10 HYDROLOGY & HYDROGEOLOGY

10.1 INTRODUCTION

Hydro-Environmental Services (HES) was engaged by Jennings O'Donovan (JOD) to carry out an assessment of the likely and significant potential effects of the proposed Garrane Green Energy Project on the hydrological (surface water) and hydrogeological (groundwater) environment.

This chapter assesses the effects of the Project (refer to **Chapter 1: Introduction**) on the hydrological and hydrogeological environment. The Project includes all elements of the application for the construction of the Project (**Chapter 2: Project Description**). Where likely significant effects are predicted, this chapter identifies appropriate mitigation strategies therein. The assessment will consider the potential effects during the following phases of the Project:

- Construction of the Project
- Operation of the Project
- Decommissioning of the Project

Common acronyms used throughout this Environmental Impact Assessment Report (EIAR) can be found in **Appendix 1.4.**

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

- **Figure 10.1** – Regional Hydrology Map
- **Figure 10.2** – Local Hydrology Map
- **Figure 10.3** – Existing Site Drainage Map
- **Figure 10.4** – CFRAM Flood Map
- **Figure 10.5** – EPA Monitoring and Surface Water Sampling Locations
- **Figure 10.6** – Bedrock Aquifer Map
- **Figure 10.7** – Local Karst Features
- **Figure 10.8** – Designated Sites Map
- **Figure 10.9** – Groundwater Resources
- **Figure 10.10** – Potential Local Receptors (GW Wells)
- **Figure 10.11** – Cumulative Hydrological Study Area
- **Appendix 10.1** - Flood Risk Assessment

- **Appendix 10.2** - Original Laboratory Reports
- **Appendix 10.3** - WFD Compliance Assessment Report

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR in **Appendix 2.1**. This document will be a key construction contract document, which will ensure that all mitigation measures, which are considered necessary to protect the environment during the construction and decommissioning phase are implemented. It will include and apply all of the construction and decommissioning phase mitigation described within the EIAR and incorporate any additional considerations or work programs required by planning conditions, if permitted. For the purpose of this application, a summary of the mitigation measures is included in **Appendix 18.1**.

10.1.1 Development Description

Permission is being sought by the Developer for the construction of 9 no. wind turbines, a permanent Met Mast, Access Tracks, an on-site 110kilovolt (kV) Substation with a 'loop in' Grid Connection to the existing 110kV overhead line (OHL) between Charleville and Killonan, and all ancillary works. Temporary accommodation requirements at locations along the TDR are not included in the planning application but are assessed as part of the EIAR. The full description of the Project is provided in **Chapter 2: Project Description** of this EIAR.

Please note that for the purposes of this chapter, where:

- the 'Project' is referred to, this relates to the Development works within the Redline Planning Boundary, and also includes the works along the Turbine Delivery Route which are outside the redline.
- the 'Site' is referred to, this relates to the land which falls within the proposed Garrane Green Energy Redline Boundary (refer to **Figure 1.1**).
- the 'Turbine Delivery Route' (TDR) is referred to, this relates to the proposed TDR from Foynes Port to the Site.
- the 'Grid Connection' is referred to, this related to the proposed grid connection from the proposed on-site 110kV Substation to the lattice end masts with a loop in connection to the exiting 110kV OHL between Charleville substation and Killonan substation.

10.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford. Our core area of expertise and experience is hydrology and hydrogeology. We routinely work on hydrogeological assessments for groundwater supplies.

The chapter of the EIAR has been prepared by Michael Gill, Conor McGettigan and Nitesh Dalal.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer with over 23 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Slievecallan WF, Cahermurphy (Phase I & II) WF, Carrownagowan WF, and Croagh WF and over 120 other wind farm related projects across the country.

Conor McGettigan (BSc, MSc) is an Environmental Scientist with over 5 years' experience in the environmental sector in Ireland. Conor holds an M.Sc. in Applied Environmental Science (2020) and a B.Sc. in Geology (2016). In recent times Conor has assisted in the preparation of hydrological and hydrogeological impact assessments for a variety of developments. Conor has prepared the hydrology and hydrogeology chapter of environmental impact assessment reports for several wind farm developments on peatlands. Conor also routinely prepares hydrological and hydrogeological assessment reports, Water Framework Directive (WFD) compliance assessment reports and flood risk assessments for a variety of development types including wind farms.

Nitesh Dalal (B.Tech, PG Dip., MSc) is an Environmental Scientist with over 7 years' experience in environmental consultancy and environmental management in India. Nitesh holds a M.Sc. in Environmental Science from University College Dublin (2024), a PG Diploma in Health, Safety and Environment from Annamalai University, India (2021) and B.Tech. in Environmental Engineering (2016) from Guru Gobind Singh Indraprastha University, India (2016).

10.2 ASSESSMENT METHODOLODY AND SIGNFICANT CRITERIA

10.2.1 Relevant Legislation

The EIAR is prepared in accordance with the requirements of the EIA Directive.

The requirements of the following legislation are also complied with:

- Planning and Development Acts, 2000 (as amended).
- Planning and Development Regulations, 2001 (as amended).
- S.I. No. 477/2011: European Communities (Birds and Natural Habitats) Regulations, implementing EU Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Directive 2009/147/EC on the conservation of wild birds (the Birds Directive).
- S.I. No. 293/1988: Quality of Salmonid Water Regulations.
- Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("WFD").
- S.I. No. 99/2023: European Union (Drinking Water) Regulations.
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009, as amended, and S.I. No. 722/2003 European Communities (Water Policy) Regulations 2003, as amended, which implement EU Water Framework Directive (2000/60/EC) and provide for the implementation of 'daughter' Groundwater Directive (2006/118/EC).
- S.I. No: 122/2010: European Communities (Assessment and Management of Flood Risks) Regulations, resulting from EU Directive 2007/60/EC.
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations,
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended.
- S.I. No. 296/2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009, as amended.

10.2.2 Relevant Guidance

The Hydrology and Hydrogeology chapter of this EIAR is carried out in accordance with the guidance contained in the following documents:

- Circular Letter PL 1/2017: Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive).
- Environmental Protection Agency (2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.
- European Commission (2017): Environmental impact assessment of projects – Guidance on the preparation of the environmental impact assessment report (Directive 2011/90/EU as amended by 2014/52/EU).
- Institute of Geologists Ireland (2013) Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements.
- DoE/NIEA (2015): Wind farms and groundwater impacts - A guide to EIA and Planning considerations.
- OPW (2009) The Planning System and Flood Risk Management.
- National Roads Authority (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Wind Energy Development Guidelines for Planning Authorities, 2006 (the Guidelines);
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Watercourses.
- Good Practice During Wind Farm Construction (Scottish Natural Heritage, 2010).
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note).
- PPG5 – Works or Maintenance in or Near Water Courses (UK Guidance Note).
- CIRIA (Construction Industry Research and Information Association) Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006).
- Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2001.
- Limerick County Council (2022): Limerick Development Plan (2022-2028).

10.2.3 Assessment Structure

This chapter is structured in accordance with the EIA Directive and current EPA guidelines: *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (2022).

As outlined in the EPA Guidelines on the Information to be Contained in Environmental Impact Assessments (EPA, 2022) there are 7 stages in the preparation of an EIAR. The first 4 stages include Screening, Scoping, the Consideration of Alternatives and Project Description and these are dealt with in the preceding chapters of the EIAR.

Stage 5 refers to Describing the Baseline Environment: The EPA Guidelines state that this section should refer to the current state of the environmental characteristics and involves the collection and analysis of information on the condition, sensitivity and significance of relevant environmental factors which are likely to the significantly affected by the Development. The EPA guideline's criteria require that the baseline environment is described in terms of the context, character, significance and sensitivity of the existing environment. The baseline hydrological and hydrogeological environment is described in **Section 10.4** of this chapter.

Stage 6 refers to the Assessment of Effects. This section should identify, describe and present an assessment of the likely significant effects of the Project on the environment. This section includes potential effects arising from all phases (construction, operation and decommissioning phases) of the Project as well as any potential cumulative effects which may arise as a result of the Project. The guideline criteria for the assessment of effects states that the purpose of an EIAR is to identify, describe and present an assessment of the likely significant effects. The likely effects are described with respect to their quality (positive, neutral or negative), significance (imperceptible to profound), extent (i.e. size of area or number of sites effected), context (is the effect unique of being increasingly experienced), probability (likely or unlikely), duration (momentary to permanent), frequency and reversibility. The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR. The potential likely significant effects of the Project on the hydrological and hydrogeological environment are detailed and assessed in **Section 10.6**.

Stage 7 refers to Mitigation and Monitoring and should describe the measures envisaged to avoid, prevent, reduce or offset any identified significant adverse effects on the environment. The section may also present any post-consent monitoring proposed to ensure that the Project performs as intended. Mitigation measures and post mitigation residual effects for the Project in relation to the hydrological and hydrogeological environment are included in **Section 10.7**.

In summary the structure of this EIAR chapter is as follows:

- Outline of the Assessment Methodology and Significance Criteria.
- Description of baseline conditions at the Site.
- Identification and assessment of potential likely and significant effects on the hydrological and hydrogeological environment associated with the Project, during the Construction, Operational and Decommissioning phases of the Project.
- Mitigation measures to avoid or reduce the potential effects.
- Identification and assessment of residual effects of the Project considering the implementation of the prescribed mitigation measures.
- Identification and assessment of the potential cumulative effects if and where applicable.
- Summary of Significant Effects and Statement of Significance.

10.2.4 Water Study Area

The Water Study Area for the hydrological and hydrogeological impact assessment is defined by the regional surface water catchments and groundwater bodies within which the Project is located.

A regional hydrology map showing WFD surface water catchments and sub-catchments is included as **Figure 10.1**. The relevant surface water catchments within which the Project is located are detailed in **Section 10.3.4**. In addition, the bedrock aquifers and groundwater bodies which underlie the Site are detailed in **Section 10.3.9**.

10.2.5 Desk Study

A desk study of the Water Study Area was completed in Summer 2022 to collect all relevant hydrological, hydrogeological and meteorological data. The desk study was completed to supplement site walkover surveys and site investigations (**Section 10.2.6**). The desk study information has been checked and updated, where necessary, in May and June 2025.

The desk study involved consultation with the following sources:

- Department of Housing, Planning and Local Government: the River Basin Management Plan 2022-2027. https://www.gov.ie/en/policy-information/8da54-river-basin-management-plan-2022-2027/.
- Environmental Protection Agency databases (www.epa.ie).
- Environmental Protection Agency's Hydrotool Databases (www.catchments.ie).
- Geological Survey of Ireland – Geological and Groundwater Databases (www.gsi.ie).
- Met Eireann Meteorological Databases (www.met.ie).
- National Parks and Wildlife Services Public Map Viewer (www.npws.ie).

- Water Framework Directive Map Viewer (www.catchments.ie).
- Bedrock Geology 1:100,000 Scale Map Series. Geological Survey of Ireland (GSI, 2003).
- Geological Survey of Ireland (2003) – Groundwater Body Initial Characterization Reports.
- OPW Flood Mapping Databases (www.floodinfo.ie).
- Aerial Photography, 1:5,000 and 6" base mapping.
- Myplan.ie; National Planning Application Map Viewer. https://myplan.ie/national-planning-application-map-viewer.
- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas. https://www.seai.ie/technologies/seai-maps/wind-atlas-map/.
- Department of Housing, Planning and Local Government, EIA Portal. https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal.
- Reports from the Maigue River Trust (https://maigueriverstrust.ie/).

10.2.6 Field Work

Hydrological walkover surveys were undertaken by HES on 09th August 2022, 7th December 2022, 26th March 2024, and 31st July 2024. These surveys were completed by Michael Gill and Conor McGettigan (refer to **Section 10.1.2** for qualifications and relevant experience). These site investigations included detailed drainage mapping, soil probing at proposed infrastructure locations, surface water flow monitoring and field hydrochemistry. Surface water grab sampling was completed during the March and July 2024 site visits. The sampling in March 2024 was preceded by a significant rainfall event while the sampling completed in July 2024 occurred during a dry period with low rainfall.

The hydrological and hydrogeological data used in this assessment includes:

- HES walkover surveys and drainage mapping at the Site on 09th August 2022, 07th December 2022, 26th March 2024, and 31st July 2024 whereby water flow directions and drainage patterns were recorded.
- The surveys included field hydrochemistry and stream flow monitoring of watercourses draining the Site in order to determine the origin and nature of surface water flows.
- A total of 9 no. surface water grab samples were taken (March and July 2024) to determine the baseline water quality of the primary surface waters originating from the Site.

- Excavation of 10 no. trial pits by Whiteford Geoservices Ltd. at the in September 2022 and September 2024.

Other works completed for the Project which informed the assessment include:

- HES completed a Stage III Flood Risk Assessment for the Project (refer to **Appendix 10.1**).
- A WFD Compliance Assessment Report has been completed for the Project and is included as **Appendix 10.3**.
- Preliminary Site Investigation Works for Construction of New Wind Turbines, Access Tracks and Associated Infrastructure Report No: 2177-22B, 17th October 2022 (refer to **Appendix 9-1**).
- Desktop Study and Walkover Survey for Preliminary Determination of Ground Conditions. Report No: 2177-22A, 17th June 2025 (**Appendix 9-2**).
- A Site Investigation Report (Whitefords, 2025).
- JoD completed a Spoil Management Plan for the Project Development (2025).

10.2.7 Evaluation of Potential Effects

The conventional source-pathway-target model (see below, top) was applied to assess potential effects on downstream environmental receptors (see below, bottom as an example) as a result of the Project.

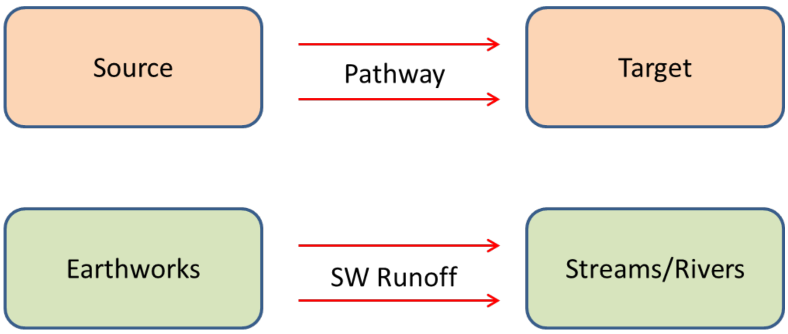

Plate 10.1: The conventional source-pathway-target model

Where potential effects are identified, the classification of effects in the assessment follows the descriptors provided in the Glossary of Impacts contained in the Environmental Protection Agency (May 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

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

The assessment of effects is Stage No. 6 of 7 in the EIAR process. In order to provide an understanding of the stepwise assessment process applied, a summary guide is presented below, which defines the steps (Steps 6a to 6g) taken in each element of the assessment of effects process (refer to **Table 10.1** below). The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model, and the EPA impact descriptors are combined.

Using this defined approach, the assessment of effects process is then applied to all wind farm construction, operation and decommissioning activities (including the substation and grid connection) which have the potential to generate a significant adverse effect on the hydrological and hydrogeological environment.

Table 10.1: Steps in Assessment Stage 6 (Assessment of Effects) and Stage 7 (Mitigation Measures)

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

10.2.7.1 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 effects 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[1], has been used in conjunction with EPA guidance. The following table presents rated categories and criteria for rating Site attributes (NRA, 2008[(1)]).

Levels of importance are defined in **Table 10.2** for hydrology and in **Table 10.3** for hydrogeology are used to assess the potential effect that the Project may have on them (NRA, 2008).

Table 10.2: Estimation of Importance of Hydrology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale.	River, wetland or surface water body ecosystem protected by EU legislation, e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality, 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 a wide range of leisure activities.
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.
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.
Low	Attribute has a low quality,	Locally important amenity site for small range of leisure activities. Local potable water source supplying <50 homes.

[1] National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes [Accessed: 25/07/2024]

Importance	Criteria	Typical Example
	significance or value on a local scale.	Quality Class D (Biotic Index Q2, Q1) Flood plain protecting 1 residential or commercial property from flooding. Amenity site used by small numbers of local people.

Table 10.3: Estimation of Importance of Hydrogeology Criteria (NRA, 2008)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale.	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very High	Attribute has a high quality, significance or value on a regional or national scale.	Regionally Important Aquifer with multiple wellfields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation - NHA status. Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source.
High	Attribute has a high quality, significance or value on a local scale.	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality, significance or value on a local scale.	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality, significance or value on a local scale.	Poor Bedrock Aquifer Potable water source supplying <50 homes.

10.2.7.2 Magnitude

The magnitude of potential effects arising as a product of the Project are defined in accordance with the criteria provided by the EPA, as presented in **Table 10.4**. These descriptive phrases are considered general terms for describing potential effects of the Project, and provide for considering baseline tends, for example; a "Moderate" impact is one which is consistent with the existing or emerging trends.

Table 10.4: Describing the Magnitude of Effects

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

Magnitude of Impact	Description
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 (**Table 10.5** and **Table 10.6**) (NRA, 2008). These descriptive phrases are considered development specific terms for describing potential effects of the Project, and do not provide for considering baseline tends and therefore are utilised to qualify impacts in terms of weighting impacts relative to site attribute importance, and scale where applicable.

Table 10.5: Qualifying the Magnitude of Effects on Hydrological Attributes

Magnitude of Impact	Description	Example/s
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
Minor Beneficial	Results in minor improvement of attribute quality.	Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually

Magnitude of Impact	Description	Example/s
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 10.6: Qualifying the Magnitude of Impact on Hydrogeological Attributes

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

10.2.7.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential effects, rating of significant environmental effects is done in accordance with relevant guidance in **Table 10.7**. This matrix qualifies the magnitude of potential effects based on weighting same depending on the importance and/or sensitivity of the receiving environment.

Table 10.7: Weighted Rating of Significant Environmental Effects

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

10.2.7.4 Scoping Responses and Consultation

Information has been provided by a number of consultee organisations during the assessment, and this is summarised in **Table 10.8**. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has changed in response to specific issues indicated by respective consultees.

Table 10.8: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response
Health Service Executive (HSE)	7th June 2024	The proposed development has the potential to have a significant impact on the quality of both surface and ground water. All drinking water sources, both surface and ground water, must be identified. Public and Group Water Scheme sources and supplies should be identified in addition to any private wells supplying potable water to houses in the vicinity of the proposed development. Measures to ensure that all sources and supplies are protected should be described. Any potential significant impacts to drinking water sources should be assessed. *Response: Section 10.3.18 identifies all surface and groundwater sources with the potential to be impacted by the Project. The assessment presented in Section 10.5.2.8 assumes that all local dwellings have a potable well supply.* The impact on sensitive receptors of the proposed development combined with any other wind farm/renewable energy developments in the vicinity should be considered. The EIAR should include a detailed assessment of any likely significant cumulative impacts of the proposed windfarm development. *Response: A comprehensive cumulative assessment on the hydrological and hydrogeological environment has been completed (Section 10.7.4)*

Consultee	Type and Date	Summary of Consultee Response
Geological Survey of Ireland (GSI)	11th June 2024	The GSI recommend the use of their online databases in the preparation of this Chapter. No specific issues relating to the hydrogeological environment were raised by the GSI in their scoping response. *Response: GSI online databases were used in combination with site walkover surveys and site-investigation data to characterise the baseline environment.*
Office of Public Works (OPW)	4th October 2024	The OPW identified their drainage channels at maintenance corridors at the Site. The OPW requested a 10m wide strip of land running parallel to the main channels C1, C1/34 and a 5m wide strip of land running parallel to the channels C1.35, C1, 35/1, C1/36, C1/36/1, C1/36/2, C1/37, C1/37/1 and C1.37/2, should be provided to facilitate access and maintenance activities. This area should be accessible to mechanical plants and should not be landscaped, paved or otherwise development in a manner that would prevent access. *Response: The OPW requirements have been incorporated into the design of the Project.*
Uisce Éireann	9th July 2024	Uisce Éireann note that the proposals are located within the surface water abstraction catchment for the Adare Public Water Supply, with the abstraction point located on the River Maigue, located 21km downstream of the proposed development. There is a potential pollution pathway due to hydrological connectivity between the Charleville Stream_020 and Maigue_030 which are tributaries to the Maigue_080, where Uisce Éireann abstracts, that would need to be considered. *Response: An assessment of the potential effects on the Adare Public Water Supply is presented in Section 10.5.2.13.*

10.2.8 Limitations and Difficulties Encountered

No significant limitations or difficulties were encountered during the preparation of the Hydrology and Hydrogeology Chapter of the EIAR.

Access to the OPW FSU portal has been unavailable during 2025 (https://www.gov.ie/en/office-of-public-works/collections/flood-studies-update-fsu-programme/). This has limited our ability to complete final checks on flood modelling data. While this is not ideal, our own modelling is relatively consistent with CFRAM mapping, and that mapping provides confidence in our assessment approach and design responses.

10.3 BASELINE DESCRIPTION

10.3.1 Introduction

An investigation of the existing (surface water and groundwater) hydrologic and hydrogeologic characteristics of the Site, GCR and TDR was conducted by undertaking a desk study, by consultation with relevant authorities, and via site surveys. All data collected has been interpreted to establish the baseline conditions within the study area, and the significance of potential adverse effects has been assessed.

10.3.2 Site Description and Topography

The Site is located in south Co. Limerick and just north of the Cork-Limerick county border. The Site is located approximately 2.5km north of Charleville Town, Co. Cork, approximately 5.8km west of the village of Kilmallock and approximately 13.5km southeast of Croom in

Co. Limerick. The Site is located in the townlands of Garrane and Garroose in the north and Ballynagoul and Creggane in the south. The EIAR site boundary has a total area of approximately 158.75hectares (ha).

Land cover at the Site is mapped by Corine landcover mapping (Corine 2018) as agricultural pastures. Land cover was verified at the Site through the inspection of recent aerial imagery and site walkover surveys completed by HES. The Site is comprised of agricultural pastures with field separated be hedgerows, deeply incised field drains and natural watercourses. Several existing farm access tracks are present in the west of the Site i.e. to the west of the Charleville Stream, a tributary of the River Maigue. During the walkover surveys some poor agricultural land was recorded along the eastern banks of the Charleville Stream. Corine land cover mapping shows industrial lands to the south of the Site, corresponding to the location of the Rathgoggan North Wastewater Treatment Plant (WwTP). No significant land use changes have been recorded by historic Corine mapping (1990-2018).

The Site is located between the N20 to the west and the L1537 to the east and these north-south orientated public roads facilitate access to the existing Site. The N20 joins Charleville to the south to Croom in the north while the L1537 joins Bruree to the north to Charleville. An existing farm access tracks extents into the interior of the Site from the N20.

