of the drainage channels at the Site are man-made and were dug out in relatively straight lines to improve land drainage. Some of the small drains will be diverted whilst others will be culverted with appropriately sized culverts as set out in the **Surface Water Management Plan** attached to **Appendix 2.1**.

The site access tracks will only be used temporarily during construction and will be used very infrequently during the operational phase for occasional maintenance activities. The volume of water in the small drains at the Site is generally minimal, many of these drains are ephemeral and dry out completely during dry spells, they are not classified as rivers or streams by the EPA or Tailte Éireann. Careful planning of culvert sizing and the drainage diversion methodology detailed in the **Surface Water Management Plan** will ensure that the crossing of small drains at the Site will result in an anticipated negligible flood risk posed at site access tracks crossing over drainage channels. 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.

In terms of the Grid Connection route options, the chosen route will follow the existing road network to either Carrigdangan or Dunmanway. The Grid Connection route option to Carrigdangan substation would traverse across eighteen watercourses along the road network, two mapped watercourses within the Redline Boundary, and four field surveyed drainage channels within the Redline Boundary. The Grid Connection route option to Dunmanway substation would traverse across thirty-three watercourses along the road network, two mapped watercourses within the Redline Boundary, and four field surveyed drainage channels within the Redline Boundary. The use of existing infrastructure at bridges, horizontal directional drilling (HDD) under watercourses and/or the replacement of some exiting culverts with appropriately sized new culverts along the chosen Grid Connection route will be carried out to facilitate the construction of the Grid Connection route. Short duration temporary shallow trenching will be carried out along the reminder of the Grid Connection route. None of these activities are considered likely to increase the flood risk along the existing road network.

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 options is considered to be negligible.

The drainage design will ensure that surface water runoff 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 Proposed Development and in accordance with the guidelines, there is no requirement to proceed further in the staged process of the flood risk assessment.

9.3.9 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 does exist downstream of the site along the Ouvane River to the south-west of the Site downstream of its confluence with the Gortloughra River.

The most recent assessment of the Ouvane River by Cork County Council was carried out in 2020 which indicated that this river had a Q-Value of 4-5 or "*High*" at the time of monitoring. Details of this closest Cork County Council monitoring point to the Site on the Ouvane River is outlined in **Table 9.15**.

Table 9.15: EPA Monitoring Points and Latest Available Q-Values

Station ID	RS21O070200
Station Name	Br SW of Cappaboy
WFD Waterbody Code	IE_SW_21O070200
Type	River
Latest Monitoring Year	2020
Latest Status	High
Latest Q-Value	4 - 5
Approximate Distance from the EIAR Boundary	3.7 Km
Easting	108849.38
Northing	59017.27
Local Authority	Cork County Council

Four rounds of water quality monitoring for laboratory analysis and field hydrochemistry measurements on unstable parameters including pH, dissolved oxygen (DO), electrical conductivity, total dissolved solids (TDS) and temperature were conducted across the following dates.

Table 9.16: Water Quality Monitoring Rounds and Dates

Monitoring Round	Monitoring Dates
Round 1	14th and 15th of June 2021
Round 2	4th and 5th of April 2022
Round 3	13th and 14th of June 2023
Round 4	2nd and 3rd of April 2024

In total, 12 different water quality monitoring locations were analysed throughout the monitoring programme for a wide variety of laboratory and field measured parameters. The water quality monitoring locations have been mapped and are shown on **Figure 9.4** in **Volume III**. A number of water quality parameters are physically or chemically unstable and must be analysed in-situ immediately after collection with a field monitoring (FM) multi-parameter meter. The pH values across the Site ranged from between pH 6.42 at FM3 during monitoring round 1 to pH 7.63 at FM6 during monitoring round 2. The majority of the pH concentrations recorded were relatively pH neutral or slightly acidic. Slightly acidic pH concentrations are not uncommon in waterbodies of a catchment containing forestry plantations such as those located near the northern extent of the Site. Small pockets of localised acidic peatland soils could also potentially be influencing the pH in the network of small rivers and streams at the Site.

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 waterbody. 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 four monitoring rounds ranged from between 44 μS/cm at FM6 during monitoring round 4 to 120 μS/cm at FM7 during monitoring round 2. 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 30 mg/L at FM1 during monitoring round 4 to 84 mg/L at FM7 during monitoring round 2. 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 were not indicative at any of the monitoring locations.

Dissolved oxygen (DO) concentrations ranged from 6.93 mg/L at FM5 during monitoring round 3 to 11.97 mg/L at FM7 during monitoring round 4. 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. Lower concentrations of DO in stagnant water is also due to the enhanced consumption of dissolved oxygen by plants and microbial life. Water at lower altitudes can hold more dissolved oxygen than water at higher altitudes. The DO concentrations were notably lower during monitoring round 3 after a prolonged dry spell resulted in lower flow rates in the stream network and when the highest average temperature of the four monitoring rounds were recorded at 17.68°C. With the exception of monitoring round 3, the recorded DO concentrations at all monitoring locations were within the ≥ 9 mg/L mandatory value as set out in the *Salmonid Water Regulations 1988*. In terms of % saturation, with the exception of FM5 during monitoring round 3, all of the recorded DO results across the four monitoring rounds were within the 80 – 120% range as set out in the *European Communities Environmental Objectives (Surface Water) Regulations 2009*.

Surface water temperatures ranged from between 8.09°C at FM7 during monitoring round 4 to 21.32°C at FM11 during monitoring round 3. This equates to a difference of 13.23°C between the maximum and minimum recorded results. Increases in surface water temperature resulting from human activities may exceed the thermal tolerances of aquatic biota that are adapted to colder environments. The *European Communities Environmental Objectives (Surface Water) Regulations 2009* and the *European Communities (Quality of Salmonid Waters) Regulations, 1988* screening criterion for temperature both relate 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 13.23°C between the maximum and the minimum results across the four 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 9.17: 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	14/06/2021	6.81	49	34	11.50	14.21

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (µS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM2	14/06/2021	6.76	49	34	11.03	14.92
FM3	14/06/2021	6.42	50	35	9.74	16.74
FM4	14/06/2021	7.01	52	36	11.55	15.81
FM5	14/06/2021	7.16	66	46	9.96	18.91
FM6	14/06/2021	6.75	63	44	10.73	17.80
FM7	14/06/2021	6.79	68	48	11.35	14.24
FM8	14/06/2021	7.19	47	33	11.52	16.86
FM9	14/06/2021	7.05	47	33	10.71	16.02
FM10	14/06/2021	7.52	60	42	10.54	17.77
FM11	14/06/2021	7.16	50	35	10.11	18.44
FM12	14/06/2021	7.20	52	36	10.92	16.73

Table 9.18: 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	4/04/2022	7.08	60	42	11.09	8.17
FM2	4/04/2022	7.06	51	36	10.59	9.17
FM3	4/04/2022	7.37	65	45	10.74	10.21
FM4	4/04/2022	7.44	72	50	11.34	9.65
FM5	4/04/2022	7.23	85	60	10.54	10.24
FM6	4/04/2022	7.63	69	49	10.93	9.98
FM7	4/04/2022	7.03	120	84	10.95	8.31
FM8	4/04/2022	7.10	66	46	11.16	9.22
FM9	4/04/2022	7.35	66	46	10.68	9.37
FM10	4/04/2022	7.33	88	62	10.73	10.59
FM11	4/04/2022	7.55	63	44	10.44	10.61
FM12	4/04/2022	7.54	81	57	11.02	10.09

Table 9.19: 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	14/06/2023	7.25	52	37	8.71	15.64
FM2	14/06/2023	6.72	56	39	8.37	15.13
FM3	14/06/2023	7.22	57	40	8.10	19.34
FM4	14/06/2023	7.28	64	45	8.37	15.50
FM5	14/06/2023	7.28	75	52	6.93	19.46
FM6	14/06/2023	7.59	65	46	8.13	18.31
FM7	14/06/2023	6.78	108	75	9.09	15.82
FM8	14/06/2023	7.50	54	38	8.60	17.48
FM9	14/06/2023	7.37	62	43	8.10	17.86
FM10	14/06/2023	7.57	67	47	8.14	19.22
FM11	14/06/2023	7.28	53	37	7.49	21.32
FM12	14/06/2023	7.05	66	46	8.39	17.05

Table 9.20: 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	3/04/2024	7.11	47	30	11.90	8.12
FM2	3/04/2024	7.08	47	37	10.11	8.78
FM3	3/04/2024	7.45	44	31	10.20	9.01
FM4	3/04/2024	7.11	45	32	9.59	8.21
FM5	3/04/2024	7.49	49	34	9.95	9.14
FM6	3/04/2024	7.32	72	50	10.27	8.21
FM7	3/04/2024	7.01	90	45	11.97	8.09
FM8	3/04/2024	7.33	55	33	10.78	9.95
FM9	3/04/2024	7.47	48	49	10.89	9.90
FM10	3/04/2024	7.25	70	54	10.70	10.01

Field Monitoring Location	Monitoring Date	pH	Specific Electrical Conductivity @20°C (μS/cm)	Total Dissolved Solids (ppm)	Dissolved Oxygen (mg/L)	Temperature (°C)
FM11	3/04/2024	7.61	65	42	10.77	10.59
FM12	3/04/2024	7.17	65	35	10.85	9.23

A total of 24 surface water samples were also collected at multiple locations for laboratory analysis on a broad range of parameters during the four 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 four monitoring rounds are compared to various screening criteria in **Table 9.21**, **Table 9.22**, **Table 9.23** and **Table 9.24** below. The sample locations have been mapped and are shown on **Figure 9.4** in **Volume III**. It should be noted that two separate laboratories were utilised for analyses across the four monitoring rounds. As a result, the laboratory limits of detection may vary slightly for particular analyses. It should also be noted that the Redline Boundary has been modified and reduced throughout the design phase, as a result, some of the monitoring locations are located outside of the finalised Redline Boundary.

