9 HYDROLOGY & HYDROGEOLOGY

9.1 INTRODUCTION

This chapter assesses the impacts of the Project on the receiving hydrologic and hydrogeologic environments. The Project refers to all elements of the application for the construction of the Firlough Wind Farm (FWF), Firlough Hydrogen Plant (FHP) and associated cable connection and delivery routes (**Chapter 2: Development Description**). The assessment techniques used are aimed at identifying hydrological and hydrogeological constraints on the layout of the proposed wind farm, including areas in which development should be avoided and areas in which additional mitigation measures are required. Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Project:

- Construction
- Operation
- Decommissioning

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

- **Figure 9.1a – Site Location & Layout Wind Farm**
- **Figure 9.1a – Site Location & Layout Hydrogen Plant**
- **Figure 9.1c – Project Location and Layout**
- **Figure 9.2a – Surface Water Network Wind Farm**
- **Figure 9.2b – Surface Water Network Hydrogen Plant**
- **Figure 9.3a – WFD Status Wind Farm**
- **Figure 9.3b – WFD Status Hydrogen Plant**
- **Figure 9.4a – WFD Risk Wind Farm**
- **Figure 9.4b – WFD Risk Hydrogen Plant**
- **Figure 9.5 – Surface Water Flow Chart**
- **Figure 9.6a – Surface Water Mapping and Survey Overview Wind Farm**
- **Figure 9.6b – Surface Water Mapping and Survey Overview Grid Connection Route**
- **Figure 9.6c – Surface Water Mapping Interconnector Route**
- **Figure 9.6d – Surface Water Mapping Turbine Delivery Routes and Construction Haulage Routes**
- **Figure 9.6e – Surface Water Mapping and Survey Project Overview**

- **Figure 9.7a – Bedrock Aquifer Wind Farm**
- **Figure 9.7b – Bedrock Aquifer Hydrogen Plant**
- **Figure 9.8a – Groundwater Vulnerability Wind Farm**
- **Figure 9.8b – Groundwater Vulnerability Hydrogen Plant**
- **Figure 9.9a – Designated & Protected Areas Wind Farm**
- **Figure 9.9b – Designated & Protected Areas Hydrogen Plant**
- **Figure 9.10a – SW Network and Water Resources Wind Farm**
- **Figure 9.10b – SW Network and Water Resources Hydrogen Plant**
- **Figure 9.11 – Micro catchments Wind Farm**
- **Figure 9.12a – Constraints Map Wind Farm**
- **Figure 9.12b – Constraints Map Hydrogen Plant**

- **Appendix 9.1 – Site Flood Risk Assessment Firlough Wind Farm**
- **Appendix 9.2 – Site Flood Risk Assessment Firlough Hydrogen Plant**
- **Appendix 9.3 – Preliminary Discharge and Assimilative Capacity Assessment**
- **Appendix 9.4 – Site Photographs**
- **Appendix 9.5 – Surface Water Hydrochemistry Database**
- **Appendix 9.6 – Surface Water Sampling Laboratory Certificates**
- **Appendix 9.7 – Conceptual & Information Graphics**
- **Appendix 9.8 – Firlough Hydrogen Plant – Groundwater Supply Assessment (2022); Minerex Doc. Ref.: 3131-043 (Rev1)**
- **Appendix 9.9 – Safety Material Datasheet-Clearbore**

A live 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 are implemented during the construction, operational phase and decommissioning of the Project.. It will include and apply all of the mitigation described within the EIAR where relevant, and by relevant competent engineers at the detailed design, construction, operational and decommissioning phases of the Project. For the purpose of this application, a summary of the mitigation measures is included in **Appendix 17.1.** The CEMP will be subject to ongoing review, refinement and development throughout the project but subject at all times to fully implementing the mitigation measures specified in the EIAR.

9.1.1 Project Description

The Project comprises the "Proposed Development" the subject of the planning application and consists of the Wind Farm and associated Infrastructure on the Wind Farm Site, the Hydrogen Plant and associated infrastructure on the Hydrogen Plant Site, the Grid Connection, the Interconnector, the Construction Haulage Route, road widening and re-alignment of sections of the Killybegs Turbine Delivery Route/Galway Turbine Delivery Route as well as associated development outside the Redline Boundary not the subject of the planning application but assessed as part of part of this EIAR, including the demolition of and existing house and sheds and the construction of a new house and the modification or street furniture along the portion of both the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route . Further detail on the Proposed Development is outline in **Chapter 2 Section 2.1.**

Watercourse Crossings

Wind Farm Site

New watercourse crossings are associated with the proposed new Wind Farm Site Access Roads. Existing watercourse crossings are associated with existing Wind Farm Site Access Roads and will require upgrading. It total, during the desk-based assessment three (3 no.) watercourse crossings over mapped rivers were identified within the proposed red line boundary of the Wind Farm Site, an additional 10 no. watercourse crossings were identified over significant drainage features associated with peat harvesting activities.

Hydrogen Plant Site

The receiving river (WFD) sub basin/ EPA Ref. Dooyeaghny_or_Cloonloughan_010 runs) parallel, 70 m at the closest point along the south of the Hydrogen Plant Site which forms the Co. Sligo/Mayo County boundary and Carraun (Sligo)/Dooyeaghny (Mayo) townland boundary.

Grid Connection Route

The Grid Connection Route description and associated construction methodology is presented in **Appendix 2.4**.

The proposed Grid Connection Route will include up to six (6 no.) surface water crossings that were identified as part of the desk based study which will require Horizontal Directional Drilling methodology. The remaining water crossings will be crossed utilising either under or over crossing methodology (refer to **Appendix 2.2 Outline Construction Methodology –Firlough Windfarm 110kV Loop-In Grid Connection Report Ref No.: 05806-R01-01).**

Interconnector Route

The proposed Interconnector Route will include up to six (6 no.) surface water crossings that were identified as party of the desk based study.

Killybegs Turbine Delivery Route & Galway Turbine Delivery Route

The Killybegs Turbine Delivery Route will start at the port of Killybegs, County Donegal and utilise the N56, N15, N59, Stockane road to the Wind Farm Site, traversing a length of c. 6.7 km, N59 to the proposed Wind Farm Site, **Figure 9.1a**.

Temporary works will be required to accommodate the delivery of the turbine components. These temporary works are included as part of this application and are located in the townlands of Ballymoghany and Cloonkeelaun. No works associated with the upgrade of the route require works to a watercourse.

Where works are required along the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route within a surface water buffer zone; particular attention is required in relation to the design and methodology of bridges and/or culverts along with their associated risks. Mitigation measures laid out in this Chapter and will be implemented where necessary.

9.1.2 Statement of Authority

Minerex Environmental Limited (MEL), an RSK Group company, was commissioned by Jennings O'Donovan & Partners Ltd. (JOD) on behalf of Mercury Renewables to assess the likely significant effects of the Project on the surrounding hydrology and hydrogeological environment. RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public & private sectors. More information can be found at www.rskgroup.com. The principal members of the RSK EIA team involved in this assessment include the following persons;

- Sven Klinkenbergh – B.Sc. (Environmental Science), P.G.Dip. (Environmental Protection) – Associate, Project Manager and EIA Lead Author with c. 9 years industry experience in the preparation of hydrological and hydrogeological reports.
- Jayne Stephens - B.Sc. (Environmental Science), PhD (Environmental and Infection Microbiology). Current Role: Environmental Consultant with c. 5 years experience.
- Lissa Colleen McClung - B.Sc. Environmental Studies (hons.), M.Sc. Environmental Science (hons.). Current Role: Graduate Project Scientist with c. 1 year experience.
- Mairéad Duffy- B.Sc. Environmental Management, M.Sc. Climate Change. Current Role: Graduate Project Scientist

9.1.3 Assessment Structure

This EIAR chapter is structured as follows:

- This Methodology section discusses and presents how the environmental attributes associated with the Project are qualified in terms of importance and sensitivity, and how the Project effects are qualified and quantified in terms of nature, magnitude, scale, duration etc. This is important to consider and understand when reading the following sections.
- The Baseline Description presents compiled environmental data associated with the Project site/s. This data is used, often in combination with other disciplines (Hydrology, Hydrogeology, Geology and Ecology are often cross referenced) to qualify the importance and sensitivity of the receiving environmental attributes, and where necessary to risk assess hazardous environmental conditions.
- The Assessment of Potential Effects presents and discusses the likely significant effects arising as a product of the Project. The section describes how these effects will arise, and under conservative worst case or an unmitigated scenario, qualifies the effects and impacts in terms of nature, magnitude, scale, duration etc. This section will also comment on whether the effects can be mitigated.
- The Mitigation Measures and Residual Effects section presents and discusses appropriate and practical mitigation measures which will be applied to the Project. Mitigation measures described conceptually in the EIAR chapters, however key design considerations, and most importantly the objective of mitigation measures are included. This is complemented by conceptual and information graphics, which combined with descriptive text, and with reference to sited guidance, will inform the design team and relevant people / engineers in applying the measures to the engineered design and preparing associated management plans. This section also comments on the likely residual effect anticipated on the basis of adequate application of the mitigation measures. The residual effects are then also considered the objectives of mitigation the Project will commit to.
- The Summary of Significant Effects collates and summarises the residual effects arising as a product of the development under a mitigated scenario. Included in this section is a table presenting all of the likely significant effects, their unmitigated qualification, which mitigation measures are applied, and the qualification of residual mitigated effects which are also considered the mitigation objectives the Project is committed to.

This report references appended figures, reports and other data throughout. It is recommended to have the graphics available to view in tandem to reading the report.

9.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

9.2.1 Assessment Methodology

The following calculations and assessments were undertaken in order to evaluate the potential impacts of the Project on the hydrology and hydrogeology aspects of the environment:

- Characterise the topographical, hydrological and hydrogeological regime of the Project from the data acquired through desk study and onsite surveys.
- Water balance calculation.
- Flood risk evaluations.
- Consider hydrological or hydrogeological constraints together with proposed development design.
- Consider drainage issues, or issues with surface water runoff quality as a result of the Project, its design and methodology of construction.
- Assessment of the combined data acquired and evaluation of any likely impacts on the hydrology and hydrogeology aspects of the environment.

Where impacts are identified, measures are described that will mitigate or reduce the identified impact. Findings are presented and reported in a clear and logical format that complies with EPA (2022) *Guidelines on the information to be contained in Environmental Impact Assessment Reports.*

9.2.1.1 General Approach

The Environmental Impact Assessment Report (EIAR) is a comprehensive document that assesses the potential impacts of a proposed project on the environment. It typically includes several fundamental components, including an assessment of baseline conditions, identification of site constraints, evaluation of the proposed development layout, identification of potential unmitigated impacts, and the identification and description of mitigation measures to minimize potential impacts to acceptable levels where possible, and to evaluate likely or expected residual impacts posed by the proposed project.

During the baseline assessment phase, the importance and sensitivity of environmental attributes are qualified relative to each chapter or discipline. This process involves considering available legal instruments, guidance, and relevant information or research to form the basis of qualifying environmental attributes or receptors. Site constraints are also identified during this phase, which are then used to inform the proposed development design.

The frozen layout for the project is then evaluated in terms of its likely impact on the receiving environment. Potential unmitigated impacts are identified and qualified by considering the importance and sensitivity of the receiving environment, as well as the nature, scale, magnitude, and duration etc. of the proposed activity or impact arising from the project.

Once potential impacts have been identified, the EIAR then describes mitigation measures that will be applied to minimize impacts to acceptable levels where possible. These measures are objective-driven and are applied with a view to achieving the desired end result. Mitigation by design, such as avoiding constraints, can help minimize the most significant potential impacts, but residual risks will remain. Therefore, adequate application, design and execution of described mitigation measures, ongoing monitoring, management, and escalation of emergency response mitigation where relevant will be required, and the mitigation measures may need to be redesigned, repeated or re-applied until the objectives of mitigation are being achieved.

Once mitigation measures have been established, the likely residual impacts of the project are then reported. This report is typically presented in an objective, transparent, and comprehensive manner, which is essential to ensure that stakeholders have a clear understanding of the project's potential impacts on the environment.

Mitigation measures which are prescribed in EIAR chapters will be further developed and engineered throughout the project through the detailed design and drafting of management plans such as, Construction and Environmental Management Plans (CEMP) and Surface Water Management Plans (SWMP). Those documents, which will be drafted by suitably qualified engineers, will take mitigation measures and design considerations outlined in this report and apply it to the detailed design and CEMP, SWMP and similar management plans.

9.2.1.2 Objective Led Approach

In the previous section there are two items in particular which will be linked strongly by objectives. For instance; qualifying the importance and sensitivity of an environmental attribute or receptor will align with relevant legal instruments. For example; to qualify surface water features, the EIAR will align with the objectives of the Water Framework Directive (WFD) whereby the objective for surface waters is; *member states must achieve or maintain at least Good status in all water bodies*. This approach equates to qualifying all surface water features as very important and sensitive receptors and that any adverse impact will be viewed as potentially jeopardising the objectives of the WFD.

Similarly, when assessing each of the sites conditions and prescribing mitigation measures, the EIAR will set out to achieve mitigation and residual impact in line with the same objectives. For example, mitigation will set out measures to minimise any potential for contaminants to reach sensitive receptors identified, a system to monitor the efficacy of the mitigation measures applied, and where these measures are failing to achieve the objectives set, emergency response and mitigation measures are escalated until such time as the site stabilises and objectives of mitigation are being achieved once more.

9.2.1.3 Striving for Nature Based Solutions

Similar to objectives for water quality discussed previously, the objectives of the WFD and other instruments also include for other environmental hazards, for example; flooding. For any new development, Flood Risk Assessment will involve two main components, flood risk on site, and the potential to enhance flood risk downstream. In keeping with the objective of WFD and FRA guidance and policy, a new development in a greenfield site will invariably impact adversely on the hydrological response to rainfall whereby, unmitigated there will be a net increase in runoff rates at the site following a storm event, in turn potentially exacerbating flooding in flood risk areas downstream of the project. Despite the fact that the likely net increase will be relatively tiny compared to the runoff and discharge rates at a catchment scale, the objective set by relevant instruments and guidance is that the cumulative nature of these impacts can have significant adverse impacts, and therefore, all developments will set out to not only neutralise any potential net adverse impact, but to strive to attain a net benefit impact where by the Proposed Development will attenuate more than the net increase posed by the project.

The approach to achieving objectives and net beneficial impacts is mainly through the application of Nature Based Solutions. This can include improvements rooted in an ecological context, such as areas designated for ecological improvement, but a development can also be engineered to achieve Nature Based Solutions, for example; the introduction of new drainage networks in greenfield areas has the potential to significantly alter the hydrological regime at the site, but the same drainage network will be engineered to maintain or emulate the baseline hydrological regime in so far as possible. This can be achieved through application of Sustainable Drainage Systems but the design of such systems and drainage network must also be designed and specified in an objective led manner, while also considering constraints that might limit the application or positioning of such features.

9.2.2 Relevant Legislation and Guidance

This study complies with the EIA Directive as amended which requires Environmental Impact Assessment for certain types of development before development consent is granted.