Several farmhouses and dwellings are located along these public roads in the lands surrounding the Site. There are 144 no. dwellings within a 2km radius of the proposed turbines. These comprise of one-off houses, clusters of houses and farm buildings.

Topography across the Site is generally flat to gently undulating. Ground elevations range from 58-61mOD (meters above Ordnance Datum) in the north of the Site, to 63-73mOD in the south of the Site. Local topography falls gently towards the River Maigue which dissects the Site, flowing to the north.

10.3.3 Rainfall and Evapotranspiration

Long term Annual Average Rainfall (AAR) and evaporation data was sourced from Met Éireann (www.met.ie).

The 30-year AAR (1981-2010) recorded at the Kilmallock Garda Station, located approximately 5.75km east of the Site, are presented in **Table 10.9**. The long-term AAR at Kilmallock Garda Station for this period was approximately 944mm/year. However, the AAR recorded at Kilmallock Garda Station is not the most accurate available estimate of AAR at the Site due to the distance between the Site and this weather station.

Met Éireann also provides a grid of AAR for the entire country for the period of 1991 to 2020. Based on this more site-specific modelled rainfall values, the AAR at the Site ranges from approximately 956 to 981mm/year. The AAR for the Site is therefore considered to be approximately 971mm/yr (average of the AAR range). This is considered to be the most accurate estimate of AAR from the available sources.

Table 10.9: Local Average Long-term Rainfall Data (mm)

Station		Eastings		Northings		Ht (MAOD)		Opened		Closed		
Kilmallock		160900		127400		89		1943		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
97.9	69.6	72.9	60.5	67.5	67.1	63.5	74.5	74.9	110.6	92.60	92.4	944
Station		Eastings		Northings		Ht (MAOD)		Opened		Closed		
Site		154000		127000		N/A		N/A		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
102	79	71	64	62	67	68	76	73	100	104	106	971

The closest synoptic[2] station where the average Potential Evapotranspiration (PE) is recorded is at Shannon Airport, approximately 35km northwest of the Site[3]. The long-term average PE for this station is 578mm/year. This value is used as the best estimate of the Site PE. Actual Evaporation (AE) is estimated as 549mm/year (which is 0.95 × PE).

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

Effective rainfall (ER) = Average Annual Rainfall (AAR) – Actual Evapotranspiration (AE)

= 971mm/year – 549mm/year

ER = 422mm/year

Groundwater recharge and runoff coefficient estimates are available from the GSI (www.gsi.ie) . Within the Site groundwater coefficients are estimated by the GSI to be 8% due to the presence of low permeability subsoils. This is supported by observations made

[2] Meteorological station at which observations are made for synoptic meteorology and at the standard synoptic hours of 00:00, 06:00, 12:00, and 18:00.

[3] Please note this is the only PE data available, and the next nearest station where PE is recorded is at Cork Airport, approximately 60km southeast of the Site.

during the walkover surveys and site investigations whereby the Site was characterised by a high density of surface water features and with the subsoils comprising of low permeability tills. Therefore, conservative annual recharge and runoff rates for the Site are estimated to be 34mm/year and 388mm/year respectively.

Met Éireann's Translate Project (https://www.met.ie/science/translate) provides projections for a range of future climate change scenarios, as Ireland's future climate will depend on global greenhouse gas emissions reductions. The severity of any future climate change will depend on the degree of future warming. In relation to precipitation chances, in a 1.5°C world, average winter and summer precipitation rates are projected to be 3.94mm/day and 2.38mm/day respectively. Meanwhile, in a 4°C world, the average winter and summer precipitation rates are projected to be 4.3mm/day and 2.1mm/day respectively.

In addition to AAR, extreme value rainfall depths are available from Met Éireann. **Table 10.10** presents return period rainfall depths for the Site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 5-year, 30-year, 100-year). These extreme rainfall depths will be the basis of the proposed wind farm drainage hydraulic design.

Table 10.10: Return Period Rainfall Depths

Return Period (Years)				
Storm Duration	1	5	30	100
5 mins	3.6	5.9	9.8	13.3
15 mins	5.9	9.7	16.0	21.8
30 mins	7.7	12.4	20.0	27.0
1 hour	10.1	158	25.1	33.3
6 hours	20.1	29.8	44.8	57.7
12 hours	26.2	38.1	56.1	71.3
24 hours	34.1	48.7	70.3	88.2
2 days	42.1	58.1	80.9	99.3

10.3.4 Regional and Local Hydrology

On a regional scale, the Site is located in the Shannon Estuary South surface water catchment within Hydrometric Area 24 of the Shannon River Basin District. The Shannon

Estuary South Catchment includes the area drained by the Deel and River Maigue, and all streams entering tidal water in Shannon Estuary between Kilconly Point and Thomond Bridge, Limerick. This regional surface water catchment has a total area of 2,033km². The largest urban centre in the catchment is the southern section of Limerick City with the other main urban centres being Newcastle West, Charleville, Kilmallock, Rathkeale and Mungret (EPA, 2024).

More locally, the Site is located within 3 no. WFD river sub-catchments of the River Maigue: The eastern section of the Site is located in the Maigue_SC_020 river sub-catchment, the western section of the Site is located in the Maigue_SC_010 river sub-catchment whilst a very small areas in the north of the Site is mapped in the Maigue_SC_040 river sub-catchment.

Within the Maigue_SC_010 river sub-catchment, the Site is mapped in the Charleville Stream_020 WFD river sub-basin. The EPA named Charleville Stream (EPA Code: 24C02) is a 2nd order stream which dissects the Site, flowing from south to north approximately 95m east of T3. The Charleville Stream discharges into the River Maigue (EPA Code: 24M01) approximately 180m southwest of T7. Several other watercourses are mapped by the EPA in this area of the Site. A small, locally unnamed, 1st order stream, referred to by the EPA as the Graigues Stream (EPA Code: 24G37) is mapped to originate along the N20 before flowing to the northeast through the Site and approximately 80m west of T5 (refer to **Figure 10.3**). This stream confluences with another small stream, referred to by the EPA as the Creggane Stream (EPA Code: 04C50), which flows from the west. This confluence is located approximately 190m northwest of T5. The Graigues Stream then continues to flow for approximately 250m before it discharges into the River Maigue at the same location as the Charleville Stream. Upstream of the Site the River Maigue itself flows to the east under the N20 at Creggane Bridge, and continues to the east, dissecting the northwestern section of the Site. The River Maigue flows to the east approximately 85m south of T8, before veering to the north downstream of its confluence with the Charleville and Graigues Streams.

Within the Maigue_SC_020 river sub-catchment, the easter section of the Site is mapped in the Maigue_030 WFD river sub-basin. The main drainage feature in this area is the River Loobagh (EPA Code: 24L01) which discharges into the River Maigue downstream of the Site and approximately 280m north of T7. A small locally unnamed stream, referred to by the EPA as the Loobagh Stream (EPA Code: 24L28) is mapped to flow along the northeastern boundary of the Site and approximately 80m east of T4. This stream discharges into the River Maigue just south of the confluence of the River Maigue and the main River Loobagh. Meanwhile, the EPA named Ballysallagh Stream (EPA Code: 24B67) is mapped to flow to the north approximately 270m east of the Site Entrance from the Local Road L1537. This stream flows to the north and discharges into the River Loobagh upstream of Garroose Bridge.

Within the Maigue_SC_040 river sub-catchment, the Site is also mapped in the Maigue_030 WFD river sub-basin, with the River Maigue flowing to the north approximately 215m east of T9.

Downstream of the Site, the River Maigue continues to the north, flowing through Bruree and Croom before becoming tidal at Adare, approximately 20km northeast of the Site (straight line distance).

Table 10.11 presents a summary of the hydrological setting of the Project infrastructure with respect to WFD catchments, sub-catchments and river sub-basins.

A regional hydrology map showing the WFD catchments and sub-catchments is included as **Figure 10.1**. Meanwhile, a local hydrology map for the Site presents the WFD river sub-basins and is included as **Figure 10.2**. An existing site drainage map is attached as **Figure 10.3**.

Table 10.11: Project Infrastructure and WFD Regions

Catchment	River Sub-Catchment	WFD River Sub-Basin	Development Infrastructure
Shannon Estuary South	Maigue_SC_010	Charleville Stream_020	T1, T2, T4, T6, access tracks, 4 no. spoil storage areas, met mast, Site Entrance 1 and ecological enhancement areas. T3 and T7 also lie on the catchment divide between the Charleville Stream_020 and the Maigue_030 WFD river sub-basins.
	Maigue_SC_020	Maigue_030	T5, 110kV Substation, temporary construction compound, 2 no. spoil storage areas (to the south of the substation and to the north of T02), Grid

Catchment	River Sub-Catchment	WFD River Sub-Basin	Development Infrastructure
			Connection and Site Entrance 2 and ecological enhancement areas.
	Maigue_SC_040	Maigue_030	T7 and T9 are proposed on the catchment divide between the Charleville Stream_020 and the Maigue_030 WFD river sub-basins. A spoil storage area in the vicinity of T9 also encroaches upon this sub-basin.

10.3.5 Surface Water Flows

There are several OPW gauging stations located in the vicinity of the Site (https://waterlevel.ie/hydro-data/#/overview/Waterlevel). 2 no. OPW gauging stations are located upstream of the Site on the River Maigue at Creggane Bridge (Station ID: 24006) and on the River Loobagh at Garroose Bridge (Station ID: 24003). However, according to the EPA databases, both of these gauging stations are currently inactive, and no flow data is available.

An active OPW gauging station is located downstream of the Site on River Maigue at Bruree. The flow volumes in the River Maigue at this location are presented in **Table 10.12**. A percentile (%tile) flow relates to the flow which will be exceeded within the river for a given percentage of time. For example, a 95%tile flow relates to the flow which will be exceeded within the river 95% of the time. 95%tile flow in the River Maigue at Bruree is recorded as being 0.51m^3/s.

Table 10.12: OPW Gauging Station at Bruree (Flow Volumes)

Flows Equalled or Exceeded for the Given Percentage of Time (m^3/s) (Data derived from 1972-2024)								
1%	5%	10%	25%	50%	75%	90%	95%	99%
26.82	15.53	11.14	5.83	2.45	1.03	0.64	0.51	0.37

The EPA's Hydrotool, available on www.catchments.ie, was also consulted in order to estimate baseline flow volumes in the area of the Site. The Hydrotool dataset contains estimates of naturalised river flow duration percentiles. Several nodes were consulted in the vicinity of the Site and **Plate 10.2** below presents the estimated flow duration curves for each of the consulted Hydrotool Nodes. Flow volumes were available along the Charleville Stream, the River Maigue and the River Loobagh which drain the Site.

From the available data, the smallest flow volumes are modelled to occur within the Charleville Stream. A 95%tile flow volume in the Charleville Stream at Node 24_119 is estimated to be $0.025m^3/s$ (25l/s). In contrast the 95%tile flows in the Maigue and River Loobagh in the Site are estimated to be $0.179m^3/s$ and $0.0259m^3/s$ respectively. Downstream of the Site and upstream of Bruree the 95%tile flow volume in the Maigue is $0.419m^3/s$.

Due to the increasing flow volumes downstream of the Site the potential for effects associated with the Project decreases progressively downstream.

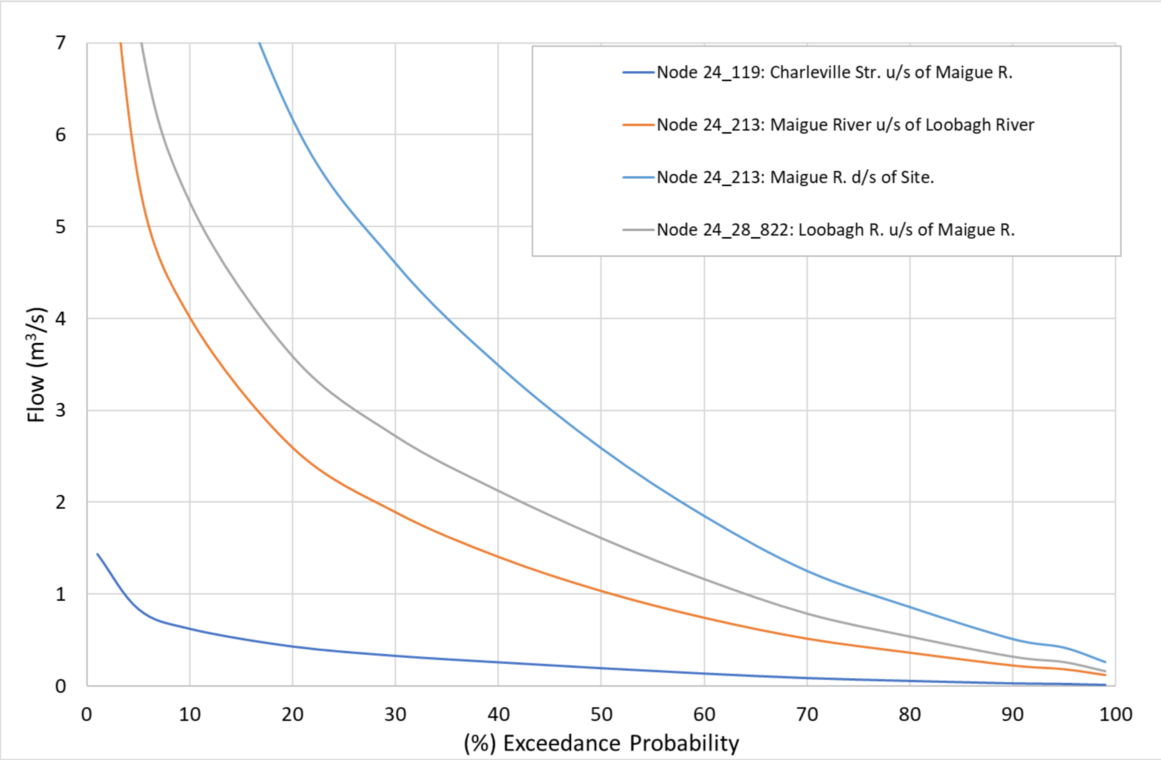

Plate 10.2: EPA Hydrotool Node Flow Duration Curves

10.3.6 Site Drainage

As discussed above, the Site is drained by the River Maigue and its tributaries.

An existing drainage map for the Site is shown within **Figure 10.3**. The drainage map was created using OSI mapped watercourses, aerial photography, field mapping and Lidar data. Lidar data allows detailed mapping on the topographic contours of the Site, thereby allowing identification of potential drainage pathways at the Site that are greater than 150m in length.

Based on this assessment the main drainage pathways at the Site are shown and the connectivity (i.e., pathways and outlet points) of these drains with the downstream EPA mapped streams/rivers can be clearly illustrated.

In addition to the EPA mapped watercourses described in **Section 10.3.4**, the natural drainage at the Site is further facilitated by a network of manmade drains. These agricultural field drains are typically deeply incised and are located along existing hedgerows and field boundaries. The drains connect downstream to the natural watercourses which flow through the Site.

2 no. rounds (26th March 2024 and 31st July 2024) of surface water flow monitoring were completed in the main watercourses draining the Site and the results are shown in **Table 10.13** below. The measured flows vary depending on the nature of the watercourse being monitored. The smallest flows were recorded at SW1. SW1 is small hydrological feature (drain) in the south of the Site. The greatest flows were recorded at SW5 on the River Maigue at Bruree. The monitoring locations are shown on **Figure 10.5**.

Table 10.13: HES Surface Water Flow Monitoring (L/S)

Location	Easting (Irish Grid)	Northing (Irish Grid)	EPA Watercourse Name (EPA Code)	26th March 2024	31st July 2024
SW1	154981	125842	small unmapped drain	approximately 1	No flow
SW2	155024	127475	Loobagh	>400	>200
SW3	153669	127353	River Maigue	>400	>400
SW4	154263	126047	Charleville Stream	approximately 60	approximately 30
SW5	154978	130464	River Maigue	>500	>500

10.3.7 Summary Flood Risk Assessment

This section is a summary of the flood risk assessment (FRA) undertaken by HES for the Project. The full FRA report is attached **Appendix 10.1**.

Identifiable text on local available historical 6" or 25" mapping does not identify any lands that are "liable to flood" in the vicinity area of the Site.

The OPW Past Flood Events Map (www.floodinfo.ie) records the occurrence of 2 no. historic and 1 no. recurring flood instances in the vicinity of the Site. The mapped flood events all occur at the same location along the N20 National Road on the western side of the Site.

The historic flood events include the fluvial flood events at Maigue Creggane Bridge in August 1986 (Flood ID-205) and November 1982 (Flood ID-503). A recutting flood event is also mapped at this location (Flood ID-747). The Kilmallock Area Engineer's Report, available to view at www.floodinfo.ie, notes that "*the road is rendered impassable and major traffic chaos is caused on average once every 5 years*."

The GSI Winter 2015/2016 Surface Water Flood Map (www.floodinfo.ie) shows surface water flood extents for this winter flood event. This flood event is recognised as being the largest flood event on record in many areas across the country. The flood map for this event records localised areas of surface water flooding to the west of the Site. No infrastructure is proposed in these areas.

CFRAM fluvial mapping has been completed for the area of the Wind Farm Site (**Figure 10.4**). CFRAM River Flood Extents for the Present-Day scenario are mapped extensively along the River Maigue and its tributaries in the vicinity of the Site. CFRAM River Flood extents cover large areas of the Site. In terms of the Project infrastructure, a total of 5 no. turbines are mapped within CFRAM fluvial flood zones. T5 and T8 are mapped in the low probability flood zone associated with the 1 in 1,000-year fluvial flood event. Meanwhile, T4, T6 and T7 are mapped in the high probability fluvial flood event associated with the 1 in 10-year flood event.

There are no National Indicative Fluvial Mapping (NIFM) for the Present-Day Scenario mapped within the Site. NIFM flood zones are mapped immediately upstream and to the west of the Site along the River Maigue.

The Site is mapped as Benefited Land, associated with an Arterial Drainage Scheme (ADS). Benefited land is land that was drained as part of a scheme. All watercourses in the vicinity of the Site are mapped as ADS channels and are maintained by the OPW, with periodic dredging being completed as a control measure for flooding.

A Stage III level site-specific FRA was carried out for the Site to assess the capacity and design flood levels of the river channel network (River Maigue and its tributaries). In the base modelled scenario, the modelled flood zone mapping is very similar to the flood mapping included in www.floodinfo.ie (i.e. the CFRAM Mapping). Proposed turbines T4, T5, T6, T7, and T8 are inundated by flood water in the 100-yr and 1000-yr DFs (design flood (DF) events). The footprint of the Project which overlaps with the modelled extent of the 20-

year flood event includes 1,220m of Access Track, 3 no. whole hardstands and turbine bases (T4, T6 and T7) and 2 no. partial turbine hardstands (T5 and T8). The modelled flood level for the 100-year flow (1% AEP) for the Site ranges between 57.09mOD at the northern downstream end, approximately 57.5mOD in the central area of the Site (i.e. where the 3 reaches join/confluence) and 57.98 at the southern end of the Site. The modelled flood level for the 1000-year flow (0.1% AEP) for the Site ranges between 57.28mOD at the northern downstream end, 57.66 mOD in the central area of the Site and 58.0mOD at the southern end of the Site. The 1,000-year level is approximately 0.17m higher than the 100-year level.

- Within the FRA a Justification Test has been completed for the proposed wind farm infrastructure within the mapped fluvial flood zones (*i.e*. T4, T5, T6, T7 and T8, and associated hardstand and Access Tracks). Flood resilience measures have been proposed which include the reinstatement of the turbine hardstand within the floodplain to reduce the area of less permeable surfaces within the flood zone, the reduced area operational hardstands and Access Tracks will be set at the 1 in 20-year flood level, the placement of sensitive electrical components and transformers well above flood levels. Refer to Section 10.6.1.3 for a full description of the flood resilience proposals.

A quantitative analysis, as presented in **Appendix 10.1,** has shown that the volume of the proposed infill within the flood zone equates to 7,025m^3 during the construction phase and 9,555m^3 during the operational phase. The volume of the infill is relatively small in comparison to the total volume of water stored within the modelled flooded areas. If you distribute the proposed infill volume over the flooded areas in each scenario, the potential for increases in water level within the modelled area ranges between ~4 and ~6mm. It should also be noted that this quantitative analysis is conservative and does not consider the floodplains upstream or downstream of the Site. The volumetric analysis has shown that the Project will therefore have an imperceptible effect on flood levels downstream of the Site and there will be no increase in the downstream flood risk.

10.3.8 Surface Water Quality

10.3.8.1 EPA Water Quality Monitoring

The Environmental Protection Agency (EPA) conducts an ongoing monitoring programme as part of Ireland's requirements under the WFD[4]. The monitoring programme includes an assessment of biotic indices (biological quality ratings ranging from Q1-5) known as Q-Values. The Q-Rating is a water quality rating system based on both the habitat and the

[4] EPA (2023) EPA River Quality Surveys: Biological, Hydrometric Area 27 [Accessed: 25/07/2024]

invertebrate community assessment and is divided into status categories ranging from Q1 (Bad) to 4-5 (High).

Biological Q-rating data for EPA monitoring points on the local watercourses downstream of the Site are shown in **Table 10.14** below. The most recent available Q-Ratings for local watercourses in the area of the Site date from 2023.

The River Loobagh achieved a rating of Q4 ('Good' status') at Garroose Bridge (Station ID: RS24L010600) upstream of the Site. Meanwhile, the Charleville Stream achieved a Q3-4 ('Moderate' status) rating upstream of its confluence with the River Maigue (Station ID: RS24C020800). Meanwhile, downstream of the Site, the River Maigue achieved Q3-4 ratings at Bruree (Station ID: RS24M010300) and further downstream at Howardstown Bridge (Station ID: RS24M010400).

A map of local EPA monitoring stations is attached as **Figure 10.5**.

Table 10.14: Latest EPA Water Quality Monitoring Q-Rating Values

Watercourse	Station ID	Easting	Northing	EPA Q-Rating
River Loobagh	RS24L010600	155024	127457	Q4 (Good)
Charleville Stream	RS24C020800	154236.84	127370.51	Q3-4 (Moderate)
River Maigue	RS24M010300	154959.14	130436.29	Q3-4 (Moderate)
River Maigue	RS24M010400	154073.65	132879.35	Q3-4 (Moderate)

10.3.8.2 HES Water Quality Monitoring

Field hydrochemistry measurements of unstable parameters including temperature(°C), DO (% and mg/l), pH (pH units) and turbidity (NTU) were taken at 5 no. surface water sampling locations (SW1-SW5) across 2 no. monitoring rounds. Note that no monitoring was completed at SW1 on 31st July 2024 as this hydrological feature (drain) was dry. The results are presented in **Table 10.15** below. The monitoring locations are shown in **Figure 10.5**. Temperature ranged from 7.8 to 9.2°C. Dissolve oxygen ranged from 79 to 94% saturation. pH was neutral to slightly basic and ranged from 7.3 to 8.2. Meanwhile, specific electrical conductivity ranged from 157 to 402µS/cm.