Biochemical Oxygen Demand (BOD) concentrations were below the laboratory limit of detection in all 24 samples analysed during each monitoring round. It is noted that the limit of detection at the first lab was <2 mg/L for BOD which is greater than the "*High*" and "*Good*" status thresholds of 1.3 mg/L and 1.5 mg/L respectively as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009.* The limit of detection for BOD at the second lab was <1 mg/L which is below both the "*High*" and "*Good*" status thresholds as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*. All of the BOD results from monitoring rounds 3 and 4 did meet the "*High*" status threshold as set out in the "*European Communities Environmental Objectives (Surface Waters) Regulations 2009"*. The results from monitoring rounds 1 and 2 were all below the laboratory limit of detection and were therefore not considered to be elevated.

Total suspended solids (TSS) were reported below the laboratory limit of detection in 13 out of 24 samples analysed across the four monitoring rounds. A maximum concentration of 15 mg/L TSS was recorded at monitoring location SW2 during monitoring round 3. None of the recorded results for TSS exceeded the mandatory threshold value of ≤ 25 mg/L TSS as set out in the *Salmonid Water Regulations 1988*.

Concentrations of total nitrogen were below the laboratory limit of detection at both laboratories (<2.5 mg/L and <1 mg/L) in all 24 samples analysed across the four monitoring rounds. There are no applicable EQS against which to compare the total nitrogen results. However, since all of the recorded results for total nitrogen were below the limits of detection for both laboratories, the natural background concentrations were not considered to be elevated at the time of monitoring.

Concentrations of nitrate were below the laboratory limit of detection at both laboratories of <8.9 mg/L and <4.4 mg/L in all 24 samples analysed across the four monitoring rounds. The nitrate concentrations at all monitoring locations were therefore all below the 50 mg/L threshold value set out in the *European Union Drinking Water Regulations 2023*. For nitrite, the results were below the laboratory limit of detection in 19 out of 24 samples analysed. Five other results, all recorded during monitoring round 2, did marginally exceed the ≤0.05 mg/L as set out in the *Salmonid Water Regulations 1988* with a maximum result of 0.074 being recorded at SW4 during monitoring round 2.

Concentrations of total phosphorus were below the laboratory limit of detection in 20 out of 24 samples analysed across the four monitoring rounds. The most elevated total phosphorous concentration recorded was 0.03 mg/L which was recorded at each of the three monitoring locations SW1, SW2 and SW6 during monitoring round 3. There are no applicable screening criteria for rivers against which to compare total phosphorous, however, since all concentrations were either below or fractionally above the laboratory limit of detection, it can be concluded that the total phosphorous concentrations were not elevated. Orthophosphate concentrations were below the laboratory limit of detection in 19 out of 24 samples analysed with a maximum concentration of 0.054 mg/L being recorded at SW3 during monitoring round 4. Each of the five detectable orthophosphate concentrations exceeded the "*High*" status criteria whilst four of the samples exceeded the "*Good*" status criteria as set out in the *European Communities Environmental Objectives (Surface Waters) Regulations 2009*.

Chloride concentrations ranged from between below the laboratory limit of detection to 17.8 mg/L at SW5 during monitoring round 2. The maximum detected concentration for chloride did not exceed the 250 mg/L threshold value set out in the *European Union Drinking Water Regulations 2023*.

The ammonia as N concentrations were recorded below the laboratory limit of reporting in 8 out of 24 samples analysed. Of the 16 laboratory detections of ammonia, 6 exceeded the "*High*" status criteria and 6 also exceeded the "*Good*" status criteria as set out *in the European Communities Environmental Objectives (Surface Waters) Regulations 2009.*

Table 9.21: Surface Water Results from Round 1 Monitoring on 15 June 2021

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) Regulations 2023	EC Environmental Objectives (Surface Waters) Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	<2	<2	<2	<2	<2	<2	≤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	4	2	2	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	-	-	-	-	-	-
Total Phosphorus as P (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-

Chloride (mg/L)	10.2	<10	10.3	<10	10.2	11.4	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.066	<0.066	<0.066	<0.066	<0.066	<0.066	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	0.04	<0.025	<0.025	<0.025	<0.025	0.033	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.011	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Table 9.22: Surface Water Results from Round 2 Monitoring on 5 April 2022

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	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU (Drinking Water) Regulations 2023	EC Environmental Objectives (Surface Waters) Regulations 2009	EC (Quality of Salmonid Waters) Regulations, 1988
Biochemical Oxygen Demand (mg/L)	<2	<2	<2	<2	<2	<2	≤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	5	<2	<2	4	8	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	-	-	-	-	-	-

Total Phosphorus as P (mg/L)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-
Chloride (mg/L)	13.3	15.1	14.7	14.6	17.8	13.9	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<8.9	<8.9	<8.9	<8.9	<8.9	<8.9	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	0.068	0.067	0.072	0.074	0.069	<0.066	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	<0.025	0.043	<0.025	<0.025	0.051	<0.025	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.012	0.035	0.019	<0.010	0.023	<0.010	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Table 9.23: Surface Water Results from Round 3 Monitoring on 3 June 2023

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	Cyprinid Guide Limits	Salmonid Guide Limits	EC (Quality of Surface Water Intended For The Abstraction of Drinking Water) Regulations, 1989	EU (Drinking Water) Regulations 2023	EC Environmental Objectives (Surface Waters) 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)	13	15	<5	<5	<5	<5	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-

Total Phosphorus as P (mg/L)	0.03	0.03	<0.02	<0.02	<0.02	0.03	-	-	-	-	-	-
Chloride (mg/L)	12.1	11.1	8.87	9.16	14.2	14.8	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.10	0.10	0.09	0.09	0.11	0.13	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

Table 9.24: Surface Water Results from Round 4 Monitoring on 2 April 2024

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) Regulations 2023	EC Environmental Objectives (Surface Waters) 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)	<5	<5	<5	<5	<5	<5	≤25	≤25	50	-	-	≤25
Total Nitrogen as N (mg/L)	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-

Total Phosphorus as P (mg/L)	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	-	-	-	-	-	-
Chloride (mg/L)	9.83	9.81	8.18	7.53	7.79	10.2	-	-	250	250	-	-
Nitrate as NO_3 (mg/L)	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	-	-	50	50	-	-
Nitrite as NO_2 (mg/L)	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	≤0.03	≤0.01	-	0.5	-	≤ 0.05
Orthophosp-hate as PO_4-P (mg/L)	<0.03	<0.03	0.054	<0.03	<0.03	<0.03	≤0.4	≤0.2	-	-	High ≤ 0.025 Good ≤ 0.035	-
Ammonia as N(mg/L)	0.013	0.012	0.011	<0.01	0.018	0.013	-	-	-	-	High ≤ 0.04 Good ≤ 0.065	- -

9.3.10 Hydrogeology

The underlying bedrock within the Site and along the Grid Connection route options is variable, it consists of a combination of the following at a scale of 1:500,000 according to the Geological Survey Ireland (GSI):

- Shallow marine, (Cork Group, Old Head Sandstone Fm); Sandstone & mudstone;
- Marine (Cork Group) (extends into the Visean); Mudstone, sandstone & thin limestone; and,
- Continental redbed facies; Sandstone, conglomerate & siltstone (in places extends into the Carboniferous)

The bedrock formations underlying the Site are classified by the GSI as Locally Important (LI), bedrock which is moderately productive only in local zones. The Site and both Grid Connection route options are spread across three underlying groundwater bodies (GWBs) which are the Bandon GWB, the Beara Sneem GWB and the Ballinhassig West GWB.

The three GWBs which underly the Site and Grid Connection route options share many common characteristics due to their geographical locations and topography being quite similar, especially at the Site where the boundaries of these three GWBs meet. The rocks in these GWBs have no intergranular permeability, the aquifers are generally characterised as having low to moderate permeability. Diffuse recharge will occur via rainfall percolating through the subsoil or areas of outcropping rock. The proportion of the effective rainfall that will recharge the aquifer is determined by the permeability of the soil and subsoil, and by the slope. Due to the generally low/moderate permeability of the aquifers within these GWBs, and the multiple steep slopes at the Site, a high proportion of the recharge will discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing further the available groundwater resource in the underlying aquifer.

Permeability is highest in the upper few metres but generally decreases rapidly with depth. In general, groundwater flow is concentrated in the upper 15m of the aquifer, although deeper inflows form along fault zones or connected fractures can be encountered. The water table can vary from a few metres up to more than 10m below ground surface, depending upon topography. Groundwater is generally unconfined. Flow path lengths are generally short, ranging from 30-300m. Local groundwater flow directions are controlled by local topography. Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps (GSI,2004). There are no known karst features recorded in close proximity to the Site nor along the Grid Connection route options. The closest evidence of karstification to the Site is recorded within an enclosed depression approximately 25km northwest of the Site near the townland of Tubbrid, Co. Kerry.

In terms of the TDR, only minor works that are short in duration will be carried out along the TDR. The groundwater is not expected to be intercepted by any of the proposed works along the TDR. No impacts to any GWB are expected to occur as a result of the works along the TDR.

The Ballinhassig West GWB is a Registered Protected Area (RPA) as it is a WFD GWB intersecting with WFD Designated Salmonid Waters under *S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988*. Groundwater flow paths are expected to be generally short, ranging from 30-300m. Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps. The nearest turbine position to a designated salmonid river in the Ballinhassig West GWB is located approximately 620m north of T02. Any potentially impacted groundwater is most likely to discharge to small springs or seeps across this distance given that groundwater flow paths are generally not anticipated to exceed a maximum of 300m. The Beara Sneem and the Bandon are RPAs for Shellfish as these GWBs intersect with coastal Designated Shellfish Zones under *S.I. No. 55/2009 European Communities (Quality of Shellfish Waters) (Amendment) Regulations 2009*. Due to the absence of proximity to coastal shellfish zones, shallow depths of trenching along the proposed grid connection route options and minor short duration works along the TDR, 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.