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

- Drinking Water Directives (98/83/EC) on the Quality of Water Intended for Human Consumption and resultant SI No. 122 of 2014 (Drinking Water) Regulations and SI No. 464 of 2017 (Amendment) Regulations.
- Quality Required of Surface Water Intended for Abstraction of Drinking Water (75/440/EEC) and S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009; European Communities Environmental Objectives (Surface Waters) Regulations 2009 SI No. 272 of 2009 as amended (S.I. No. 327 of 2012, S.I. No. 386 of 2015 ,S.I. No. 77 of 2019).
- Dangerous Substances Directive (76/464/EEC) and resultant SI No. 12 of 2001: Water Quality (Dangerous Substances) Regulations
- Quality of Fresh Waters Needing Protection or Improvement in order to Support Fish Life (78/659/EEC) and resultant SI No. 293 of 1988: Quality of Salmonid Waters Regulations
- SI No. 258 of 1998: Water Quality (Phosphorous Regulations)
- The Water Framework Directive (2000/60/EC) and resultant regulations:
  - European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003) as amended (S.I. No. 788 of 2005, S.I. No. 547/2008, S.I. No. 101 of 2009, S.I. No. 272 of 2009, S.I. No. 9 of 2010, S.I. No. 610 of 2010, S.I. No. 489 of 2011, S.I. No. 31 of 2014, S.I. No. 350 of 2014, S.I. No. 386 of 2015.
  - European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009) as amended
  - European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010)
  - European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011)
  - European Union (Water Policy) Regulations 2014 (S.I. No. 350 of 2014)

The Water Framework Directive (WFD), which was enacted by the European Union (EU) in 2000, requires all Member States to protect and improve water quality in all waters so that we achieve good ecological status by 2015, is a wide-reaching piece of legislation which replaces a number of the other water quality directives (for example, those on Water Abstraction) while implementation of others (for example, The Integrated Pollution Prevention and Control and Habitats Directives) will form part of the 'basic measures' for the Water Framework Directive. The fundamental objective of the Water Framework Directive aims at maintaining "high status" of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least "good status" in relation to all waters by 2021* (WFD). (*Current RBMP cycle).

This study had regard to the following guidance documents, which take account of the legislation:

- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) Environmental Good Practice on Site (fourth edition) (C741)
- Enterprise Ireland (n.d.) "Best Practice Guide (BPGCS005) Oil Storage Guidelines"
- Environmental Protection Agency (EPA) (2014) "Guidance on the Authorisation of Direct Discharges to Groundwater".
- EPA (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015 (Supersedes 2003 version)
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Supersedes 1997 and 2002 versions)
- Exploration & Mining Division, Minerals Ireland, Dept. of Communications, Climate Action & Environment (2019) "Exploration Drilling – Guidance on Discharge to Surface and Groundwater".
- Inland Fisheries Ireland (IFI) (2016) "Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters" *Inland Fisheries Ireland*
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- Law, C. and D'Aleo, S. (2016) Environmental Good Practice on Site Pocket Book. (C762) 4th edition. CIRIA
- Masters-Williams, H. et al. (2001) "Control of Water Pollution From Construction Sites. Guidance for Consultants and Contractors (C532)
- Murphy, D. (2004) "Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites" Eastern Regional Fisheries Board

- National Roads Authority (NRA) (2008) "Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes"
- NRA (2008) "Environmental Impact Assessment of National Road Schemes" – A Practical Guide – Rev 1
- NRA (2008) "Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes"
- NatureScot (2019) "Guidance – Good Practice during Wind Farm Construction", *Scotland's Nature Agency.* 4th Edition pp. 1-83.
- Office of Public Works (2009) "The Planning System and Flood Risk Management, Guidelines for Planning Authorities"
- Office of Public Works (OPW) (2013) "Construction, Replacement or Alteration of Bridges and Culverts" Office of Public Works
- Scottish Environment Protection Agency (SEPA) (2010) "Engineering in the Water Environment: Good Practice Guide – River Crossings" *Scottish Environment Protection Agency*
- Scottish National Heritage (SNH) (2018) Environmental Impact Assessment Handbook – Version 5
- Transport Infrastructure Ireland (TII) (2014) "Drainage Design For National Road Schemes - Sustainable Drainage Options".

9.2.3 Desk Top Study

Desk top study assessments were undertaken of the hydrology and hydrogeology aspects of the Project before and after field investigations. This involved the following components:

- Acquisition and compilation of all available and relevant maps of the Project.
- Study and assessment of the proposed locations of turbines, access roads, Wind Farm Substation, Hydrogen Plant Substation, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route Grid Connection Route, Interconnector Route, Construction Haul Route and Hydrogen Plant relative to available data on site topography and slope gradients.
- Study and assessment of the proposed locations of turbines, access roads Wind Farm Substation, Hydrogen Plant Substation, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route, Grid Connection Route, Interconnector Route, Construction Haulage Route and Hydrogen Plant relative to available data on hydrology and hydrogeology.
- Study of geospatial data obtained from various sources including; Environmental Protection Agency (EPA), Geological Survey Ireland (GSI), Teagasc, Ordinance Survey Ireland (OSI), National Parks and Wildlife (NPWS) overlain with the Proposed

Development plan drawings using a Graphic Information System (GIS). Data was assessed at a regional, local and site-specific scale.

- Assessment of relevant additional data was obtained where relevant, for example; rain data obtained from Met Éireann, and river discharge rates and synoptic data sets obtained from the EPA.

9.2.4 Field Work

Field inspections were carried out at the Wind Farm Site and Hydrogen Plant Site during 2020, 2022 and January 2023.These works consisted of the following:

- Site walk over including recording and digital photography of significant features, **Appendix 9.4.**
- Drainage distribution and catchment mapping.
- Field hydrochemistry of the drainage network (electrical conductivity, pH and temperature).
- Recording of GPS co-ordinates for all investigation and monitoring points in the study.
- Baseline sampling of surface water for analytical laboratory testing.

9.2.5 Evaluation of Potential Effects

9.2.5.1 Sensitivity

Sensitivity is defined as the potential for a receptor to be significantly affected by a proposed development [1]. The EPA provides guidance on the assessment methodology, including defining general descriptive terms in relation to magnitude of impacts however, in terms of qualifying significance of the receiving environment the EPA guidance also states that:

"*As surface water and groundwater are part of a constantly moving hydrological cycle, any assessment of significance will require evaluation beyond the development site boundary.*"[2]

To facilitate the qualification of hydrological and hydrogeological attributes, guidance specific to hydrology and hydrogeology as set out by National Roads Authority (NRA) [3], and guidance specific to landscape as set out by Scottish National Heritage (SNH) [4], has been used in conjunction with EPA guidance.

The following table presents rated categories and criteria for rating site attributes:

[1] Environmental Protection Agency (EPA) (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports
[2] Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements DRAFT September 2015. Environmental Protection Agency, Ireland
[3] National Roads Authority (NRA) (2008) Guidelines on the information to be contained in Environmental Impact Assessment Reports
[4] Scottish National Heritage (SNH) (2018) Environmental Impact Assessment Handbook V5

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

Importance	Criteria
Extremely High	Attribute has a high quality, significance or value on an international scale.
Very High	Attribute has a high quality, significance or value on a regional or national scale.
High	Attribute has a high quality, significance or value on a local scale.
Medium	Attribute has a medium quality, significance or value on a local scale.
Low	Attribute has a low quality, significance or value on a local scale.

Considering the above categories of rating importance and associated criteria, the following table presents rated sensitivity categories (SNH, 2018):

Table 9.2: Criteria for Rating Site Sensitivity - Landscape Character Specific

Importance	Criteria
High Sensitivity	Key characteristics and features which contribute significantly to the distinctiveness and character of the landscape character type. Designated landscapes e.g. National Parks, Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs) and landscapes identified as having low capacity to accommodate proposed form of change, that is; sites with attributes of **Very High Importance**.
Medium Sensitivity	Other characteristics or features of the landscape that contribute to the character of the landscape locally. Locally valued landscapes which are not designated. Landscapes identified as having some tolerance of the proposed change subject to design and mitigation, that is; sites with attributes of **Medium to High Importance**.
Low Sensitivity	Landscape characteristics and features that do not make a significant contribution to landscape character or distinctiveness locally, or which are untypical or uncharacteristic of the landscape type. Landscapes identified as being generally tolerant of the proposed change subject to design and mitigation, that is; sites with attributes of **Low Importance**.

9.2.5.2 Magnitude

The magnitude of potential impacts arising as a product of the Project are defined in accordance with the criteria provided by the EPA, as presented in the following table[5]. These descriptive phrases are considered general terms for describing potential effects of the Project, and provide for considering baseline trends, for example; a *Moderate* impact is one which *is consistent with the existing or emerging trends*.

Table 9.3: Describing the Magnitude of Impacts

Magnitude of Impact	Description
Imperceptible	An effect capable of measurement but without significant consequences.
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences.
Slight Effects	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities.

[5] Environmental Protection Agency (EPA) (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports

Magnitude of Impact	Description
Moderate Effects	An effect that alters the character of the environment in a manner that is consistent with existing and emerging baseline trends.
Significant Effects	An effect which, by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment.
Very Significant Effects	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 [6]. 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 9.4: Qualifying the Magnitude of Impact 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
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 >100 mm

[6] National Roads Authority (NRA) (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes

Table 9.5: 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

9.2.5.3 Significance Criteria

Considering the above definitions and rating structures associated with sensitivity, attribute importance, and magnitude of potential impacts, rating of significant environmental impacts is done in accordance with relevant guidance as presented in **Table 9.6**. This matrix qualifies the magnitude of potential effects based on weighting same depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects (**Table 9.3: Describing the Magnitude of Impacts**) are linked directly with the Proposed Development specific terms for qualifying potential impacts (**Table 9.4: Qualifying the Magnitude of Impact on Hydrological Attributes** and **Table 9.5: Qualifying the Magnitude of Impact on Hydrogeological Attributes**). Therefore, qualifying terms (**Table 9.6**) are used in describing potential impacts of the Project. This is largely driven by the likely far reaching characteristic of potential effects arising as a product of the Project in terms of Hydrology and Hydrogeology.

Table 9.6: Weighted Rating of Significant Environmental Impacts

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

9.3 BASELINE DESCRIPTION

9.3.1 Introduction

The Proposed Development associated with the Project is situated upon two separate sites, i.e., the Wind Farm Site and the Hydrogen Plant Site. Other components of the Project are located on lands connecting these sites as well as other discrete locations which are required to facilitate the Project. The following sections describe the location and setting of the Wind Farm Site, the Hydrogen Plant Site and the other lands associated with the Project.

The Proposed Development is 'significant' relative to the historic use of the sites which is characterised as being rural peatland generally, however, there are a number of established wind farms in the region including, for example; Carrowleagh Wind Farm directly to the adjacent (east) and the Bunnyconnellan Wind Farm c. 5 km south of the proposed Wind Farm Site (**Chapter 2, Figure 2.3**).

9.3.2 Site Description

Wind Farm Site

The Wind Farm Site is situated in the townland of Carrowleagh, northeast of the village of Bunnyconnellan, Co. Mayo, Irish Grid Reference (ITM): 536617, 821819. The Wind Farm Site is within the lower northwestern foothills of the Ox Mountains, adjacent to the county boundary between Mayo and Sligo. The site elevations range from 120 m O.D. in the northwest up to c. 170 m O.D. in the southeast, **Figure 9.1a.**

The Wind Farm Site area measures approximately 445 ha and is covered in extensive cutover blanket bog with some forestry to the west and southwest of the boundary. Due to it's historical use, the Wind Farm Site is partially connected via a network of existing access tracks to turf cutting plots, which will require widening for turbine and machinery delivery. In addition to this, there is an extensive drainage network throughout the Wind Farm Site that has been established to facilitate peat cutting in the area.

Hydrogen Plant

The Hydrogen Plant Site is located in a rural setting and has an area of c. 6.5 ha, 0.6 km from the N59 national road. It is located in County Sligo in the townland of Carraun, adjacent to the Co. Mayo border, 6 km west of the Wind Farm Site, **Figure 9.2b.** Site elevations range from 53 m OD at the northwest corner to 45 m OD along the southern boundary. A watercourse runs 70 m at the closest point along the south of the Hydrogen Plant Site which forms the Co. Sligo/Mayo County boundary and Carraun (Sligo)/Dooyeaghny (Mayo) townland boundary.

The Hydrogen Plant Site is pastureland, currently an agricultural field used for grazing horse. There is an area of cutover, boggy peat adjacent to the south of the site boundary which has been avoided. It is 5.3 km northwest of the village of Bunnyconnellan (Co. Mayo) and 2.9 km south of the village of Corballa (Co. Sligo).

Grid Connection Route

The Wind Farm will be connected to the Glenree – Moy 110 kV Overhead Line (OHL) via underground cabling (UGC). The Grid Connection Route will extend approximately 6.65 km in length and traverse in an east to southeasterly direction from the Wind Farm Substation to the Glenree – Moy 110 kV Overhead Line. Approximately 300 m of the Grid Connection Route will follow internal Wind Farm access roads proposed for the Project / Forestry Roads, 375 m of cabling will cross private lands, while c. 5,925 m will utilise the L-5137-9, L-5136-0, L-1102 and along a permanent access track for 355 m to the tie in towers beneath the existing Moy to Glenree OHL in the townland of Rathreedane. The grid connection cable will be buried, with intermittent cable joint bays and other ancillary infrastructure where required. There will be two new 16 m high steel lattice loop-in/out masts at the connection point location.

Interconnector Route

The Interconnector underground cable route will connect the Wind Farm Substation to the Hydrogen Plant Substation, extending 8.2 km. Approximately 1.5 km of the Interconnector Route will follow internal access roads proposed for the Project (Wind Farm Site and Hydrogen Plant Site) while the remaining 6.7 km will utilise the L-5137-9, L-5136-0, L-1102, L-6612 and L-6612-1 in the townlands of Carrowleagh, Carha, Knockbrack and Carraun.

Killybegs Turbine Delivery Route, Galway Turbine Delivery Route and Construction Haulage Route

It is intended that the port of entry for the large turbine components will be Killybegs Port, County Donegal and will utilise the N56, towards Donegal, turning onto the N15 south towards Sligo Town bypassing Ballyshannon and Bundoran and Sligo Town. The route will then turn westwards onto the N59 through Ballisodare and continue towards Ballina. The route will turn towards Stockane along Stockane road for 6.4 km to the proposed Wind Farm Site entrance.

The Galway Turbine Delivery Route will utilise, it is proposed that the turbine nacelles, tower hubs and rotor blades will be landed at Galway Port, County Galway. From there they will be transported to the N83 some 3.0 km north of the harbour. The route primarily follows the national road network namely the N83, N17, N5, N4 and N59 before turning left onto the L-2604-0, L-5137-0 and L-5137-9 towards the Wind Farm Site entrance.

It is understood that temporary works will be required to accommodate the delivery of the turbine components. These temporary works are located in the townlands of Ballymoghany and Cloonkeelaun.

The Construction Haulage Routes will utilise the L6612 and L1102 to facilitate the delivery of materials.