Table 10.15: HES Field Hydrochemistry Monitoring

Location	Temp (°C)	SPC (µS/cm)	DO (% Sat)	pH
SW1	8.4	215	82	7.5
SW2	7.9 – 9.1	237 – 258	79 – 84	7.3 – 7.5

Location	Temp (°C)	SPC (µS/cm)	DO (% Sat)	pH
SW3	7.8 – 8.7	241- 256	88 – 93	7.9 - 8.2
SW4	8.2 – 8.8	278 – 307	88 - 94	8.1 - 8.2
SW5	7.8 – 8.5	361 - 402	85 - 92	7.4 - 7.6

Surface water grab samples were also taken at these locations for laboratory analysis on 26th March and 31st July 2024. The results are shown alongside relevant water quality regulations in Table 10.16.

Table 10.16 below. Original laboratory reports are attached as **Appendix 10.2**.

Suspended solid concentrations ranged from <5 to 86mg/l. Suspended solid concentrations were below the S.I 293/1988 threshold limit of 25 mg/l in 5 of the 9 no. samples. 3 no. exceedances were recorded in the March monitoring round at SW3 (32mg/l), SW4(86mg/l) and SW5 (32mg/l). One exceedance was also recorded at SW4 in the July monitoring round. The high concentrations of suspended solids recorded on 26th March 2024 resulted from the intense rainfall which preceded this monitoring round. Meanwhile, the high exceedance at SW4 in July likely resulted from disturbance of the riverbed sediment during sampling.

Ammonia concentrations in the July sampling round were found to be of 'High' status with regards to the threshold of ≤0.04mg/l as detailed in S.I. 272/2009. Ammonia concentrations exceeded the Good status threshold of ≤0.065mg/l in 4 of the 5 no. samples obtained during the March monitoring round due to the heavy rainfall.

Similarly, BOD and orthophosphate concentrations were of 'High' status in the July monitoring round and exceeded the respective 'Good' status thresholds in the March sampling. The results of the monitoring are therefore strongly influenced by the preceding weather conditions, with the March sampling round being completed after several hours of heavy rainfall.

Nitrate concentrations were found to be below the level of detection of the laboratory in 6 of the 9 no. samples (<5.0mg/l NO_3), and chloride concentrations ranged from 6.4 to 79.6mg/l.

Table 10.16: Surface Water Quality Data (March – July 2024)

Location ID	Suspended Solids (mg/l)	BOD_5 (mg/l)	Ortho phosphate (mg/l)	Nitrate (mg/l NO_3)	Ammonia (mg/l)	Chloride (mg/l)
EQS	**≤25(5)**	**≤ 1.3 to ≤ 1.5(6)**	**-≤ 0.035 to ≤0.025(6)**	**-**	**-≤0.065 to ≤ 0.04(6)**	**-**
SW1	<5	3	0.04	<5	0.04	6.4
SW2	<7 - 16	<1 - 3	<0.02 - 0.06	<5 – 6.9	<0.02 - 0.07	17.2 – 18.3
SW3	<6 - 32	1 - 5	<0.02 - 0.12	<5	0.03 - 0.16	11 – 23.5
SW4	33 - 86	1 - 6	<0.02 - 0.12	<5 – 50.2	0.03 - 0.17	11.8 – 79.6
SW5	<6 - 32	1 - 4	<0.02 - 0.08	<5 – 7.8	0.03 - 0.11	11.0 – 54.5

10.3.9 Hydrogeology

The bedrock geology underlying the Site comprises various Dinantian Limestones lithologies. The north of the Site is underlain by Dinantian Lower Impure Limestones (undifferentiated Visean Limestones). An area towards the centre of the Site is underlain by Dinantian Pure Unbedded Limestones of the Waulsortian Limestone Formation. The south of the Site is underlain by Dinantian Upper Impure Limestones (undifferentiated Visean Limestones). A north-northeast to south-southwest trending fault is mapped within the Site, approximately 50m west of T1. A smaller east to west trending fault is mapped approximately 50m north of T6.

The undifferentiated Visean Limestones which underlie the north and south of the Site are classified by the GSI as a Locally Important Aquifer (LI) - Bedrock which is Moderately Productive only in Local Zones. Meanwhile, the Dinantian Pure Unbedded Limestones towards the centre of the Site are classified by the GSI as a Regionally Important Aquifer - Karstified (diffuse).

In terms of the Project infrastructure, T2, T3 and T4 are mapped to be underlain by the Regionally Important Aquifer. All other turbines and the 110kV substation, construction compound and Grid Connection are underlain by the Locally Important Aquifer.

A bedrock aquifer map is included as **Figure 10.6.**

[5] S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations

[6] S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy).

In terms of Groundwater Bodies (GWBs), the Site is underlain by 3 no. GWBs.

The northern section of the Site is underlain by the Hospital GWB which is characterised by poorly productive bedrock. According to the GSI's Initial Characterisation Report for this GWB (GSI, 2004), the GWB comprises low transmissivity and low storativity rocks. Most groundwater flow will occur in the upper weathered zone of the aquifer. Groundwater flowpaths will be relatively short (30-300m) and discharge will be to the numerous surface watercourses which cross the aquifer. Local groundwater flow directions will be controlled by topography with the overall flow direction being towards the major rivers. The GSI do note that along the southern part of the GWB there may be some cross-flow from this GWB to the adjacent karstic GWBs. In terms of the Project, 5 no. proposed turbines (T5, T6, T7, T8, T9) are underlain by the Hospital GWB.

The centre of the Site is underlain by the North Kilmallock GWB which is characterised by a karstic flow regime. According to the GSI's Initial Characterisation Report for this GWB (GSI, 2004), the limestones are highly transmissive and have low storativity. Recharge only occurs where subsoil thickness and permeability permit. Groundwater flow in this aquifer will be concentrated in an approximately 30m zone at the top of the bedrock. This zone is likely to comprise an epi-karstic layer of a few metres, below which is a network of diffuse solutionally-enlarged joints and small conduits, fractures and faults. Flow path lengths are generally 500-2000m. Shallow groundwater discharges to the streams and rivers crossing the GWB, and to seeps at the heads of streams. In terms of the Project, 3 no. turbines (T2, T3 and T4) are underlain by the North Kilmallock GWB.

The southern section of the Site is underlain by the Charleville GWB. The GSI's Initial Characterisation Report for this GWB states that this GWB is comprised of primarily of low transmissivity rocks, although localised zones of enhanced permeability do occur along faults. Recharge occurs diffusely through the subsoils and via outcrops, however subsoils are generally thick, and recharge is limited. Most flow in this aquifer will occur near the surface of the rock in a thin weathered zone. Groundwater flow is influenced by topography and most flow is of a local nature. Unconfined flow path lengths are relatively short, and in general are between 30 and 300m. The main discharges are to the streams and rivers crossing the aquifer. In terms of the Project, 1 no. turbine (T1), the 110kV Substation, construction compound and Grid Connection are underlain by the Charleville GWB.

10.3.10 Site Hydrogeological Data

Trial pits were excavated at the Site by Whiteford Geoservices in September 2022 and September 2024. The quantity of site investigations (10 no. trial pits and geophysical surveys) is considered to be sufficient given the scale of the Site and the predictability of the soils/subsoils encountered which correlate with the GSI mapped soils and subsoils, details of the site investigation works are detailed **Section 9.2.6.1** of **Chapter 9 Soils and Geology**. The findings of the site investigations are summarised as follows:

- The trial pits extended to a maximum depth of 3.6mbgl (metres below ground level).
- The Site is overlain by a dark brown, organic, sandy, silty TOPSOIL to depths of between 0.15 to 0.45mbgl.
- The TOPSOIL is underlain by glacial till deposits comprised of slightly gravelly SILT and occasionally slightly gravelly SILTY/CLAY with typically low cobble content.
- Granular deposits were encountered at the base of 2 no. trial pits (TP-C and TP-E) at depths of 3.4 and 2.7mbgl.
- A groundwater strike was only encountered in 1 no. trial pit, within the granular deposits at the base of TP-C. The inflow encountered at 3mbgl is described as being weak.
- No significant ingress of groundwater was recorded.
- No peat was recorded during site investigations and all organic soils encountered were classified as Topsoil (refer to Section 9.3.7.1).
- The geophysical surveys identified the presence of intact limestone at 4m to 5m at the Met Mast and T5, and 6m to 8m at turbine T1. Formations typical of highly decomposed limestone were also recorded at turbines T2 and T3 (6m to 8m below ground level) and at turbines T3, T4, T6, T7, T8 and T9 (4m to 6m below ground level).

Based on site investigations and walkover surveys, there is considered to be a low degree of connectivity between surface and groundwaters in the area of the Site. High rates of surface water runoff occur due to the presence of low permeability glacial till deposits with a high clay content. Evidence for this can be seen in the high density of surface water drainage features within the Site.

Localised groundwater seepages can be expected from excavations within the subsoil. The potential effects of excavation dewatering are assessed in Section 10.5.2.2.

10.3.11 Groundwater Vulnerability

The GSI describes Groundwater Vulnerability is a term used to represent the natural ground characteristics that determine the ease with which groundwater may be contaminated by human activities. Groundwater vulnerability embodies the characteristics of the intrinsic geological and hydrogeological features at a site that determine the ease of groundwater contamination. Groundwater vulnerability is related to recharge acceptance, whereby in areas where recharge occurs more readily, a higher quantity of contaminants will have access to groundwater. Groundwater vulnerability is mapped by the GSI (www.gsi.ie).

The mapped groundwater vulnerability rating of the bedrock aquifer underlying the Site is predominantly "Low". All proposed turbine location and the Substation are mapped in areas of "Low" vulnerability. Some areas of "Moderate" and High" groundwater vulnerability are mapped in the southeast of the Site and overlap with the Grid Connection and Site Entrance 2.

Direct site investigations at the Site comprising of trial pits did not encounter any bedrock, although geophysical surveys did record weathered and competent bedrock (Refer to Chapter 9). Across the Site the subsoils comprise of glacial tills of low permeability. Furthermore, due to the low permeability nature of the underlying bedrock aquifers, groundwater flowpaths are likely to be short (30 – 300m), with recharge emerging close by and discharging into local surface water streams. This means there is a low potential for groundwater dispersion and movement within the bedrock aquifer, therefore surface water bodies such as drains and streams/rivers are more vulnerable (to contamination from human activities) than groundwater across much of the Site.

Table 10.17: Groundwater Vulnerability and Subsoil Permeability and Thickness (Groundwater Protection Schemes Report 1999)

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

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

10.3.12 Karst Features

Karst features are mapped by the GSI and available through the GSI online viewer (www.gsi.ie).

There are no mapped karst features within the vicinity of the Site. The closest mapped karst feature is a spring, referred to by the GSI as Broghill Pond. This feature is mapped approximately 2.45km southwest of T1. Several other springs are mapped near Charleville Town and further to the west.

No karst features were recorded during the site walkover surveys or the intrusive site investigations. Shallow rock was not encountered during the site investigation Trial Hole campaign (refer to Section 9.3.15), however, the geophysical surveys (Appendix 9.2 and Appendix 9.3) did identify the presence of intact limestone at 4m to 5m at the Met Mast and T5, and 6m to 8m at turbine T1. Formations typical of highly decomposed limestone were also recorded at turbines T2 and T3 (6m to 8m below ground level) and at turbines T3, T4, T6, T7, T8 and T9 (4m to 6m below ground level).

A map of local karst features is included as **Figure 10.7**.

10.3.13 Groundwater Hydrochemistry

No groundwater quality data is available for the Site. Groundwater sampling is not generally undertaken for this type of development in terms of EIAR reporting, as groundwater quality impacts are not anticipated due to the scale and shallow nature of the proposed works. Groundwater sampling for baseline characterisation is typically only undertaken for wind farm developments if the local hydrogeological regime is deemed to be particularly sensitive/vulnerable to pollution such as in a karstic environment. However, despite some areas of the Site being mapped to be underlain by a karst aquifer, the site-specific data does not indicate that groundwater will be particularly vulnerable. As stated previously the local hydrogeological regime at the Site is characterised by high rates of groundwater recharge, the Site is overlain by low permeability glacial till subsoils and no karst features were encountered during walkover surveys or during the intrusive site investigations. Therefore, surface waters are considered to be the main sensitive receptor at this Site.

Nevertheless, the GSI's Initial Characterisation Reports for the underlying GWBs were consulted for hydrochemical information.

For the Hospital GWB, the characterisation report states that groundwaters sampled in the impure limestones are hard to very hard (310- 425 mg/l as $CaCO_3$), with corresponding high alkalinities (295-355 mg/l as $CaCO_3$) and electrical conductivities (680-860 μS/cm). The pHs are neutral. Groundwaters have a calcium–bicarbonate signature. In the Lower Impure Limestones, iron and manganese concentrations frequently fluctuate between zero and more than the EU Drinking Water Directive maximum admissible concentrations (MACs). Hydrogen sulphide can often reach unacceptable levels. These components come from the muddy parts of these rock units and reflect both the characteristics of the rock-forming materials and the relatively slow speed of groundwater movement through the fractures in the rock allowing low dissolved oxygen conditions to develop.

For the North Kilmallock GWB, the characterisation report states thar no EPA or GSI hydrochemical data are available for this GWB. The hydrochemistry of the Waulsortian limestone aquifer in the Fedamore GWB (north of this GWB) shows a very hard (370–430mg/l as $CaCO_3$), calcium-bicarbonate type water with high alkalinities (330–380mg/l as $CaCO_3$) and electrical conductivities, and neutral pHs.

Meanwhile, in relation to the Charleville GWB, the characterisation report states that the lower and upper impure limestone aquifers that form the bulk of the GWB have a calcium-bicarbonate signature, are hard (280-360mg/l $CaCO_3$) and alkaline (240-290mg/l $CaCO_3$), with high conductivities (630-660μS/cm). Both iron and manganese can exceed allowable concentrations, with these components coming from the shales. Hydrogen sulphide may be problematic. The bedrock strata of these aquifers are calcareous.

10.3.14 Groundwater Recharge

Groundwater recharge properties of the area can be derived from the groundwater recharge map provided by the GSI. The mapped groundwater recharge coefficient for the Site is predominantly 8% of the effective rainfall. Some small areas of the wind farm Site have slightly higher groundwater recharge coefficients of 22-60%, with these areas located in the southeast and southwest of the Site. No turbines are located in these areas. However, based on site investigations, the present of low permeability soils/subsoils and a high density of surface water drainage features, the GSI mapped groundwater recharge coefficient of 8% is considered to be representative of the entire Site.

Furthermore, the maximum recharge capacity of the Locally Important Aquifer will limit potential recharge to groundwaters by rejecting additional rainfall. The GSI state that the annual recharge capacity of the aquifer is approximately 33mm/year. Slightly higher recharge capacity area estimated for the Regionally Important Karst Aquifer ranging from approximately 100 to 400mm/yr.

Considering all of the above, the Site is characterised by low to very low groundwater recharge rates in overburden (soils/subsoils), very low recharge capacity in the Locally Important Bedrock Aquifer and given that the Regionally Important Karst Aquifer is overlain by low permeability subsoils. This implies that the vast majority of rainfall falling at the Site will enter the existing manmade surface water drainage channels and the local streams and rivers.

10.3.15 Groundwater Levels and Groundwater Flow Directions

Groundwater flow directions at the Site are presumed to follow local topography, and groundwater flow paths are considered to be short due to the low permeability of the Locally Important Aquifer which underlies much of the Site.

The GSI's Characterisation Report for the Hospital and Charleville GWBs states that groundwater flow paths in this aquifer are short/local (30-300 m), with groundwater discharging locally to the streams, rivers and springs. Overall, the general groundwater flow directions are towards the River Maigue.

Note that the GSI's Characterisation Report for the North Kilmallock GWB states that Groundwater flow paths in regionally important aquifers are generally long (several km's). However, groundwater can also discharge locally to surface water features or springs if the topography is variable, or low permeability subsoil induces discharge of the groundwater where it begins to become confined. In discharge zones, flow paths will be much shorter, at around 100–300m poorly productive underlying bedrock aquifer.

10.3.16 Water Framework Directive

The Water Action Plan 2024: A River Basin Management Plan for Ireland outlines the new approach that Ireland will take as it works to protect and restore its rivers, lakes, estuaries and coastal waters over the 3rd cycle of the EU Water Framework Directive (WFD). The Water Action plan was published in September 2024 and builds on the lessons learned from the previous river basin management plans.

The following evidence-based priorities have been adopted for the 3rd river basin planning cycle:

- Ensure full compliance with relevant EU legislation.
- Prevent deterioration.
- Meet the water standards and objectives for designated protected areas.
- Protect high-status waters.
- Implement targeted actions and pilot schemes in focus sub-catchments aimed at (i) targeting water bodies close to meeting their objective and (ii) addressing more complex issues that will build knowledge for future cycles.

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

10.3.16.1 Groundwater Body Status

Local GWB status information is available from (www.catchments.ie).
All GWBs underlying the Site achieved "Good" status in the latest WFD cycle (2016-2021) (**Table 10.18**). This status is based on the quantitative status and chemical status of each GWB. The Hospital GWB has been deemed to be "not at risk" of failing to meet its respective WFD objectives. Meanwhile, both the North Kilmallock and Charleville GWB's have been deemed to be "at risk" of failing to meet their WFD objectives. Agricultural has been listed as a significant pressure on both of these GWBs.

Table 10.18: WFD Groundwater Body Status

GWB	Overall Status 2010-2015	Overall Status 2013-2018	Overall Status 2016-2021	3rd Cycle Risk Status	WFD Pressures
Hospital	Good	Good	Good	Not at Risk	None
North Kilmallock	Good	Good	Good	At Risk	Agriculture
Charleville	Good	Good	Good	At Risk	Agriculture

10.3.16.2 Surface Waterbody Status

A summary of the WFD status and risk result for Surface Water Bodies (SWBs) in the vicinity and downstream of the Site are shown in **Table 10.19**.

The Charleville_020 and Maigue_030 SWBs in the vicinity of the Site achieved "Moderate" status in the latest WFD cycle (2016-2021). This represented an improvement in status for the Charleville_020 SWB, while the status of the Maigue_030 SWB has remained unchanged in all 3 no. WFD cycles. Further downstream the status of the River Maigue generally ranges from "Moderate" to "Poor" whilst the Maigue_050 SWB is of "Good" status. In terms of risk status, the Charleville_020 and Maigue_030 SWBs in the vicinity of the Site are deemed to be "at risk" of failing to meet their WFD objectives. Further downstream the vast majority of the SWBs along the River Maigue are also deemed to be "at risk". Meanwhile, the Maigue_050 is "not at risk".

Agriculture is listed as a significant pressure on the Charleville_020 and Maigue_030 SWBs in the vicinity of the Site. Urban wastewater is also listed as a significant pressure on the Charleville Stream_020 SWB.

A WFD Compliance Assessment is included as **Appendix 10.3**.

Table 10.19: WFD Surface Waterbody Status

SWB	Overall Status (2010-2015)	Overall Status (2013-2018)	Overall Status (2016-2021)	Risk Status (3rd Cycle)	Pressures
Charleville Stream_020	Poor	Poor	Moderate	At risk	Agriculture, Urban Wastewater
Maigue_030	Moderate	Moderate	Moderate	At risk	Agriculture
Maigue_040	Moderate	Moderate	Moderate	At risk	Agriculture
Maigue_050	Good	Moderate	Good	No at risk	None
Maigue_060	Unassigned	Moderate	Moderate	At risk	Agriculture, Hydromorphology
Maigue_070	Good	Moderate	Moderate	At risk	Agriculture
Maigue_080	Moderate	Poor	Poor	At risk	Agriculture, Anthropogenic and Hydromorphology
Maigue_090	Unassigned	Moderate	Poor	Under Review	None
Maigue Estuary	Moderate	Moderate	Moderate	At risk	Agriculture

10.3.17 Designated Sites & Habitats

10.3.17.1 Nature Conservation Designations

Within the Republic of Ireland designated sites include Natural Heritage Areas (NHAs), Proposed Natural Heritage Areas (pNHAs), Special Areas of Conservation (SACs), candidate Special Areas of Conservation (cSAC) and Special Protection Areas (SPAs).

The Project is not mapped within or in the immediate vicinity of any designated areas.

The nearest designated site is the Blackwater River (Cork/Waterford) SAC (Site code: 002170) situated approximately 6.4km south of the Site. This SAC is mapped within a different surface water catchment to the Project and there is no hydrological linkage between the Site and this SAC.

There are downstream hydrological connections with some Natura 2000 sites within the Shannon Estuary South surface water catchment. Designated sites that lie downstream of the Site include:

- Lower River Shannon SAC (Site Code: 002165) is located approximately 20km to the north-northwest (straight line distance) and downstream of the Site along the River Maigue. The SAC includes the River Maigue estuary. The length of the hydrological flowpath between the Site and this SAC is approximately 25km.
- The River Shannon and River Fergus Estuaries SPA (Site Code:004077) is located approximately 25km to the northwest (straight line distance) and downstream of the Site along the River Maigue Estuary. The length of the hydrological flowpath between the Site and this SPA is approximately 34.5km.
- The Inner Shannon Estuary - South Shore pNHA (Site Code: 000435) is located approximately 26.5km to the northwest (straight line distance) and downstream of the Site. The length of the hydrological flowpath between the Site and this pNHA is approximately 37km; and,
- The Fergus Estuary and Inner Shannon, North Shore pNHA (Site Code: 002048) is located approximately 30km to the northwest (straight line distance) and downstream of the Site.
- Ballyhoura Mountains SAC (site code: 002036) is located ~9km southeast of the SAC (closest straight-line distance). There are no ecological or hydrological linkages between the Wind Farm Site and the SAC.
- Kilcolman Bog SPA (site code: 004095) is located approximately 14.1km south-southwest of the SPA (closest straight-line distance). There is no ecological or hydrological linkages between the Wind Farm Site and the SAC.