9.3.11 Wells

Mapping and searches of the GSI well databases confirms that there are no known groundwater abstraction wells located within the Redline Boundary. The closet known groundwater well is located approximately 2.4km to the northeast of the Site boundary, and approximately 580m west of the Dunmanway Grid Connection route option, in the townland of Coolcaum. This borehole is classified as being utilised for agricultural and domestic use and has been drilled to a depth of 40m.

For the remainder of the Dunmanway Grid Connection route option, there is one GSI mapped well located approximately 1km east of this option at the closet extent in the townland of Acres, or approximately 1.2km north-east of the existing substation in Dunmanway. Given that the nature of the Proposed Development is expected to result in limited impact with groundwater, combined with the generally short groundwater flow paths in the region that are generally between 30-300m long, potential impacts on all of these wells are expected to be negligible.

There are no mapped wells located in close proximity to where any works will be caried out along the TDR with the closest being located approximately 150m east of a blade laydown area near the townland of Castlemore. Temporary use of this area as a blade laydown area is expected to have a negligible impact on the identified wells that are located approximately 150m east of this location.

There are no mapped holy wells located within the Site nor in close proximity to the Grid Connection route options, nor along the TDR where any works will be carried out. The closest mapped holy well to the Proposed Development is located approximately 4.4km south-east of the Site in the townland of Togher. This holy well is located approximately 520m southwest of the existing road along which the Dunmanway Grid Connection route option would traverse. Given that the nature of the Proposed Development is expected to result in limited impact with groundwater, combined with the generally short groundwater flow paths in the region that are generally between 30-300m long, potential impacts on all of these wells are expected to be negligible. The location of these wells relative to the Site and other wells in the wider region, including holy wells, are outlined on **Figure 9.16** in **Volume III**.

The main Site and the Grid Connection route options are divided across three underlying groundwater bodies (GWBs) which are the Bandon GWB, the Beara Sneem GWB and the Ballinhassig West GWB as is discussed in detail above. The three GWBs which underly the main site contain aquifers that are generally characterised as having low to moderate permeability. Groundwater flow paths are expected to be short (approximately 30-300m) on account of the steep topography and low to moderate soil permeability. Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps.

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 within or in close proximity to the Site have the potential to maintain a groundwater well for abstraction. 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 regardless of the productivity status of the underlying aquifer. The upper estimate for a flow path of 300m has been conservatively assumed to exist at the site. No dwellings are located within or on the Redline Boundary as can be seen on **Figure 9.16** in **Volume III**. Due to the absence of private dwellings within the Redline Boundary, or within 300m of the main development features, any potential impacts on local private wells is expected to be negligible. Any potential impacts to groundwater would most likely discharge to a surface water prior to impacting upon private wells in the region. Along both of the grid connection route options, only shallow trenching will be carried out to facilitate the cable installation, groundwater is most unlikely to be intercepted along either of the Grid Connection route options. Only minor short duration works that are not expected to intercept groundwater will be required along the TDR. Potential impacts associated with groundwater along either of the Grid Connection route options and the TDR are therefore expected to be negligible. Potential risks to groundwater quality and drinking waters sources are discussed in **Section 9.4.4.9.**

9.3.12 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 aquifers within the Site range from predominantly "*Rock at or Near the Surface*" and to a lesser extent "*Extreme*". The majority of the wider west Cork Region, including along the grid connection route options and TDR, is also classified for groundwater vulnerability by the GSI as "*Rock at or Near the Surface*", "*Extreme*" and "*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 Site with higher altitude areas generally being characterised as more vulnerable than less elevated areas. 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 9.25** below. The GSI mapped "*Extreme*" classification locations align with the mapped blanket peat areas at the Site and the "*Bedrock at or Near the Surface"* classification locations are consistent with bedrock outcrops at the surface and areas where shallow subsoil has been identified. Extensive peat/soil probing at the Site confirmed that the depth to the top rock ranged from depths of between in 0 – 3.8m. This is consistent with the GSI groundwater vulnerability classifications for the Site of "*Extreme*" and "*Rock at or Near the Surface*".

The sandstone and mudstone bedrock formations 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 Redline Boundary. These low permeability materials protect underlying groundwater and restrict 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 the 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 would be discharged to a nearby watercourses more rapidly than to groundwater. As a result, surface waters such as rivers, streams and small 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 9.25: 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

The majority of the proposed Grid Connection route options and TDR are underlain by aquifer vulnerabilities classified as "*Extreme*" and "*Moderate*" with "*Rock at or Near the*

Surface" also mapped along the route options. These groundwater vulnerability classifications are consistent with those mapped in the wider west Cork region. Shallow trenching which will be backfilled is expected to be required for the chosen Grid Connection route option, the shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden. Minor short duration works along the TDR are also not expected to breach the groundwater table. As a result, potential impacts on groundwater along both of the Grid Connection route options and the TDR is expected to be negligible. Mitigation measures to minimise potential risks to groundwater quality are outlined in **Section 9.5**.

9.3.13 Groundwater Levels

The blanket peat, sandstone shales and till, which constitute the dominant surface layers at the Site normally form in areas where the underlying bedrock is characterised by low to moderate permeability as is the case at the Site. In areas where blanket peat exists at the Site, the overlying bog typically forms part of a fully saturated perched aquifer system. In these areas of the Site, the water table is generally either at or just below 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 this perched water table at or very near the surface was observed in some areas when gouge cores were advanced at turbine locations, gouge coring at turbine locations is discussed in **Chapter 8: Soils and Geology.** Much of the site is characterised by steep slopes, these areas are likely to have a very low groundwater level since less time is allowed for stormwater to infiltrate, thus rainfall is easily converted to runoff and rapidly flows down the slope. Since areas of steep slopes, shallow subsoils, generally shallow blanket peat and bedrock outcrops make up the majority of the Site area, the depth to groundwater is not anticipated to exceed more than approximately five metres at any area of the Site.

9.3.14 Groundwater Hydrochemistry

There is no groundwater hydrochemistry data available for the 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.

According to the GSI (2004), the Bandon GWB, the Beara Sneem GWB, and the Ballinhassig West GWB have alkalinity concentrations raging from 4-310 mg/L ($CaCO_3$) and are underlain by non-carbonate rock units such as sandstones, mudstones and siltstones.

The hardness in the Bandon and Ballinhassig West GWBs generally ranges from 40-224 mg/l which is categorised as moderately soft to moderately hard. The hardness in the Beara Sneem GWB ranges from almost zero to 360 mg/l $CaCO_3$, concentrations above 250 mg/L $CaCO_3$ are classified as hard water.

The Old Red Sandstone formations of the Bandon and Ballinhassig West GWBs largely contain calcium bicarbonate type water. Conductivities in these units are relatively low, ranging 125-600 *µ*S/cm, with an average of approximately 300-312 *µ*S/cm. Conductivities in the Cork Group rocks are quite similar with an average of approximately 380 *µ*S/cm and a range from 160 to 433 *µ*S/cm. In general, high iron (Fe) and manganese (Mn) concentrations can occur in groundwater derived from old red sandstone due to the dissolution of Fe and Mn from the sandstone/shale where reducing conditions occur. Background chloride concentrations in all aquifers will be higher than in the Midlands, due to the proximity to the sea. In terms of the Beara Sneam GWB, conductivity in the groundwater ranges from 100-700 *µ*S/cm, with an average of approximately 370 *µ*S/cm.

Groundwater flow paths at the main site are expected to be short, any potential impacts on groundwater at the Site are anticipated to be highly localised as groundwater readily discharges to the surrounding surface water network. Only shallow trenching which will be backfilled is expected to be required for whichever of the two Grid Connection route options is chosen. The shallow trenching is not expected to breach the groundwater table and will be excavated upon the overburden. Minor short duration works along the TDR are also not expected to breach the groundwater table. As a result, potential impacts on groundwater at the Site, along the Grid Connection route and TDR is expected to be negligible. Mitigation measures to minimise potential risks to groundwater quality are outlined in **Section 9.5**.

9.3.15 Water Framework Directive Water Body Status & Objectives

The Site area is divided across three separate catchments, namely, the Bandon-Ilen Catchment Area (~59%), the Dunmanus-Bantry-Kenmare Catchment Area (~21.8%) and the Lee Cork Harbour and Youghal Bay Catchment Area (~19.2%). The latest available water quality status for waterbodies in each of these catchment areas has been reviewed. This review included an analysis of the Water Framework Directive (WFD) surface water body status and the associated objectives assigned for the surface water network both within and surrounding the Site. All three of these catchment areas are similar in size with the Bandon-Ilen Catchment Area covering an area of 1,799 km^2, the Dunmanus-Bantry-Kenmare Catchment Area covering of 1,900 km^2 and the Lee Cork Harbour and Youghal Bay Catchment covering an area of 2,181 km^2. 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 WFD.

Approximately 59% of the Site area, including all areas south of the most elevated ridgeline and summit of Shehy More (546m) drains to the Bandon-Ilen Catchment Area, or more immediately to the Bandon_SC_10 Subcatchment Area. All river waterbodies at the Site which form part to the Bandon_SC_10 Subcatchment Area are assigned "*Moderate*" status under the 2016 – 2021 cycle of the WFD. This represents a status decrease from "*Good*" which was assigned to the same river waterbodies for the 2013 – 2018 cycle of the WFD.
The north-western extent of the Site accounts for approximately 21.8% of the total Site area. This area of the Site drains to the Dunmanus-Bantry-Kenmare Catchment Area, and more immediately to the Coomhola_SC_10 Subcatchment Area. All river waterbodies at the Site which form part to the Coomhola_SC_10 Subcatchment Area are assigned "*High*" status under the 2016 – 2021 cycle of the WFD. This "*High*" status remains unchanged from the earlier 2013 – 2018 cycle of the WFD.