9.3.2.1 Site Walk Over and Observations

Site walk over surveys for the Wind Farm and Hydrogen Plant were tailored in line with the Proposed Development site layout. Photographs obtained during site surveys are presented in **Appendix 9.4.** Site works were conducted between c. June 2020 and 2021 as well as October 2022.

9.3.2.2 Field Work Restrictions

Access at the Wind Farm Site is good given the historic nature of the site (peat harvesting), whereby access tracks have been established from the main road off the both the N59 and R294 through mature forests on to the Wind Farm Site. Access to the proposed Hydrogen Plant Site was also good but limited to the drainage ditch to the southern boundary of the Hydrogen Plant Site where surface water samples were obtained.

9.3.3 Topography

Topography at the Wind Farm Site, is generally flat, with minor undulating fields ranging from c. 110 maOD in the west to 160 maOD to the east of the Wind Farm Site. Topography elevations at the Hydrogen Plant Site range from 53 maOD at the northwest corner to 45 maOD along the southern boundary. A watercourse runs 70 m at the closest point along the south of the Hydrogen Plant Site which forms the Co. Sligo/Mayo County boundary and Carraun (Sligo)/Dooyeaghny (Mayo) townland boundary.

Topography is discussed in greater detail in relation to stability and constraints in **EIAR Chapter 8: Soils and Geology**.

9.3.4 Land Use & Environmental Pressures

Wind Farm

Land use practices on the Wind Farm Site, in consultation with Corine 2018 (GSI, 2022) data indicates the proposed Wind Farm Site is situated over 'Peat bogs' with surrounding 'Coniferous forest' and 'Traditional woodland scrub', and 'Land principally occupied by agriculture with significant areas of natural vegetation', **Chapter 8 Figure 8.2a.** The Wind Farm Site has been significantly impacted by agricultural practices including extensive land improvement works involving drainage and excavation and manipulation of natural soil profiles or horizons. **Appendix 9.4 – Plate 9.**

Hydrogen Plant

Land underlying the proposed location of the hydrogen plant is comprised of Peat Bogs and surrounded by pastoral land **Chapter 8 Figure 8.2b,** and is currently an agricultural field used for grazing horses.

Grid Connection Route

The proposed Grid Connection Route traverses both coniferous forests land along with peat bogs upon exiting the Wind Farm Site and the remaining of its entirety traverses pastures, **Figure 8.2a**.

Interconnector Route

The proposed Interconnector Route similarly traverses both coniferous forestry land along with peat bogs upon exiting the Wind Farm Site (c. 1.3 km), the remaining route to the Hydrogen Plant traverses *pastures* and *peat bogs* until terminating at the Hydrogen Plant Site.

Killybegs Turbine Delivery Route, Galway Turbine Delivery Route and Construction Haul Routes

The land underlying the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route and Construction Haul Routes is a combination of pastoral land, peat bogs and coniferous forests and haul routes traverse 'Coniferous forest' and 'Pasturelands', **Figure 8.2a.**

Land uses present environmental pressures on the hydrological and hydrogeological environmental. The main issue associated with these practices is nutrient loading through deposition of waste, and concentrations will spike through the liberation of nutrients in soils through erosion soils for example; livestock movements or clear felling forested areas. As such, for the purposes of this assessment the impact of nutrient loading in the receiving water environments is coupled with entrainment of solids in runoff, also referred to as Total Suspended Solids.

9.3.5 Regional and Local Hydrology

Surface water networks draining all the elements of the Proposed Development are mapped and presented in **Figure 9.2a, Figure 9.2b, Figure 9.5.**

Wind Farm Site

The proposed Wind Farm Site is situated within both the Moy Catchment, (Catchment ID: 34_01), which has an area of 2,110.72 km^2, and the Easky-Dunneil-Coastal Catchmane (Catchment ID: 35_03), with an area of 359.52 km^2, **Figure 9.2a**.

Surface water runoff associated with the Site drain into two sub catchments and/or three river sub basins, or four no. rivers:

- Sub Catchment: Glenree_SC_010; River Sub Basins: Brusna (North Mayo)_020; Brusna (North Mayo)_010; and Glenree_020
- Sub Catchment: Easky_SC_010; River Sub Basin; Gowlan (Sligo)_010

Surface waters draining to the west of the Wind Farm Site eventually combine in Moy River, from which waters eventually flow to Killala Bay and into the North Atlantic Ocean. Surface waters draining the east of the Wind Farm Site join the Easky River which flows directly to the North Atlantic Ocean, **Figure 9.5.**

Watercourse crossings over mapped rivers at the Wind Farm Site include the following:

- Brusna (North Mayo)_020:
    - **WCC1:** Existing culvert (ITM: 535655.0, 822422.7),

- **WCC2:** Existing culvert (ITM: 535962.07, 822192.53),
- **WCC3:** New; recommend Clear Span Bridge (ITM: 535618.8, 821488.6)

There are a number of identified existing culverts that will also require upgrading at the Wind Farm Site, pending an assessment by a qualified engineer, including:

- **WCC4 and WCC4a:** Existing; (ITM: 536307.9, 820831.0)
- **WCC5:** Existing; (ITM: 536333.6, 820511.8)
- **WCC6:** New; (ITM: 536248.3 821365.5)
- **WCC7:** Existing; (ITM: 536219.8, 821696.3)
- **WCC8:** Existing; (ITM: 535928.1, 822525.1)
- **WCC9:** New; (ITM: 537144.7, 822336.6)
- **WCC10:** Existing; (ITM: 537155.3, 822183.6)
- **WCC11:** New (ITM: 536636.0, 822009.3)
- **WCC12:** Existing; (ITM: 536906.3, 821550.5)
- **WCC13:** New (ITM: 535387.5, 822742.1)

Hydrogen Plant Site

The proposed Hydrogen Plant Site is situated within the Moy Catchment, **Figure 9.2b**.

Surface water runoff associated with this element of the Proposed Development drain into one sub catchments and/or one river sub-basins, or 1 no. rivers:

- Sub Catchment: Leaffony_SC_010;
- River Sub Basins: Dooyeaghny_010, Cloonloughan_010

Surface waters draining the proposed Hydrogen Plant Site eventually combine in Moy River, from which waters eventually flow to Killala Bay and into the North Atlantic Ocean, **Figure 9.5**.

While no watercourse crossings are required as part of the Hydrogen Plant Site development, the drainage design takes into account a discharge point for wastewater from the Hydrogen Plant Site via a formed headwall and outfall pipe directly to the receiving river sub basin.

Grid Connection Route

The proposed Grid Connection Route is also situated within the Moy Catchment **Figure 9.2a**.

Surface water runoff associated with this element of the Proposed Development drain into one sub catchments and/or one river sub-basins, or 1 no. rivers:

- Sub Catchment: Glenree_SC_010;
- River Sub Basins: Brusna (North Mayo)_020; Glenree_020 and Behy (north mayo)_010

Surface waters draining the proposed Development eventually combine in the Moy Estuary, from which waters eventually flow to Killala Bay and into the North Atlantic Ocean.

The identified watercourse crossings along the proposed Grid Connection Route as presented in **Figure: 9.6b** include:

- Brusna (North Mayo)_020
  - **GCR WCC6:** (ITM: 533876.6,822171.4)
  - **GCR WCC5:** (ITM: 532571.2,821960.1)
- Glenree_020:
  - **GCR WCC4:** (ITM: 532665.2, 821361.9)
  - **GCR WCC3:** (ITM: 532457.2, 820870.0)
- Behy (North Mayo)_010:
  - **GCR WCC2**: (ITM: 532509.2, 820278.8)
  - **GCR WCC1:** (ITM: 532738.0, 819171.9)

Interconnector Route

The proposed Interconnector Route is situated within the Moy Catchment **Figure 9.2a.** Surface water runoff associated with this element of the Proposed Development drain into two (2 no.) sub catchments and/or two river sub-basins, or 2 no. rivers:

- Sub Catchment: Glenree_SC_010; Leaffony_SC_010;
- River Sub Basins: Brusna (North Mayo)_020; Dooyeaghny_010_or_ Cloonloughan_010

Surface waters draining the proposed Development eventually combine in the Moy Estuary, from which waters eventually flow to Killala Bay and into the North Atlantic Ocean.

The identified watercourse crossings along the proposed Interconnector Route as presented in figure 9.6c include:

- Brusna (North Mayo)_020
  - **GCR WCC5:** (ITM: 532571.2, 821960.1)
  - **GCR WCC6:** (ITM: 533876.6, 822171.4)

- **ICR WCC4:** (ITM: 532363.8, 822055.4)
- **ICR WCC3:** (ITM: 532067.2, 822288.0)
- **ICR WCC2:** (ITM: 531535.6, 822437.5)
- **ICR WCC1:** (ITM: 531027.8, 822551.4)

Killybegs Turbine Delivery Route and Galway Turbine Delivery Route

Both the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route (TDR) are situated within the Moy Catchment **Figure 9.2a**.

Surface water runoff associated with this element of the Proposed Development drain into three sub catchments and/or three river sub-basins, or 3 no. rivers:

- Sub Catchment: Glenree_SC_010; Leaffony_SC_010; Leffony_SC_010;
- River Sub Basins: Brusna (North Mayo)_010; Brusna (North Mayo)_020; Bellawaddy_020

The portion of both Killybegs Turbine Delivery Route and Galway Turbine Delivery Route coming off the N59 will cross a number of watercourses as presented in **Figure 9.6c**:

- Bellawaddy_020: **TDR WCC1** - (ITM: 532337.0, 826153.5)
- Bellawaddy_010: **TDR WCC2** - (ITM: 533267.9, 825695.6)
- Brusna (North Mayo)_010: **TDR WCC3** - (ITM: 533913.4, 825282.7)
- Brusna (North Mayo)_020: **TDR WCC4** - (ITM: 535009.4, 821949.8)

9.3.6 Site Drainage

Wind Farm Site

The Wind Farm Site is characterised by a relatively extensive network of non-mapped natural and artificial drainage channels. Drainage channels identified during desk study assessment and during site surveys are presented in **Figure 9.6a**. Photographs of some significant features are presented in **Appendix 9.4**.

In line with the extensive drainage network identified, there are a number of existing surface water crossings (culverts and/or bridges). Existing surface water crossings associated with surface water features and relatively significant drainage features identified are presented in **Figure 9.6a**.

Note: Mapping of minor natural or artificial drainage channels has been completed so far as practical, and is not considered fully comprehensive due to some site access constraints (non-existent access tracks, overgrown drainage ditches).

Hydrogen Plant Site

Drainage at the proposed Hydrogen Plant location is limited to approximately 3 no. field drains, an area of cutover, boggy peat adjacent to the south of the Hydrogen Plant Site boundary and the Dooyeaghny_or_Cloonloughan_010 River which runs 70 m at the closest point along the south of the Hydrogen Plant Site.

9.3.7 Water Framework Directive Water Body Status, Risk & Objectives

Details in relation to the Water Framework Directive (WFD) 2016-2021 status and risk assigned to surface waterbodies associated with all elements of the Project are presented in **Figures 9.4a, 9.4b, 9.5a and 9.5b.**

Wind Farm Site

The WFD status (2016-2021) for all surface water bodies / rivers and streams directly draining the Wind Farm Site's redline boundary are classified as 'Good' Status. To the north, further downstream the WFD 2016-2021 status for the river draining the Wind Farm Site (Easky_030), have been classified as 'High', **Figure 9.4a, Figure 9.5**.

Surface water bodies (rivers and streams) draining the north and northwest of Wind Farm Site's redline boundary, or immediately downgradient were found to be not at risk of deteriorating (WFD, 2022). The Glenree_020, directly draining the southern portion of the Wind Farm Site, however, was found the be at risk due to the significant pressures of alterations to the hydro-morphology of the river, **Figures 9.4a, Figure 9.5.**

Groundwater underlying the Wind Farm Site, the Foxford Groundwater body, is classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and not at risk of deteriorating.

Hydrogen Plant Site

The WFD status (2016-2021) for the Dooyeaghny_010 or Cloonloughan_010 rivers directly draining the proposed Hydrogen Plants location is mapped as 'Good' Status before flowing into the Moy Estuary. According to the Catchment Report[7] issued by the EPA, no significant pressures were identified during the 3rd Cycle Draft Assessment. Furthermore, the River Waterbodies Risk is currently under review during this cycle assessment, **Figure 9.4b, Figure 9.5.**

[7] EPA (2021) "3rd Cycle Draft Moy and Kilalla Bay Catchment Report (HA 34)" *Environmental Protection Agency- Catchment Science & Management Unit*. Version no. 1.

Groundwater underlying the Hydrogen Plant Site, the Foxford Groundwater body, is classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and not at risk of deteriorating.

Grid Connection Route

Similar to the above, the WFD status (2016-2021) for surface water bodies associated with the GCR (Brusna (North Mayo)_020, Glenree_020 and Behy (North Mayo)_010) are mapped with 'Good' Status. The only river at risk of deteriorating, as stated above is the Glenree_020, **Figure 9.4a, Figure 9.5**.

Groundwater underlying the Grid Connection Route, the Foxford Groundwater body and Ballina Gravels Group 1 are classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and are not at risk of deteriorating.

Interconnector Route

Similar to the above, the WFD status (2016-2021) for surface water bodies associated with the Interconnector Route (Brusna (North Mayo)_020, Dooyeaghny_010 or Cloonloughan_010 are mapped with 'Good' Status, **Figure 9.4a,**

Groundwater underlying the Interconnector Route, the Foxford Groundwater body and Ballina Gravels Group 1 are classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and are not at risk of deteriorating.

Killybegs Turbine Delivery Route and Galway Turbine Delivery Route

The WFD status (2016-2021) for surface water bodies associated with both the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route; Brusna (North Mayo)_010 and Brusna (North Mayo)_020 are mapped with 'High' and 'Good' Status, respectively. The Bellawaddy_020 is also mapped as having 'Good' status, encompassing the northern-most portion of section of the turbine delivery route common to for Killybegs and Galway **Figure 9.4a.**

Groundwater underlying the Interconnector Route, the Foxford Groundwater body and Ballina Gravels Group 1 are classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and are not at risk of deteriorating.

9.3.8 Surface Water Hydrochemistry

Wind Farm Site

Baseline surface water sampling was carried out at four 4no. locations at the proposed Wind Farm Site, **Figure 9.6a** which are representative of drainage and surface water network channels associated with the Wind Farm Site (**Figure 9.2a**), refer also to Site Photographs **Appendix 9.4 – Plates 1-4.** Laboratory certificates for surface water samples for both the Wind Farm Site and Hydrogen Plant Site are presented in **Appendix 9.6**.

With reference the Wind Farm Site specific Surface Water Hydrochemistry Database, **Appendix 9.5,** surface water quality observed at all 4 no. monitoring locations (**Figure 9.6a**), related to the Wind Farm is of similar standard and is generally of good quality when screened against relevant reference concentrations, however the following is noted:

- Ammoniacal Nitrogen as N was elevated above the relevant reference concentration (0.02 mg/L Ammoniacal Nitrogen as N) at all monitoring locations (Min Max Range; 0.0168 – 0.068 mg/L Ammoniacal Nitrogen as N). Elevations occurred during at least two out of four monitoring events for all monitoring, ranging up to four of four monitoring events at a number of locations.
- pH was below the relevant reference range (pH 4.5 – 9) at SW2 (pH 4.87) during the 12/08/2021 sampling event.