Other designated sites are mapped within the River Maigue catchment and downgradient of the Site include Tory Hill SAC/pNHA (Site code: 000439), Glen Bog SAC (site code: 001430), and Adare Woodlands pNHA (Site Code: 000429). However, these designated sites are located approximately 14km, 14.7km and 17km from the Site and are not hydrologically connected to the Site. All water draining the Site will be in the River Maigue and there will be no potential for effects on the designated sites which are not mapped along the course of the River Maigue.

A map of designated sites is included as **Figure 10.8**.

10.3.17.2 Nutrient Sensitive Areas

Nutrient Sensitive Areas (NSA) comprise Nitrate Vulnerable Zones and polluted waters designated under the Nitrates Directive (91/676/EEC) and areas designated as sensitive areas under the Urban Wastewater Treatment Directive (UWWTD)(91/271/EEC). Sensitive areas under the UWWTD are water bodies affected by eutrophication associated with elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients.

There are no NSAs in the vicinity or downstream of the Site.

10.3.17.3 Bathing Waters

Bathing waters are those designated under the Bathing Water Directive (76/160/EEC) or the later revised Bathing Water Directive (2006/7/EC).

There are no designated bathing waters in the vicinity or downstream of the Site.

10.3.17.4 Shellfish Areas

The Shellfish Waters Directive (2006/113/EC) aims to protect or improve shellfish waters in order to support shellfish life and growth.

There are no designated shellfish areas located in the vicinity of the Site.

The closest designated shellfish area is the West Shannon Ballylongford (IEPA2_0061) shellfish protected area. However, this shellfish protected area is approximately 57km to the northwest (straight line distance) and is located within the Lower Shannon Estuary.

10.3.17.5 Salmonid Waters

The River Maigue or the Charleville Stream are not designated in the Salmonid Regulations (S.I. 293/1988).

10.3.17.6 Freshwater Pearl Mussel

No areas downstream of the Site are listed as being Margaritifera sensitive areas.

10.3.17.7 Geological Heritage Areas

The Knocksouna County Geological Site (CGS) (Site Code: LK022) is located 1.5km to the east of T7. There is a hydrogeological element associated with this CGS with the site described as a series of warm water springs and a high, bedrock crag. The springs at Knocksouna occur along a roughly east-west line at the foot of Knocksouna Hill, where twelve individual springs emerge through the alluvial floodplain of the River Loobagh over a distance of about 700m. The CGS is among a group of warm springs located in Munster that share a location on the eastern margin of the Mississippian (Namurian) basin where normal limestone groundwater undergoes deep circulation and returns to the surface via fault or fracture zones.

This CGS is located on the northern banks of the River Loobagh, with this watercourse, and the EPA mapped Loobagh Stream, acting as hydrological barriers between the Site and the CGS. In terms of the potential hydrogeological connectivity between the Site and the CGS, some sections of the Site and the CGS are underlain by the North Kilmallock GWB. However, the potential for hydrogeological connectivity is limited by the presence of glacial till deposits of low permeability at the Site which restrict groundwater recharge. Note that GSI's Initial Characterisation Report for the North Kilmallock GWB states that recharge will only occur where subsoil thickness and permeability permit. Such conditions are not present at the Site with the local hydrogeological regime being dominated by high rates of surface water runoff. Furthermore, the CGS is located upgradient of the Site and a significant distance from the nearest proposed turbine (T7). Therefore, there is no hydrogeological connectivity between the Site and the Knocksouna CGS.

10.3.18 Water Resources – Drinking Water Protected Areas

10.3.18.1 Surface Water

According to the 3rd Cycle Shannon Estuary South Catchment Report (EPA, 2024) there are 5 no. SWBs in the catchment identified as Drinking Water Protected Areas (DWPAs).

The nearest DWPA to the Site is the Loobagh_020 DWPA (IEPA1_SH_24L010400). This DWPA is approximately 6.5km east and upstream of the Site. Therefore, there is no potential for the Project to impact this surface water abstraction.

The closest downstream DWPA is the Maigue_080 DWPA (IEPA1_SH_24M010900) which is situated approximately 13.5km northwest (straight line distance) of the Site. This DWPA is downstream of the Site via the River Maigue. This abstraction is for Uisce Éireann's Adare Water Supply (Licence Code: 1900PUB1002). The maximum daily abstraction is estimated to be 1,927m^3/day. The length of the hydrological flowpath between the Site and this DWPA is approximately 16.7km.

10.3.18.2 Groundwater

The GSI do not map the presence of any National Federation registered Group Water Schemes (GWS) or Public Water Schemes (PWS) or an associated Source Protection Area within the Site or in the surrounding lands (www.gsi.ie).

The closest mapped PWS is the Bruree PWS. The source protection area associated with the Bruree PWS is located approximately 2.7km north of the closest turbine (T9). The source protection report states that the source for the main supply is located on the northern bank of the River Maigue. The aquifer feeding the Bruree supply is considered to be sandstones but recharge from the river is likely to be induced during pumping. Hydrochemical results from analysis and testing have also indicated mixing of groundwater and water from the river.

Meanwhile, the source protection area associated with the Rockhill PWS is approximately 3km northwest of the closest proposed turbine (T9). The source protection report states that the source is from a regionally important aquifer. The GSI map this PWS to be located on a Regionally Important Aquifer – fissured bedrock and the Lower Limestone Shale Formation.

The source protection area associated with the Ballyagran PWS is located approximately 6km west of the closest turbine (T8). The GSI also map this PWS to be located on a Regionally Important Aquifer – fissured bedrock and the Lower Limestone Shale Formation. An information request was submitted to Uisce Éireann for the location of all Uisce Éireann groundwater abstraction locations within 5km of the Site was submitted. The only abstraction points identified by Uisce Éireann were the borehole associated with the Bruree

PWS and the Rockhill PWS. No additional abstractions were identified within 5km of the Site.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). There are no wells with such an accuracy mapped within the vicinity of the Site. A well (GSI Name: 1411NWW033) with a locational accuracy of 1km overlaps with the southeast of the Site. This well is located in the townland of Ballynagoul and its use is listed as unknown on the GSI well database.

A map of local groundwater resources is included as **Figure 10.9**.

We accept that the GSI database does not include all potential water wells. As stated in **Section 10.3.2** there are 157 no. residential dwellings within a 2km radius of the proposed turbine locations. The closest inhabited dwelling not involved in the Project is located 702m from the nearest turbine (T8). The closest dwelling involved in the Project is located 529m from T3. Given the local hydrogeological regime, which is characterised by high rates of surface water runoff and low rates of groundwater recharge, a 2km radius was considered to be sufficient when identifying the potential sensitive receptors. This 2km study area is also consistent with IGI Guidance (IGI, 2013). The impact assessment presented below in **Section 10.5.2.8** assumes that all local dwellings contain a private groundwater well supply. In addition, all Water Framework Directive (WFD) GWBs 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 GWBs nationally, regardless of the productivity status of the underlying aquifer.

10.3.19 EPA Licenced Activities

An existing Industrial Emissions (IE) Licence exists immediately to the south of the Site. This licence (P0386-04) is held by Kerry Ingredients (Ireland) Ltd, the Dairy and Food Ingredients Division of the Kerry Group. Process effluent from an existing diary processing plant at Charleville is currently discharged via an underground pipeline for treatment at a Wastewater Treatment Plant in the townland of Rathgoggan North. This WwTP discharges treated effluent into the River Maigue. Treated effluent travels through an outfall pipeline which passes through the Site before it is discharged to the River Maigue just north of its confluence with the Loobagh River. Note that the WwTP formerly discharged to the Charleville Stream but now discharges to the River Maigue due to the increased assimilative capacity of this watercourse. The discharge is subject to the conditions and Emission Limit

Values (ELVs) specified in the IE Licence (P0386-04). The ELVs in relation to emissions to water are detailed in Schedule B of the IE Licence which states that:

- The maximum volume permitted is 5,000m^3/day or 250m^3/hr.
- ELCs are set out in relation to BOD (20mg/l), COD (75mg/l), suspended solids (35mg/l), Total Nitrogen (15mg/l), Ammonia as N (3mg/l), Orthophosphate as P (0.5mg/l), Total Phosphorus (2mg/l) and oils, fats and grease (10mg/l).

According to the 2024 Annual Environment Report (2024), shows that the treated effluent being released into the hydrological environment was 100% compliant with the ELVs.

10.3.20 Receptor Sensitivity

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

10.3.20.1 Groundwater / Aquifers

Due to the nature of wind farm developments (and associated grid connections and TDR works) being near surface construction activities, effects on groundwater are generally negligible and surface water is the main sensitive receptor assessed during impact assessments.

However, general construction works have the potential to contaminate groundwaters with hydrocarbons and cement-based products being used at the Site. The following sensitive groundwater receptors are identified for impact assessment:

- The underlying Locally Important Aquifers and Regionally Important Aquifers. The Locally Important Bedrock Aquifers are considered to be of Medium Importance whilst the Regionally Important Bedrock Aquifer which underlies the centre of the Site is considered to be of Very High Importance (**Table 10.2**).
- All local private groundwater abstractions in the vicinity of the Site. These private potable water sources are considered as being of Low Importance (**Table 10.3**).
- The Bruree PWS located downgradient of the Site.
- The WFD status of the underlying GWBs (Hospital, North Kilmallock, and Charleville GWBs).

Note that the Ballyagran and Rockhill PWSs have been screened out of the impact assessment. Groundwater in the vicinity of the Site will follow surface topography and will discharge into local surface water features. There is no hydrological and hydrogeological connection between the Site and these PWSs. The Bruree PWS is included in the impact assessment as it likely sources some of its supply from the River Maigue.

10.3.20.2 Surface Waters

Surface waters are the main sensitive receptors associated with the Project due to the local hydrological regime which is characterised by high surface water runoff rates and low rates of groundwater recharge. The primary potential contamination of downstream surface waters is via elevated concentrations of suspended solids and nutrient enrichment.

All watercourses draining the Site are particularly vulnerable due to the nature of the proposed works in the catchments of these waterbodies. The watercourses which drain the Site include the Charleville stream and the Maigue and their tributaries.

Further downstream the estuarine and coastal waters of Maigue Estuary, the Upper Shannon Estuary, Lower Shannon Estuary, the Mouth of the Shannon (HAs 23;27) and the Southwestern Atlantic Seaboard (HA 23) are less susceptible to potential effects, even in an unmitigated scenario, due to the saline nature of these waters and the large volumes of waters within these waterbodies.

The following surface water receptors are carried through to the impact assessment:

- The local surface waters within and downstream of the Site including the Charleville Stream and the River Maigue, their associated tributaries and other small streams which drain the Site. The Charleville Stream and the River Maigue in the vicinity of the Site can be considered as being of High Importance due to their Q3-4 ratings (**Table 10.2**). Further downstream (approximately 20km straight line distance), the River Maigue forms part of the Lower River Shannon SAC and the waters here can be considered as being of Extremely High Importance due to this designation.
- The WFD status of all SWBs in the vicinity and downstream of the Site.
- The Bruree PWS downstream of the Site includes some input from the River Maigue and will therefore need to be included in the assessment.

10.3.20.3 Designated Sites

In terms of designated sites, the only designated sites with the potential to be affected by the Project will occur downstream of the Site along the River Maigue. Where designated these waters can be considered as being of Extremely High Importance. However, the River

Maigue only becomes designated near Adare, where the river becomes tidal. Estuarine waters can be considered to be less susceptible to potential effects that freshwaters due to the saline nature of these waters and the large volume of water.

For the purposes of a conservative assessment, the Lower Shannon SAC will be included in the impact assessment.

All other downstream designated sites have been screened out due to their distant location from the Site.

The Knocksouna CGS has been screened out of the impact assessment due to the distance between the Site and the CGS, the location of the CGS upgradient of the Site, the presence of hydrological barriers between the Site and the CGS and due to the presence of glacial till deposits of low permeability which restrict groundwater recharge at the Site.

10.4 HYDROLOGICAL AND HYDROGEOLOGICAL CHARATERISTICS OF THE PROJECT

10.4.1 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against impacts on surface watercourses. Two distinct methods will be employed to manage drainage water within the Site. The first method involves 'keeping clean water clean' by avoiding disturbance to existing drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the site that might carry silt or sediment, and nutrients, to route them towards new proposed silt traps and settlement ponds (or stilling ponds) prior to controlled diffuse release into the existing drainage network.

During the construction phase, all runoff from works areas (i.e. dirty water) will be slowed down and treated to a high quality prior to being released. A schematic of the proposed site drainage management is shown as **Plate 10.3** below.

The design of the proposed drainage network will facilitate:

- The collection of surface water runoff from upgradient of the Project footprint (clean runoff interceptor drains) and the buffered redistribution of clean runoff downgradient of the Project footprint by means of culverts and buffered outfalls to vegetated areas with a view to maintaining or improving the hydrological regime at the Site.

- The collection of surface water runoff from the footprint of the Project i.e., the construction areas (construction runoff interceptor drains) and management of potentially contaminated runoff in the constructed treatment train. Where possible the buffered outfalls from the treatment train / stilling ponds will be redistributed with a view to maintaining or improving the hydrological regime at the Site.
- Where extensive drainage networks exist, collected / diverted runoff will likely be diverted back into the existing network. In such instances it is important to include the existing drainage network in designing and specifying the treatment train and attenuation features, including improving, modifying, and constructing attenuation features in drainage channels. Similar to considerations for newly constructed drainage channels, the modification and/or improvements of existing drainage will be designed with a view to maintaining or improving the hydrological regime at the Site.
- Mitigation measures to address surface water runoff and drainage include in line attenuation features such as check dams and stilling ponds and buffered outfalls. Both check dams and stilling ponds provide mitigation against potential effects to water quality, erosion, and discharge velocity, however they also facilitate buffered and diffuse percolation of surface water runoff into the receiving environment along the permitter of the Project footprint. Attenuation features have been designed to take into consideration for a 1 in 100-year rainfall event, including an additional 20% to account for climate change.
- Check dams will be constructed along the length of constructed drainage at regular intervals in line with relevant guidance. Check dams will be permanent (for the life of the project / drainage network), made of suitable locally sourced coarse aggregate (similar geology), and are intended to attenuate (impede) surface water runoff in the drainage channel, therefore slowing the velocity of the runoff in turn reducing the potential for erosion in the channel and allowing suspended solids to settle out if present. At low velocity, the runoff has increased opportunity to percolate through the coarse aggregate and into the surrounding area, effectively contributing to bog water levels at that location.
- Stilling ponds with buffered outfalls will be constructed at drainage outfalls associated with the construction runoff drainage network. Buffered outfalls will be established at intervals along the clean runoff drainage network. Multiple outfalls along the drainage routes facilitates the strategic management of runoff with a view to maintaining the baseline hydrological regime in so far as possible. Similar to check dams; stilling ponds will be permanent (for the life of the projects / drainage network), made of suitable coarse aggregate, and are intended to attenuate surface water runoff in the drainage channel, slowing the velocity of the runoff before discharging to vegetated areas (buffered outfall).

Slowing the water velocity allows suspended solids (fine particles of silt and clay) to settle out if present. At low velocity the runoff has increased opportunity to percolate through the coarse aggregate and into the surrounding area. Through both forms of discharge (buffered outfall and percolation through aggregate) the stilling ponds will contribute to bog water levels at their locations. Stilling ponds are designed to provide attenuation to greenfield run-off rates.

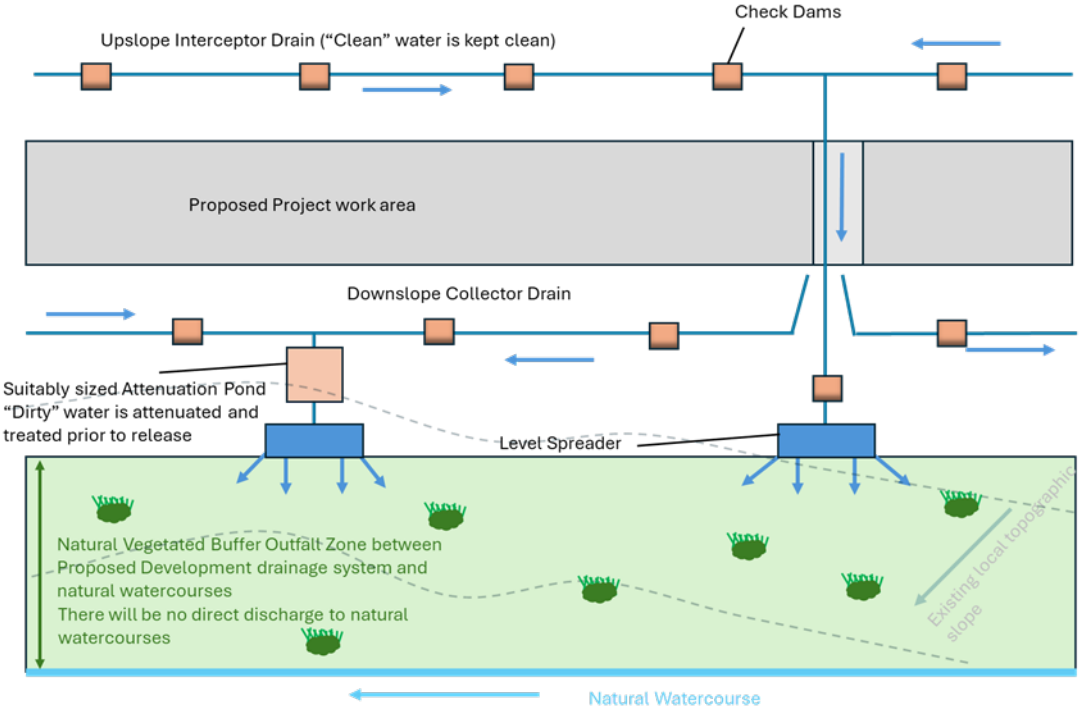

Plate 10.3: Schematic of Proposed Site Drainage Management

10.4.2 Development Interaction with the Existing Drainage Network

In relation to hydrological constraints, a self-imposed buffer zone of 50m has been put in place for on-site EPA mapped streams and rivers. Agricultural drains at the Site are not considered a major hydrological constraint and therefore a reduced 10m buffer was applied to these.

The best practice design approach to wind farm layouts in existing agricultural areas is to utilise and integrate with the existing infrastructure where possible, whether it be existing Access Tracks or the existing drainage network. Utilising the existing infrastructure means that there will be less requirement for new construction/excavations, which have the potential to impact on downstream watercourses in terms of suspended solid input in runoff (unless managed appropriately). The existing agricultural drains have no major ecological or hydrological value and can be readily integrated into the proposed wind farm drainage scheme and can be rerouted as required to facilitate the Project.

10.4.3 Watercourse Crossings

There are 2 no. watercourse crossings required on the proposed Access Tracks which cross watercourse locations. Water Crossing 1 (WC01) is located on the Maigue River on the Access Track northwest of T7 and Water Crossing 2 (WC02) is located on the Charleville (Stream) on the Access Track east of T3. These will be a clear span bridge type construction.

There are several additional crossings over manmade drains within the Site. These crossings will be required for the construction of the internal site access tracks to the proposed location of turbines from the Site entrances.

10.5 ASSESSMENT OF LIKELY SIGNFICANT EFFECTS

10.5.1 Do Nothing Scenario

If the Project were not to proceed, the opportunity to generate renewable energy and electrical supply to the national grid would be lost, as would the opportunity to further contribute to meeting Government and EU targets for the production and consumption of electricity from renewable sources and the reduction of greenhouse gas emissions and compliance with the Climate Change and Low Carbon Emissions Act 2015-21 would be impeded.

Should the Project not proceed, the existing agricultural land-use practices will continue at the Site.

The existing surface water drainage regime (agricultural drains) will continue to function and may be extended in some areas. The existing flooding regime that occurs at the Site will continue.

In the 'Do Nothing' scenario, there may be a slight change in average annual rainfall (AAR) at the Site as a result of climate change. This is discussed in **Section 10.3.3** above and any change in AAR will result in changes in local recharge and runoff volumes.

10.5.2 Construction Phase Potential Effects

This section identifies the likely significant effects of the construction phase of the Project. It should be noted that the main potential effects on the hydrological and hydrogeological environment will occur during the construction phase.

10.5.2.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including the construction of Site entrances, construction of the new Access Tracks, upgrades to existing Access Tracks, construction of turbine hardstand areas, turbine foundations, 110kV Substation compound, temporary construction compound, met mast, internal grid cabling, spoil storage areas, Grid Connection cabling and all associated landscaping and drainage works at the Site will require varying degrees of earthworks resulting in excavation of soils and subsoils.

It is currently estimated that the quantity of excavated material, when bulked up, due to site clearance and preparation of foundations, access tracks and substation will be approximately 25,635m^3 of topsoil and 20,770m^3 of subsoil. Therefore, there will be a total of 46,405m^3 of spoil to be managed on Site.

It is envisaged that spoil generated can be used as structural fill in Access Tracks, turbine hardstands, turbine foundation construction, reinstatement, roadside berms, hedgerow and tree planting and landscaping.

Where excess topsoil or subsoil material is generated which cannot be utilised for reinstatement or landscaping purposes, it is proposed to develop a permanent spoil storage area (berm) where excess soil and subsoil will be stored permanently. The permanent spoil area (berm) is 4,050m^2 and will be 2m in height with a storage capacity of 8,100m^3.

Other potential sources of sediment laden water include:

- Drainage and seepage water resulting from excavations.
- Stockpiled excavated material providing a point source of exposed sediment.
- Erosion of sediment from emplaced site drainage channels.
- Runoff from the proposed spoil storage areas.

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

Pathways: Drainage and surface water discharge routes.

Receptors: Downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, likely effect on the downstream surface water quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality.

10.5.2.2 Potential Effects from Excavation Dewatering and Potential Effects on Surface Water Quality

Some minor groundwater/surface water seepages will likely occur in turbine base excavations, substation compound excavations, sections of the internal cabling trenches, and this will create additional volumes of water to be treated by the runoff management system.

Surface water runoff and shallow groundwater inflows may require some management and treatment in order to reduce suspended sediments. No contaminated land was noted at the Site and therefore pollution issues (resulting from previously contaminated soil/subsoils) will not occur in this respect. The main potential significant effects are as a result of turbidity and suspended solids in downstream surface watercourses.

With respect to the Grid Connection, some minor groundwater/surface water seepages will also occur in shallow trench excavations, and this will create additional volumes of water to be treated by the drainage management system. Inflows will require management and treatment to reduce suspended solids. No contaminated land was noted along the Grid Connection therefore pollution issues are not anticipated in this respect.

Pathway: Overland flow and groundwater flow paths.

Receptor: Downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, unlikely effect on downstream surface water quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality.