The north-eastern extent of the Site accounts for approximately 19.2% of the total Site area and drains to the Lee Cork Harbour and Youghal Bay Catchment Area, and more immediately to the Lee [Cork]_SC_010 Subcatchment Area. All river waterbodies downstream of the Site which form part to the Lee [Cork]_SC_010 Subcatchment Area are assigned "*Good*" status under the 2016 – 2021 cycle of the WFD. This "*Good*" status remains unchanged from the earlier 2013 – 2018 cycle of the WFD. One lake waterbody in the Lee [Cork]_SC_010 Subcatchment Area, namely Lough Allua is a "*Poor*" status under the 2016 – 2021 cycle of the WFD. The closest lake to the Site, Lough Nambrackderg, does not have a designated status under the WFD although it should be considered as a sensitive waterbody as a conservative approach. There are no mapped surface waters contained within the Site which drain to the Lee [Cork]_SC_010 Subcatchment Area with only runoff from the northern extent of Shehy More draining to this subcatchment Area. The closest mapped rivers to the Site beyond the north-eastern Site boundary in the Lee [Cork]_SC_010 Subcatchment Area are currently designated as "*Good*" status under the 2016 – 2021 cycle of the WFD.

In terms of the assigned risk of waterbodies not meeting their objectives by 2027, all surface waterbodies at the north-western extent of the Site which drain to the Dunmanus-Bantry-Kenmare Catchment Area are classified as "*Not At Risk*" of meeting their WFD objectives.

All surface waterbodies which drain the southern extent of the Site to the Bandon-Ilen Catchment Area are classified as "*At Risk*" of not meeting their WFD objectives. No mapped surface waterbodies exist at the north-eastern extent of the Site which forms part of the Lee Cork Harbour and Youghal Bay Catchment Area. The closest downstream surface waterbodies to the Site in this catchment area are currently classified as "*Not at Risk*" of meeting their objectives under the WFD. A **Water Framework Directive Assessment** for the Proposed Development is contained in **Appendix 9.3**.

9.3.16 Groundwater Body Status

The three groundwater bodies which underly the Site and the Grid Connection route options, have been assigned "*Good Status*" under the Water Framework Directive (WFD) which is based on an assessment of the chemical and quantitative status of the GWB. The status is derived from representative monitoring points selected specifically for the WFD groundwater monitoring programme. The Beara Sneem GWB (IE_SW_G_019), the Ballinhassig West GWB (IE_SW_G_005) and the Bandon GWB (IE_SW_G_086) which underly the Site 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. Waterbodies may be categorised as "*Review"* either because additional information is needed to determine their status before resources and more targeted measures are initiated or measures have already been undertaken although the outcome has not yet been measured/monitored. The GWBs which underly the site and/or the grid connection route options are not categorised as "*Review*" under the 3rd cycle of the WFD. 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 does not apply to the GWBs underlying the Site or the Grid Connection route options.

In terms of the TDR, the existing road network does intersect the Banson GWB which is a designated nutrient sensitive area. Only short duration minor works that are not expected to intercept any groundwater body will be carried out. Potential impacts on groundwater from works carried out along the TDR are expected to be negligible.

9.3.17 Designated Sites & Habitats

Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), often 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 is not located within any of the aforementioned categories of designated areas of conservation. Other non-Natura 2000 Sites in the wider region which are considered to be sensitive, or which require certain actions to taken are also addressed in this section. These sites include WFD Designated Salmonid Waters, Margaritifera Sensitive Areas, Priority Areas for Action (PAAs and Registered Protected Areas (RPA) for Shellfish. All of the surface waters at the Site located south of the Shehy More mountain uppermost ridgeline and summit ultimately flow into the Bandon River, which in turn flows into the Bandon River SAC (Site Code 002171). The downstream distance from the nearest design elements to the Bandon River SAC is approximately 10.5km via the EPA named "*Shehy_Beg*" river which merges with the Bandon River near the townland of Togher, Co. Cork. Multiple other rivers and streams merge with the "*Shehy_Beg"* river prior to its confluence with the Bandon River. Given the considerable ~10.5km downstream distance from the Site to the Bandon River SAC, in addition to the dilution effect of multiple other merging rivers and streams, hydrological connectivity from the Site to the Bandon River SAC is considered to be highly tenuous.

The Grid Connection route option to Dunmanway follows the existing road network which already traverses through the Bandon River SAC. Approximately 455m west of the existing substation at Dunmanway is the Bandon Valley South of Dunmanway pNHA through which the Bandon River SAC also flows. With the exception of horizontal directional drilling locations along the Dunmanway Grid Connection route, only shallow trenching along the existing roadway is proposed to facilitate the construction of the Grid Connection route, the shallow trenching will not breach the groundwater table. 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. If test pits and boreholes were located directly on, or extended through the proposed alignment, these areas could act as weak points that may serve as conduits where inadvertent fluid returns or frac out occurs.

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 arisen 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 it is biodegradable which further reduces the potential for adverse impacts in the event of frac-out occurring. Due to the vast majority of the Grid Connection route option to Dunmanway requiring shallow trenching which will be backfilled, the temporary nature of the construction works, the established HDD technique with controls and use of non-toxic fluids, the potential impacts on Bandon River SAC are expected to be negligible.

Approximately 4.5km west of the Site is the Conigar Bog NHA. However, the closest hydrological distance from the Site to the Conigar Bog NHA is approximately 25km in an overall upstream direction. Given that pollutants do not migrate or flow upstream, and the considerable hydrological distance of 25km, any hydrological connectivity between the Site and the Conigar Bog NHA is considered to range from highly tenuous to almost non-existent. Approximately 11.5km north-west of the Site is the Slaheny River Bog NHA. There is no hydrological connectivity between the Site and the Slaheny Bog NHA. Other NHAs in the wider region north of the Site include the Doughill Bog NHA and the Sillahertnage Bog NHA which are not hydrologically connected to the Site.

Approximately 9km west of the north-western Site is the Derryclogher (Knockboy) Bog SAC. None of the surface waters which drain the Site are hydrologically connected to the Derryclogher (Knockboy) Bog SAC. Approximately 4.8km north-east of the Site is the Lough Allua pNHA. None of the surface waters which drain the Site are hydrologically connected to the Lough Allua pNHA. Approximately 6.3 km north-west of the Site is the Gouganebarra Lake pNHA and the Ballagh Bog pNHA. None of the surface waters which drain the Site are hydrologically connected to the Gouganebarra Lake pNHA or the Ballagh Bog pNHA. No works will near a designated site along the TDR, potential impacts associated with works along the TDR on any designated sites are therefore expected to be negligible. The catchment locations surrounding the Site area are mapped on **Figure 9.9 in Volume III** and the designated sites in the wider region are mapped in **Figure 9.5 in Volume III**.

None of the surface waters which drain the Site are classified as WFD Designated Salmonid Waters under *S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988* nor do they intersect any waters under this designation. The rivers and streams located beyond the north-eastern Site boundary, in the Lee, Cork Harbour and Youghal Bay Catchment Area are designated as waters which do intersect designated Salmonid Waters. Detailed basin delineation using LiDAR has been carried out as part of the **WFD Assessment** attached as **Appendix 9.3**. None of the proposed turbine positions, Turbine Hardstand areas or access tracks etc. are modelled to fall within the drainage basin of the Salmonid Waters within the Lee, Cork Harbour and Youghal Bay Catchment Area. Any potential runoff or groundwater flow directions from the Proposed Development are modelled to flow towards the Dunmanus-Bantry-Kenmare Catchment Area. As a result, potential impacts from the Site, on waters classified as waters which intersect designated Salmonid Waters are expected to be negligible.

In terms of potential impacts from the grid connection route options, the existing road along which both route options would follow does intersect WFD Designated Salmonid Waters under S*.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988.* HDD could potentially be required at an upper maximum of eight WFD Designated Salmonid Waters along the Dunmanway Grid Connection route option and at potentially an upper maximum of thirteen WFD Designated Salmonid Waters along the Carrigdangan Grid Connection route option. The number of locations where HDD would be required along both Grid Connection route option was unknown at the time of preparing this report. As a conservative approach, it has been assumed that all watercourses along both grid connection route options would require HDD which is unlikely to be the case. The use of well-established HDD techniques, with control measures, including the use of non-toxic fluids will be in place regardless of the grid connection route option that is chosen.

In terms of the TDR, minor short duration works such as vegetation clearing, checking road widths, use of oversail areas and temporary road widening along the existing road network will be carried out at seven locations that are in close proximity to WFD Designated Salmonid Waters under S*.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988.* With appropriate mitigation measures in place, the potential impacts on WFD Designated Salmonid Waters under *S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988* are expected to be negligible. The Ballinhassig West GWB which underlies approximately 19.2% of the total site area at the north-eastern extent, and both Grid Connection route options, is a RPA as a WFD GWB intersecting with WFD Designated Salmonid Waters. As discussed in **Section 9.3.10**, groundwater flow paths are expected to be generally short, ranging from 30-300m. Groundwater discharges to the numerous streams and rivers crossing the aquifer and to small springs and seeps. The nearest turbine position to a designated salmonid river in the

Ballinhassig West GWB is located approximately 620m north of T02. Any potentially impacted groundwater is most likely to discharge to small springs or seeps across this distance given that groundwater flow paths are generally not anticipated to exceed a maximum of 300m.

The Site is located within three separate Margaritifera Sensitive Areas in accordance with the EU Habitats Directive. These include the Bandon/Caha, Owvane, and Lee Upper Margaritifera Sensitive Areas. These Margaritifera Sensitive Areas and their associated sensitivities are discussed in detail in **Chapter 6: Biodiversity**.

The Site is located within the Caha and Allua Priority Areas for Action (PAAs). All areas of the Site located south of the summit of Shehy More mountain are located within the Caha PAA, this area of the Site accounts for approximately 59% of the total Site Area. The Caha PAA comprises of two waterbodies, the Caha_020 and Coolkellure Lake. The Caha_020 waterbody is a section of the Caha River that rises in the Shehy Mountains and merges with the Bandon River 4km north of Dunmanway. The Caha river flows from Drumlough, Crushterra and Gurteen in the west and northwest of the waterbody to Inchicuhan crossroads at Ardcahan in the south. Sediment and nutrient loading are considered to be the most likely issues impacting water quality in the Caha_020 waterbody. The Caha_020 waterbody is located approximately 12.3km downstream of the Site via the Shehy_Beg River and the Bandon River, hydrological connectivity between the Site and the Caha_020 waterbody is therefore highly tenuous. The Dunmanway Grid Connection route option would follow the existing road network which currently crosses over the Caha_020 waterbody.