Elevated concentrations of Nitrogen compounds (Ammoniacal Nitrogen) as observed at all monitoring locations is indicative of historic and current land practices at the site, **(Chapter 8 Figure 8.2)**. Low pH in surface water can be attributed to a range of environmental characteristics and pressures, including the presence of peat (**Chapter 8: Soils and Geology**).

Hydrogen Plant Site

In terms of the Hydrogen Plant the 2 no. monitoring locations (upstream and downstream of the proposed Development), surface water quality observed at both locations was of good quality, and did not exceed any Environmental Quality Standards (EQS). With the exception of Mercury in the surface water samples, which potentially* exceeds the EQS of 0.07 µg/l. *(Surface water samples indicated <1 ug/l i.e. below the laboratory Limit of Detection (LOD) for surface water of <1 ug/l. The LOD for Mercury is above the Environmental Quality Standard 0.07 ug/l). The Mercury concentrations in groundwater samples were below the laboratory LOD <0.01 ug/l, therefore although surface water baseline conditions includes potential for elevated Mercury, the Hydrogen Plant Site will not contribute significant additional concentrations of Mercury. The source of mercury in the surface water samples is situated some place upstream of the Hydrogen Plant Site.

9.3.9 Hydrogeology – Bedrock Aquifer

Consultation with GSI (2022) Groundwater maps indicates that all elements of the Wind Farm Site and Hydrogen Plant Site are underlain by a Locally Important Bedrock Aquifers (LI), that is; bedrock which is moderately productive only in local zones. This bedrock aquifer, the Ballina Limestone Formation (Lower), encompasses an area of 102 km^2, **Figure 9.7a, Figure 9.7b.**

The closest mapped karst features within 10 km of the Proposed Development is one 1 no. spring c. 7 km north of the Wind Farm Site. No other karst features were identified during the desk top assessment which would impact any portion of the Proposed Development during the construction or operational phases.

9.3.10 Groundwater Vulnerability & Recharge

Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels. These factors are controlled by the types of subsoil that overlie the groundwater, the way in which the contaminants recharge the geological deposits (point or diffuse source) and the unsaturated thickness of geological deposits from the point of contaminant discharge.

Where low permeability subsoil overlies the bedrock, it is the thickness of subsoil between the release point of contaminants and bedrock that is considered when assessing vulnerability of bedrock aquifers, regardless of whether the low permeability materials are saturated or not. The GSI vulnerability mapping guidelines allow for the assignment of vulnerability ratings from "extreme" to "low", depending upon the subsoil type and thickness. With regard to sites where low permeability subsoil is present, the following thicknesses of unsaturated zone are specified (GSI, 2022).

Table 9.7: Groundwater Vulnerability Ratings

Vulnerability Rating	Thickness of unsaturated zone (m)
Rock at or Near Surface (X)	0
Extreme (E)	0 to 3
High (H)	3 to 5
Moderate (M)	5 to 10
Low (L)	>10

Wind Farm Site

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the proposed Wind Farm Site itself is underlain by an area classified as 'Moderately Productive Bedrock (LI)' with a vulnerability rating which ranges from 'Low' to 'Moderate' Vulnerability. The eastern half of the Wind Farm Site is classified as Moderate Vulnerability while the remaining western portion of the Wind Farm Site is classified as 'Low' Vulnerability, **Figure 9.8a**).

The potential groundwater recharge rate (recharge coefficient) for the local area, as mapped by GSI, ranges significantly depending on the underlying soil / subsoil type, and varies significantly relative to the thickness of overburden or aquifer vulnerability. The underlying Locally Important Bedrock will therefore have an inferred maximum recharge capacity per annum assigned, that is; effective rainfall available for recharge but in excess of maximum recharge capacity will form rejected recharge once conditions become saturated. Peat has very low permeability, however peat stores large amounts of water, that is; bog water levels in intact peatland areas are generally near the surface[8]. Combining these factors results in the Wind Farm Site being characterised by low recharge rates and high surface water runoff rates.

The Locally Important Aquifer (LI) underlain the Wind Farm Site possess a maximum annual recharge capacity of c. 37 mm/yr effective rain fall. This is calculated from the effective rainfall of the area (922.50 mm) with a recharge coefficient of 4.00%. This recharge coefficient is considered very low[9].

Considering all of the above, the Wind Farm Site is characterised by low to very low recharge rates in overburden (soils/subsoils) and very low recharge capacity in the underlying bedrock aquifer. This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the Wind Farm Site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally. As such, the surface water network associated with the Wind Farm Site is characterised as having a rapid hydrological

[8] Labadz J, et al (2010) Peatland Hydrology. Draft Scientific Review, IUCN UK Peatland Programme's Commission of Inquiry on Peatlands. UK.
[9] Williams N. H., et al. (2011) A NATIONAL GROUNDWATER RECHARGE MAP FOR IRELAND. National Hydrology Conference 2011, Ireland.

response to rainfall. This is indicative of lands comprising of blanket peat or catchments with elevated peat cover [10] [11].

Hydrogen Plant Site

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the proposed Hydrogen Plant Site is underlain by an area classified as 'Moderately Productive Bedrock (LI)' with a vulnerability rating of 'High' Vulnerability, **Figure 9.8b**. The Locally Important Aquifer (LI) underlain the Hydrogen Plant Site possess a maximum annual recharge capacity of c. 68.5 mm/yr effective rain fall. This is calculated from the effective rainfall of the area (684.60 mm) with a recharge coefficient of 10.00%. This recharge coefficient is considered low. A more detailed interpretation of character and recharge rates of the groundwater body for the Hydrogen Plant Site is presented in **Appendix 9.3 – Preliminary Discharge and Assimilative Capacity Assessment.**

Grid Connection Route

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the proposed Grid Connection Route is underlain by an area classified as 'Moderately Productive Bedrock (LI)' with a vulnerability rating range from 'Moderate' to 'High' Vulnerability, **Figure 9.8a**.

Interconnector Route

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the proposed Interconnector Route is underlain by an area classified as 'Moderately Productive Bedrock (LI)' with a vulnerability rating range from 'Moderate' to 'High' Vulnerability, **Figure 9.8a**.

Killybegs Turbine Delivery Route and Galway Turbine Delivery Route

Consultation with the GSI Groundwater Map Viewer (2022) indicates that the section of the turbine delivery route common to Killybegs and Galway turbine delivery route is underlain by an area classified as 'Moderately Productive Bedrock (LI)' with a vulnerability rating range from 'Low' to 'High' Vulnerability, **Figure 9.8a.**

9.3.11 Flood Risk Identification

A stand alone Site Flood Risk Assessment (SFRA) Stages 1 & 2 for the Wind Farm Site and Hydrogen Plant Site have been prepared as part of this EIAR, the report is presented in **Appendix 9.1 – Site Flood Risk Assessment Firlough Wind Farm and Appendix 9.2**

[10] Misstear B., Brown L. (2008) Water Framework Directive – Recharge and Groundwater Vulnerability. EPA STRIVE Report, EPA, Ireland.
[11] Jennings S. (2008) Further Characterisation Study: An Integrated Approach to Quantifying Groundwater and Surface Water Contributions of Stream Flow, RPS, Ireland

– Site Flood Risk Assessment Firlough Hydrogen Plant. This FRA assessment details site-specific rainfall and evapotranspiration rates as well as a preliminary water balance assessment for the estimated baseline runoff conditions and the estimated post Development conditions at both sites.

9.3.12 Groundwater Levels, Flow Direction & Groundwater Hydrochemistry

Wind Farm Site

Groundwater levels have not been assessed on the Wind Farm Site due to the shallow nature of the development excavation, max depth c. 2.85 m (turbine foundations) with minimal risk to groundwater and associated receptors. Bog water levels have not been assessed as part of this study. Peat at the Wind Farm Site is generally thin / superficial, with some deeper pockets of peat. Extensive peat cutting an associated drainage will have impacted in bog water levels significantly (**Chapter 8: Soils & Geology**).

Hydrogen Plant Site

In regard to the Hydrogen Plant Site, as part of feasibility assessment works, a Site Investigation and Groundwater Resource Assessment was carried out by Minerex Environmental Ltd, Minerex Doc. Ref.: 3131-043 (Rev 1) Date: 28/10/2022, which indicates groundwater levels and c. 50-80 m below ground level. Standing water and some saturated areas are observed in the peatland area immediately south of proposed Hydrogen facility. The Minerex report also notes the occurrence of 2 no. springs discharging into the neighbouring tributary catchment to the west of the proposed Hydrogen Plant Site. Water demand requirements for the Hydrogen Plant will be variable month to month depending on wind energy production. Water supply for the Hydrogen Site is outlined in **Chapter 2 Section 2.6.6.3,** where the abstraction of Groundwater combined with rain water harvesting is specified.

Groundwater flow directions are presumed to follow the topography of the area. Groundwater flow paths are considered to be short due to the underlying bedrock aquifer being poorly productive. Therefore, groundwater flow likely circulates in the upper overburden, recharging and discharging in local zones, thus the groundwater is considered to be young.

Groundwater underlying all elements of the Wind Farm Site and Hydrogen Plant Site design, the Foxford Groundwater body, are classified as having a 'Good' status during the 2016-2021 WFD assessment (Cycle 3) and not at risk of deteriorating. Due to the absence of any recorded groundwater quality data within or proximal to the study area, no published data on groundwater quality for the Wind Farm Site or Hydrogen Plant Site is available. The Ballina Gravels Group 1, making up the Foxford Groundwater body, underlying portions of the Grid Connection Route and Interconnector Route are classified as having a 'Good' status during the 2016-2021 WFD assessment cycle and are not at risk of deteriorating.

9.3.13 Designated Sites & Habitats

Designated and Protected areas associated with Wind Farm Site and Hydrogen Plant Site are detailed in **Figure 9.5** and presented in **Figures 9.9a and 9.9b**.

Wind Farm Site

The Wind Farm Site is not positioned within any designated or protected area (SPA, SAC, NHA). However, directly adjacent to the land holding is the Ox Mountains Bogs SAC (EU_Site_Code:IE0002006) and Ox Mountains Bogs Proposed Natural Heritage Area. Surface waters draining the east of the Wind Farm Site (Gowlan (Sligo)_010 flow through this SAC. Further downstream, surface waters draining the west of the Wind Farm Site eventually meet the River Moy SAC, c. 12 km west, **Figure 9.9a.**

Hydrogen Plant Site

The Hydrogen Plant Site is not positioned within any designated or protected area (SPA, SAC, NHA). However similar to the proposed Wind Farm Site it is hydrologically linked to the Killala Bay / Moy Estuary SAC/SPA, c. 2.29 km to the south **Figure 9.9b.** The Killala Bay/Moy Estuary Proposed Natural Heritage Area (pNHA) is located c. 6.29 km to the west of the Hydrogen Plant.

Grid Connection Route

The Grid Connection Route is not positioned within any designated or protected area (SPA, SAC, NHA). However, it is hydrologically linked to the River Moy SAC, Killala Bay / Moy Estuary SAC/SPA/NHA, **Figure 9.9b.**

Interconnector Route

The proposed Interconnector Route is not positioned within any designated or protected area (SPA, SAC, NHA). However, it is hydrologically linked to the River Moy SAC, Killala Bay / Moy Estuary SAC/SPA/NHA, **Figure 9.9b.**

Killybegs Turbine Delivery Route and Galway Turbine Delivery Route

The Killybegs Turbine Delivery Route is not positioned within any designated or protected area (SPA, SAC, NHA). However, both turbine delivery routes are hydrologically linked to the River Moy SAC and Killala Bay / Moy Estuary SAC/SPA/NHA, by way of both the Glenree_020 and the Bellawaddy_020 **Figure 9.9a.** Galway Turbine Delivery Route passes through several designated or protected areas, however given that there are no works outlined on this route, this remains out of the scope of assessment.

9.3.14 Water Resources

Drinking water rivers designated in accordance with European Communities (Drinking Water) (No. 2) Regulations 2007 (SI no. 278/2007) are protected for the purposes of drinking water abstraction, however no such surface water bodies were identified within the Wind Farm Site, Hydrogen Plant Site, Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route nor downstream of these sites. Furthermore, no National Federation of Group Water Schemes (NFGWS) or GSI Public Supply Source Protection Areas were identified within nor in the vicinity of the Wind Farm Site or the Hydrogen Plant Site, **Figures 9.10a and 9.10b.**

Groundwater is however nationally protected under the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. no. 278/2007).

Groundwater as a resource or source for the production hydrogen has been assessed at the Hydrogen Plant Site. A Groundwater Resource Assessment was carried out by Minerex Environmental Ltd/ (**Appendix 9.8**) includes Pump Tests and groundwater quality analysis in a series of 8 no. boreholes drilled on or adjacent to the Hydrogen Plant Site. A constant rate discharge pumping test carried out over approximately 546 hours concluded that a sustainable yields of 2.25 l/s (194 m^3/d) and 0.44 l/s (38 m^3/d) have been established for Boreholes 6 and 7, respectively, with a cumulative yield of 232 m^3/d (84,680 m^3/yr) which is consistent with the two boreholes being able to meet the water demand of the plant (annual water budget of 66,256 m^3 or 182 m^3/d used for assessment).

9.3.15 Wells

Consultation with GSI well database (2022) indicates that the Wind Farm Site, Hydrogen Plant Site, Grid Connection Route and Interconnection Route do not intersect with any mapped well buffer zones (250 m).

One 1 no. borehole was identified along both the turbine delivery routes redline boundary, on the L-2604-0. The identified borehole, (GSI Ref. 1131NEW006) is sourced for agricultural and domestic use **Figures 9.10a**. This well is the closest mapped well to the Wind Farm Site at approximately 5 km distance.

The closest mapped well (GSI Ref. 1131NEW005, Agri & domestic use) to the Hydrogen Plant Site is approximately 1.1 km to the north (**Figure 9.10b**).

Governing industry guidelines stipulate a buffer zone of 250 m is required for abstraction boreholes.

Temporary works will be required to accommodate the delivery of the turbine components, along both the turbine delivery routes in the townlands of Ballymoghany and Cloonkeelaun, however the closest proposed works are located c. 850 m from the identified borehole.

9.3.16 Receptor Sensitivity

All receptors associated with the Project i.e. streams, rivers, and groundwater, are considered highly sensitive receptors when considering;

- Water Framework Directive (WFD) status (2016-2021) of 'Good', with some sections ranging to 'High'. The WFD objective to protect waterbodies with at least Good status by the next review period (2027).
- Sensitive protected areas e.g. SAC, SPA associated with the catchment and the sensitive habitats and species associated with same.
- The designation of all waterbodies within the Redline Boundary and downstream surface water bodies and all groundwater bodies as sources of drinking water.

The Water Framework Directive (WFD), which was passed by the European Union (EU) in 2000, requires all Member States to protect and improve water quality in all waters with the aim of achieving good ecological status between 2015 and 2027, is a wide-reaching piece of legislation which replaces a number of the other water quality directives.