10.5.2.3 Potential Effects from the Release of Hydrocarbons

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

Construction plant will be used at all elements of the Project, including site entrances works, Access Tracks works, upgrades to existing Access Tracks, turbine base/hardstanding construction, substation compound works, construction compound constructions, met mast construction and cable route excavations.

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Surface water quality in downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and groundwater quality in the underlying bedrock aquifers/GWBs (Hospital, North Kilmallock, and Charleville GWBs).

Pre-Mitigation Potential Effects:

Negative, slight, indirect, unlikely effect on local groundwater quality.

Negative, significant, indirect, short term, unlikely effect on downstream surface water quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality. There would be no potential significant effects on local groundwater quality due to the local hydrogeological regime which is characterised by high rates of surface water runoff and low rates of groundwater recharge due to the presence of low permeability glacial till deposits with a high clay content.

10.5.2.4 Potential Effects from the Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative effects on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of ≥ 6 ≤ 9 is set in S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations, with artificial variations not in excess of ± 0.5 of a pH unit. Entry of cement-based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to aquatic species and habitats.

Concrete will be used at all elements of the Project, including site entrances works, Access Tracks works, upgrades to existing Access Tracks, turbine base/hardstanding construction, substation compound works, construction compound constructions, met mast construction and cable route excavations. The largest volumes of concrete will be used at the turbine bases, and at the substation compound.

Pathway: Site drainage network.

Receptors: Downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and underlying bedrock aquifers/GWBs.

Pre-Mitigation Potential Effects:

Negative, moderate, indirect, short term, unlikely effect on downstream surface water quality.

Negative, imperceptible, indirect, short-term, unlikely effect on local groundwater quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality. There would be no potential significant effect on local groundwater quality due to the local hydrogeological regime which is characterised by high rates of surface water runoff and low rates of groundwater recharge due to the presence of low permeability glacial till deposits with a high clay content.

10.5.2.5 Potential Effects from Wastewater Disposal

Release of effluent from on-site temporary wastewater treatment systems has the potential to effect groundwater and surface water quality if site conditions are not suitable for an on-site percolation unit.

During the construction phase welfare facilities will be located at the temporary construction compounds. There will be no requirement for the storage of wastewater along the Grid Connection between the Substation and the loop in connection to the existing overhead line.

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Down-gradient well supplies, groundwater quality and downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site).

Pre-mitigation Potential Effects:

Negative, significant, indirect, short-term, unlikely effect on downstream surface water quality.

Negative, slight, indirect, short-term, unlikely effect on local groundwater quality and down-gradient groundwater wells.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality. There would be no potential significant effects on local groundwater quality due to the local hydrogeological regime which is characterised by high rates of surface water runoff and low rates of groundwater recharge due to the presence of low permeability glacial till deposits with a high clay content.

10.5.2.6 Potential Effects from Morphological Changes to Surface Watercourses

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

Within the Site, there are a total of 2 no. new proposed crossings over mapped natural watercourses. A new crossing is proposed over the Charleville Stream between T3 and T4 and a crossing is proposed over the River Maigue between T7 and T8.

In addition, there is a high density of manmade agricultural drains within some areas of the Site. However, these are not considered to be a significant constraint and can be rerouted around the proposed infrastructure and/or integrated into the proposed drainage design.

The Grid Connection does not cross any EPA mapped watercourses between the Substation and the loop-in connection to the existing overhead line.

Pathways: Local drainage network.

Receptors: Surface water flows, stream morphology and water quality in the Charleville Stream and the River Maigue.

Pre-Mitigation Potential Effect: Negative, significant, direct, long-term, likely effect on the local drainage network.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on the local drainage network.

10.5.2.7 Potential Effects on Groundwater Levels During Excavation Works

Small scale local temporary dewatering may occur at some excavation locations (i.e. turbine bases, cable trenches) and these have the potential to temporarily affect local groundwater levels. However, temporary reductions in groundwater levels by short duration and transient dewatering works will be very localised and of small magnitude due to the nature and permeability of the local subsoil encountered during the site investigations. Groundwater level effects will not be significant due the local hydrogeological regime of the Site (low permeability glacial till subsoils and short groundwater flowpaths to local watercourses). Any effects will be temporary and will be contained within the Site.

There are no GWS or PWS are mapped immediate vicinity of the Site. Furthermore, the GSI do not map the presence of any wells with a locational accuracy of <100m in the local area. A well with a locational accuracy of 1km is mapped to overlap with the southeast of the Site. Given the poor accuracy of this well, the conservative assessment in this chapter assumes that all local dwellings have a private groundwater supply well.

There are several dwellings in the lands surrounding the Site which may contain a local private groundwater well supply. Any potential water level effects will be temporary and are unlikely to be significant beyond 50m from any excavation. We note that there are no dwellings within 500m of any proposed turbine locations. The closest inhabited dwelling not involved in the Project is (H33) located 702m from the nearest turbine (T8). The closest dwelling involved in the Project is H28 located 529m from T3.

No groundwater level impacts are predicted from the construction of the Grid Connection, Access Tracks, Substation compound, TDR works or met mast due to the shallow nature of the associated excavations (i.e. 0 - approximately 1.2m).

Pathway: Groundwater flow paths.

Receptor: Groundwater levels within the underlying GWBs and at local groundwater wells.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, temporary, unlikely effect on local groundwater levels within the Site. No impact outside of the Site.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no potential significant effect on local groundwater levels.

10.5.2.8 Potential Effects on Groundwater Quality in Local Private Groundwater Well Supplies

The most significant risk to groundwater wells will be due to groundwater contamination due to the accidental release of hydrocarbons and cement-based products as a result of construction activities within the Site.

We have completed an assessment of private wells within 2km of the Site, following the assumption that all dwellings are likely to have a private groundwater well. There are 166 sensitive receptors within 2km of the proposed turbines. This includes 3 no. commercial properties, 6 No. derelict houses and 157 No. residential receptors of which 5 no. are involved in the Project (refer to Figure 10.10). A number of private dwelling houses were identified along the local roads in the lands surrounding the Site. The dwellings are located along the N20 to the west of the Site and the L1537 to the east. Local topography in the area slopes towards the Charleville Stream and the River Maigue and the N20 and L1537 are located upgradient of all the proposed works areas. The closest inhabited dwelling not involved in the Project is located 702m from the nearest turbine (T8). The closest dwelling involved in the Project is located 529m from T3.

Furthermore, there are no dwellings within 500m of any proposed turbine locations. The closest dwelling to a proposed turbine is located approximately 529m from T3.

The closest dwellings to the proposed 110kV Substation compound is approximately 180m to the northeast. Several other dwellings are also mapped along the L1537. However, the 110kV Substation is located downgradient of these houses and any shallow groundwater flow will flow to the west towards the Charleville Stream. Therefore, there is no potential to impact on these local wells.

Therefore, given the significant distances which exist between local dwellings and proposed infrastructure locations, local topography and prevailing groundwater flow directions, there is no potential for effects on groundwater well supplies.

Due to the shallow nature of the proposed works (road upgrade and widening) along the Grid Connection (<1.2m) and Site entrances, no effects on private groundwater well supplies will occur.

Pathway: Groundwater flowpaths.

Receptor: Down-gradient groundwater supplies (groundwater wells).

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, long term, unlikely effect on down gradient water supplies.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on downgradient water supplies.

10.5.2.9 Potential Effects from the Use of Siltbuster

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

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

The benefits of using a Siltbuster system in emergency scenarios where all other water treatment systems have proven ineffective are considerable. An example of treatment capability of Siltbuster systems from northwest Mayo is provided in **Plate 10.4**. This is a duration curve of downstream water quality data post Siltbuster treatment. The system was setup so that any water not meeting discharge criteria was recycled back to the settlement ponds. The graph shows all data, and only 24 data points out of 1,194 records were above 20 mg/L (i.e. recycling, and repeat treatment occurred at these times to ensure compliance at the discharge location).

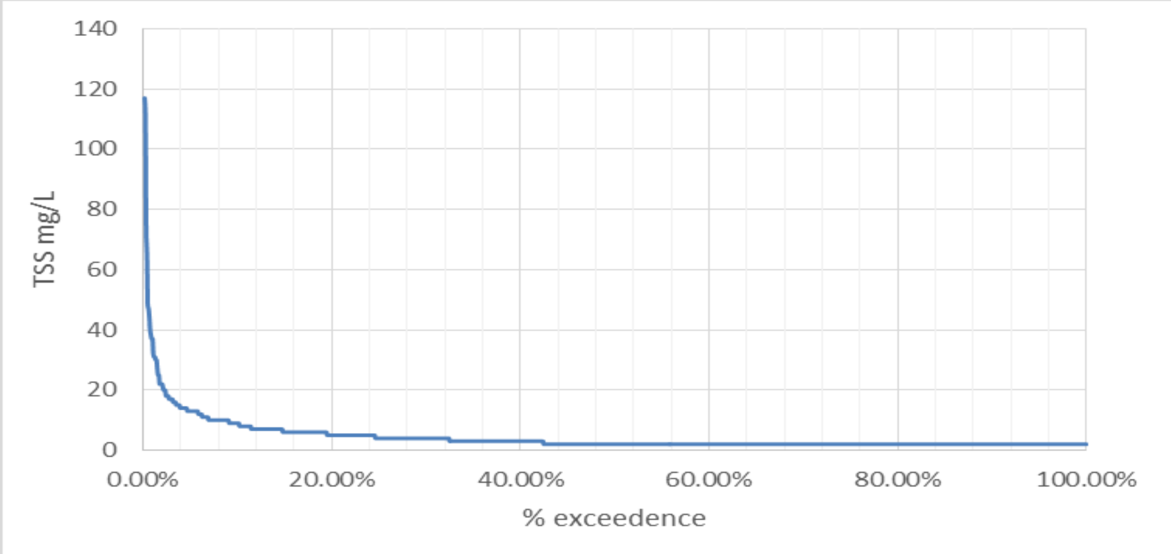

Plate 10.4: TSS treatment data using Siltbuster systems (with chemical dosing)

Pathways: Drainage and surface water discharge routes.

Receptors: Downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

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

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on downstream surface water quality.

10.5.2.10 Potential Effects Associated with Piled Foundations

Turbines T4, T5, T6, T7 and T7 will require piled foundations comprising of rotary bored piles into bedrock supporting the concrete base slab with a central upstand to support the tower. The turbines will use a buoyant foundation type using 16 no. 10m long piles bored at least 3m into intact the limestone bedrock.

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

- Creation of preferential pathways, through lower permeability subsurface layers (if an aquitard such as silts and clays, i.e. glacial till), to allow downward flow into the underlying bedrock aquifer;
- Creation of preferential pathways, through a low permeability subsurface layer (an aquitard such as silts and clays, i.e. glacial till), to allow upward migration of groundwater to the surface, thus potentially altering local hydrochemistry and therefore vegetation at the surface; and,

- Creation of a blockage to regional groundwater flow within the underlying aquifer due to placement of pile clusters.

These pathways are analogous to pathways described for piling works associated with contaminated land sites, as detailed in Environment Agency (2001). However, with respect to these pathways required for inclusion in the assessment, no upward or downward pathways were observed during the site investigations. Regional groundwater flow is the dominant groundwater flow pathway at this site and no upward or downward groundwater flowpaths exist as would occur in a bog setting.

Pathway: Groundwater flowpaths (upward and/or downward pathways, and regional groundwater flows).
Receptor: Groundwater quality in the underlying GWBs (Hospital, North Kilmallock, and Charleville GWBs) and groundwater hydrochemistry.
Pre-Mitigation Potential Effect: Negative, moderate, direct, short term, likely effect on groundwater quality/hydrochemistry.
Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no potential significant effect on water levels.

10.5.2.11 Potential Effects from Turbine Delivery Route Works

Minor earthworks are required along the turbine delivery route. This EIAR considers 2 no. potential TDRs from Foynes Port (Limerick) and from the Port of Galway to the Site. The enabling works along the TDRs are described in **Chapter 2: Project Description** and are generally minor and comprise of road verge widening, hedge trimming, passing bays and all associated works.

Pathway: Surface water flows.
Receptors: Downgradient surface water quality.
Pre-Mitigation Potential Effect: Negative, slight, indirect, temporary, likely effect on downstream surface water quality.
Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no potential significant effect on surface water quality.

10.5.2.12 Potential Effects on Surface Water Quality Due to Fluvial Flooding During Construction

Some areas of the Site, including the proposed location of T4, T5, T6, T7 and T8 and their associated hardstands and site Access Tracks are located in fluvial flood zones along the Charleville Stream and the River Maigue.

Should a flood event coincide with the construction phase of the Project when major excavations and earthworks are being undertaking within the floodplains, there is the potential for surface water quality effects.

However, during such a flood event, surface water quality in the general area would be significantly compromised due to natural river erosion due to the large flow volumes. During flooding, floodwaters are generally highly turbid with a large suspended solid concentration due to the sheer volume and flow of water.

The likelihood of a 1 in 100-year fluvial flood event happening during the 16-18 months construction programme is very low (there is only 1% chance of a flood event of this magnitude happening in any given year). Therefore, there is 1.5% chance of a 1 in 100-year fluvial flood event occurring during the construction programme.

Pathways: Drainage and surface water discharge routes.
Receptors: Surface water quality in watercourses and associated water dependent ecosystems downstream of the Site including the Charleville Stream and the River Maigue.
Pre-Mitigation Potential Effect: Negative, significant, indirect, short-term, likely effect on the downstream surface water quality.
Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on downstream surface water quality.

10.5.2.13 Potential Effects on Public Water Supplies

The Site is not located within any source protection area associated with a PWS or GWS.

<u>Bruree PWS</u>

The source protection zone associated with the Bruree PWS is mapped approximately 2.7km north of the closest turbine (T9). The Bruree PWS is included for the purposes of a conservative assessment. This PWS is predominantly sourced from a Regionally Important Aquifer – fissured bedrock and the borehole is located adjacent to the River Maigue. The length of the hydrological flowpath between the Site and the River Maigue adjacent to the supply well is approximately 3.3km.

The Source Protection Report for this PWS states that "*the aquifer feeding the Bruree public supply is considered to be sandstones however recharge from the river is likely to be induced during pumping.*" Furthermore, the report concludes that "*Overall the source at Bruree is a reasonable yielding well which is likely to be taking a significant proportion of its water from the river Maigue. The vulnerability of the source to contamination, although it is extreme, is less important than the river water quality.*"

Whilst, the Project would have no potential to effect water quality in the bedrock aquifers which feed the well, any deterioration in surface water quality at the Site could affect water quality in the River Maigue which could enter the well which supplies the Bruree PWS. However, at the distances involved the potential for effects is limited.

<u>Adare PWS</u>

The Adare PWS is a surface water abstraction located on the River Maigue (Maigue_080 DWPA). The length of the hydrological flowpath between the Site and the Maigue_080 DWPA is approximately 17km. Due to this distant location of the Site to this PWS, there is limited potential for effects.

Pathway: Surface water flowpaths.

Receptor: Water Quality in the Bruree PWS and the Adare PWS.

Pre-Mitigation Potential Effect:

Negative, slight, indirect, short-term, unlikely effect on the Bruree PWS.

Negative, imperceptible, indirect, short-term, unlikely effect on the Adare PWS.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no potential significant effects on the Bruree or Adare PWS.

10.5.2.14 Potential Effects on Hydrologically Connected Designated Sites

The Project is not located within any designated conservation site. However as stated above **Section 10.3.17**, several designated sites are downstream and hydrologically connected with the Site.

The Lower River Shannon SAC is assessed for the purposes of a conservative assessment as this is the closest downstream hydrologically connected designated site. All other downstream designated sites (River Fergus Estuaries SPA and Inner Shannon Estuary - South Shore pNHA) have been screened out of the impact assessment due to their distant location from the Site and the large volumes of saline waters within the waterbodies associated with these designated sites. Note that the Project does not in any way rely upon the dilution or assimilative capacity provided by any downstream watercourse. The mitigation measures prescribed in this EIAR ensure the protection of all watercourses in the immediate vicinity of the Site. By protecting watercourses proximal to the works locations, all downstream watercourses are also protected.

Even in an unmitigated scenario the potential for effects on the Lower River Shannon SAC are limited due to the following:

- The distance between the SAC and the Site.
- The length of the hydrological flowpath between the Site and the SAC is approximately 25km.
- The SAC is associated the River Maigue Estuary which contains saline waters which are less vulnerable to effects than freshwaters.
- The significant volumes of water within the estuary limit the potential for effects.

Pathway: Surface water flowpaths.
Receptor: Lower River Shannon SAC.
Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, short term, unlikely effect on the Lower River Shannon SAC.
Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on the Lower River Shannon SAC.

10.5.2.15 Potential Effects on WFD Status

The WFD (Water Framework Directive) status for GWBs and SWBs are defined within **Section 10.3.16**. The GWBs underlying the Site are all assigned "Good" Status. The SWBs in the vicinity of the Site have an assigned status ranging from "Moderate" to "Good".
Changes in surface water or groundwater flow regimes and water quality has the potential to impact on the objectives and status of the associated GWBs and SWBs.

A detailed WFD Compliance Assessment Report is included as **Appendix 10.3**. The conclusions of the WFD Compliance Assessment are presented in Section **10.7.1.15** below.
Pathways: Groundwater flowpaths and Surface Water Flowpaths.
Receptors: Underlying WFD GWBs and downstream WFD SWBs.

Pre-mitigation Potential Effects:

Indirect, negative, significant, temporary, unlikely effect on downstream SWBs.

Indirect, negative, slight, temporary, unlikely effect on underlying GWBs.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be the potential for significant effects on the WFD status of downstream SWBs. There would be significant effects on the WFD status of the underlying GWBs.

10.5.2.16 Potential Effects Associated with Ecological Enhancement Proposals

The proposed Ecological Enhancement proposals at the Site includes the planting of approximately 0.669ha of woodland, 1.646km of hedgerow to compensate for the loss of existing hedgerow and the enhancement and re-vitalisation of 5.433km of existing degraded hedgerow. Further details are provided in the Habitat Management Plan.

The measures have limited potential to impact the hydrological/hydrogeological environment due to the scale of the proposed works. During the planting works there may be a potential for temporary negative effects on surface water quality. However, the long-term effect of the ecological enhancement will be a positive effect.

Pathway: Woodland/hedgerow planting and hedgerow enhancement.

Receptor: Downstream surface water quality.

Pre-Mitigation Potential Effect: Negative, imperceptible, indirect, temporary, unlikely effect on downstream surface water quality during the planting works and a positive, imperceptible, indirect, long-term, likely effect on surface water quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on downstream surface water quality.

10.5.2.17 Potential Effects Associated with Kerry Pipeline Crossing

As stated in Section 10.3.19, there is an existing underground pipeline within the Site. This pipeline extends from the WwTP in the townland of Rathgoggan North, and discharges treated effluent into the River Maigue just north of its confluence with the Loobagh River.

Potential unsupervised or poorly planned construction and excavation works in the vicinity of the pipeline, have the potential to damage the pipeline, potentially causing a leakage of wastewater on site. The greatest risk of potential effects occurs at crossings over the pipeline. Note that this pipeline does not carry raw or untreated wastewater but rather treated effluent (ELVs are detailed in IE Licence P0386-04) which limits the potential for significant adverse effects. Nevertheless, the leakage of treated wastewater would have the potential to negatively affect surface water quality within the Site, as these watercourses do not have the same assimilative capacity as the River Maigue to which the pipeline discharges.

Pathway: Construction/Excavation Works.

Receptor: Surface water quality.

Pre-Mitigation Potential Effect: Negative, moderate, indirect, temporary, unlikely effect on downstream surface water quality.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on local surface water quality.

10.5.3 Operational Phase Potential Effects

This section identifies the likely significant effects of the operational phase of the Project. It should be noted that the main potential effects on the hydrological and hydrogeological environment will occur during the construction phase.

10.5.3.1 Potential Effects from the Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the vegetated surface with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. This could potentially increase runoff from the Site and increase flood risk downstream of the Project. In the baseline scenario runoff rates are high as a result of the prevailing hydrogeological regime (8% groundwater recharge and 92% surface water runoff). In order to assess the potential change as a result of Access Track and hardstand footprints we have increased the runoff rate to the maximum, i.e., 100% (8% higher than the baseline conditions). The assessed footprint comprises turbine bases and hardstandings, Site Access Tracks, site entrances, substation and temporary construction compounds. During storm rainfall events, additional runoff coupled with the increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

The emplacement of the proposed permanent development footprint (approximately 8.89ha within the Site), as described in **Chapter 2: Development Description Table 2.8**, (assuming emplacement of impermeable materials as a worst-case scenario which would result in an increase in the runoff from 92% to 100%). The total area of the Site is approximately 158.75ha. Therefore, the proposed permanent footprint of the Project equates to 5.6% of the total Site area.

This could result in an average total site increase in surface water runoff of approximately 377m^3/month (**Table 10.20**). This represents a potential increase of approximately 0.24% in the average daily/monthly volume of runoff from the Site area in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from the naturally high surface water runoff rates and the relatively small area of the Site being developed, the proposed total permanent development footprint being approximately 8.89ha, representing 5.6% of the Site.

The calculations shown in **Table 10.20** relate to the new permanent Development footprint and represent a worst-case scenario whereas it is presumed that the footprint replaces natural ground at all development locations. In reality, the Development includes upgrades to existing Access Tracks which will not result in an increase in Site runoff as these are not new roads and will not alter local runoff and recharge rates, and drainage water will be slowed and attenuated by the installed drainage features. Therefore, the increase in runoff volumes will be less than that shown in **Table 10.20** below.

Table 10.20: Baseline Site Runoff V Development Runoff

Development Type	Site Baseline Runoff/ wettest month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff/month (m^3)	Hardstanding Area 92% Runoff/month (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions across Site (m^3)
Wind Farm	154,813	4,993	88,900	9,423	9,046	377	12.16	0.24

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

Pathway: Site drainage network.
Receptor: Surface waters including the Charleville Stream and the River Maigue and water dependent ecosystems.

Pre-Mitigation Potential Effect: Negative, slight, direct, long-term, likely effect on all downstream surface watercourses.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on the downstream surface watercourses.

10.5.3.2 Potential Effects from Runoff Resulting in Contamination of Surface Waters

During the operational phase, the potential for silt-laden runoff is much reduced compared to the construction phase. In addition, all permanent drainage controls will be in place and the disturbance of ground and excavation works will be complete. Some minor maintenance works may be completed, such as maintenance of Site entrances, internal Access Tracks and hardstand areas. These works would be of a very minor scale and would be very infrequent.

These minor activities could, however, result in the release of suspended solids to surface water and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies.

During such maintenance works there is a small risk associated with the release of hydrocarbons from site vehicles. However, no refuelling works will be undertaken on-site during the operational phase.