Coolkellure Lake is 3.5 hectares in area and is located in an upland area within the waterbody Bandon_020 which is currently at "*Moderate*" status and is not part of the PAA. The lake is the abstraction source for the drinking water supply for Dunmanway. The primary water quality issue with Coolkellure Lake is elevated phosphorus, most likely due to clear felling of forestry is the primary water quality issue impacting Coolkellure Lake. No forestry felling is proposed at the Site, localised small area felling and replanting may be required along TDR at pinch point although these works will have a negligible impact on Coolkellure Lake. The Coolkellure Lake is located approximately 10.4km in an overall upstream direction from the nearest surfaces waters at the Site. Given this considerable distance, and since contaminants such as phosphorous do not generally flow upstream, hydrological connectivity between the Site and Coolkellure Lake is considered to be highly tenuous.
At the north-east section of the Site, approximately 19.20% of the total site area falls within the Allua PAA. The Allua PAA is divided into two sections or waterbodies which are the Lee

(Cork)_020 and Lough Allua. Lough Allua is protected for salmonids and is also used locally as a recreational water for both bathing and kayaking. The Lee (Cork)_020 is assigned "*High*" status for the 2016 – 2021 WFD cycle. Lough Allua is currently at "*Poor*" status for the 2016 – 2021 WFD cycle. This is due to a combination of an unsatisfactory fish community dominated by coarse fish (roach and perch) as well as high nutrient levels and physical modification. None of the surface waters which drain the Site are hydrologically connected to the Lee (Cork)_020 waterbody nor Lough Allua.

Both the Bandon GWB (IE_SW_G_086) and the Beara Sneem GWB (IE_SW_G_019) which underly the Site and both Grid Connection route options are designated as a Registered Protected Areas (RPA) for Shellfish due to these GWBs extending from the Site as far as the south-east and west coasts of County Cork respectively. Due to the site being located approximately 15km inland from the nearest coastline, potential impacts on shellfish are expected to be negligible.

9.3.18 Water Resources

All of the rivers and streams at the Site located to the south of the summit of Shehy More Mountain are designated as river Drinking Water Protected Areas (DWPA) from which there is a known qualifying abstraction of water for human consumption as defined under Article 7 of the WFD. The rivers and streams located beyond the north-eastern Site are also designated as Drinking Water Rivers.

In terms of the TDR and both Grid Connection route options, these design elements all follow the existing road network to the northeast of the Site would cross multiple watercourses that are designated as a Drinking Water Rivers. The Bandon River, which the Grid Connection route option to Dunmanway traverses across is also designated as a Drinking Water River in accordance with the *European Communities (Drinking Water) Regulations 2023 (S.I. No, 99/2023)* in addition to multiple other rivers and streams along this Grid Connection route option that are tributaries of the Bandon River. With the exception of horizontal directional drilling locations along the Grid Connection route options, only shallow trenching along the existing roadway is proposed to facilitate the construction of the chosen Grid Connection route. Only short duration minor works such as vegetation clearing, use of oversail areas and temporary road widening will be required in the vicinity of these watercourses along the TDR.

All of the rivers identified above are designated as Drinking Water Rivers in accordance with *the European Communities (Drinking Water) Regulations 2023 (S.I. No, 99/2023)*. All

Water Framework Directive GWBs nationally have been identified as DWPAs due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD. As a result, the rivers, streams, and GWB's at the Site and along the Grid Connection route options and TDR, should be considered to be highly sensitive in terms of potential chemical pollution and/or sediment laden runoff.

The EPA maintains a register of water abstractions in accordance with the *Water Environment (Abstractions and Associated Impoundments) Act 2022 (S.I. No. 48 of 2022)*. 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. This request was made on July 7th 2023. 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 was received from the EPA on 13th July 2023. The publicly available register indicates that there are no registered abstraction points located within 5km of the Site. The closest registered abstraction point to the Site is located approximately 6km west of the Site near the townland of Lackareagh. The primary abstraction purpose at this Site is for hydropower. This hydropower site is located in an overall upstream direction relative to the Site, potential impacts on hydropower at this site would therefore be negligible.

Consultation with local residents in the wider area has indicated that residents in the townland of Coolmountain do extract water from an unnamed stream that is a tributary of the Shehy_Beg River as their drinking water supply. This small unnamed channel has been labelled as "*Channel 16*" for the purposes of ease of identification and is shown on **Figure 9.16** in **Volume III.** Channel 16 is located beyond the eastern Site boundary; the closest design element would be the proposed Onsite Substation and Control Buildings location which is approximately 500m to the west of Channel 16. Any potential run-off from the Substation location is modelled to flow toward the Shehy_Beg River and not towards Channel 16. Any potential impacts on the drinking water supply at Channel 16 are therefore expected to be negligible.

There are no registered abstraction points located along or within the vicinity of the proposed Grid Connection route option to Carrigdangan. The closest registered abstraction point to this Grid Connection route option is located approximately 9km east of the existing substation at Carrigdangan where the primary abstraction purpose is for quarrying. There are no registered abstraction points located along or within the vicinity of the proposed Grid Connection route option to Dunmanway. The closest registered abstraction point to this Grid Connection route option is located approximately 2.2km south of the existing substation at Dunmanway where the primary abstraction purpose is for mining or quarrying. The proposed Grid Connection route options are both expected to have a negligible impact on these regional abstraction points since only shallow trenching that is not expected to breach the water table will be carried out along the chosen Grid Connection route option.

In terms of the TDR, there are no abstraction points located in close proximity to any proposed works locations along the TDR. Therefore, potential impacts on abstractions points resulting from works associated with the TDR are expected to be negligible.

As discussed in **Section 9.3.11**, the GSI well databases indicate that there are no known groundwater abstraction wells located within the Site with the closest being located approximately 2.4km to the northeast of the Site, or approximately 580m west of the Dunmanway Grid Connection route option, in the townland of Coolcaum. This borehole is classified as being utilised for agricultural and domestic use and has been drilled to a depth of 40m. For the remainder of the Dunmanway Grid Connection route option, there is one GSI mapped well located approximately 1km east of this option at the closet extent in the townland of Acres, or approximately 1.2 km north-east of the existing substation in Dunmanway.

In terms of the Carrigdangan Grid Connection route option, a registered borehole is located approximately 900m northeast of the route in the townland of Scrahan where the primary use is registered as agricultural and domestic. Given that the nature of the Proposed Development is expected to result in limited impact with groundwater, combined with the generally short groundwater flow paths in the region that are generally between 30-300m long, potential impacts on all of these wells are expected to be negligible.

There are no mapped wells located in close proximity to where any works will be caried out along the TDR with the closest being located approximately 150m east of a blade laydown area near the townland of Castlemore. Given this considerable distance and the limited use of this area as a laydown area, potential impacts on the nearest wells are expected to be negligible.

There are no mapped holy wells located within the Site nor in close proximity to the Grid Connection route options or TDR. The closest mapped holy well to the Proposed Development is located approximately 3.8km south-east of the Site in the townland of Togher. This holy well is located approximately 520m southwest of the existing road along which the Dunmanway Grid Connection route option would traverse. Given that the nature of the Proposed Development is expected to result in limited impact with groundwater, combined with the generally short groundwater flow paths in the region that are generally between 30-300m long, potential impacts on all of these wells are expected to be negligible. Consultation with Uisce Éireann has confirmed that there are no known public water supplies (PWS) in existence in the area surrounding the Site or along the Grid Connection route options. Uisce Éireann maintains records of Water Supply Zones (WSZ's) through which water is delivered to each tap from a particular WSZ. A WSZ is a defined supply area served by a single source or group of connected sources. There are no WSZs located within the Site nor along the Carrigdangan Grid Connection route option according to Uisce Éireann's publicly available WSZ data for west Cork which was last updated in August 2024. Approximately 600m east of the L-4607 local road along which the Carrigdangan Grid Connection route would traverse is the Johnstown WSZ. Since only shallow backfilling that is not expected to breach the water table will be carried out, coupled with the approximate 600m distance at the closest extent, potential impacts on the Johnstown WSZ are expected to be negligible.

A small portion of the Dunmanway Grid Connection route option traverses through the Dunmanway WSZ as it follows the road network to Dunmanway. Due to the shallow trenching nature of the Grid Connection works that will be backfilled, no impacts on the Dunmanway WSZ are anticipated.

The Turbine Delivery Route (TDR) also slightly intersects the Coppeen WSZ along the L-8684 local road near the townland of Moneygaff West, the Crookstown WSZ along the R-585 regional road near the townland of Farranduff and the Cork Harbour and City WSZ to the east of Crookstown along the N22 national road. No works will be carried out at any of these locations that is considered to have potential to impact on the these WSZs. Potential impacts on any WSZ as a consequence of works being undertaken along the TDR are therefore expected to be negligible.

There are no National Federation of Group Water Schemes (NFGWS) located within 5km of the Site or the Grid Connection route options or along the TDR, with the closest being located approximately 5.2km north of the Site which is not hydrologically connected to the Site. The nearest public supply source protection area is located approximately 9.3km north of the Site at the townland of Carrignadoura. This area comprises both an inner and an outer source protection area, neither of which is hydrologically connected to the Site. As a result, no adverse impacts on NFGWS are expected to occur as a result of the Proposed Development.

The Site is divided across three separate locate Electoral Divisions (ED) of Garrown, Douce and Bealanageary. The published census data from the Central Statistics Office (CSO) relating to water supply data in private households from the year 2016 has been reviewed. A breakdown of the reported water supply type in the three Electoral Divisions that intersect the Site is outlined in **Table 9.26**. There may be some uncertainty or errors in the census data which the general republic responded to. Nevertheless, the data strongly indicates that the majority of households in the localised region are utilising a "*Other Private Source*" for their drinking water supply. There are no dwellings located within or on the EIAR boundary. Given the rural location, it is considered that private groundwater wells, which are discussed in **Section 9.3.11**, are likely to makeup a large portion of these private sources.