Ultimately, all surface waters and groundwaters associated with the Project are considered sensitive and important attributes in their own right and must be protected in accordance with the WFD. In that context, all waters are considered to be Medium to High Sensitivity attributes and of High to Very High importance. However, waters associated with designated and protected areas should be considered the highest in the scale, that is; High Sensitivity and Very High Importance.

Risk to receptors must consider both the hazard, and likelihood of adversely impacting on any given sensitive receptor, and therefore parameters such as; distance from potential source of hazard to receptor (buffer zones for example), pathway directness and/or connectivity, and assimilative capacity of the receiving water body will also be considered.

In terms of groundwater sensitivity and susceptibility, as discussed in previous sections, all groundwater associated with the Wind Farm Site and the Hydrogen Plant Site is protected as a source of drinking water, under the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. no. 278/2007). However, the bedrock aquifers underlying the site and surrounding area is that of Local Importance (LI), which can be expressed as an aquifer with relatively low to moderate production and connectivity, and therefore the risk of potential adverse impacts on groundwater will be limited to localised zones.

In terms of surface water sensitivity, as stated above, the vast majority of potential contaminants or unmitigated adverse impacts will infiltrate to surface water bodies, however sensitive receptors are of variable distance from the Proposed Development and the pathways are of variable condition for each proposed element of the Proposed Development. Should tributary streams carry contaminants from the Wind Farm Site (in absence of mitigation) during construction, operational and/or decommissioning, there is receptors such as blanket bog which ['Ecosystem function: soil nutrients' (see Conservation Objectives Report for site)], could be affected adversely were the stream to be in flood and affect the pH and nutrient status of adjoining bog. There is no ecological connectivity between the Ox Mountains SAC and the Hydrogen Plant and Interconnector Route, the Grid Connection Route and/or the Killybegs Turbine Delivery Route or Galway Turbine Delivery Route.

9.3.17 Grid Connection Route

The Grid Connection Route description and associated construction methodology is presented in **Appendix 2.4.**

The Wind Farm will be connected to the existing Glenree – Moy 110kV Overhead Line (OHL) via underground cabling (UGC). The Grid Connection Route is approximately 6.65 km in length and traverse in a east to southeasterly direction from the Wind Farm substation to the existing Glenree – Moy 110kV OHL. Approximately 250 m of the Grid Connection Route will be within the Wind Farm Site, 6,040 m will be located along the public road corridor and 355 m will be located off road in third party lands, utilising public local road networks and existing access tracks, **Figure 9.1a.** There will be two new 16 m high steel lattice loop-in/out masts at the connection point location. They will be 6.196 m wide and will require 4 x 3.6 m^2 foundation stands that have a total width of 10.7 m.

- Section 1 of the Grid Connection Route will contain (8 no.) joint bays, (3 no.) Horizontal Directional Drilling (HDD) locations to cross existing watercourses and (1 no.) culvert crossings.
- Section 2 of the Grid Connection Route will contain (8 no.) joint bays, (1 no.) HDD location to cross existing watercourses and (3 no.) culvert crossings.

The Grid Connection Route will include up to 4 no. surface water crossings that were identified as part of the desk based study which will require Horizontal Directional Drilling methodology. The remaining water crossings will be crossed utilising either under or over culvert crossing methodology (refer to **Outline Construction Methodology –Firlough Windfarm 110kV Loop-In Grid Connection Report Ref No.: 05806-R01-01).**

Identified watercourse crossings along the proposed Grid Connection Route include:

- Brusna (North Mayo)_020
  - **GCR WCC6:** (ITM: 533876.6,822171.4)
  - **GCR WCC5:** (ITM: 532571.2,821960.1)
- Glenree_020:
  - **GCR WCC4:** (ITM: 532665.2, 821361.9) (Loughnagore Stream, HDD)
  - **GCR WCC3:** (ITM: 532457.2, 820870.0) (Glenree Stream, HDD)
- Behy (North Mayo)_010:
  - **GCR WCC2**: (ITM: 532509.2, 820278.8) (Fiddaun Stream, HDD)
  - **GCR WCC1**: (ITM: 532738.0, 819171.9) (Srafaungal River, HDD)

9.3.18 Interconnector Route

The overall length of the interconnector from the Wind Farm Substation to the Hydrogen Plant Substation is 8.2 km, of which 6.7 km is located along the public road corridor, 0.44 km is in the Wind Farm Site along existing roads and the remaining 1.05 km is located off road in third party lands. The Interconnector Route will include up to six (6 no.) surface water crossings which include:

- Brusna (North Mayo)_020
  - **GCR WCC5:** (ITM: 532571.2, 821960.1)
  - **GCR WCC6:** (ITM: 533876.6, 822171.4)
  - **ICR WCC4:** (ITM: 532363.8, 822055.4)
  - **ICR WCC3:** (ITM: 532067.2, 822288.0)
  - **ICR WCC2:** (ITM: 531535.6, 822437.5)
  - **ICR WCC1:** (ITM: 531027.8, 822551.4) (HDD)

Similar to the Grid Connection Route, an interconnector cable will be laid to connect the Firlough Wind Farm substation to the Hydrogen Plant substation. One location along the Interconnector Route will require a Horizontal Directional Drilling (HDD) technique to cross the Brusna (North Mayo)_020.

9.3.19 Killybegs Turbine Delivery Route, Galway Turbine Delivery Route and Construction Haulage Route

The Killybegs Turbine Delivery Route starts at the port of Killybegs, County Donegal and utilises the N56, N15, N59, Stockane road to the Wind Farm Site, traversing a length of 6.7 km, N59 to the proposed Wind Farm location, **Figure 9.1c.**

The Galway Turbine Delivery route starts at Galway Port, County Galway and utilises the N83 for 3.0 km north of the harbour, before taking the N17, N5, N4, N59 and Stockane road L-2604-0, L-5137-0 and L-5137-9 towards the Wind Farm Site entrance, **Figure 9.1c**.

Upgrade works will be required to accommodate the delivery of the turbine components. These temporary works along the L6612 off the N59 on the turbine delivery route from Killybegs Port and Galway Port to include the following to facilitate the delivery of abnormal loads and turbine component deliveries, which include:

- Improvement of the N59 and L-6612 junction in the townland of Ballymoghany to include for the temporary widening of it. The associated accommodation works will include the installation of new drainage pipes, the construction of a 1.2 m high concrete retaining wall and the erection of timber stock proof fencing and 2 no. agricultural gates.
- Localised widening of the L-6612 road in the townland of Cloonkeelaun. The associated accommodation works will include the construction of a 1.2 m high concrete retaining wall and the erection of concrete post and timber rail stock proof fencing and 2 no. agricultural gates.

Both turbine delivery routes will cross 4 no. watercourses:

- Bellawaddy_020
    - **TDR WCC1:** (ITM: 532337.0, 826153.5)
- Bellawaddy_010
    - **TDR WCC2:** (ITM: 533267.9, 825695.6)
- Brusna (North Mayo)_010
    - **TDR WCC3:** (ITM: 533913.4, 825282.7)
- Brusna (North Mayo)_020:
    - **TDR WCC4:** (ITM: 535009.4, 821949.8)

No upgrade works are necessary on the Construction Haulage Routes (L6612 and L1102) to facilitate the delivery of materials. As outlined in **Chapter 15, Section 15.4.4**.

9.4 ASSESSMENT OF POTENTIAL EFFECTS

This section can be broken down into the following sub-sections:

- How potential effects are classified in terms of Magnitude on surface waters
- How potential effects are classified in terms of Magnitude on Groundwater
- The 'Do Nothing' impact
- Impacts of Climate Change
- Assessments of All potential effects on Hydrology and Hydrogeology during the construction, operational phase and decommissioning of the Project.
- The effects are outlined, summarized and the following **Section 9.5** will outline the mitigation measures for these effects and then state the residual effects.

9.4.1 Assessing the Magnitude of Potential Effects – Surface Water

The receiving environment associated with the Project is considered as ranging from Low to Very High Sensitivity. With reference to **Section 9.2.5**, receptor sensitivity is qualified as follows:

- Surface Water; Very High
- Groundwater; Bedrock Aquifer; Low
- Bog Water - In areas of cut over peat or where existing drainage networks exist; Medium

To account for this, the potential impacts associated with the Project will be limited to Magnitudes associated with respective environmental characteristics, as presented in the **Table 9.8.**

Table 9.8: Magnitude of potential impacts relative to receptor sensitivity

Sensitivity (Importance of Attribute)	Magnitude of Impact				
	Negligible (Imperceptible)	Small Adverse	Moderate Adverse	Large Adverse	
Very High (Surface water, Bog water in intact or designated peat)	Imperceptible	Significant / Moderate		Profound / Significant	Profound
Medium (Bog water in existing impacted areas)	Imperceptible	Slight		Moderate	Significant
Low (Groundwater, relative to the scale of the site)	Imperceptible	Imperceptible		Slight	Slight / Moderate

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

9.4.2 Assessing the Potential Magnitude of Potential Effects – Groundwater

9.4.2.1 Bog Water Levels

Peatlands in Ireland, have been fragmented and drained by a long history of exploitation. Drawdowns in groundwater levels in peatbog areas are directly linked to peripheral drainage in peatland area. Deep-cut drainage channels have been observed intercepting regional groundwater flows and identified as a zone for continuous groundwater discharge[12]. As was noted over a 28-year record, Clara Bog demonstrated the impact of peripheral groundwater drainage (caused by marginal peat cutting) on uncut raised bog hydrology which revealed an elongated groundwater catchment area with a lateral hydraulic gradient underlying the bog[25]. The actual scale of impact of cut drains on groundwater levels can be highly variable at any particular location, ranging from <5 m to >100 m, as was seen at Clara Bog; despite the bog having little in the way of surface drainage, groundwater subsidence levels of >1 m were measured up to 170 m from the bog margin and decrease to >0.1 up to 900 m at varying locations. The Wind Farm has the potential to impact on bog water levels proximal to excavations and/or drainage channels. Existing drainage at the Wind Farm Site, particularly in cutover peat, forestry and agricultural areas, are intended to drain the respective area, however existing tracks and adjacent drains can also impact on bog water levels. Lowering of the water table in peat lowers the potential for peat growth i.e., sub-optimal conditions. This will lead to the gradual decline in productivity in the acrotelm (living layer of peat), and in time the degradation of the drained peat area, potentially leading to erosion.

The scale of the impact is dependent on the depth of the excavation in question and subsequent lowering of the water table at the location. This can vary depending on the underlying characteristics of the development. In peat the impact can be minimal in scale initially but over time and as the acrotelm layer degrades and recedes the impact can continue to progress slowly/chronically, potentially leading to profound impacts in worst

[12] Regan, S., Flynn, R., Gill, L., Naughton, O. and Johnston, P. (2019). "Impacts of groundwater drainage on peatland subsidence and its ecological implications on an Atlantic raised bog", *Water Resources Research.* Vol 55(7) pp. 6153-6168.

case scenarios. However, it is noted that the Wind Farm Site is characterised by shallow peat or peaty soil generally with isolated areas of deeper saturated peat (**EIAR Chapter 8: Soils and Geology**). Therefore, the scale of such impact is likely limited to the extent of those isolated pockets if impacted. Furthermore, the Wind Farm Site is generally characterised as having extensive existing drainage features, and therefore impacts arising from drainage can be in line with baseline conditions.

With appropriate environmental engineering controls and measures (i.e. Mitigation measures), these potential risks can be significantly reduced. Furthermore, in areas impacted by draining activities, if considered adequately mitigation measures have the potential to have a positive impact on bog water levels, particularly in places already impacted by drainage.

9.4.2.2 Groundwater Levels Wind Farm

Groundwater levels are unlikely to be impacted to a significant extent due to:

- Baseline conditions i.e. upland area, locally important poor aquifer with moderate productivity and indicative low groundwater recharge.
- Characteristics of the development i.e. excavations will generally be shallow and any potential dewatering will likely be for short duration. Deeper excavations will potentially encounter groundwater, however due to the Baseline character volumes will likely be low and dewatering of such locations will not impact groundwater levels to a significant extent.

9.4.2.3 Groundwater Levels Hydrogen Plant

Groundwater levels in terms of the proposed location of the Hydrogen Plant have been assessed fully Minerex report Ref. **3131-043 (Rev1**). Bedrock groundwater aquifer water levels are in the order of 50 mbGL, however there remains the potential for perched groundwater to be intercepted during excavation and construction works. The Minerex report details results of a pumping test performed over a relatively significant time period, monitored groundwater levels, and estimated the sustainable yield and associated zone of contribution. Over pumping of the well can potentially reduce groundwater levels in excess of seasonal fluctuation, however with continuous monitoring and management, the risk of adversely impacting on groundwater levels in the locality will be easily mitigated.

9.4.2.4 Local Groundwater Levels and Supplies (Wells)

The Project has the potential to impact on groundwater levels proximal to excavation and dewatering activities. Dewatering of excavations in particular can create a relatively significant cone of depression, or lowering of the water table in the surrounding area. The degree to which the water table is lowered is dependent on the baseline static water level, is proportional to the depth of the particular excavations and/or depth at which the pump is placed, and the hydrogeological characteristics of the surrounding geology / aquifer.

The potential productivity and connectivity of groundwater in the underlying bedrock aquifer/s is considered low (**Baseline**) however the availability of groundwater in a social or agricultural sense is considered important, therefore the importance of groundwater quantities underlying the Proposed Development is considered 'Medium to High' sensitivity and importance. Any impact to the availability of groundwater for use (lowering of water level in wells) is considered a potentially significant adverse impact of the Project.

Contaminants released due to an environmental incident have the potential to infiltrate soils/subsoils potentially reaching the water table and in turn adversely impacting on groundwater quality.

Considering the quality of the groundwater underlying the Proposed Development (**Baseline**), and the 'Very High' sensitivity and importance associated with groundwaters nationally, any introduction of contaminants is considered a potentially profound adverse impact of the Project.

The release of suspended soils does not have significant potential to adversely impact on groundwater due to the natural process of filtration associated with percolation of water through soils and bedrock (Potential exception: Karst geology. There is no indication of karst geology underlying the site (**Baseline**). Hydrocarbons (e.g. diesel) pose the most significant risk to groundwater quality and can persist for many years.

It is noted:

- Excavations will generally be shallow (c. 2.85 m depth for turbine foundations).
- The recommended buffer distance for existing wells in relation to deep excavations, i.e., foundations is 250 m.
    - There are no mapped wells within the Wind Farm Site, or within 4 km of the Wind Farm Site.
    - There are no mapped wells within the Hydrogen Plant Site, or with 1 km of the Hydrogen Plant Site.
    - There are no mapped wells along the Interconnector Route or within 700 m of the proposed route.
    - There is one (1 no.) identified well along the Killybegs turbine delivery route **Section 9.3.15.**

- The underlying bedrock aquifer is classified as Locally Important with low productivity except for local zones.

Considering the baseline data and Development characteristics the risk of lowering groundwater levels to a significant extent is not considered likely. There are no groundwater source protection areas within the hydrogeological catchment of the proposed Developments.