Maintenance works will likely be contained within the Site boundaries. No works will be undertaken along the GC or the TDR.

Pathways: Drainage and surface water discharge routes.

Receptors: Downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and water dependent aquatic ecosystems.

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

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on downstream surface water quality.

10.5.3.3 Potential Effects on Downstream Flood Risk

A Stage 3 flood risk assessment (**Appendix 10.1**) carried out for the Site determined that T5 is mapped in the low probability flood zone associated with the 1 in 1,000-year fluvial flood event. Meanwhile, T4, T6 and T7 are mapped in the high probability fluvial flood event associated with the 1 in 10-year flood event. T8 is located in the 100-year flood zone.

All other key Project infrastructure including the 110kV Substation, site compound, designated spoil storage areas, site entrances, and 4 no. turbines (T1, T2, T3 and T9) are outside the modelled 100-year and 1,000-year flood zones and are therefore located in Flood Zone C (Low Risk).

Construction in fluvial flood zones has the potential to increase flood risk due to floodplain storage reduction and alteration of drainage patterns. The total volume of displaced floodwater is estimated to be 7,025m^3 during the construction phase and 9,555m^3 during the operational phase. However, there are no receptors located in the immediately upstream or downstream of the Site which may be at risk from any increased flood levels. The closest downstream receptors along the River Maigue are located at Bruree, in excess of 3km downstream of the Site.

Pathways: Drainage and surface water discharge routes.

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

Pre-Mitigation Potential Effect: Negative, significant, direct, long term, likely effect on proposed wind farm infrastructure.

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

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on the proposed wind farm infrastructure. There would be no significant effect on downstream receptors.

10.5.3.4 Potential Effects from use of Water Supply at Substation

It is proposed to install a groundwater well adjacent to the 110kV Substation in accordance with the Institute of Geologists Ireland, Guide for Drilling Wells for Private Water Supplies (IGI, 2007). The well will be flush to the ground and covered with a standard manhole. An in-well pump will direct water to a water tank within the roof space of the control building.

The proposed groundwater well and associated extraction has the potential to effect local groundwater levels in the surrounding lands. However, the abstraction will be small (approximately 3m^3/day), limiting the potential for effects.

Pathway: Groundwater flowpaths

Receptor: Groundwater levels.

Pre-Mitigation Potential Effect: Direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be a potential significant effect on the local groundwater levels due to the water supply at the 110 kV Substation.

10.5.3.5 Potential Contamination Due to Wastewater

Release of effluent from the welfare facilities at the 110kV Substation compound has the potential to effect groundwater and surface water quality if site conditions are not suitable for an on-site percolation unit. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Pathways: Groundwater flowpaths and site drainage network.

Receptors: Groundwater quality (Charleville GWB) and surface water quality in the Charleville Stream and the River Maigue.

Pre-mitigation Effects:

Negative, significant, indirect, temporary, unlikely effect on surface water quality.

Negative, slight, indirect, temporary, unlikely effect on local groundwater.

Pre-Mitigation Significance of Effects: With the absence of mitigation measures there would be no significant effect on surface or groundwater quality.

10.5.3.6 Potential Effects on WFD Status

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

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

A full assessment of the potential effects of the operational phase of the Project on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as **Appendix 10.3**.

10.5.4 Decommissioning Phase Potential Effects

The Wind Farm is expected to have a lifespan of 35 years. Upon decommissioning, the wind turbines will be dismantled and all above ground components would be removed off-site for recycling.

The potential effects associated with decommissioning will be similar to those associated with construction but of a reduced magnitude, due to the reduced scale of the proposed decommissioning works in comparison to construction phase works. Turbine foundations and hardstands will remain and will be covered with earth and allowed to naturally revegetate. These areas will be reinstated to match the existing landscape as closely as possible Site access tracks will continue to be used as amenity pathways and will therefore not be removed. The underground cables will be cut and tied, and the ducting will be left in place. Excavation and removal of this infrastructure would result in considerable disturbance to the local environment in terms of disturbance to underlying soils and an increased sedimentation (if turbine foundations and hardstands are being reinstated there is a risk of silt-laden run-off entering receiving waters) and an increased possibility of contamination of local groundwater.

The Grid Connection and the Substation will become an asset of the national grid under the management of ESB and& EirGrid and will likely remain in place upon decommissioning of the wind farm as required by ESB/EirGrid.

Prior to the Decommissioning work, a comprehensive plan will be drawn up that takes account of the findings of this EIAR and the contemporary best practice at that time, to manage and control the component removal and ground reinstatement.
However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change.

According to the SNH guidance, it is, therefore: "best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures. No significant effects on the hydrological and hydrogeological environment are envisaged during the decommissioning phase of the Project.

10.6 MITIGATION MEASURES

The Project has associated potential effects as described in the previous sections of this report. The following sections outline mitigation measures to be implemented during the construction, operational and decommissioning phases of the Project.

10.6.1 Design Phase

10.6.1.1 Mitigation by Avoidance

The proposed wind farm layout have been subject to an iterative design process which considered a wide range of environmental constraints including hydrological buffer zones around watercourses (50m) and manmade drains (10m) (these hydrological buffer zones are best practice and the standard approach used in wind farm developments), archaeological and ecological constraints, set back distances from local houses and the national road (N20), as well as minimising interaction with the industrial outflow pipeline which passes through the Site. The proposed wind farm layout also considered the fluvial flood zones within the Site which are mapped along the River Maigue and the Charleville Stream.

In terms of hydrology, all of the Project infrastructure, with the exception of the 2 no. proposed watercourse crossings, are located outside of the 50m delineated hydrological buffer zone which was applied to the natural streams and rivers within the Site. This set-back distance ensures that there is no unnecessary disturbance to these streams and rivers and provides space for the proposed wind farm drainage system to be installed, thereby protecting downstream water quality. Furthermore, where possible, infrastructure has been placed outside of the 10m buffer zone assigned to the manmade drains. Whilst some infrastructure does encroach upon these drain buffers, the drains are manmade features and are not considered to be a significant hydrological constraint. They can be rerouted around or culverted beneath the proposed infrastructure.

Following a review of all of the identified constraints, the proposed 9 no. turbine layout is considered to be the optimum layout for a wind farm. A series of turbine layout were initially considered, and the proposed layout was optimised to ensure it has the least effect on flooding, and the least potential to cause downstream flood effects. As described above in Section 10.3.7, a total of 5 of the 9 no. turbines are located in fluvial flood zones within the Site (4 no. turbines in Flood Zone A and 1 no. turbine in Flood Zone B). Assessments have shown that the avoidance of infrastructure within the flood zones would have rendered the Project, a 4 no. turbine wind farm, unviable.

Therefore, avoidance of infrastructure within the flood zones was not possible. However, the Project has been designed to minimise the potential effects of construction and operation of the wind farm within the flood zone. Several design workshops were completed between HES, The Developer and JoD to ensure that the Project has been designed to minimise the potential effects associated with flooding. Several key elements of the Project have avoided the flood zones, including the substation, 4 no. turbines, the construction compound and all spoil storage area which are located above the 1 in 1,000-year flood level. As discussed above, in order to ensure Project viability, it was necessary to propose 4 no. turbine within the flood zones. Bespoke design measures, detailed in **Section 10.6.1.3** below and in the Site Specific Flood Risk Assessment (**Appendix 10.1**), have been incorporated into the Project to ensure that there is infrastructure is not at significant risk of flooding and to ensure that the Project does not significantly affect the downstream flood risk.

In summary, the mitigation by avoidance incorporated into the design of the Project is as follows:

- The location of all infrastructure outside of the 50m hydrological buffer zones, with the exception of the 2 no. watercourse crossings
- The location of all infrastructure where possible outside of the 10m drain buffer

10.6.1.2 *The location of the substation, 4 no. turbines, the construction compound and all spoil storage area which are located above the 1 in 1,000-year flood level.* Mitigation by Design

The descriptive mitigation measures outlined in this report will be applied to the Project design and construction methodologies with a view to avoiding and/or minimising any potential adverse effects to water quality in the receiving surface water network. Details on how such measures will be applied (objectives, design considerations, layout) will be contained in a Surface Water Management Plan (SWMP) (appended to the CEMP in **Appendix 2.1**). The aims and examples of important considerations in relation to mitigation measures described in the SWMP are further clarified here in **Section 10.6.2** for the construction phase and **Section 10.6.3** for the operational phase.

10.6.1.3 Flooding Considerations

A series of turbine layout were initially considered, and the proposed layout was optimised to ensure it has the least effect on flooding, and the least potential to cause downstream flood effects.

Additional design measures that were incorporated into the layout include the following:

- All proposed turbines are located outside of 50m watercourse buffers, and 10m buffers for drains.
- All proposed spoil storage areas are located outside of mapped flood zones. There will be no storage of spoil within the flood zones.
- The layout design is intended to minimise earthworks requirements, for hardstands, turbine bases, drainage management, and access tracks within the flood zones.
- All turbines within the flood zones will be constructed with piled foundations, and this will reduce earthworks volumes at those locations (as piled turbine bases are smaller than standard bases).
- Minimise access roads and hardstands buildups (in flood zones, by keeping them as close to existing ground level as possible) during the construction phase, and increase to 1 in 20-year flood levels for operational phase.
- Access tracks will be marked with snow poles to allow for emergency vehicular access.
- The final operational phase hardstand area at each of the turbines in flood zones will be as small as possible (the large construction phase hardstand areas will be reinstated).
- All existing flood zone drainage pathways will be maintained , either by avoidance, by culverting, or by diverting existing drains locally.
- Bespoke construction phase and operational phase drainage has been designed to maximise water quality protection, and minimize flooding effects.
- Detailed emergency response procedures have been outlined for potential flood events during the construction phase and during the operational phase.
- Certain biodiversity enhancement have been designed to avoid mapped flood zones.
- Critical electrical components at turbines, such as transformers in nacelles, and other sensitive electrical components are proposed above 1000-yr flood levels.
- The proposed substation is located in Flood Zone C (i.e. above the 1000-yr flood level).

- As per Section 50 requirements, the river crossings will be located at a height which includes a 300mm freeboard above the 1 in 100-year flood event plus climate change. Additional culverts will be constructed on the access roads on approach to the river crossings to minimise flow disruption during flood events.

10.6.2 Construction Phase

10.6.2.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Proposed Mitigation by Avoidance: The key mitigation measure during the construction phase is the avoidance of sensitive hydrological features, by application of suitable buffer zones (i.e. 50m to main watercourses, and 10m to main drains).

Where possible all of the key development areas (turbines, hardstands, construction compounds etc.) have been located significantly away from the delineated 50m watercourse buffer zones. Where works are proposed within the buffer zone *i.e.* at watercourse crossings additional mitigation measures are proposed. The only infrastructure elements located within the 50m watercourse buffers are the river crossings over the River Maigue and the Charleville Stream.

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

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

Furthermore, all designated spoil storage areas are located outside of the fluvial flood zones. There will be no storage of spoil material within the flood zones.

Proposed Mitigation by Design:

Presented below are temporary and long-term drainage control measures that will be utilised during the construction phase. As stated above there is an existing drainage network at the Site which comprises of agricultural drains and surface water streams. The measures outlined below will be used in conjunction with the existing drainage network to ensure the protection of all rivers and downstream watercourses.

Source controls:

- Interceptor drains, vee-drains, diversion drains, erosion and velocity control measures such as the use of sand bags, oyster bags filled with gravel, filter fabrics and other similar/equivalent or appropriate systems.
- Small working areas, covering temporary stockpiles, weathering off of side-cast spoil, cessation of works in certain areas or other similar/equivalent or appropriate measures.

In-Line controls:

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

Treatment systems:

- Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as "Siltbuster" (mitigation measures in relation to the use of Siltbuster are prescribed in **Section 10.6.2.9**), and/or other similar/equivalent or appropriate systems.

It should be noted that the existing network of manmade agricultural drains present in some areas will be integrated and enhanced as required and used within the Project drainage system. The integration of the existing drainage network and the proposed wind farm network is relatively simple. The key elements are the upgrading and improvements to water treatment elements, such as in-line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

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

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion.

- Temporary silt traps will be placed in the existing drains downstream of construction works, and these will be diverted into proposed interceptor drains, or culverted under/across the works area.
- During the operational phase, runoff from individual turbine hardstanding areas will not be discharged directly into the existing drainage network but discharged locally at each turbine location through field drains, main drains, and existing settlement ponds.
- Buffered outfalls which will be numerous over the Site will promote percolation of drainage waters across the bog surface and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the Site.
- Velocity and silt control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works.
- Existing culverts will be lengthened where necessary to facilitate Access Track widening.

Pre-Commencement Temporary Drainage Works: Prior to the commencement of Access Track upgrades (or new road/hardstand or turbine base installs) the following key temporary drainage measures will be installed:

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

Silt Fences: Silt fences will be emplaced within drains down-gradient of all construction areas. Silt fences are effective at removing heavy settleable solids. This will act to prevent entry to the existing drainage network of sand and gravel-sized sediment, released from the excavation of mineral sub-soils of glacial and glacio-fluvial origin and entrained in surface water runoff. Inspection and maintenance of these structures during the construction phase will be completed and is critical to their functioning to stated purpose. They will remain in place throughout the entire construction phase.

Silt Bags: Silt bags will be used where small to medium volumes of water need to be pumped from excavations (e.g. the proposed underpass locations). As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through.

Settlement Ponds: The Project footprint will be divided into drainage catchments (based on topography, outfall locations, catchment size) and stormwater runoff rates based on the 10-year return period rainfall event will be calculated for each catchment. These flows will then be used to design settlement ponds for each drainage catchment. The settlement ponds will either be designed for 4.1hr or 24hr retention times used to settle out medium silt (0.01mm) and fine silt (0.004mm) respectively (EPA, 2006). Settlement ponds along Access Tracks and at Turbine Hardstands will have 4.1hr retention as there is additional in-line drainage controls proposed along Access Tracks and at hardstands.

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

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

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

Water Treatment Train: If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a 'Siltbuster' or similar equivalent treatment train (sequence of water treatment processes)) will be used to filter and treat all surface discharge water collected in the dirty water drainage system. This will apply to all of the construction phase.

Pre-emptive Site Drainage Management: The works programme for the construction stage of the Project will also take account of weather forecasts and predicted rainfall in particular. Large excavations and movements of subsoil or soil stripping will be suspended or scaled back if heavy rain is forecast. The extent to which works will be scaled back or suspended will relate directly to the amount of rainfall forecast.

The following forecasting systems are available and will be used on a daily/weekly basis, as required, to allow site staff to direct proposed and planned construction activities:

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

Earthworks will be suspended in the event of an orange warning for rainfall. Prior to earthworks being suspended the following further control measures will be completed:

- All open spoil excavations will be secured and sealed.
- Temporary or emergency drainage will be created to prevent back-up of surface runoff.
- Working during heavy rainfall and for up to 24 hours after heavy events will not be allowed to ensure drainage systems are not overloaded.
- All drainage systems will be inspected after orange rainfall events to ensure functionality, and any identified repairs will be completed.

Management of Runoff from Spoil Storage Areas: It is proposed that excavated spoil will be temporarily stored in the 6 no. proposed spoil storage areas and permanently stored in 1 no. spoil storage berm adjacent to the Substation. These designated spoil storage areas are all located outside of the fluvial flood zones and above the 1 in 1,000 year flood level (refer to **Figure 10.4**). These spoil storage areas are also located outside of the 50m hydrological buffer zones. During the initial placement of subsoil, silt fences, straw bales and biodegradable matting will be used to control surface water runoff from the spoil storage areas.

Where applicable the vegetative topsoil layer of the spoil storage areas will be rolled back to facilitate placement of excavated spoil, following which the vegetative topsoil later will be reinstated. Where reinstatement is not possible, the spoil storage areas will be sealed with a digger bucket and seeded as soon as possible to reduce sediment entrainment in runoff. Drainage from the spoil storage areas will ultimately be routed to oversized swales and a number of stilling ponds and a 'Siltbuster' with appropriate storage and settlement designed for a 1 in 10 year return period before being discharged to the onsite watercourses.

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

Proposed Drainage and Water Quality Monitoring: Monitoring is detailed in **Section 10.6.5** below.

Allowance for Climate Change: Climate Change rainfall projections are typically for a mid-century (2050) timeline. The projected effects of climate change on rainfall are therefore modelled towards the end of the life cycle of the Project, as the turbines have a life span of approximately 35 years. It is likely that the long-term effects of climate change on rainfall patterns will not be observed during the lifetime of the proposed wind farm. As outlined in the above sections we have designed settlement ponds for a 1 in 10 year return flow. This approach is conservative given that the project will likely be built over a much shorter period

(16-18 months), and therefore this in-built redundancy in the drainage design more than accounts for any potential short term climate change rainfall effects.

Additional Measures for Works within Buffer Zone: In addition to the above mitigation measures, where works are proposed within the delineated 50m hydrological buffer zone the following additional mitigation measures will be implemented:

- Double row silt fences will be emplaced immediately down-gradient of the construction areas.

Measures along the Grid Connection: The GCR will require excavation of cable trenches in greenfield areas. These works are transient in nature with very limited excavation at any one time. Spoil removed from the trench will be reinstated. Any excess spoil will be transported to a licenced facility. A silt fencing filtration system will be installed on all existing drainage channels for the duration of the cable construction to prevent contamination of any watercourse.

10.6.2.2 Potential Effects from Excavation Dewatering and Potential Effects on Surface Water Quality

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

- Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place.
- If required, pumping of excavation inflows will prevent build-up of water in the excavation.
- The interceptor drainage will be discharged to the Site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters.
- The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit.
- There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur.
- Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken.

- A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available onsite for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.

10.6.2.3 Potential Effects from the Release of Hydrocarbons

- During construction, where possible, all refuelling on site will be within the temporary compound within the dedicated re-fuelling area.
- All plant will be inspected and certified to ensure they are leak free and in good working order prior to use onsite.
- Site vehicles will be refuelled offsite where possible.
- Only essential refuelling will be completed outside of the dedicated re-fuelling area but not within 50m of any watercourses. Onsite re-fuelling of plant and machinery will be carried out using a mobile double skinned fuel bowser:
    - The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off site, and will be towed around the site by a 4x4 jeep to where machinery is located;
    - The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages.
    - The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on site.
    - Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations.
    - A non-permeable High-Density Polyethylene (HDPE) membrane will be provided beneath connection points to catch any residual oil during filling and disconnection. These membrane will be inspected and if there is any sign of oil contamination will be removed from the site by a specialist waste contractor.
- Onsite refuelling will be carried out by trained personnel only;
- A permit to fuel system will be put in place;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;

- All fuel storage areas will be bunded appropriately for the duration of the construction phase. Fuels will be stored in the Temporary Construction Compound and bunded to at least 110% of the storage capacity of fuels to be stored. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded area;
- Fuel and oil stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building (at the substation) will be bunded appropriately to 110% of the volume of oils that will be stored, and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages is included within the Construction and Environmental Management. Spill kits will be available to deal with any accidental spillage in and outside the re-fuelling area.

10.6.2.4 Potential Effects from the Release of Cement-Based Products

- No batching of wet-cement products will occur onsite. Ready-mixed supply of wet concrete products and emplacement of pre-cast elements will take place.
- Where possible pre-cast elements for culverts and concrete works will be used.
- Vehicles will undergo a visual inspection prior to being permitted to drive into the wind farm Site to ensure that there is no excess cementitious material which could be deposited on site.
- Where concrete is delivered onsite, only the chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. A dedicated bunded area will be created to cater for concrete wash-out and this will be located in the Temporary Construction Compound.
- The contractor will use weather forecasting to plan dry days for pouring concrete.
- The contractor will ensure pour site is free of standing water and plastic covers will be ready in case of a sudden rainfall event.
- No surplus concrete will be stored or deposited anywhere on Site.
- Raw or uncured waste concrete will be disposed of by removal from the Site and returned to the source location or disposed of appropriately at a suitably licensed facility.

- Where shuttering is required to be installed in order contain the concrete during pouring, it will be installed to a high standard with minimal potential for leaks. Additional measures will be taken to ensure minimal potential of leaking, these measures are the use of plastic sheeting and the use sealing products at joints.

10.6.2.5 Potential Effects from Wastewater Disposal

- During the construction phase, the Project will include an enclosed wastewater management system at the temporary compound capable of handling the demand during the construction phase with 90 construction workers on site at peak.
- A self-contained port-a-loo with an enclosed wastewater holding tank will be used at the on-site temporary construction compound area, maintained by the providing contractor, and removed from the site on completion of the construction works.
- Water supply for the site office and other sanitation will be brought to site and removed after use by a licensed contractor to be discharged at a suitable offsite treatment location.
- Wastewater/sewerage from the staff welfare facilities located in the temporary construction compound will be collected and held in a sealed storage holding tank, fitted with a high-level alarm. The high-level alarm is a device installed in the storage tank that is capable of sounding an alarm during a filling operation when the liquid level nears the top of the tank.
- All wastewater will be emptied periodically, tankered off-site by a licensed waste collector and disposed of at a suitable wastewater treatment plant that has sufficient capacity. There will be no onsite treatment of wastewater.
- No water or wastewater will be sourced on the Site, nor discharged to the site.

10.6.2.6 Potential Effects from Morphological Changes to Surface Watercourses

Mitigation measures for the upgrade of the existing crossings and the new proposed crossing are detailed below:

- The 2 no. new watercourse crossings will be via clear span bridge crossings and the existing banks will remain undisturbed as much as possible.
- No instream excavation works are proposed and therefore there will be no direct effect on the stream at the proposed crossing location.
- Any guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland will be incorporated into the design of the proposed crossings.
- As a further precaution near stream construction work will only be carried out during the period permitted by Inland Fisheries Ireland (2016) in the guidance document:

"Guidelines on Protection of Fisheries during Construction Works in and Adjacent to Waters" (IFI, 2016), that is, May to September inclusive. This time period coincides with the period of lowest expected rainfall, and therefore minimum runoff rates and the risk of entrainment of suspended sediment in runoff.

- During the near stream construction work double row silt fences will be emplaced immediately down-gradient of the construction area. There will be no batching or storage of cement allowed on-site.
- All new Access Track river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

10.6.2.7 Potential Effects on Groundwater Levels During Excavation Works

The majority of the infrastructure is underlain by Locally Important Aquifers whilst some areas are underlain by a Regionally Important (Karstic) Aquifer.

No significant groundwater dewatering will be required due to the relatively shallow nature of the excavations. Direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt, we would define dewatering as a requirement to permanently drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor.