Table 9.26: 2016 Census Data Water Supply by Type in Electoral Divisions at the Site

Electoral Division	No. of Permeant Private Households	Public Main	Group Scheme With Public Source	Group Scheme With Private Source	Other Private Source	None	Not Stated
Garrown	**91**	0 (0%)	0 (0%)	3 (3.3%)	87 (95.6%)	0 (0%)	1
Douce	**95**	8 (8.4%)	0 (0%)	1 (1.1%)	84 (88.4%)	1 (1.1%)	1
Bealanageary	**64**	11 (17.2%)	8 (12.5%)	9 (14.1%)	34 (53.1%)	2 (3%)	0

The locations of water supply zones, dwellings near the Site, GSI/EPA mapped boreholes, wells, springs and holy wells, relative to the Site and the Grid Connection route options are mapped on **Figure 9.16** in **Volume III.**

9.3.19 Receptor Sensitivity

All water-based receptors associated with the Proposed Development, such as streams, rivers, lakes and groundwater, are considered to be highly sensitive in accordance with the criteria set out in **Table 9.3**. A key basis for this consideration is due to the hydrological connectivity of the water bodies at the Site to Drinking Water Protected Areas and the Bandon River SAC. The characterisation of the local water courses as highly sensitive is further warranted by the "*High*" and "*Good*" WFD status of many local rivers located within and downstream of the Site, and the associated sensitive habitats or species associated with same. Ultimately, all surface water and groundwater associated with the Site, Grid Connection route options and TDR are considered highly 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 9.3.12**, 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 and the pathways are of variable condition for each proposed turbine location and/or any part of the Proposed 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 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 will mimic the existing hydrological regime and will therefore significantly reduce potential changes to flow volumes leaving the Site.

A self-imposed 50m buffer zone from all waterbodies will be maintained during the construction phase wherever possible. The only exceptions to this rule will be as follows:

- Where the Grid Connection route traverses existing bridges that are already located within the 50m buffer zone, horizontal directional drilling will be carried out at potential upper maximum of eighteen watercourses for the Carrigdangan Grid Connection option, and eighteen watercourses for the Dunmanway Grid Connection option;
- Along the TDR, the route crosses multiple mapped rivers and streams with minor works being carried out or laydown areas being utilised at eleven locations in close proximity to a watercourse. The type of minor works that would be required along the

TDR include temporary road widening for overrun areas, areas to be cleared for oversail areas, vegetation clearance, checking the width of access roads and the use of fields as blade laydown areas. The locations of watercourse relative to the TDR are shown on **Figures 9.17** to **9.65** in **Volume III**.

- Where small drains at Site will be culverted or diverted, such as for the borrow pit location, site access tracks and at the T09 Turbine Hardstand area; and,
- Where pre-existing unpaved access tracks at the Site will be utilised in locations that are already within the 50m buffer zone of rivers. This includes multiple areas immediately adjacent to the existing access tracks as can be seen on **Figures 9.7A** in **Volume III**.

The vast majority of the Proposed Development areas are located greater than 50m distance away from watercourses. The significant buffer zone distance of 50m from sensitive watercourses will ensure that sensitive watercourses will not be impacted as a result of excavations or other construction works such the construction of access tracks. 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. 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, the use of sediment fences and/or straw bales will be implemented to reduce the potential for surface water runoff to sensitive watercourses. The proposed 50m buffer zone relative to the surface waters at the Site is mapped on **Figure 9.8** in **Volume III**. It is noted through experience and consultation with Inland Fisheries Ireland (IFI) on other windfarm developments that their recommendation has typically been for a minimum 15m buffer zone from all watercourses 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 likely to be a poorly permeable aquifer and can support only local scale flow systems. As the proposed construction works at the Site will not be located within close proximity to any dwellings, the risk of potential adverse impacts to groundwater 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 partially or fully infiltrate to surface water systems rather than recharging via percolation into groundwater.

Potential impacts during the construction phase 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 **Figure 9.1** and **Table 9.3**, groundwater at the proposed Site can be classed as medium sensitivity from potential adverse effects.

9.3.20 Other Infrastructure - Boreholes

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

EIA Reports should be compliant with current best practice guidelines 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 Proposed Development is considered as being of **Very High Importance** and **Highly Sensitive**, and therefore classification of any potential impacts associated with the Proposed Development will be limited to Magnitudes associated with **Very High Importance**, as presented in the **Table 9.27** below.

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 Proposed Development is considered as being of **Medium Importance** and **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 Development does not proceed, current land use practices such as agricultural grazing 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 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 Proposed Development will lead to a net increase of surface water runoff of approximately 7,431 m^3/month (or 3.26% relative to the area of the Site) during the wettest month of the year. This is considered to be a likely, negative, slight or moderated, slight weighted significance, permanent impact of the Proposed Development. The increase in hardstand area associated with the Proposed 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 Proposed Development.

9.4.4.2 Assessment of Effects - Earthworks

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

- Construction of access tracks and amenity routes;
- Widening of the local road network to facilitate the delivery of turbines and other infrastructure;
- Temporary Construction Compound;
- Turbine Foundations and Turbine Hardstand areas;
- Borrow pit excavations;

- Foundations for the proposed Onsite Substation and Control Buidlings;
- Foundations for the proposed Met Mast;
- Trenching for underground electrical cabling, including along the Grid Connection route; and,
- Temporary 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 runoff 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 of the Site to surface water quality deterioration through the release of elevated suspended solids are considered to be:

- Proposed crossings of EPA mapped rivers or small drainage channels that ultimately drain to the Site's network of rivers and streams;
- Turbine Hardstand and infrastructure development, particularly at moderate to high gradient slopes to existing waterways; and,
- Upgrading of the pre-existing unpaved tracks at the Site that area already located within the 50m buffer zone of rivers and streams at the Site.

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 existing sheep at the Site accessing rivers or streams which has the potential to disturb riverbanks resulting in increased sediment laden runoff, 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. This potential impact is considered to be in contrast to Baseline conditions 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 is negligible to low. However, in the unlikely 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 obliterate 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 to 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 8.3 Peat Stability Risk Assessment** of **Chapter 8 – Soils and Geology**, the risk of mass movement or landslide is negligible to low.

9.4.4.2.1 Monitoring

Monitoring of peat, subsoils, bedrock and material management during the construction phase of the Proposed 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, 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 or the borrow pit 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 Proposed 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 Proposed Development which is in contrast to the Baseline conditions. The potential effects on groundwater during the operational phase of the Proposed Development is considered to be negligible to low. Contaminated land has not been identified at the Site and therefore the potential for sources of contamination other than elevated suspended solids or chemical spills to be released to surface waters through dewatering activities is not anticipated.

9.4.4.4 Diversion and Enhancement of Drainage

The Development will likely 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 Proposed 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 & Drainage Channel Diversions

At the Site, one new bridge would be constructed within the Redline Boundary, to the southwest of T06. Five existing culverts would be upgraded, and three new culverts would be installed in the Site to facilitate the construction of the Grid Connection route and the site access tracks. A maximum of 6 drainage channels would also require slight diversions to be implemented in the Site to allow for the access tracks, turbine hardstand areas and borrow pit to be constructed. These locations are shown on **Figure 9.7A** in **Volume III**. These EPA mapped rivers and small drainage channels ultimately drain to the river and stream network downstream of the Site and they are therefore considered sensitive to the potential release of pollutants.

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. Multiple existing crossings in the form of small culverts are in place along the exiting unpaved access tracks located within the Site. 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 route options and TDR, 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 Proposed 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 Proposed 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 runoff 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 Mussel (*Margaritifera margaritifera*) are particularly sensitive to changes in water quality, and in particular elevated suspended solids. The Site is located within three separate Margaritifera Sensitive Areas in accordance with the EU Habitats Directive. These include the Bandon/Caha, Owvane, and Lee Upper Margaritifera Sensitive Areas. **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 WFD assigned "*Good*" and "*High*" quality of the Baseline surface waters draining many parts of the Site, and 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 Proposed 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 solids 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 steep topography and low to moderate permeability subsoils 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 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 to moderate permeability subsoils and the generally steep topography 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 the subsoils. 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, 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, an accidental hydrocarbon spillage is considered to be a likely, negative, significant, significant weighted significance, localised medium to long term impact of the Proposed 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 Proposed 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. There will be a toilet installed at the control building in the substation which will be connected to a holding tank, fitted with an alarm and taken off site for disposal at a licensed facility prior to reaching its holding capacity.

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 leak and to be intercepted by surface water drainage features, ultimately discharging to surface waters at the Site. This is considered to be an unlikely, negative, significant, profound weighted significance, medium to long term impact of the Proposed 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 Proposed Development has the potential to result in the accidental spillage or deposition of construction waste into soils and peatlands. This in turn has the potential for waste materials to leach out toward preferential drainage flow paths that are ultimately be connected to the Sites 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 and 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 Proposed Development, which is in contrast to Baseline.

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

9.4.4.7 Potential Effects on Hydrologically Connected Designated Sites

The Site is situated upstream of the Bandon River SAC (Site Code 002171) which is also crossed over by the existing road network which the Dunmanway Grid Connection route option would traverse. The Site is located within three separate Margaritifera Sensitive Areas which are the Bandon/Caha, Owvane, and Lee Upper Margaritifera Sensitive Areas. The Site is located within the Caha and Allua Priority Areas for Action (PAAs). Both the Bandon GWB (IE_SW_G_086) and the Beara Sneem GWB (IE_SW_G_019) which underly the Site and Grid Connection route options are designated as a Registered Protected Areas (RPA) for Shellfish. The Ballinhassig West GWB which underlies approximately 19.2% of the total site area at the north-eastern extent, both Grid Connection route options, and the

TDR, is a RPA as a WFD GWB intersecting with WFD Designated Salmonid Waters. All Water Framework Directive GWBs nationally have been identified as Drinking Water Protected Areas (DWPA) as is discussed in **Section 9.3.17**.