9.4.3 Do Nothing Impact

The "Do Nothing Impact" is the effect on the Wind Farm Site should the proposed wind farm not be constructed. Site investigations and assessments of the baseline hydrological and hydrogeological conditions at the Wind Farm Site indicate that parts of the site have already experienced impacts to baseline conditions through peat harvesting across the entirety of the Wind Farm Site (**Appendix 9.4 – Plate 9 and 20**), and the installation of drainage networks associated with peat harvesting, (**Appendix 9.4 – Plate 8, 9 and 19**).

Peat harvesting activities (reconstitution of soils and drainage) have had a profound impact to the site relative to *absolute* baseline or (hypothetically) *perfect natural conditions* with regard to the hydrology or hydrogeology of the site in terms of drainage infrastructure in particular. Those activities are likely to apply pressure to the receiving surface water network and potentially regularly contribute nutrients and/or suspended solids to the receiving surface water systems. Release of contaminants will likely peak on occasion particularly during intrusive activities such as felling or peat cutting, or after heavy rainfall events.

Should the Project not proceed, the existing land-use practice on the Wind Farm Site of commercial afforestation peat harvesting, and agricultural activities (pastoral lands) will likely continue with associated gradual alteration of the existing environment and associated pressures on surface water and groundwater quality.

In regards to the Hydrogen Plant Site, should the Project not proceed, the existing land-use practice, i.e., agricultural activities (pastoral lands) of live-stock gazing will likely continue with associated pressures on surface water quality.

9.4.4 Effects from Climate Change

Climate change vulnerability is outlined in **Chapter 16 Section 16.3.1.2,** this assesses the projected changes, project exposure, project assessment, and the project risk of sea level rise, storm surges, coastal erosion, cold snaps/frost, heatwaves, dry spells, extreme rainfall, flooding, wind speeds.

9.4.5 Construction Phase Potential Effects

9.4.5.1 Release of Suspended Solids

Excavation and construction activities introduce the risk of solids being entrained in runoff. Runoff contaminated with suspended solids will add turbidity to the receiving surface water body, can block fish gills and smother spawning grounds, reduce light penetration for flora growth, and promote bacteria and algae production. Nutrients that are associated with the solids (inorganic nutrients such as phosphorus and organic such as hydrocarbons, and sewage if present) can lead to eutrophication of the water environment and eventually to fish-kills due to lowering of oxygen supply. Some ecological receptors are particularly sensitive to perturbations in water quality, and in particular suspended solids.

The degree to which inorganic solids are entrained in runoff is related to the particle sizing of the soil components. Smaller inorganic particles (e.g. clay) will be easily entrained and will remain in suspension for a longer period than larger particles (silt / sand), and will require lower flow rates and longer retention rates to settle out of the water column when given the opportunity. Peat, comprising mostly of organic matter, will behave in a similar manner to a fine grained soil whereby much of the material will remain in suspension for a relatively long period of time, but will also dissolve and degrade within the water body, dramatically impacting on water quality.

Release of suspended solids can be attributed to enhanced nutrient enrichment. This is highly dependent on the type of soil, for example; peat released in water will disintegrate and most of the constituents of the peat material (carbon) will eventually dissolve in to the water column and / or consumed by micro-organism. However, peat and other soils / subsoils will contribute varying degrees of loading of various compounds and nutrients, including Nitrogen (N) and Phosphorous (P) compounds, which are attributed to Nutrient Enrichment, or excessive loading of N and P in waters leading to eutrophication and potentially profound adverse impacts on ecological attributes downstream of the Proposed Development.

Peat soils behave differently to mineral soils, when it comes to some nutrients such as phosphorous. High organic matter soils (OM > 20%, i.e. peat) do not adsorb P in the same way that mineral soils do. Therefore P does not bind to peat soil particles, however mineral soils associated with forestry do have the capacity to build up or increase the store of phosphorous they hold.[13]

[13] Teagasc (2021) "Environment - Phosphorus Use on Peat Soils" *Agriculture and Food Development Authority*.

Earthworks during the construction phase of the Project will include the removal of vegetation cover, excavation, storage and reuse of materials, it is likely that a high volume of suspended solids will be entrained by surface water runoff and intercepted by surface water networks associated with the proposed development, particularly during sustained rainfall events.

The most vulnerable aspects to surface water quality deterioration are:

- Exposed soils / peat generally, including; new drainage channels, temporary stockpiles.
- Infrastructure development, particularly in relatively close proximity to surface water receptors, and in areas characterised by extensive existing drainage networks which present a direct connection to mapped surface water features.
- Construction of infrastructure within surface water buffer zones, and/or instream works associated with proposed watercourse crossing locations.
- Runoff laden with sediments from HDD pose the risk of potential perturbations within surface waterbodies, which are hydrologically linked to designated and protected areas.

Vehicular movements and excavation works associated with the construction phase (earthworks) of the Proposed Development have the potential to impact on soil stability particularly at a localised scale. The risk associated with stability issues varies depending on the degree of the issue at hand e.g. peat depth at a particular location. Earthworks in relation to reinstatement must also be considered. Localised stability issues, and erosion or degradation of soil by e.g. vehicular movements, have the potential to increase the potential for entrainment of suspended solids in surface water runoff, impact or obstruct established drainage networks, and increase the amount of excavation works required generally which in turn increases the potential for standard effects associated with earthworks.

The worst-case scenario associated with earthworks activities is the potential for significant stability issues leading to mass movement or landslides in close proximity to and intercepted by the surface water network associated with the Wind Farm Site or the Hydrogen Plant Site.

EIAR Chapter 8: Soils and Geology indicates that peat depths are generally low and the risk of significant stability issues leading to mass movement or landslides is low.

The Proposed Development has the potential to alter drainage which if unmanaged has the potential to create new preferential pathways for runoff potentially leading to erosion of soils / construction materials and entrainment of solids in runoff in the process.

Mechanism/s:
- Construction activities; Excavation, handling/transport, temporary storage of soils / subsoils / bedrock, vehicle tracking.
- Erosion in areas impacted by construction activities.
- Erosion in areas with newly formed preferential pathways for water runoff.
- Peat / slope stability, significant or localised.
- Reinstatement activities; similar to construction.

Impact
- Release of suspended solids entrained in runoff, intercepted by surface water network.

Receptor/s:
- Surface Water. Surface water quality, ecological sensitivities and WFD status.

The potential release of elevated suspended solids to surface waters is considered to be a **direct and indirect, adverse, large** in scale, **localised** (potentially regional), **moderate to significant** effect of the Project. This potential impact is considered to be **unavoidable** and conforms to baseline conditions (e.g., peat cutting) at the Wind Farm Site, but contrasting to baseline conditions at the Hydrogen Plant Site. Considering the mobility characteristics of surface waters to downstream receptors, it is **not considered reversible** and has the potential for indirect impacts to receptors downstream. However, with appropriate mitigation measures in place and via the implementation of environmental engineering controls, this potential risk can be significantly reduced. Potential effects impacting on water quality are discussed in greater detail in the following sections of this chapter.

9.4.5.2 Clear Fell of Afforested Areas

Felling of forestry will be necessary for areas of the Proposed Development in afforested sections within the Redline Boundary. This is an **unavoidable** consequence of the Project. The Wind Farm Substation is within afforested areas **Figure 9.1a**. Subsequently, tree felling will be required as part of the Proposed Development. To facilitate the construction of the substation, c. 5.83 ha coniferous forestry will need to be clear-felled. The likely felled area of approximately 5.83 ha will represent approximately 1.3% of the proposed Wind Farm Site area (445 ha). In a spatial or land use context this is considered a **slight** impact.

There is a range of potential **adverse** impacts associated with the activity which will require management and mitigation. Potential effects include.

1. Soil erosion, compaction and degradation: The removal of trees and underbrush during clear-felling can expose soils to wind and water erosion, leading to soil loss, compaction and degradation. This is mainly caused by vehicular movements.
2. Geology: Clear-felling can cause changes in the geology of an area, leading to soil instability, landslides, and other geological hazards, especially in close proximity to sensitive receptors.
3. Hydrology & Hydrogeology: The removal of trees and vegetation can lead to changes in hydrological processes, causing changes in water flow rates and patterns, such as the lowering of water tables.
4. Water quality: Clear-felling can cause increased sediment runoff and nutrient pollution in waterways, which can impact water quality, negatively affecting aquatic ecosystems and downstream water users.
5. Soil nutrient loss and nutrient loading of receiving waters: Clear-felling removes vegetation and leaves soil bare, exposing it to weathering, which can cause the entrainment of solids and/or the loss of soil nutrients, essential for plant growth. This in turn will lead to an increase in nutrients i.e., Nitrogen and Phosphorous compounds, dissolved organic carbon, potassium etc. in receiving waters flowing from the site, which is considered a negative impact of the Proposed Development.

The overall potential effects here are considered to be of **moderate** significance**, permanent but reversible**, and **adverse**, though this is of a minor scale. With appropriate mitigation measures, planning and management this impact can be reversed, and disturbance minimised.

9.4.5.3 Demolition of Existing House and Agricultural Sheds

The demolition of a house (A) and four agricultural sheds (B-E) will be necessary on the Project. This is an **unavoidable** consequence of the Project.

There is a range of potential **adverse** impacts associated with the activity which will require management and mitigation. Potential effects include.

1. Soil erosion, compaction and degradation: The demolition of a house and agricultural sheds can expose soils to wind and water erosion, leading to soil loss, compaction and degradation. This is mainly caused by vehicular movements.
2. Geology: Demolition of a house and agricultural sheds can cause changes in the geology of an area, as mentioned in point 1.

3. Water quality: Demolitions can cause increased sediment runoff and nutrient pollution in waterways, which can impact water quality, negatively affecting aquatic ecosystems and downstream water users.
4. Hydrology and Hydrogeology: The demolition of the House and Agricultural sheds will increase the area of unsealed ground therefore increasing the recharge capacity of the area, leading to reduced surface water runoff.
5. Soil nutrient loss and nutrient loading of receiving waters: demolition involves the removal of vegetation and concreate sealing, this leaves soil bare, exposing it to weathering, which can cause the entrainment of solids and/or the loss of soil nutrients, essential for plant growth. This in turn will lead to an increase in nutrients i.e., Nitrogen and Phosphorous compounds, dissolved organic carbon, potassium etc. in receiving waters flowing from the area, which is considered a negative impact of the proposed Development, however the new sealing of ground for construction of replacement house will neutralise this effect.

The overall potential effects here are considered to be of **slight** significance**, permanent**, and **adverse**, **small** in scale. With appropriate mitigation measures, planning and management this effect can be reduced, and disturbance minimised.

9.4.5.4 Release of Hydrocarbons and Chemicals

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

During the construction phase of the Project, plant equipment and vehicles associated with excavation, material transport, and construction activities introduce the risk of hydrocarbon (fuel and oil) spillages and leaks, particularly in relation to regular refuelling which in turn implies the requirement of a fuelling station which will likely include fuel storage on site OR will be supplied by fuel tanker scheduled to refuel the plant machinery directly.

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

Mechanism/s:

- Lubricants and other construction consumables – minor in scale.
- Fuel leak from personnel vehicle – minor in scale.
- Fuel leak from plant machinery – minor in scale.
- Fuel spill during refuelling – significant in scale.
- Fuel leak from storage - significant in scale.
- Fire retardant leaching from on-site intervention – minor in scale.

Impact

- Release of hydrocarbons in runoff, intercepted by surface water network.
- Release of hydrocarbons to ground, intercepted by groundwater.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quality for the purposes of extraction.

With regards to surface waters at the Wind Farm Site and Hydrogen Plant Site, an accidental hydrocarbon spillage is considered a **likely, adverse, direct and indirect, small** in scale**, moderate to profound, localised (potentially regional), permanent but reversible** effect which is in contrast to baseline conditions. However, with implementing mitigation and best practice the risk of an accidental spill can be greatly reduced. Guidelines for the management of water resources and fire retardant chemicals are detailed in the EPA Guidance on Retention Requirements for Firewater Run-off.

In terms of groundwater associated with the Proposed Development an accidental hydrocarbon spillage is considered to be a **likely, indirect, adverse, small** in scale**, moderate to profound, localised (potentially regional), permanent but reversible** effect, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

9.4.5.5 Release of Horizonal Directional Drilling Materials

Both the Grid Connection Route and Interconnector Route will require Horizontal Directional Drilling. Depending on the drill material in question, etc. the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g., ecology. For example, the introduction of bentonite-based clay material can lead to changes in water quality as opposed to a non-toxic single component polymer-based product.

In terms of the HDD process, drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously remains the same. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment[14]. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the grid connection route. It is unspecified at this time which drilling lubricant will be used during UGC route works. From experience in the industry the use of Clearbore is recommended when working beneath watercourses. Clearbore is a single component polymer-based product that is designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. The product is not toxic to aquatic organisms and is biodegradable.

An accidental contaminant spillage (also known as drill return or frack out), would have a **likely, adverse, direct, small** in scale**, slight, localised (potentially regional), long term to permanent** effect which is in contrast to baseline conditions. However, with implementing mitigation and best practice the risk of an accidental spill can be greatly reduced.

In terms of groundwater associated with the Project an accidental drilling fluid breakout is considered to be a **likely, indirect, adverse, small** in scale**, moderate to significant,**

[14] Moore Group (2016) "Appropriate Assessment of Cork Lower Harbour Main Drainage Project Estuary Crossing by Horizontal Directional Drilling", Moore Group Environmental Services on behalf of Irish Water, Ref No. 15184.

localised (potentially regional), temporary to long term but reversible effect of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies, or groundwater bodies. Similar to the release of suspended solids, **Section 9.4.4.1,** the introduction of drill arisings to the receiving surface water receptor is considered a **direct, adverse, moderate to profound significance** impact of the Project. This can be mitigated using appropriate mitigation and management of activities.

9.4.5.6 Release of Construction or Cementitious Materials

The Proposed Development will require concrete structures, including in relation to portions of the Proposed Development which are in close proximity receptors e.g. surface water crossings.

Depending on the material in question, the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g. ecology. For example, the introduction of cementitious material (concrete / cement / lean mix etc.) can lead to changes in soil and water pH, and increased concentrations of sulphates and other constituents of concrete can further impact water quality. Fresh or wet concrete is a much more significant hazard when compared to set or precast concrete which is considered inert in comparison, however it should also be noted that any construction materials or waste deposited, even if inert, is considered contamination. Surface water runoff, or groundwater coming into contact with concrete will be impacted to a degree, however water percolating through lean mix concrete will be impacted significantly.

The production / acquisition, transport of material and management of plant machinery must also be considered.

Mechanism/s:

- Accidental spillage or unmanaged deposition of construction materials such as wet concrete which is intercepted by drainage

	or surface water networks associated with the Proposed Development.
	• Dust generation in relation to the production of concrete and management of raw materials.
	• Transport of material on site and washout of plant machinery.
	• Pouring, forming, deposition of concrete during construction.
	• Generation of waste.
Impact	• Release of cementitious material in runoff, intercepted by surface water network.
Receptor/s:	• Surface Water. Surface water quality, ecological sensitivities and WFD status.
	• Groundwater. Groundwater quality for the purposes of extraction.