In relation to the proposed dewatering works located overlying the Regionally Important Aquifer, no significant effect on groundwater levels will occur due to the following reasons:

- No karst features are mapped by the GSI within the Site.
- No karst features were encountered during the site walkover surveys or trial pit excavations.
- No bedrock was encountered during the site investigations which extended to depths of 3.6mbgl.
- The Site was found to be underlain by low permeability till deposits.
- Shallow groundwater inflows into turbine base excavations will be largely fed by recent rainfall.
- Any shallow groundwater seepage will be small in comparison to the expected surface water flows during heavy rainfall events.
- The management of surface water will form the largest portion of water to be managed and treated.

In terms of locally mapped and unmapped wells, the implementation of the drainage design measures will ensure that the recharge to the aquifers will not be altered, thus downgradient water levels will not be altered. As such there are no well supplies down-gradient of the Site that can be affected by temporary dewatering during turbine base construction.

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

10.6.2.8 Potential Effects on Groundwater Quality in Local Private Groundwater Well Supplies

Notwithstanding the potential for the location of private wells downstream/downslope of the Project (or if wells are installed in the future), the potential for effects is negligible for the following conclusive reasons:

- The Site is underlain by low permeability till subsoils.
- There is no shallow bedrock at the Site.
- Groundwater flowpaths are typically short (approximately 300m maximum).
- Groundwater flows within the Site emerge as springs/baseline along streams/rivers and leave the Site as surface water flows and not groundwater flows.
- Groundwater flow directions will mimic surface topography and flow towards the Charleville Stream and the River Maigue.
- All local dwellings are located upgradient of the Site.
- Therefore, the potential to effect local wells is very low as groundwater flowpaths between the Projects infrastructure and potential source typically do not exist.
- Nevertheless, mitigation is provided in the EIAR to deal with typical construction phase groundwater hazards such as oils and fuels.
- Therefore, based on our hydrogeological assessment of the Site with regard to groundwater user risk and the proposed mitigation measures, we can robustly say the potential to effect local wells/water supply sources is negligible.

10.6.2.9 Potential Effects from the Use of Siltbuster

Measures employed to prevent overdosing and potential chemical carryover:

- The Siltbuster system comprises an electronic in-line dosing system which provides an accurate means of adding agents so overdosing does not occur.
- Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff, means the correct amount of chemical is added by the dosing system.

- Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment.
- Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover.
- Use of biodegradable chemical agents can be used at very sensitive sites (i.e. adjacent to SACs).
- Sludge from the siltbuster will be removed off site for disposal at a licenced facility.

10.6.2.10 Potential Effects Associated with Piled Foundations

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

- Mitigation measures for sediment control are detailed in **Section 10.6.2.1**, **10.6.2.2** and **10.6.2.6**.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 10.6.2.3**.
- Mitigation measures for the control of cement-based products during construction works are detailed in **Section 10.6.2.4**.

Proposed mitigation measures relative to piling works will comprise:

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

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

Scenario 1: Creating a Pathway for Downward Flow

To ensure downward flow of water and/or pollutants from the piling works does not occur, the concrete added to the bored pile will seal the pile annulus. As a result, the potential for the piling works to create pathways for downward flow of water or pollutants that could affect groundwater quality in the underlying aquifer is imperceptible.

Scenario 2: Creating a Pathway for Upward Flow

To ensure upward flow of underlying groundwater via potential pathways created by piling works does not occur, the concrete added to the bored pile will seal the pile annulus. As a result, the potential for piling works to create pathways for upward flow of groundwater to the surface is imperceptible.

Scenario 3: Blocking Regional Groundwater Flow

The piles have a very small footprint and if required would account for a very small percentage of the overall footprint associated with the Project. The proposed piles would not penetrate any great distance into the underlying bedrock aquifer, as they will likely find sufficient resistance upon reaching the top of bedrock. The ability of a single cluster of piles, to alter or affect local or regional groundwater flow in the bedrock aquifer is imperceptible.

10.6.2.11 Potential Effects from Turbine Delivery Route Works

No significant effects will occur for the following reasons:

- All works are relatively minor and localised and cover very small areas.
- Excavation/earthworks will all be small scale.
- These works are distributed over a wide area.
- All works are temporary in nature.

Nevertheless, the "Pre-commencement Temporary Drainage Works" described in **Section 10.6.2.1** will be employed at all the TDR works areas.

10.6.2.12 Potential Effect on Surface Water Quality Due to Fluvial Flooding During Construction

A key element of the site layout design has been to design for flood events and flood resilience. For example:

- Excavation works and infill are minimised in flood zones;
- Turbines within the flood zones will be constructed using piled foundations which will reduce ground disturbance within the flood zone and will also reduce spoil volumes and earthworks within the flood zones;
- During the construction phase, turbine hardstands (T4, T5, T6, T7 and T8) located within the modelled flood zones will be constructed as close to ground level as possible, depending on the grade from the nearest river crossing;

- Construction compounds and soil/subsoil storage areas are located outside of mapped flood zones;
- The proposed substation is located on land above the 0.01% AEP flood elevation, i.e. the Substation is located in flood zone C;
- As per Section 50 requirements, the main river crossings will be located at a height which includes a 300mm freeboard above the 1 in 100-year flood event plus climate change. Additional culverts will be constructed on the Access Tracks on approach to the river crossings to minimise flow disruption during flood events;
- All Access Tracks within the floodplain during the construction phase will be constructed as close to existing ground level as possible, depending on the grade from the nearest river crossing. Turbine cabling and access track infrastructure can be submerged temporarily without any impact on their function; and,
- Site Access Tracks located within mapped flood zones are designed to have shallow flood depths and be accessible by emergency response vehicles should that be required. All site trackways will be demarked by reflective marker poles. No turbine maintenance will occur during flood events, so the requirement for emergency vehicle access will be limited to fire or turbine failure.

Despite the low likelihood of a fluvial flood event occurring during the construction of the wind farm, weather/rainfall events of those magnitudes likely to generate significant rainfall which would in turn cause fluvial flooding would be forecastable.

An emergency response system has been development for the construction phase of the project to respond to high rainfall events which may result in fluvial flooding.

A potential fluvial flooding event at the Site would likely be identified ~5-7 days in advance, with more accurate forecasts of severity within 24-48 hours of occurrence. Weather warnings will be issued from Met Eireann at least 60 hours before an event, but there will be indications from a week out that a likely significant event might occur. Preparation for a significant event will need to begin from the initial indications of the pending flood event. This will allow time for preparation and the implementation of additional emergency mitigation measures outlined below if there were to be a pending risk of an extreme flooding event. A forecast red weather warning (combining high river levels and heavy rainfall) is the defined trigger for the Managed Retreat described below.

The first point of mitigation is ongoing monitoring of weather forecasts, weather warnings, wind direction, and rainfall depths. The project Environmental Manager or the site ECoW will be responsible for monitoring weather forecasts during the construction phase.

When a pre-determined rainfall trigger levels is exceeded (e.g., sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any yellow or greater rainfall warning (>25mm/hour) issued by Met Eireann), planned responses will be undertaken.

- Cessation of all construction works until the storm event, including the storm runoff has passed. All construction works will cease during storm events such as yellow warning rainfall events. Following heavy rainfall events, and before construction works recommence, the Site will be inspected and corrective measures implemented to ensure safe working conditions e.g. dewatering of standing water in open excavations, etc.
- Exposed soils/peat (exposed temporary stockpiles) will be covered with plastic sheeting during all relatively heavy rainfall events and during periods where works have temporarily ceased before completion at a particular area (e.g., overnight and weekends).

With regards to the fluvial flood zones at the Site, a **Managed Retreat** from the fluvial flood zones will be implemented in the event of a high intensity rainfall event and/or red weather warning related to rainfall. This will include the following:

- Any areas where soil/subsoil is exposed at the surface will be compacted firmly with a digger bucket of a suitably sized excavator.
- Open trenches will be backfilled and compacted.
- All oils, fuels and waste material will be removed from the flood zones.
- Existing sediment control measures will be removed, as these may be washed away and deposited elsewhere by the floodwaters.
- Site access tracks will be scraped, and any excess soft material will be removed from the flood zones.
- All plant, machinery and equipment will be removed from the flood zones.

10.6.2.13 Potential Effects on Public Water Supplies

Mitigation measures implemented for the protection of groundwater and surface water quality at the Site will ensure that there is no potential for effects on the Bruree PWS or the Adare PWS.

- Mitigation measures for sediment control are detailed in **Section 10.6.2.1** and **Section 10.6.2.2**.

- Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 10.6.2.3**.
- Mitigation measures for the control of cement-based products during construction works are detailed in **Section 10.6.2.4**.
- Mitigation measures for the protection of surface water quality in the event of a fluvial flood event during the construction phase are prescribed in **Section 10.5.2.12**.

Implementation of these mitigation measures will ensure the protection of surface water quality in receiving waters.

10.6.2.14 Potential Effects on Hydrologically Connected Designated Sites

Mitigation measures implemented for the protection of surface water quality at the Site will ensure that there is no potential for effects on the Lower River Shannon SAC.

- Mitigation measures for sediment control are detailed in **Section 10.6.2.1** and **Section 10.6.2.2**.
- Mitigation measures for the control of hydrocarbons during construction works are detailed in **Section 10.6.2.3**.
- Mitigation measures for the control of cement-based products during construction works are detailed in **Section 10.6.2.4**.
- Mitigation measures for the protection of surface water quality in the event of a fluvial flood event during the construction phase are prescribed in **Section 10.5.2.12**.

Implementation of these mitigation measures will ensure the protection of surface water quality in receiving waters.

10.6.2.15 Potential Effects on WFD Status

Mitigation measures relating to the protection of surface water drainage regimes and surface water quality within the Site have been detailed in **Section 10.5.2.1** (suspended solids), **Section 10.5.2.3** (hydrocarbons), **Section 10.5.2.4** (cement-based products), **Section 10.5.2.5** (wastewater) and **Section 10.5.2.6** (morphological changes to watercourses). These mitigation measures will also be implemented during the construction of the Grid Connection.

Similarly, mitigation measures for the protection of groundwater quantity and quality have been detailed in **Section 10.5.2.7** (groundwater levels), **Section 10.5.2.3** (hydrocarbons), **Section 10.5.2.4** (cement-based products), **Section 10.5.2.5** (wastewater).

The implementation of these mitigation measures will ensure the protection of downstream SWBs and underlying GWBs. There will be no deterioration in the status of any WFD waterbody and the Project will not impact the ability of any waterbody to achieve its WFD objectives.

10.6.2.16 Potential Effects Associated with Ecological Enhancement Proposals

All planting works will be undertaken during dry weather.

All mitigation measures with respect to suspended solids entrainment in surface waters and hydrocarbons detailed in **Section 10.6.2.1** and **Section 10.6.2.3** will be implemented during the ecological enhancement works.

10.6.2.17 Potential Effects Associated with Kerry Pipeline Crossing

The works crossing the pipeline have a small footprint, and will be of short duration which limits the potential for significant effects. All works will also be completed during dry weather and in accordance with a specific works method statement.

The prescribed mitigation measures, as per the method statement, are as follows:

- Prior to the commencement of any works in the vicinity of the pipeline, the pipeline centreline will be staked out by the Contractor.
- Checks will also be completed by the Contractor for the presence of any other underground services using cable avoidance tools.
- The depth of the pipeline will be established by the Contractor by hand excavation of a trial hole.
- The use of an excavator with a toothless bucket and hand excavations.
- All excavation works to be completed under the supervision of the Resident Engineer and Kerry Group Personnel will be invited to attend.
- Upon completion of the pipeline crossing, it will be delineated with suitable and robust markers to ensure that all site traffic is routed to cross at the designated slabbed point.
- All construction workers will be briefed regarding the designated crossing points and no other crossing points will be permitted.

10.6.3 Operational Phase

10.6.3.1 Potential Effects from the Progressive Replacement of Natural Surfaces with Lower Permeability Surfaces

The Project design has been optimised to use the existing infrastructure (Access Tracks and hardstands) where practicable. Where practicable the existing Access Tracks will be upgraded as part of the Project. These works in these areas will not alter the existing runoff and recharge rates. This design prevents the unnecessary creating of additional hardstand areas which would increase surface water runoff from the Site.

All turbines located within the flood zones will have a reduced hardstand area in comparison with a typical wind turbine hardstand (refer to Drawings 6839-JOD-GGE-XX-DR-C-0213 to 6839-JOD-GGE-XX-DR-C-0215). This bespoke design will therefore have a positive effect on runoff rates in comparison to a typical wind farm design due to less areas of the site being covered in impermeable surfaces.

As part of the proposed wind farm drainage design, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing site drainage network. The new proposed drainage measures will then create significant additional attenuation to what is already present. The operational phase drainage system will be installed and constructed in conjunction with the existing site drainage network and will include the following:

- Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed into downstream field drains.
- Collector drains will be used to gather runoff from Access Tracks and turbine hardstanding areas of the Site likely to have entrained suspended sediment, and channel it to new local settlement ponds for sediment settling.
- On sections of Access Track transverse drains ('grips') will be constructed where appropriate in the surface layer of the track to divert any runoff off the track into swales/roadside drains.
- Check dams will be used along sections of access track drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock. Check dams will be monitored to ensure no blockages/bypass and ongoing effective operation.

- Settlement ponds, emplaced downstream of Access Track sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to existing drains.
- Settlement ponds will be designed in consideration of the greenfield runoff rate.
- All surface water runoff from the development will have to pass through the proposed settlement ponds prior to release into the existing site drainage network.

10.6.3.2 Potential Effects from Runoff Resulting in Contamination of Surface Waters

Mitigation measures for sediment control are the same as those outlined for the construction phase in **Section 10.6.2.1** and **Section 10.6.2.2**.

Mitigation measures for the control of hydrocarbons during maintenance works are similar to those outlined in **Section 10.6.2.3**.

10.6.3.3 Potential Effects on Downstream Flood Risk

During the operational phase, access to the Site will be infrequent, and will be only done for scheduled maintenance works. In advance of scheduled site visits review of weather and river water levels will be completed and works will be postponed, and thereafter rescheduled to avoid high risk periods and weather warning events.

A key element of the site layout design has been to design for flood events and flood resilience during the operational phase. For example:

- As per Section 50 requirements, the main river crossings will be located at a height which includes a 300mm freeboard above the 1 in 100-year flood event plus climate change. Additional culverts will be constructed on the Access Tracks on approach to the river crossings to minimise flow disruption during flood events;
- During the operational phase, the tracks will be set to the 1 in 20-year flood level. In the event of a flood event, the maximum flooded depth along Access Tracks will be between 200 and 400mm. Access tracks will be marked with snow poles to allow for emergency vehicular access. The proposed access point for emergency access is from the southern end of the Site which is unlikely to be affected during flood events.
- The turbine plinths within the flood zone will be located at a height which includes a 150mm freeboard above the 1 in 1,000-year flood event plus climate change.
- During the operational phase, turbine hardstand areas will be reduced, with the reduced hardstand area being built up to the 1 in 20-year flood level. The reinstatement of these

hardstand areas post construction will reduce the hardstand area in the flood zone and will reduce the downstream flood risk.

- In the unlikely event that a key component of a turbine fails during the operational phase, the hardstand will need to be built back again, and will be built up to the 1 in 20-year flood level. Once works are complete, the hardstand will be reinstated once again.
- Culverts constructed beneath the site access track within the flood zones will allow flood waters to pass through should a flooding event occur, maintaining hydrological flowpaths in a flood event.
- The associated drainage will be attenuated for greenfield run-off, the Project will not increase the risk of flooding elsewhere in the catchment.

Furthermore, a quantitative assessment presented in Appendix 10-1 shows that the volume of floodwater displaced by the Project infrastructure within the flood zones, represents only a very small percentage of the overall volume of floodwater (0.89% of the 100-year flood volume, and 0.72% of the 1,000-year flood volume). The displaced floodwater would only result in a rise in flood levels of 5-6mm across the modelled flood area. Therefore, due to the small volume of floodwater being displaced by the Project, combined with the flood resilience measures described above, the Project has imperceptible potential to increase the downstream flood risk (refer to **Appendix 10.1** for quantitative analysis).

10.6.3.4 Potential Effects from Use of Water Supply at Substation

The abstraction rate for the proposed groundwater well at the 110kV Substation will be very small 3m^3/day. This abstraction volume is comparable to approximately 3 no. domestic wells supplying single households. The well at the Substation is proposed in a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones and the Charleville GWB. Due to the small, proposed abstraction rate and the aquifer type, and the general geological and hydrogeological conditions in the area, no significant effects on local groundwater levels will occur. The proposed abstraction rate is too small to generate effects any distance away from the well.

For these reasons no specific mitigation measures are required.

10.6.3.5 Potential Contamination due to Wastewater

It is proposed to install a sealed underground holding tank for effluent (wastewater) from the Substation compound. The tank shall be routinely emptied by a licensed contractor. A level sensor will be installed in the tank which shall be linked to the on-site SCADA system.

If the level of the tank contents rise to a predetermined 'high' level a warning shall appear on the overall SCADA system for the site and automatic notification shall be sent to the facility manager. A formal service agreement will be entered into with a suitably permitted waste contractor, in relation to the servicing and de-sludging of the wastewater holding tank on site. There will be no discharge of wastewater to ground at the Site, and therefore there is no potential to impact groundwater or surface water quality.

10.6.3.6 Potential Effects on WFD Objectives

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

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

A full assessment of the potential effects of the operational phase on the status of the receiving waterbodies is included in WFD Compliance Assessment Report attached as **Appendix 10.3**.

10.6.4 Decommissioning Phase

Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures. No significant effects on the hydrological and hydrogeological environment are envisaged during the decommissioning phase of the Project.

10.6.5 Monitoring

The monitoring programme during the course of construction works (unless otherwise specified by any required planning condition) will include:

- One baseline monitoring visit (in advance of construction), including upstream and downstream biological Q value sampling and reporting.
- Once daily general visual inspections by site EM at all sample sites identified.
- Weekly grab sample inspections by site EM (Sample parameters will include, suspended solids, and on-site measurement of: turbidity, pH, temperature, electrical conductivity). At two locations within the WF site in man-made drains, and at SW3 and SW4.

- Monthly grab sampling by site EM at surface water monitoring locations SW3, SE4 and SW5 (refer to **Figure 10.5**). Analysis suite will include (same as Table 10.16 including suspended solids, BOD, nitrite, nitrate, ammonia, orthophosphate and chloride).
- Monthly inspections and grab sampling during post construction for 3 months.
- Annual upstream and downstream biological Q value sampling and reporting, including one post construction event.

The Site Environmental Manager (EM) will have a stop works authority. Weekly site meeting will include for scheduling of works according to weather forecast. Suitable locations (further downstream) for biological Q-Value sampling will be identified by Site EM.

10.7 RESIDUAL AND CUMULATIVE EFFECTS

This section identifies the likely significant effects of the Project with the implementation of the prescribed mitigation measures.

10.7.1 Construction Phase

10.7.1.1 Potential Effects from Earthworks Resulting in Suspended Solids Entrainment in Surface Waters

Post Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effect on surface water quality in downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, there will be no significant effects on surface water quality in downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

10.7.1.2 Potential Effects from Excavation Dewatering and Potential Effects on Surface Water Quality

Post Mitigation Residual Effects: The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of release of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effect on surface water quality in downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

Significance of Effects: For the reasons outlined above, there will be no significant effects on surface water quality in downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

10.7.1.3 Potential Effects from the Release of Hydrocarbons

Post Mitigation Residual Effects: The potential for the release of hydrocarbons is a risk to surface water and groundwater quality. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effect on surface water quality in downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and groundwater quality in the underlying bedrock aquifers/GWBs (Hospital, North Kilmallock, and Charleville GWBs).

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, there will be no significant effects on surface water quality in downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and groundwater quality in the underlying bedrock aquifers/GWBs (Hospital, North Kilmallock, and Charleville GWBs).

10.7.1.4 Potential Effects from the Release of Cement-Based Products

Post Mitigation Residual Effect: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality. Proven and effective measures to mitigate the risk of releases cement-based products have been proposed and will break the pathway between the potential source and each receptor. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effect on surface water quality in downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and groundwater quality in the underlying bedrock aquifers/GWBs (Hospital, North Kilmallock, and Charleville GWBs).

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, there will be no significant effects on surface water quality in downstream watercourses (Charleville stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and groundwater quality in the underlying bedrock aquifers/GWBs (Hospital, North Kilmallock, and Charleville GWBs).

10.7.1.5 Potential Effects from Wastewater Disposal

Post Mitigation Residual Effects: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all construction sites containing welfare facilities. Proven and effective measures to mitigate the release of wastewater on-site have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effect on down-gradient well supplies, groundwater quality and downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site).

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, there will be no significant effects on down-gradient well supplies, groundwater quality and downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site).

10.7.1.6 Potential Effects from Morphological Changes to Surface Waters

Post Mitigation Residual Effects: The potential for the construction of watercourse crossings and associated in-stream works is a risk to downstream surface water quality. Proven and effective measures to protect water quality have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be a negative, imperceptible, direct, long-term, unlikely effect on Surface water flows, stream morphology and water quality in the Charleville Stream and the River Maigue.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation measures, there will be no significant effects on Surface water flows, stream morphology and water quality in the Charleville Stream and the River Maigue.

10.7.1.7 Potential Effects on Groundwater Levels During Excavation Works

Post Mitigation Residual Effects: Due to the local hydrogeological regime (low permeability tills subsoils), along with the relatively shallow nature of the proposed works, the potential for water level drawdown effects at receptor locations is negligible. The residual effect is considered to be a negative, imperceptible, indirect, short-term, unlikely effects on local groundwater levels within the underlying GWBs and at local groundwater wells.

Significance of Effects: For the reasons outlined above, and with the implementation of the above-listed mitigation measures, there will be no significant effects on the local groundwater levels within the underlying GWBs and at local groundwater wells.

10.7.1.8 Potential Effects on Groundwater Quality in Local Private Groundwater Well Supplies

Post Mitigation Residual Effects: For the reasons outlined above (separation distances, and prevailing geology, topography and groundwater flow directions), the residual effect is considered to be a negative, imperceptible, indirect, long term, unlikely effect on groundwater supplies (groundwater wells).

Significance of Effects: For the reasons outlined above, there will be no significant effects on groundwater supplies (groundwater wells).

10.7.1.9 Potential Effects from the Use of Siltbuster

Post Mitigation Residual Effects: With the implementation of the dosing technology and the continual monitoring of pre and post treatment water, the appropriate volume of chemical agent can be added to ensure that chemical carryover concentrations are present only in trace amounts which will not cause any effects to receiving waters. The residual effect is considered to be a negative, imperceptible, indirect, temporary, unlikely effect on downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems.