In the event that the Dunmanway Grid Connection route option is the preferred option, horizontal directional drilling (HDD) will be carried out at a maximum of three locations along the road network which intersect the Bandon River SAC. The locations would be at the Caha River and at two unnamed tributaries of the Caha River near the townland of Aultagh. With the implementation of appropriate mitigation measures, potential impacts on all watercourses, including those located within the Bandan River SAC are expected to be negligible.

Any accidental release of potential contaminants to the environment as a result of the Proposed 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 Proposed 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 Proposed 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 considered unlikely. Furthermore, considering the geographical scale of the Site and the Bandon River, 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 are classified by the GSI as Locally Important (LI), bedrock which is moderately productive only in local zones. 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. During the operational phase, there will be a toilet installed at the control building in the substation which will be connected to a holding tank, fitted with an alarm and taken off site for disposal at a licensed facility prior to reaching its holding capacity. Therefore, there is no potential for the Proposed Development to impact on groundwater due to drilling of boreholes for extraction purposes.

9.4.4.9 Potential Effects on Local Groundwater Supplies (Wells)

Mapping and searches of the GSI well databases confirms that there are no known groundwater abstraction wells located within the Site. The closet known groundwater well is located approximately 2.4km to the northeast of the Site, or approximately 580m west of the Dunmanway Grid Connection route option, in the townland of Coolcaum. There are also no known groundwater wells located in close proximity to works will occur along the TDR.

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 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 predominantly follow the down gradient slope direction of Shehy More Mountain which is also the case for the rivers and streams which rise at and flow from Shehy More Mountain. There are no dwellings located within the Site or within 300m of the main development features. However, the closest dwelling to a proposed design feature is situated approximately 300m to the south of the Met Mast access track, it is anticipated that any potential groundwater impacts will have significantly attenuated across this distance in the underlying poorly productive aquifer. It is noted that a small number of dwellings are located approximately 300m south of the proposed Onsite Substation and Control Buildings, in the townland of Tooreen. However, the construction of the Onsite Substation and Control Buildings will not require deep excavations and any potential interactions with groundwater is expected to be negligible. Furthermore, given that there is a very steep slope separating the substation from these dwellings, groundwater would most likely discharge to mountain streams or springs across the approximately 300m distance to the nearest dwellings.

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 advance to approximately 3m and mass reinforced concrete gravity bases will be constructed. Minimal excavation dewatering is expected to be required at turbine positions or Turbine Hardstand locations. Excavations will occur in a moderate to 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. A combination of low to moderate permeability subsoils, the temporary nature of the construction works, moderate 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 Proposed 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 Potential Groundwater and Surface Water Effects due to the Grid Connection Cable Works and the TDR

The Dunmanway Grid Connection route option is located primarily within the Bandon GWB, the Carrigdangan Grid Connection route options is located primarily within Ballinhassig West GWB with a small section of both options being located within the Beara Sneem GWB. A small portion of the TDR is located with the Beara Sneem GWB, with the majority of the TDR where any works will be carried out being located within the Ballinhassig West GWB, Bandon GWB and the Ballinhassig East GWB. One blade laydown area along the TDR is also located near the boundary of the Lee Valley Gravels GWB and the Ballincollig GWB. No works along the TDR are expected to intercept groundwater, potential impacts from these works are therefore expected to be negligible.

According to the GSI, the GWBs which underly the main Site are all categorised as poorly productive bedrock. The GSI well database has indicated that there is one GSI mapped well located approximately 580m west of the Dunmanway Grid Connection route option, in the townland of Coolcaum. For the remainder of the Dunmanway Grid Connection route option, there is one GSI mapped well located approximately 1km east of this option at the closet extent in the townland of Acres, or approximately 1.2 km north-east of the existing substation in Dunmanway.There is also a mapped holy well located approximately 520m southwest of the Dunmanway Grid Connection route option in the townland of Togher. For the Carrigdangan Grid Connection route option, there is one GSI mapped well located approximately 900m north-east of the route in the townland of Scrahan.

Shallow trenching, which will be backfilled is expected to be required for whichever Grid Connection route option is chosen. For the purpose of conservatism, it is assumed that all crossings along the both the Dunmanway and Carrigdangan grid connection route options would require HDD. This would result in a potential total maximum of thirty-three crossings requiring HDD along the Dunmanway option and eighteen along the Carrigdangan option as a conservative assumption. The HDD locations shown on **Figure 9.7B** in **Volume III**. 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. If test pits and boreholes were located directly on, or extended through the proposed alignment, these areas could act as weak points that may serve as conduits where inadvertent fluid returns or frac out occurs. 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 arisen 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 Grid Connection requiring shallow trenching which will be backfilled, the temporary nature of the construction works, the established HDD technique with controls and use of non-toxic fluids is expected to result in a neutral to negative, slight to moderate significance, localised impact of the Proposed 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.

9.4.6 Potential Groundwater and Surface Water Effects due to Wind Farm Internal Cabling Works at the Site

The Wind Farm Internal Cabling works at the Site will follow the hardstand and road alignment and will be predominantly buried within shallow cable trenches. There are no known groundwater wells located within the Site, the known wells located beyond the Site are discussed in **Section 9.3.11**. The closest internal cable works at the Site to a mapped well is expected to occur at the T06 turbine location, approximately 2.8 Km south-east of the closest GSI mapped well. 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. Excavations required for Wind Farm Internal Cabling works will be relatively shallow and are generally not anticipated to intercept the groundwater table. No significant potential to impact on groundwater supplies from such excavations are anticipated to occur at any area of the Site.

The pre-existing unpaved road alignment at the Site which will be upgraded is located within 50m of surface waters in some areas as is shown on **Figure 9.8** in **Volume III**. Since the Wind Farm Internal Cabling works will follow the track alignment, these works will also occur within the 50m buffer of watercourses in some areas. The installation of the Wind Farm Internal Cabling works will require shallow trenching along the track alignment. Given that the majority of the trackalignment is pre-existing and will be upgraded, coupled with the absence of proximal groundwater wells and the sealed nature of the Wind Farm Internal Cabling works at the proposed crossings, internal cable works are expected to result in a neutral to, slight significance, localised impact of the Proposed Development which is in contrast to the Baseline. With appropriate mitigation measures in place, the potential impacts on groundwater and surface waters can be managed and reduced to imperceptible to slight.

9.4.7 Reinstatement of Redundant Access Track, Hardstand Areas and Borrow Pit

Access tracks, borrow pits and Turbine Hardstand areas, such as Temporary Construction Compound areas that would 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 Turbine Hardstand areas will require the removal of the top layer of hardstand and temporary access tracks. The underlying soil or peat will not be significantly exposed during such top layer surface removals. Any excess soil or peat from the top layer removals will be used to reinstate the single borrow pit at the Site.

Depositing of acrotelm (or vegetated peat) and soil 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 hardstand aeras or 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 assuming that the mitigation measures and precautions described in this report are implemented. Reinstatement of redundant infrastructure or borrow pit area following the Proposed Development construction phase is considered a positive, or beneficial impact of the Proposed 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.

9.4.8 Operational Phase Effects

The replacement of the vegetated surfaces 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, Onsite Substation and Control Buildings and Met Mast.

During prolonged heavy rainfall events, additional surface water runoff at increased flow velocity could increase sediment 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.

Water supply for the Onsite Substation and Control Buildings sanitation facilities will be brought to Site and removed after use as wastewater from the Site by a licensed waste haulage contractor to be discharged at a suitable off-site treatment location. No water will be sourced on the Site or discharged to the Site during the operational phase. No operational phase effects are anticipated from water and wastewater sourcing and disposal.

9.4.9 Decommissioning Phase

Decommissioning of the Proposed Development would 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 the following key elements:

- De-energising of the Site via a high voltage (HV) disconnection followed by low voltage (LV); disconnection of turbines;
- Removal of the Onsite Substation and Control Buildings;
- Controlled dismantling of turbine components such as blades, tower and nacelle;
- Controlled removal of the Met Mast; and,
- 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 crane Turbine Hardstand areas adjacent to the turbines;

- The Site access roads;
- The hardstanding area for the Onsite Substation and Control Buidlings;
- The borrow pit; and,
- 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 be an imperceptible to slight, neutral, permanent impact on the hydrological and hydrogeological setting surrounding the Site.

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

The Proposed 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 Proposed 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 layout and associated infrastructure layout across multiple design iterations. Hydrological constraints maps have been developed which identify 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 proposed 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 Proposed 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 from the Site 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 is a recommended approach for identifying areas of the Proposed Development which pose an elevated risk in terms of sensitive surface water receptors. A self-imposed 50m buffer zone can therefore be considered a conservative approach.

The layout of the Proposed 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:

- Where the Grid Connection route traverses existing bridges that are already located within the 50m buffer zone, horizontal directional drilling will be carried out at a potential maximum of eighteen watercourses for the Carrigdangan Grid Connection option, or thirty-three watercourses for the Dunmanway Grid Connection option;
- Where small drains at site will be culverted or diverted, such as for the borrow pit, site access track and the T09 Turbine Hardstand area; and,
- Where pre-existing unpaved access tracks at the Site will be utilised in locations that are already within the 50m buffer zone of rivers. This includes areas immediately adjacent to the existing access tracks such as the borrow pit and the temporary spoil storage area.

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.

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.** 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, the established drainage network at the Site, and the limits of the Proposed 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.