This process also gives rise to result in the accidental spillage or deposition of construction waste into soils and in turn impact on surface water runoff, or accidental spillages directly intercepted by drainage or surface water networks associated with the Project. The accidental spillage or deposition of construction materials such as wet or lean mix concrete which is intercepted by drainage or surface water networks is considered a **likely, adverse, direct and indirect,** and therefore **localised and potentially regional** effect. While **small to moderate** in scale**,** it is considered to be **a moderate to significant**, **temporary to medium term** effect of the Development, which is in contrast to baseline. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

In terms of groundwater associated with the Project an accidental introduction of lean mix concrete is considered to be a **likely, indirect, adverse, small** in scale**, moderate to significant, localised (potentially regional), temporary to long term but reversible** effect of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

9.4.5.7 Release of Waste Water Sanitation Contaminants

Welfare facilities will be required at the Wind Farm Site and the Hydrogen Plant Site during the Construction phase, therefore, the Proposed Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto peat/soils and ultimately into surface waters during the construction phase of the Project.

The level of risk posed by such facilities is dependent on the condition and upkeep of facilities that are put in place, and the chemical agents used if applicable, and therefore can range from a potentially significant to insignificant impact in direct correlation to the type of sanitation used (e.g. septic tank versus port-a-loo). It is proposed that porta-loos will be used for the Proposed Development.

Accidental release of wastewater to surface waters would likely result in an increase in biochemical oxygen demand (BOD) which in turn would lower the dissolved oxygen concentration and adversely impact on aquatic life. Wastewater sanitation chemicals are also pollutant risks due to their inherent toxicity to aquatic flora and fauna and their potential to adversely impact on the productivity or status of surface water systems. The level of risk posed by such temporary facilities is dependent upon the following key factors:

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

In addition to direct adverse impacts on ecological sensitivities downgradient of both sites, runoff of suspended solids and/or other contaminants will potentially impact on the WFD status and objectives associated with the receiving surface water networks associated with the Proposed Development. Considering the quality of the surface water draining from the site (baseline), and the 'Very High' sensitivity and importance of the associated surface water networks downstream, any introduction of contaminants is considered a potentially profound adverse impact of the Proposed Development.

Potential incidents of release contaminants at the site will likely be short lived or temporary, however the potential impacts to downstream receptors can be long lasting, or permanent.

Mechanism/s:	• Waste water leak – minor in scale. • Chemical leak – minor in scale
Impact	• Release of waste water / chemicals in runoff, intercepted by surface water network.
Receptor/s:	• Surface Water. Surface water quality, ecological sensitivities and WFD status. • Groundwater. Groundwater quality for the purposes of extraction.

A potential worst-case scenario(s) associated with wastewater sanitation is the potential for wastewater or sanitation chemicals to accidentally spill or leaking and to be intercepted by surface water drainage features, ultimately discharging to surface waters. This is considered to be a **likely, adverse, direct and indirect,** and therefore **localised and potentially regional** effect. While **small** in scale**,** it is considered to be **moderate to significant**, **temporary to long term but reversible** impact of the Development, which is in contrast to baseline. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

In terms of groundwater associated with the Project an accidental introduction of wastewater or sanitation chemicals is considered to be a **likely, indirect, adverse, small** in scale**, moderate to significant, localised (potentially regional), temporary to long term but reversible** effect of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

9.4.5.8 Hydrologically Connected Sensitive Receptors

Designated Sites

Contaminants arising as a product of the Project will potentially be intercepted by the drainage and surface water network associated with the Wind Farm Site, Hydrogen Plant Site, Interconnector Route, Grid Connection Route, Killybegs Turbine Delivery Route or Galway Turbine Delivery Route. Each element of the Project is hydrologically connected and situated up stream of the following designated sites which are discussed in detail in **Section 9.3.13, Figure 9.9a** and **Figure 9.9b:**

- River Moy SAC
- Killala Bay / Moy Estuary SAC/SPA
- The Killala Bay/Moy Estuary pNHA

Therefore, maintaining surface water quality is a key component of environmental objectives, and therefore any contaminants arising will potentially adversely impact on downstream designated site/s.

The potential of the Proposed Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered to be a likely, indirect, adverse, moderate to profound, temporary to long-term effect of the Project which conforms to Baseline (e.g., cumulative upstream impacts).

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

Drinking Water

Surface waters, under the scope of the objectives of the WFD are considered attributes with the 'Very High' sensitivity and importance and will be protected in their own right. Although potential contamination incidents will be temporary in terms of the waters themselves, it is important to consider the potentially long lasting or potentially permanent impact/s of contaminants on the ecological attributes dependent on the surface water bodies associated with designated areas. The geographical scale of catchments upstream of designated areas downstream of the Wind Farm Site and Hydrogen Plant Site, Grid Connection Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route **(Figure 9.10a, Figure 9.10b, Figure 9.2a, Section 9.3.5)** should be considered in terms of the assimilative capacity of the surface water systems which will buffer against any potential contaminants introduced at each site, that is; contaminants will be 'diluted' in receiving waterbodies. This does not lessen potential adverse impacts in the immediate vicinity of each site and does not reduce the need for mitigation measures to be implemented, but is considered a 'last line of defence' for the protection of designated areas downstream of the Wind Farm Site and the Hydrogen Plant Site. However, there are no rivers protected on site or downstream at either site for drinking water purposes.

9.4.5.9 Groundwater Levels and Supplies

The Project has the potential to impact on ground water levels proximal to excavations and dewatering activities. Dewatering of excavations in particular can create a relatively significant cone of depression or lowering of the water table in the surrounding area. The degree to which the water table is lowered is dependent on the baseline static water level, is proportional to the depth of the particular excavations and/or depth at which the pump is placed, and the hydrogeological characteristics of the surrounding geology / aquifer.

The potential productivity and connectivity of groundwater in the underlying bedrock aquifer/s at both sites is considered **low** (Baseline, **Section 9.3.10**) however the availability of groundwater in a social or agricultural sense is considered important, therefore the importance of groundwater quantities underlying the Proposed Development is considered **moderate to significant** sensitivity and importance. Any impact to the availability of groundwater for use (lowering of water level in wells) is considered a **direct, localised significant adverse** impact of the Development.

Contaminants released due to an environmental incident have the potential to infiltrate soils/subsoils potentially reaching the water table and in turn adversely impacting on groundwater quality. However, it is noted that the Wind Farm Development, Hydrogen Plant Development, Interconnector Route, Grid Connection Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route do not interfere with any Public Source Protection Areas as mapped by GSI (2022) or Zones of Contribution under the National Federation of Group Water Schemes as outlined and mapped by the EPA and GSI (2022). Considering the quality of the groundwater underlying the site (Baseline, **Section 9.3**), and the 'Medium to High' sensitivity and importance associated with groundwaters nationally, any introduction of contaminants is considered an unlikely, direct and indirect, adverse, slight, temporary effect of the Project which conforms to Baseline (e.g., other shallow excavations). With the implementation of appropriate mitigation measures and environmental engineering controls, these potential risks can be significantly reduced.

The release of suspended soils does not have significant potential to adversely impact on groundwater due to the natural process of filtration associated with percolation of water through soils and bedrock (Potential exception: Karst geology. There is no indication of karst geology underlying the site (Baseline, **Section 9.3**). Hydrocarbons (e.g., diesel) pose the most significant risk to groundwater quality and can persist for many years.

Considering the baseline data and Development characteristics, the risk of lowering groundwater levels to a significant extent is not considered likely. Furthermore, there are no mapped wells (**Figure 9.12a**) that intersect with the Grid Connection Route or Interconnector Route. The Hydrogen Plant does not interfere with any mapped well. However, the Wind Farm Redline Boundary intersects with one (1 no.) well, **Section 9.3.15** along the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route.

A combination of low permeability soils (. i.e. peat), the temporary nature of the construction works, and low recharge rates across both sites is expected to result in a **direct**, **likely, adverse, slight to moderate significance, small to moderate** scale**, localised** impact of the Project which is in contrast to the baseline. With appropriate mitigation measures in place, the potential impacts on groundwater wells can be managed and reduced.

9.4.5.10 Groundwater or Bog Water Associated with Wind Farm and Hydrogen Plant Sites

At the Wind Farm Site and the Hydrogen Plant Site there is the potential to impact on bog water levels proximal to excavations and/or drainage channels. Existing drainage at the Wind Farm Site, particularly in peatland areas, are intended to drain the respective area, however existing tracks and adjacent drains can also impact on bog water levels. Lowering of the water table in peat lowers the potential for peat growth i.e., sub-optimal conditions. This will lead to the gradual decline in productivity in the acrotelm (living layer of peat), and in time the degradation of the drained peat area, potentially leading to erosion.

The scale of the impact is dependent on the depth of the excavation in question and subsequent lowering of the water table at the location. This can vary depending on the underlying characteristics of the Development. In peat the impact can be minimal in scale initially but over time and as the acrotelm layer degrades and recedes the impact can continue to progress slowly/chronically, potentially leading to profound impacts in worst case scenarios. However, it is noted that the Wind Farm Site is characterised by shallow peat or peaty soil generally with isolated areas of moderately deep saturated peat, and the peat adjacent to the Hydrogen Plant Sire is shallow (**Chapter 8: Soils and Geology**). Therefore, the scale of such impact is likely limited to the extent of those isolated pockets. Furthermore, the Wind Farm Site is generally characterised as having extensive existing drainage features, and therefore impacts arising from drainage can be in line with baseline conditions, the peatland area adjacent to the Hydrogen Plant Site also possesses a degree of existing drainage but are minor features.

With regards to bog water levels at both Wind Farm Site and Hydrogen Plant Site, drainage is considered a **likely, adverse, direct and indirect, small to moderate** scale**, neutral to slight, localised, permanent but reversible** effect which conforms to baseline conditions (peatland drains).

With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced. Additionally, in areas impacted by draining activities, if considered adequately, mitigation measures have the potential to have a **neutral to beneficial** impact on bog water levels, particularly in places already impacted by drainage.

9.4.5.11 Groundwater and Surface Water Associated with Grid Connection and Interconnection Cable Works

The GSI well database has not indicated any wells mapped along or within the vicinity of the proposed Grid Connection Route or Interconnection Route. Given the incomplete nature of the GSI well database and the rural location, there is a potential for more private wells in use along these proposed Routes. Shallow trenching (c.1,220 mm deep) which will be backfilled is expected to be required for the proposed Grid Connection and Interconnection Routes, with a depth of c. 1,500 mm at Horizontal Drilling locations.

Due to the vast majority of the gird connection requiring shallow trenching and the temporary nature of the construction works, it is expected to result in a **likely, direct and indirect, adverse, small** in scale, **slight and temporary** effect which conforms to Baseline (e.g., public roads and services). With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced.

9.4.5.12 Excavation Dewatering & Construction Water

Construction waters arising from open excavations, or construction waters intercepted from construction areas are likely to be heavily laden with suspended solids. The dewatering of excavations during construction phase of the Proposed Development is likely to have significant adverse effects on surface water runoff quality in the absence of mitigation measures. Should dewatering of open excavations, i.e., foundations etc. be required, the receiving engineered drainage and attenuation features will likely receive water discharges elevated in suspended solids.

This impact is considered to be in contrast to baseline conditions although it is also temporary. Although temporary, considering the mobility characteristics associated with flowing surface waters, it is not considered reversible. However, with the implementation of appropriate mitigation measures and environmental engineering controls, this potential impact can be reduced to within water quality regulatory limits. Potential effects impacting on water quality are discussed in greater detail in the following sections of this report.

Considering the nature of the site, it is assumed that there is no significant source of ground contamination at the site and therefore the potential to draw in contaminants during dewatering activities is not significant. The potential effects on groundwater during the proposed operational phase of the Proposed Development is considered to be not significant.

Mechanism/s:
- Dewatering of open excavations.

Impact
- Release of suspended solids, intercepted by surface water network
- Significant surge release of suspended solids, intercepted by surface water network.
- Lowering of bog / groundwater table.

Receptor/s:
- Surface Water. Surface water quality, ecological sensitivities and WFD status.

- Groundwater. Groundwater quantity for the purposes of extraction. Groundwater / bog water quantity for water dependent terrestrial habitats.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.
- Groundwater - Negative, direct but limited, imperceptible, likely but temporary, short to medium term.

Potential dewatering through drainage in advance of excavation activities, or dewatering via pumping during excavation activities, will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered to be a **likely, adverse, direct and indirect, localised (potentially regional**), **temporary to permanent** effect of the Proposed Development which is in contrast to the baseline conditions. While **small to moderate** in scale it is considered to be **moderate to profound** in significance. With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced.

9.4.5.13 Constructed Drainage, Diversion and Enhancement of Drainage

The Proposed Development will result in diversion and enhancement of existing drainage networks at the Wind Farm Site during the construction of the proposed project relative to baseline conditions due to the extensive drainage network associated with cutover peat or forestry operations. Significant features associated with the drainage network at and around the Wind Farm Site are mapped and presented in **Figure 9.2a.**

At the Hydrogen Plant Site there will be no drainage diversion required, however the discharge line will utilise an existing drainage feature. There is no anticipated drainage diversion required as part of the Killybegs Turbine Delivery Route, Galway Turbine Delivery Route, Grid Connection Route or Interconnector Route.

The diversion and enhancement of existing drainage has the potential to impact on the hydrological regime at the Wind Farm Site, particularly in areas of intact peatland habitat, but equally in peatland areas impacted by artificial drainage, there is the potential for the Wind Farm Development to have a beneficial impact to the hydrological regime and to peatland regeneration. Peatland groundwater levels are generally dependent on rainfall. Rainfall infiltrates and percolates into peat/soil (recharge), initially through vegetated / root conduits in the acrotelm peat (living vegetated layer) or upper soil horizons, however percolation and/or permeability rates in peat, particularly the catotelm (decomposing lower layer) are poor and therefore peatland areas are characterised by rapid hydrological responses to rain fall i.e., rapid surface water runoff intercepted by the receiving drainage and surface water network. Due to this characteristic, peatlands require consistent rainfall to ensure adequate wetting of water dependant blanket peat habitats.

Poor drainage design has the potential to drain excess surface water runoff and draw water away from areas of peatland, thus reducing the potential of recharge to ground in those areas and creating an even greater hydrological response to rain fall in the receiving surface water network via more direct connections to the surface water network i.e., bypassing the peatland. Furthermore, uncontrolled surface water runoff interacting with the Wind Farm Site footprint has the potential to lead to adverse impacts including the development of new preferential pathways, erosion and peat degradation – particularly during and immediately after construction phase whereby unvegetated soils are exposed and wetting and/or drying of peat areas potentially occurs.

The Wind Farm Development will likely result in diversion, alteration and/or enhancement of the existing drainage networks at the Wind Farm Site relative to baseline conditions. The existing drainage network at the Wind Farm Site is mapped and presented in **Figure 9.6a**. Diversion of artificial drainage channels will be required at locations where the Wind Farm Development layout intercepts existing artificial drainage networks. This includes minor modifications where existing drainage will be aligned with proposed culverts etc. and/or where proposed Wind Farm Development drainage interacts or connects with existing drainage networks.