Significance of Effects: For the reasons outlined above, there will be no significant effects on downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and associated water dependent ecosystems. In fact, the use of Siltbuster systems will have a significant positive effect in respect of surface water quality.

10.7.1.10 Potential Effects Associated with Piled Foundations

Post Mitigation Residual Effects: The proposed piling works potentially pose a threat to groundwater quality in the underlying regional groundwater system, and also could potentially create a pathway for upward migration of groundwater to the surface. These potential effects will not arise at the Site due to a combination of the prevailing ground conditions, groundwater conditions, and proposed mitigation measures that will ensure the potential pathways for interaction of shallow water and deeper groundwater are prevented from occurring. In additional, due to the small footprint of proposed pile clusters, and the significant spacing between turbine foundations, the potential for such pile clusters to block regional groundwater flow is imperceptible at that scale. The proposed piled foundations therefore have no potential to change the WFD status or impact the WFD objectives of the underlying GWB. The residual effect is considered to be a negative, imperceptible, indirect, short term, unlikely effect on groundwater quality in the underlying GWBs (Hospital, North Kilmallock, and Charleville GWBs) and groundwater hydrochemistry.

Significance of Effects: For the reasons given above, there will be no significant effects on Groundwater quality in the underlying GWBs (Hospital, North Kilmallock, and Charleville GWBs) and groundwater hydrochemistry.

10.7.1.11 Potential Effects from Turbine Delivery Route Works

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

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

10.7.1.12 Potential Effects on Surface Water Quality Due to Fluvial Flooding During Construction

Post Mitigation Residual Effect: The likely residual effect following the implementation of the proposed mitigation measures (monitoring weather forecasts during the construction phase and the managed retreat from the flood zone areas of the site in the event of a forecasted flood event) is considered to be a negative, slight, direct, short-term, unlikely effect on downstream surface water quality in watercourses and associated water dependent ecosystems downstream of the Site including the Charleville Stream and the River Maigue.

Significance of Effects: For the reasons outlined above and with the application of mitigation measures, there will be no significant effects on surface water quality in watercourses and associated water dependent ecosystems downstream of the Site including the Charleville Stream and the River Maigue.

10.7.1.13 Potential Effects on Public Water Supplies

Post-Mitigation Residual Effect: Construction activities pose a threat to downstream surface water abstractions hydrologically linked with the Site. Proven and effective measures to mitigate the risk of surface water contamination have been proposed which will break the pathway between the potential source and the downstream receptor. These mitigation measures will ensure that surface water runoff from the Site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or surface water abstractions. The residual effect is considered to be a negative, imperceptible, indirect, short term, unlikely effect on water quality in the Bruree PWS and the Adare PWS.

Significance of Effects: For the reasons outlined above, there will be no significant effects on water quality in the Bruree PWS and the Adare PWS.

10.7.1.14 Potential Effects on Hydrologically Connected Designated Sites

Post Mitigation Residual Effects: Construction activities pose a threat to designated sites hydrologically linked with the Site. Proven and effective measures to mitigate the risk of surface and groundwater contamination have been proposed which will break the pathway between the potential source and each receptor. These mitigation measures will ensure that surface water runoff from the Site will be equivalent to baseline conditions and will therefore have no impact on downstream surface water quality and/or the status or ecology of the protected species and habitats within the designated sites. The residual effect is considered to be a negative, imperceptible, indirect, short term, unlikely effect on the Lower River Shannon SAC.

Significance of Effects: For the reasons outlined above, there will be no significant effects on the Lower River Shannon SAC.

10.7.1.15 Potential Effects on WFD Status

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the construction phase of the Project will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Project.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Project. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration. The Project will not compromise the ability of any SWB or GWB to meet their WFD objectives.

No residual effect on Groundwater Body WFD status will occur.
No residual effect on Surface Water Body WD status will occur.
Significance of Effects: For the reasons outlined above, no significant effects on or deterioration of the WFD GWB or SWB status, risk status or prejudice to the achievement of the objectives of the WFD will occur as a result of the Project.

10.7.1.16 Potential Effects Associated with Ecological Enhancement Proposals

Post Mitigation Residual Effect: The likely residual effects of the ecological enhancement proposals are considered to be a negative, indirect, imperceptible, temporary, unlikely effect on downstream surface water quality during the planting works and a positive, imperceptible, long-term, indirect, likely effect on downstream surface water quality.
Significance of Effects: For the reasons outlined above and with the application of mitigation measures there will be no significant effects on downstream surface water quality.

10.7.1.17 Potential Effects Associated with Kerry Pipeline Crossing

Post Mitigation Residual Effect: Construction phase activities, and the proposed crossing over the Kerry Pipeline pose a threat to surface water quality in the event of damage to the pipeline and the leakage of effluent on site. However, the works over the pipeline will be of a short duration, have a minimal footprint, and will be completed in accordance with the mitigation measures prescribed in the method statement. Based on the above, the residual effect is considered to be a negative, indirect, imperceptible, temporary, unlikely effect on local surface water quality.

Significance of Effects: For the reasons outlined above and with the application of mitigation measures there will be no significant effects on local surface water quality.

10.7.2 Operational Phase

10.7.2.1 Potential Effects from the Progressive Replacement of Natural Surfaces with Lower Permeability Surfaces

Post Mitigation Residual Effect: With the implementation of the proposed wind farm drainage measures and the bespoke wind farm design, as outlined above, the residual effect is considered to be a negative, imperceptible, direct, long-term, unlikely effect on surface waters including the Charleville Stream and the River Maigue and water dependent ecosystems.

Significance of Effects: For the reasons outlined above, there will be no significant effects on surface waters including the Charleville Stream and the River Maigue and water dependent ecosystems.

10.7.2.2 Potential Effects from Runoff Resulting in Contamination of Surface Waters

Post Mitigation Residual Effects: With the implementation of the proposed wind farm drainage measures as outlined above, and based on the post-mitigation assessment of runoff, the residual effect is considered to be a negative, imperceptible, indirect, temporary, unlikely effect on downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and water dependent aquatic ecosystems.

Significance of Effects: For the reasons outlined above, there will be no significant effects on downstream watercourses (Charleville Stream and River Maigue and their associated tributaries and all other smaller watercourses draining the Site) and water dependent aquatic ecosystems.

10.7.2.3 Potential Effects on Downstream Flood Risk

Post-Mitigation Residual Effects: With the implementation of the proposed wind farm drainage system, the bespoke wind farm design and the proposed flood resilience measures the residual effect is considered to be a negative, imperceptible, indirect, brief, likely effect on proposed wind farm infrastructure as well as upstream and downstream receptors (i.e. property and people).

Significance of Effects: For the reasons outlined above, there will be no significant effects on proposed wind farm infrastructure as well as upstream and downstream receptors (i.e. property and people).

10.7.2.4 Potential Effects from Use of Water Supply at Substation

Post-Mitigation Residual Effects: Due to the scale of the proposed abstraction and the nature of the underlying Locally Important Aquifer, the residual effect is considered to be a direct, negative, imperceptible, permanent, likely effect on local groundwater levels.

Significance of Effects: For the reasons given above, there will be no significant effects on groundwater levels.

10.7.2.5 Potential Contamination Due to Wastewater

Post-Mitigation Residual Effects: The potential for contamination resulting from wastewater disposal is a risk to surface and groundwater quality. This is a risk common to all wind farm sites containing staff welfare facilities. Proven and effective measures to prevent the release of wastewater on site have been proposed above and will the potential source and each receptor. The residual effect is considered to be a negative, imperceptible, indirect, short term, unlikely effect on surface water and groundwater quality.

Significance of Effects: For the reasons given above, and with the implementation of the listed mitigation measures, no significant effects on surface water or groundwater quality will occur.

10.7.2.6 Potential Effects on WFD Status

Post-Mitigation Residual Effects: Mitigation for the protection of surface and groundwater during the operational phase of the Project will ensure the qualitative and quantitative status of the receiving waters will not be significantly altered by the Project.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Project. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration. The Project is not likely to compromise the ability of any SWB or GWB to meet their WFD objectives.

No residual effect on Groundwater Body WFD status will occur.
No residual effect on Surface Water Body WFD status will occur.
Significance of Effects: For the reasons outlined above, no significant effects on WFD GWB or SWB status, risk status or objectives will occur as a result of the Project.

10.7.3 Decommissioning Phase

The residual effects associated with the decommissioning phase will be similar to that for the construction phase but of a reduced magnitude. Therefore, there will be no significant effects as a result of the decommissioning phase of the Project.

10.7.4 Potential Cumulative Effects

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

The main likelihood of cumulative effects is assessed to be hydrological (surface water quality) rather than hydrogeological (groundwater). Due to the hydrogeological setting (*i.e.* predominantly low permeable subsoils and high density of surface water drainage features) and the near surface nature of construction activities, cumulative effects with regard groundwater quality or quantity arising from the Project are assessed as not likely.

The greatest potential for cumulative effects will occur during the construction phase of the Project as this is when earthworks and excavations will be undertaken. The potential for cumulative effects during the operational phase of the Project will be significantly reduced as there will be no exposed excavations, there will be no sources of sediment to reach watercourses, there will be no use of cementitious materials and fuels/oil will be kept to a minimum at the Site. During the decommissioning phase, the potential cumulative effects are similar to the construction phase, but to a lesser degree with less ground disturbance. A cumulative hydrological and hydrogeological study area has been delineated as shown in **Figure 10.11** attached.

The assessment detailed in this chapter is based on flow volumes obtained from the EPA Hydrotool Nodes downstream of the Site. This assessment concludes that there will be no hydrological cumulative effects beyond EPA Hydrotool Node 24_188 on the River Maigue. At this location the River Maigue has a total upstream catchment area of 277km^2. There will be no potential for cumulative effects beyond this cumulative study area due to increases in flow volumes (as the catchment area increases) and increasing distance from the Project.

10.7.4.1 Cumulative Effects with Agriculture

The Site is located in a largely agricultural area and the primary pressures on the River Maigue relate to agricultural practices within its catchment.

Agriculture is the largest pressure on water quality in Ireland. Agricultural practices such as the movement of soil and the addition of fertilizers and pesticides can lead to nutrient losses and the entrainment of suspended solids in local surface watercourses. This can have a negative effect on local and downstream surface water quality. Within the Site itself, agricultural activities will likely be reduced during the construction phase.

In an unmitigated scenario the Project would have the potential to interact with these agricultural activities and contribute to a deterioration of downstream surface water quality through the emissions of elevated concentrations of suspended solids and ammonia.

However the mitigation measures detailed in **Section 10.6.1**, **Section 10.6.3** and **Section 10.6.4** for the construction, operation and decommissioning phases of the Project will ensure the protection of downstream surface water quality.

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

10.7.4.2 Cumulative Effects with Industrial Emissions Licence

An IE licence including emissions to water exists to the south of the Site. This licence (P0386-04) associated with the Rathgoggan North WwTP is held by Kerry Ingredients (Ireland) Ltd and includes discharge of treated effluent to the River Maigue (discharge was formerly to the Charleville Stream but the treated effluent is now piped across the Site and is discharges to the River Maigue just downstream of its confluence with the Loobagh River). However, the licence sets out strict ELVs for several hydrochemical parameters including BOD (20mg/l), COD (75mg/l), suspended solids (35mg/l), Total Nitrogen (15mg/l), Ammonia as N (3mg/l) and Orthophosphate as P (0.5mg/l). Discharge volume limits are also detailed in the IE licence (maximum of 5,000m^3/day). A review of the 2024 AER shows that this facility is operating in accordance with its discharge licence.

Furthermore, the mitigation measures detailed in **Section 10.6.1**, **Section 10.6.3** and **Section 10.6.4** for the construction, operation and decommissioning phases of the Project will ensure the protection of downstream surface water quality and quantity.
The use of a Siltbuster system at the Site can indirectly impact COD levels and could potentially result in cumulative effects with the discharge from Rathgoggan North WwTP (COD ELV of 75mg/l). If the use of chemicals in the Siltbuster system is not carefully

managed it may potentially increase COD in the effluent. However, dosing rates will be small and water quality will be continually monitored to ensure that the correct amount of chemical is added by the dosing system. The use of the Silbuster system, if required, will have an overall positive effect on water quality.

For these reasons we consider that there will not be a significant cumulative effect associated with the existing IE discharge to the Charleville Stream.

10.7.4.3 Cumulative Effects with Other Developments

A detailed cumulative assessment has been completed for all planning applications (granted and awaiting decisions) within the cumulative hydrological study area.

The planning applications identified within the cumulative study area are for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings (refer to **Chapter 2**). Based on the scale of the works, their proximity to the Project and the temporal period of likely works, no cumulative effects will occur as a result of the Project (construction, operation and decommissioning phases).

Other larger developments identified in **Section 2.3.3** are located outside of the cumulative hydrological study area.

10.7.4.4 Cumulative Effects with Other Wind Farms

Section 2.3.2 of the EIAR identified a total of 10 no. wind farms within 20km of the Site of which 7 no. are operational, 1 no. is consented and 2 no. are proposed.

Table 10.21 below identifies whether these wind farms are located within the delineated hydrological study area. Only 1 no. wind farm was identified in the hydrological cumulative study area. This is the operational Slievaragh Wind Farm. This wind farm drains to the Loobagh River and is located at the eastern boundary of the hydrological cumulative study area. There is limited potential for cumulative effects as the Slievaragh Wind Farm is already operational. Nevertheless, the mitigation measures are prescribed in this EIAR chapter will ensure that the Project does not have the potential to result in significant effects on the hydrological/hydrogeological environment.

Therefore, with the implementation of the proposed mitigation measures there will be no cumulative effects associated with the construction, operational or decommissioning phases of the Project with other wind farms within the cumulative study area.

Table 10.21: Wind Farms – Cumulative Assessment

Wind Farm Name	Status	No. Turbines	Distance from Site	Within Cumulative Hydrological Study Area
Rathnacally Wind Farm	Operational	2	c. 5.9km	No Located in Blackwater (Munster) Catchment
Boolard Wind Farm	Operational	2	c. 9.0km	No Located in Blackwater (Munster) Catchment
Kilmeedy Wind Farm	Operational	2	c. 16km	No Located in Shannon Estuary South Catchment and Deel (Newcastlewest)_SC_030 sub-catchment
Slieveragh Wind Farm	Operational	2	c. 19.3km	**Yes** Maigue_SC_020 sub-catchment
Knocknatallig Wind Farm (formerly Buttevant Wind Farm)	Operational	6	c. 11.3km	No Located in Blackwater (Munster) Catchment
Castlepook Wind Farm	Operational	14	c. 14km	No Located in Blackwater (Munster) Catchment
Kilberehert Wind Farm	Operational	3	c. 18.8km	No Located in Blackwater (Munster) Catchment
Annagh Wind Farm	Proposed	6	c. 8.6km	No Located in Blackwater (Munster) Catchment
Tullacondra Wind Farm	Consented	9	c. 20.7km	No Located in Blackwater (Munster) Catchment
Ballinlee Wind Farm	Proposed	17	c. 7.7km	No Located in Maigue_SC_030 sub-catchment

10.7.4.5 Cumulative Effects with OPW Maintenance of Drains

The existing drains and streams at the Site undergo periodic maintenance by the OPW as part of an Arterial Drainage Scheme. This maintenance comprises of periodic de-silting as a control measure to limit flooding. The overlap of construction works associated with the Project and the OPW maintenance works would have the potential to result in cumulative effects on downstream surface water quality, particularly with respect to suspended solids. Consultation will take place with the OPW prior to the commencement of any construction works at the Site to ensure that there is no overlap of works which may potentially have negative effects on downstream surface water quality.

10.7.5 Risk of Major Accidents and Disasters

Flooding can result in downstream MADs. The increased flood risk associated with the Project is outlined in detail in **Sections 10.5.3.3** and **10.6.3.3**. The potential health risks associated with flooding is also discussed in **Section 10.7.6** below.

10.7.6 Assessment of Potential Health Effects

Potential health effects arise mainly through the potential for surface and groundwater contamination which may have negative effects on public and private water supplies. There are no mapped PWS or GWS in the immediate vicinity of the Site. Notwithstanding this, the Project design and mitigation measures ensures that the potential for effects on the water environment will not be significant.

The Bruree PWS and Adara PWS are located downstream of the Site along the River Maigue. The potential effects are assessed above in **Section 10.5.2.13** and **Section 10.6.2.12** and have demonstrated that there is no potential for effects.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues.

A detailed Stage III Flood Risk Assessment has been caried out for the Site, summarised in **Section 10.3.7**. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (**Section 10.5.3.1**) demonstrates that the risk of the proposed works contributing to downstream flooding is insignificant. On-site (construction and operation phase) drainage control measures will ensure no downstream increase in local flood risk.

10.8 ASSESSMENT SUMMARY

The assessment presented in this chapter is summarised as follows:

- The impact assessment is underpinned by a comprehensive geological, hydrological and hydrogeological dataset which includes both desk study information and site-specific geological and hydrological data.
- Site investigations completed to characterise the baseline environment, and to inform the impact assessment included site walkover surveys, drainage mapping, surface

water flow monitoring, surface water quality monitoring, flood modellings, trial pit investigations and geophysical surveys.

- A clearly defined Project design (turbine locations, foundation levels, Access Track alignments, watercourse crossings, hardstand areas) has been development and has been subject to detailed and robust hydrological and hydrogeological environment assessment;
- The design of the wind farm is bespoke and is cognisant of the flood risks at the Site. The Project design includes several flood resilience proposals. Foundation levels have been informed by detailed site-specific flood modelling and analysis has shown that the Project will have no significant effect on the downstream flood risk.
- The drainage design for the Wind Farm and the prescribed mitigation measures are best-in-class, tried and tested mitigation measures for the protection of the local hydrological and hydrogeological regime.
- The findings of the Hydrology and Hydrogeology Chapter are unambiguous, underpinned by site-specific data, and conclude that there will be no significant effects on the hydrological or hydrogeological environment.

10.9 NON-TECHNICAL SUMMARY

This chapter assesses the likely significant effects that the Project (works at the Site, along the GCR and the TDR) may have on hydrology and hydrogeology (i.e. the Water environment) and sets out the mitigation measures proposed to avoid, reduce or offset any potential significant effects that are identified.

The Project comprises of a 9 no. turbine wind farm, with a short Grid Connection (GC) which comprises of a 'loop in' connection to the existing 110kV overhead line (OHL) between Charleville and Killonan, and minor works along the turbine delivery route (TDR).

Regionally, the Site is located in the Shannon Estuary South surface water catchment. This area is drained by the River Maigue and its tributaries. Downstream of the Site the River Maigue flows to the north and becomes tidal at Adare, approximately 20km northeast of the Site.

The bedrock underlying the majority of the Site is classified as a Locally Important Aquifer. This bedrock is of low permeability with short groundwater flowpaths. Some areas in the centre of the Site are mapped to be underlain by a Regionally Important Karst Aquifer.

However, due to the presence of low permeability soils and subsoils, the local hydrogeological regime is characterised by high rates of surface water runoff and low rates of groundwater recharge. There will be no effect on local private groundwater wells as a result of the Project.

Fluvial flood zones are mapped within the Site along the River Maigue and its tributaries. A total of 5 no. turbines and associated access tracks and hardstands are proposed in the mapped flood zones (100-year and 1,000-year flood zones). The Project includes several flood resilience proposals which will limit the potential effects of flooding. Furthermore, a quantitative analysis has shown that the Project will result in the displacement of 9,555m^3 of floodwaters during the operational phase. This equates to an increase in water level of 5 to 6mm across the floodplain. The flood risk assessment concludes that the Project will not result in any significant increase to the downstream flood risk.

Designated sites located downstream of the Project in the Lower River Shannon SAC. Following implementation of the appropriate mitigation measures as outlined in the EIAR no significant effects on this designated site will occur as a result of the Project.

Due to the nature of wind farm developments, being near surface construction activities, effects on groundwater are generally negligible and surface water is the main sensitive receptor assessed during impact assessments. The primary risk to groundwater would be from oil spillage and leakages at turbine foundations or during construction plant refuelling. These are common potential impacts to all construction sites (such as road works and industrial sites). These potential contamination sources are to be carefully managed at the Site during the construction and operational phases of the Project and measures are proposed within the EIAR to deal with these potential minor local impacts. Mitigation measures are also prescribed to protect groundwater quality during the proposed piling works.

During each phase of the Project (construction, operation, and decommissioning) a number of activities will take place at the Site, some of which will have the potential to significantly affect the hydrological regime or water quality at the Site or downstream. These significant potential effects generally arise from sediment input from runoff and other pollutants such as hydrocarbons and cement-based compounds.

Surface water drainage measures, pollution control and other preventative measures have been incorporated into the project design to minimise significant effects on water quality and downstream designated sites. A self-imposed 50m stream buffer was used during the design of the Project, thereby avoiding sensitive hydrological features. The surface water drainage plan will be the principal means of significantly reducing sediment runoff arising from construction activities and to control runoff rates. The key surface water control measure is that there will be no direct discharge of wind farm runoff into local watercourses or into the existing site drainage network. This will be achieved by avoidance methods (i.e. stream buffers) and design methods (i.e. surface water drainage plan). Preventative measures also include fuel and concrete management and a waste management plan which will be incorporated into the Construction and Environmental Management Plan.

No significant effects to surface water (quality and flows) and groundwater (quality and quantity, and any local groundwater wells) will occur as a result of the Project provided the proposed mitigation measures are implemented. This EIAR presents proven and effective mitigation measures to mitigate the release of sediment which will reduce the concentration of suspended solids to acceptable levels. The storage and handling of hydrocarbons/chemicals will be carried out using best practice methods which will ensure the protection of surface and groundwater quality. The proposed wind farm drainage system will be designed to slow surface water runoff from the Site by providing greater attenuation. This will ensure that the Project does not alter downstream surface water flows and will not contribute to downstream flooding.

With the implementation of the mitigation measures detailed in this EIAR there will be no change in the WFD status of the underlying groundwater body or downstream surface waterbodies as a result of the Project. The Project has been found to be fully compliant with the WFD. The Project will not result in the deterioration in the status of any SWB or GWB and will not prevent any waterbody from achieving its WFD objectives.

An assessment of potential cumulative effects associated with the Project and other developments on the hydrological and hydrogeological environment has been completed. With the implementation of the mitigation measures detailed in this EIAR, the cumulative assessment found that there will be no significant effects on the hydrological and hydrogeological environments.

No significant effects on the water environment will occur during the construction, operation or decommissioning of the Project.

10.10 REFERENCES

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