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**;
- A materials management plan will be established and will form part of the **Construction Environmental Management Plan** with the objective of establishing material balance during the construction phase. This will minimise the potential for excavated materials to be exposed for long durations and becoming vulnerable to entrainment by surface water runoff;
- No permanent or semi-permanent stockpiles will remain on the Site during the construction or operational phase of the Proposed Development;
- 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; and,
    - 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 until such time that the risk of excess

surface water loading occurring is deemed to be negligible. 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 advanced 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 runoff to reach sensitive receptors;
- No direct flow paths between stockpiles and watercourses will be permitted at the Site;
- Excavated material will be backfilled to the borrow pit as soon as reasonably practicable to prevent long duration storage at the Site which increases the risk of adverse effects on aquatic environments; and,
- All mitigation measures related to surface water quality as described throughout this Chapter 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 if required 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 the receiving environment for overland flow;
- Geofabric lined settlement ponds will buffer the runoff discharging from the drainage system which will reduce the hydraulic loading to watercourses. Settlement ponds will be designed to reduce flow velocity to 0.3 m/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 runoff 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 runoff;
- 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 runoff 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 in accordance with the *Local Government (Water Pollution) Act 1977* as amended); and,
- 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 settling ponds, buffered discharge points and other surface water runoff control infrastructure. The 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 runoff 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 hard core 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 measures are 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;
- If 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; and,
- Surface water runoff controls will be checked and maintained on a regular basis and as soon as any signs of deterioration become visible. Surface water runoff controls, 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 remains 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 measures is not to be adopted as a first principle, and is not to be relied upon to prevent adverse impacts on designated sites, it should be considered as 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 Proposed 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 a 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; and,
- 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 nature of the Site, it is unlikely that implementation of this refuelling policy will be practical in all circumstance. 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; and,
- 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 mitigated 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 Construction Compound, Onsite Substation and Control Buildings 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 Proposed 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; and,
- A detailed spill response plan will be prepared as part of the site-specific CEMP.

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 outlined 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 recommended:

- 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 a 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 Construction Compound;
- Spill kits will be readily available to Site personnel, and any spillages or deposits will be cleaned up immediately 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; and,
- 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 and Drain Diversions Proposed Mitigation Measures

At the Site, the pre-existing unpaved tracks traverse over several rivers and small drains which flow through culverts beneath the unpaved tracks at the Site. In addition to the pre-existing crossings at the Site, new access tracks will also be constructed to facilitate access to turbine and hardstand positions. One new bridge would be constructed within the Site, to the southwest of T06. Five existing culverts would be upgraded, and three new culverts would be installed at the Site to facilitate the construction of the Grid Connection route and the access tracks. A maximum of 6 drainage channels would also require slight diversions to be implemented at the Site to allow for the access tracks, Turbine Hardstand areas and borrow pit to be constructed. Detailed planning and consideration to ensure that potential impacts are assessed adequately, and in turn mitigated against, will be implemented for these locations. These locations are shown on **Figure 9.7A** in **Volume III**.

Due to the large quantity of small drains existing at the Site, the access tracks layout could not avoid intersecting all of the existing drainage channels at the Site. In terms of the Grid Connection route option to Dunmanway, thirty-three EPA mapped watercourses along the road network would be traversed to facilitate the installation of this Grid Connection. For the Carrigdangan Grid Connection route option, eighteen mapped watercourses along the road network would be traversed to facilitate the installation of the Grid Connection. The use of existing infrastructure at bridges, horizontal directional drilling (HDD) under watercourses and/or the replacement of some exiting culverts with appropriately sized new culverts along the chosen Grid Connection route will be carried out to facilitate the construction of the route.

In terms of the Turbine Delivery Route (TDR), which is from the Port of Cork to the northern entrance of the Site, the route crosses multiple mapped rivers and streams with minor works being carried out or laydown areas being utilised at a total of 49 individual locations. The type of minor works that would be required along the TDR include temporary road widening for overrun areas, areas to be cleared for oversail areas, vegetation clearance, checking the width of access roads and the use of fields as blade laydown areas. The locations of watercourse relative to the TDR are shown on **Figures 9.17** to **9.65** in **Volume III**. No actual crossings will be constructed, nor will any culverts be installed as part of the TDR works. With the implementation of sediment control fences, straw bales, check dams and all measures contained in the CEMP, potential impacts associated with TDR works at crossings are expected to be negligible.

A detailed design stage assessment in terms of culvert design will be carried out that will have cognisance to crossing locations including the characteristics of water flow at these locations. The following mitigation measures are recommended as minimum requirements to ensure that any potential impacts of the proposed watercourse crossings are minimised:

- The design of the proposed crossings and a method statement for the proposed construction will be agreed in advance with Inland Fisheries Ireland (IFI);
- The 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, which will be mandatory throughout the construction of the watercourse crossings, details of the culvert design and construction methodology, including the environmental risk/s involved which have been identified and assessed in this EIAR will be included in the CEMP at the detailed design phase. Detailed site-specific mitigation measures and best practice techniques will be contained in the construction management plan and Risk Assessment Method Statement (RAMS) for any proposed crossings of small unmapped drainage channels;

- Vehicles used in the construction of small drain crossings will only be refuelled at the Site's bunded and designated refuelling area. No refuelling will be permitted within 50m of any watercourse at the Site; and,
- 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; and,
- 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 to moderate permeability subsoils beneath the topsoil/peat and moderate recharge rates at the Site has resulted in the risk posed to groundwater quality by the Proposed Development being considered as generally low to moderate risk which is discussed in previous sections of this report. Nevertheless, mitigation measures to reduce potential risks to groundwater will be implemented as a precautionary approach. 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 Proposed Development. In order to mitigate against potential groundwater contamination by hydrocarbons, implementation of the following mitigation measures is recommended:

- In the first instance, no fuel storage should 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; and,
- The mitigation measures outlined for the protection of surface waters as set out in **Section 9.5.2.5** will be also implemented which will inadvertently serve to protect groundwater from potential hydrocarbon contamination.

The following mitigation measures are recommended 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 runoff rate. It is noted that the presence of elevated contaminants were not detected during any of the surface water quality monitoring rounds which are discussed in **Section 9.3.9**;
- 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 should be monitored for trace metal concentrations prior to, during and after the construction phase;
- The potential for livestock such as 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; and,
- The mitigation measures outlined for the protection of surface waters as set out in **Section 9.5.2.5** will be also implemented which will inadvertently serve to protect groundwater from potential non-hydrocarbon contamination.

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 should 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 Cork 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 surface waters on Site should 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;
- It is also recommended that laboratory analyses for parameters such as total suspended solids, nitrogen, phosphorous, biochemical oxygen demand and trace metals etc. is implemented 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 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 Proposed 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, 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;
- Any proposed crossings of small unmapped drains discussed in **Section 9.5.2.7** will be monitored daily during construction and during each Site visit during the operational phase. These small culvert 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 before each use by a qualified Environmental Clerk of Works; and,
- 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 Site. 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, Onsite Substation and Control Buildings, Met Mast, borrow pit and Temporary 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 should 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 should 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; and,
  - 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; and,
  - 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; and,
  - 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 Proposed 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. 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 by natural dilution as distance from the point or diffuse source of contamination increases with distance from the Site.

Mitigation by avoidance and the implemented of physical control measures will ensure that contaminant concentrations, particularly elevated suspended solids entrained in runoff 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 hardstand 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 7,431m^3/month, or +3.26% in a worst-case scenario wettest month relative to the area of the Site, therefore this is considered a slight, 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 should be immediately removed during the operational phase of the Proposed Development. No other additional impacts are anticipated during the operational phase of the Proposed Development.

9.5.3.2 Operational Phase Residual Impacts

The residual impact on the receiving surface water environment during the operational phase of the Proposed 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 in a worst-case scenario 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 9.4.9**, 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 would 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 soil or peat is not expected to be required during the Decommissioning phase. In addition, the movement of plant, vehicles and equipment is expected to be limited 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 runoff to the downstream receiving environment is expected to be low. However, the potential risk remains for spills of fuels or 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 access tracks and 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 runoff. 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 for the following:

- Mitigation measures described in this chapter to reduce the potential for runoff 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 is discussed in **Chapter 8: Soils and Geology** will be implemented; and,
- 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 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 access tracks and former 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 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 Proposed Development is evaluated in detail following the completion of the Decommissioning phase.

9.5.6 Cumulative Effects

There are 29 operational, consented and proposed wind farms within 20km of the Site, details of these are provided in **Table 2.1** in **Chapter 2**. For non-wind farm developments, including all small, medium and large-scale developments within 10km of the Site that are currently active in the planning system have been identified in **Appendix 2.4** of the EIAR.

The only other major development in the locality of the Site is the existing Shehy More Wind Farm, consisting of 11 turbines. The Shehy More Wind Farm abuts the existing Site to the north-east. The Shehy More Wind Farm is also divided across the same three catchment areas as the Proposed Development, although the proportion of the divide across these three catchment areas differs significantly. The Shehy More Wind Farm Site is predominantly located within the Bandon-Ilen and Lee,Cork Harbour and Youghal Bay Catchment areas with only a very small portion of this site located within the Dunmanus-Bantry-Kenmare Catchment Area.

With respect to hydrology, the effects of the Proposed 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 Proposed Development. However, considering the pre-existing "*Good*" and "*High*" WFD status of many of the surface waters surrounding the Proposed Development, and the high quality baseline water quality results outlined in **Section 9.3.9**, the potential for the Proposed Development to have adverse cumulative impacts on hydrology is limited to the construction phase. In further consideration of the wider locality, given that the Shehy More Wind Farm is already constructed, the potential for in-combination effects is greatly reduced due to greatest impacts on surface waters being most likely to occur during construction. In considering the absence of immediate proximity to designated sites, the Proposed Development is not considered likely to significantly contribute to cumulative effects in terms of water quality nor flood risk.

In terms of the Grid Connection route options and TDR, where short duration temporary works will be carried out, no existing or proposed developments have been identified which have the potential to result in cumulative impacts associated with the Proposed Development.

With respect to hydrogeology, and the potential effects of the Proposed Development having been assessed as likely being localised due to the moderate subsoil permeability, expected short groundwater flow paths, moderate recharge rates, comparatively high runoff rates and moderate yielding underlying groundwater aquifer only in local zones, the Proposed 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 Project, 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 Project which is in contrast to the Baseline conditions. 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 Proposed Development which conforms to the Baseline due to the pre-existing network of artificial field drains in existence at the Site. The Project, once the mitigation measures outlined are implemented, is not likely to have significant effects.

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