Mechanism/s:

- Significant changes to the hydrological regime at the Wind Farm Site.
- Construction activities (Earthworks, addressed under Release of Suspended Solids)
- Construction activities (Earthworks) within existing drainage channels.
- Connecting new and existing drainage channels.
- Poor design and/or installation of drainage network
- Poor design and/or installation of drainage infrastructure including culverts.
- Upgrading of existing culverts where necessary.

	• Poor design and/or installation of drainage infrastructure including culverts attenuation features.
Impact	• Drying - Lowering of bog / groundwater table proximal to respective drainage features. • Wetting – Excess discharge in a particular area (local flooding) • Increasing hydrological response to rainfall. • Release of suspended solids, intercepted by surface water network. • Significant surge release of suspended solids, intercepted by surface water network.
Receptor/s:	• Surface Water. Surface water quantity and flood risk. Surface water quality, ecological sensitivities and WFD status. • Groundwater. Groundwater / bog water quantity for water dependent terrestrial habitats.

Considering that pre-existing natural and artificially established drainage networks are present at the Wind Farm Site, the diversion, enhancement or introduction of additional drainage features is considered an **unavoidable, direct and indirect, adverse, localised (potentially regional**) and **permanent** effect of the Project which conforms to baseline conditions. While **small** in scale the effect is considered to be of **moderate to profound significance.** There are potential risks associated with the earthworks required to carry out such drainage works, and it is very important to recognise the drainage and surface water network are connected, that is in terms of assessing source pathway receptor, the construction or diversion of drainage is connecting source, pathway, and receptor. With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced.

9.4.5.14 Watercourse Crossings

Surface Water Crossings or Bridges over Mapped Rivers

In regard to WFD or EPA mapped rivers, watercourse crossing locations identified are listed here.

There are three (3 no.) watercourse crossing locations identified as part of the proposed Wind Farm (**Figure 9.6a,** and **Appendix 9.4, Table 9.9**).

- WWC1 (ITM: 535658.1, 822437.0) is situated on the Brusna (North Mayo)_020 river along the Wind Farm Site access track south east of the proposed location of T6 and north of the proposed location of T5. At the crossing point the river is characterised as an upland river segment (near the headwaters) with little existing modification **Appendix 9.4 – Plate 5.** The river at this location spans approximately 1.0 -1.5 m in width. The banks of the river are low and the adjacent lands are characterised as heath / blanket bog.

- WWC2 (ITM: 535960.4, 822186.3) is situated on the Brusna (North Mayo)_020 along the Wind Farm Site access track between the proposed location of T5 and T13. The river at this location was inaccessible do to overgrowth, **Appendix 9.4 – Plate 6,** however there was an audible flow recorded**.** The surrounding area is characterised as heath / blanket bog / scrub.
- WWC3 (ITM: 535626.1, 821492.6) is situated on the Brusna (North Mayo)_020 along the proposed Wind Farm Site access track c. 590 m from the Site entrance and just east of the Material Storage area, there is currently no existing infrastructure at this location, **Appendix 9.4 – Plate 7.** Of note at this location is moderate to severe sloped embankments of c. 5 m height sloping towards the stream on both sides of the proposed WWC3 location. With reference to **Appendix 8.1**, elevated risk of localised stability is an important consideration for proposed bridge design and construction.

Table 9.9: Surface Water Crossings Wind Farm – Mapped Rivers *WFD / EPA

Surface Water Drainage and/or Non-Mapped Surface Water Features					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
River Crossing	WCC1	Existing culvert to be upgraded as required	535654.2	822446.8	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
River / Drain Crossing	WCC2	Existing culvert to be upgraded as required	535967.3	822187.2	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
River Crossing	WCC3	New; No existing infrastructure	535632.9	821486.4	**Recommend Clear Span Bridge over mapped river.** Must apply to the OPW for consent on the construction of new watercourse crossing under Section 50 of the (EU Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). Mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).

In terms of the Grid Connection Route, there are six (6 no.) watercourse crossings along the proposed route, **Figure 9.6b, Table 9.10**. It has been determined that Horizonal Directional Drilling methodology will be utilized at four of these locations.

Table 9.10: Surface Water Crossings along Grid Connection Route– Mapped Rivers *WFD / EPA

Grid Connection Route (GCR) Surface Water Crossings – Mapped Rivers (WFD/EPA)					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
River Crossing	GCR WCC1	Bridge	532738.0	819171.9	Srafaungal River; HDD Bridge Undercrossing
River Crossing	GCR WCC2	Bridge	532509.2	820278.8	Fiddaun Stream; HDD Bridge Undercrossing
River Crossing	GCR WCC3	Bridge	532457.2	820870.0	Glenree Stream; HDD Bridge Undercrossing
River Crossing	GCR WCC4	Bridge	532665.2	821361.9	Loughnagore Stream; HDD Bridge Undercrossing
River Crossing	GCR WCC5	Bridge	532571.2	821960.1	Owencam (river)
River Crossing	GCR WCC6	Bridge	533876.6	822171.4	Owencam (river)
Total		**6**			

In terms of the Interconnector Route, there are six (6 no.) watercourse crossings along the proposed route, two locations include GCR_WCC5 and GCR_WCC6 that have been previously identified above, **Figure 9.6b, Table 9.11**.

Table 9.11: Surface Water Crossings along Interconnector Route– Mapped Rivers *WFD / EPA

Interconnector Route (ICR) Surface Water Crossings – Mapped Rivers (WFD/EPA)					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
River Crossing	ICR WCC1	Bridge	531027.8	822551.4	Brusna 020
River Crossing	ICR WCC2	Culvert	531535.6	822437.5	Brusna 020
River Crossing	ICR WCC3	Culvert	532067.2	822288.0	Brusna 020
River Crossing	ICR WCC4	Culvert	532363.8	822055.4	Brusna 020
River Crossing	GCR WCC5	Culvert	532571.2	821960.1	Brusna 020
River Crossing	GCR WCC6	Culvert	533876.6	822171.4	Brusna 020, HDD Bridge Undercrossing
Total		**6**			

In terms of the turbine delivery routes, 4 no. watercourse crossings have been identified, **Table 9.12**. These crossings are common to both Killybegs Turbine Delivery Route and Galway Turbine Delivery Route. It is unknown at this time if improvement works will be required along this route, however it is assumed there will be none.

Table 9.12: Surface Water Crossings along Turbine Delivery Routes – Mapped Rivers *WFD / EPA

Turbine Delivery Route (TDR) Surface Water Crossings - Mapped Rivers (WFD/EPA)					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
River Crossing	TDR WCC1	JOD to confirm	532292.8	826156.8	Assuming no upgrade works necessary
River Crossing	TDR WCC2	JOD to confirm	533271.0	825712.2	Assuming no upgrade works necessary
River Crossing	TDR WCC3	JOD to confirm	533889.9	825281.8	Assuming no upgrade works necessary
River Crossing	TDR WCC4	JOD to confirm	535006.9	821980.9	Assuming no upgrade works necessary
Total		**4**			

Construction of any new watercourse crossing, or modification of any existing watercourse crossing will have inherent risk given the level of disruption (e.g. excavations, heavy plant machinery) involved with construction activities, and the proximity, or lack thereof (potential instream works), to the primary sensitive receptor, that is; the watercourse itself.

Potential impacts on hydrology and water quality associated with the construction or upgrading of water course crossings include:

- Alteration of flow regime potentially leading to erosion and/or flooding.
- Potential loss of natural feature e.g. closed culverts implies the replacement of river/stream bed with the invert of the culvert structure, and the loss of riparian / vegetated banks.
- Potential loss of ecological function or service e.g. relatively long span structures have the potential to block light and lower soil moisture, in turn leading to loss in vegetation and bank stability through erosion.
- Harmful discharges during construction and operation, in particular the release of suspended solids.
- Other impacts associated with ecological sensitivities.

The alteration of watercourse crossings will **likely** pose an **adverse direct and indirect** at a **localised (potentially regional)**, **permanent** effect of the Proposed Development which is in contrast to the baseline conditions. While **small to moderate** in scale it is considered to be **moderate to profound** in significance on the quality and flow characteristics of the receiving surface water feature. With appropriate environmental engineering controls and measures (i.e., Mitigation measures), these potential risks can be significantly reduced.

The main contributing factors for achieving worst-case scenario/s associated with installation of new watercourse crossings include:

- The potential for poor planning and construction methodology,
- Potential for poor design of new watercourse crossings,

Poor design and construction can potentially result in significant changes in flow, erosion and deposition patterns and rates associated with the surface water feature, which can potentially lead to flow being restricted leading to increased risk of flooding locally.

Horizontal Directional Drilling

The Grid Connection and Interconnection Routes will encounter crossings at which the installation of the cable within the bridge deck is insufficient and Horizontal Directional Drilling (HDD) is required. Depending on the drill material in question, etc. the introduction of such materials can lead to a local change in hydrochemistry and impact on sensitive attributes e.g. ecology. For example, the introduction of bentonite-based clay material can lead to changes water quality as opposed to a non-toxic single component polymer-based product.

Drilling Fluid

Horizontal Directional Drilling (HDD) requires the use of a drilling fluid to assist with lubricating and mobilising drill arisings during the drilling process and is also used to promote sealing and stabilising the borehole.

There are a number of types of HDD fluid for example, polymers and bentonite. Differing fluids or fluid additives provide different functions; including:

- Lost Circulation Materials e.g., Calcium Carbonate, Mica, Nutshells, SuperSealer
- Viscosifiers / Fluid loss additives e.g., Bentonite, Guar Gum
- Weighting Agents e.g. Dolomite
- Miscellaneous e.g., Biocide, Gypsum, Lime.

For this development, Clearbore or a similar drilling fluid product will be used, only in small concentration during the HDD process. In consultation with Drilling Supplies Europe.[15] Clearbore is a high-performance water-based mud with a high carrying capacity, this makes it appropriate for tunnelling and drilling operations. Borehole stability and cuttings removal are exceptional in various ground conditions when Clearbore is used. It has been field tested in the UK, Ireland and the Middle East and has been to the satisfaction of drilling operations and managers.

Clearbore is environmentally friendly. It is produced using free flowing polymers. The fluid is composed of a blend of natural and synthetic biopolymers which will biodegrade between 4 to 52 weeks into oxides of nitrogen and carbon. Approval by the EPA required the product to be subjected to a 5-day technical scoping study to investigate the potential toxicity and environmental impact. The tests were carried out on juvenile daphnids in a Clearbore solution in laboratory conditions. The results for toxicity tests at a concentration of 1:10,000 showed a mortality rate in juvenile daphnids of 10% mortality. At this concentration (1:10,000), toxicity is stated to be "negligible". These results were below a level that would be considered an environmental threat i.e., normal use of the product, and does not include significant accidental release.[18]

Clearbore (or similar) products are characterised by a number of health and safety hazards, including low pH, which renders the material as irritant and harmful if ingested.

Fuel and Oil Spillages

Drilling will involve plant machinery which will be powered by hydrocarbons, therefore risk during the refuelling process as stated previously (**Section 9.4.4.2**) remains the same. The risk of hydrocarbon spills stems primarily from broken hydraulic hoses used during the drilling/boring process. Small-scale quantities of greases known as 'drilling fluids' are also commonly used during the drilling process to keep components of the drill rig cool and lubricated. These drilling fluids are commonly composed of a mixture of bentonite clay, which can be harmful to the environment. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the grid connection route.

Drilling Fluid Spillages

With reference to the appended Materials Safety Data Sheet for Clearbore (**Appendix 9.9**) drilling fluid to be used (or similar), in the case of a major spill, the leak should be stopped

[15] Drillingsupplieseurope.com. 2022. ClearBore | Drilling Supplies Europe. [online] Available at: <https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/>

if safe to do so, contained and prevented from entering drains or water courses. Any recoverable product should be collected, similar in means of a hydrocarbon spill, and disposed of properly. If a significant quantity of material enters drains or watercourses, emergency services will be advised immediately.

In consolation with the example Safety Material Data Sheet (SMDS) for Clearbore, while it is noted Clearbore is biodegradable. It is an organic acid which is harmful if swallowed, comes in direct contact with skin or eyes and if it is inhaled. This product is recyclable if unused or has not been contaminated. It may be possible to reclaim the product by filtration or distillation. If these options are unavailable this product should be incinerated or sent to landfill.

Drill Arisings

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies.

In consultation with Drilling Supplies Europe[16], ClearBores polymeric chains are designed to instantly break down and become chemically destroyed in the presence of small quantities of calcium hypochlorite. Following the polymer break down, cuttings will then settle out of the drill fluid which will form approximately 20% of the volume, the liquid phase will form about 80% of the volume. It is noted that settlement can be done overnight in a pit or holding tank, to leave a fluid phase of less than 400 ppm suspended solids[27]. As has been seen in the past, the remaining water phase can be decanted and disposed of to a wastewater treatment facility or in the sewerage infrastructure, with appropriate discharging licenses from relevant authorities; and the sludge/solids can be disposed of as semi-dry waste to landfill at a reduced cost.[27]

According to the Outline Construction Environmental Management Plan (2023), **Appendix 2.1** it is anticipated that 4 m³ of spoil will be excavated for each 100-metre run of 4 pipes. This spoil will be largely subsoil material. The majority of the arisings will exit the launch pit within the bentonite slurry mixture. Therefore, for each 100-metre length of crossing approximately 4 m³ of arising will need to be catered for. A mobile bunded tank will be

[16] Drillingsupplieseurope.com. 2022. ClearBore | Drilling Supplies Europe. [online] Available at: https://www.drillingsupplieseurope.com/drilling-fluids/clearbore/.

located next to the launch pit into which the arisings will be pumped. This will be stored outside of the 25-metre watercourse buffer zone.

Breakouts and Drilling Returns

Generally speaking, drilling fluids used in HDD practices are released at the beginning (launch) and termination (reception) sites of a borehole path, collected and disposed of properly. However, breakouts can in theory occur as a result of unstable conditions within the drilled bore due to low cohesion; for example, 1) the swelling and hydration of clay materials, 2) the movement and dispersion of clay minerals, 3) water blocks, and 4) low-permeability of mud cakes.[17] Drill fluid returns/frackouts can occur as a result of: poor drilling methods, and/or improper mud formulation used in bore drilling which can cause stability issues within the bore. Given the local lithology of the site with underlying sandy, clayey gravel and tills, potentials for breakouts must be considered. Breakouts can lead to failure in returns at either end of the bore path and subsequent drill mud being released outside the bore to the receiving environment (i.e., soils, subsoils, ground and/or surface waters).

Drilling Fluid Disposal

It has been advised that Clearbore drilling fluid will be used in drilling operations. In consultation with Drilling Supplies Europe, Clearbore is an environmentally friendly, High Performance Water-Based Mud suitable for tunnelling and drilling operations and is known to have a 10-fold volume to volume rheology comparison to high-yielding bentonite.

Drilling mud containing spoil recovered from the bored path can be retrieved at the launch and reception sites of the bore. This bentonite contaminated spoil can be treated in one of two ways. It can either be transferred off-site to an approved and authorized EPA license facility (in accordance with the Waste Management Act 1996 as amended) to be properly disposed of; or, the spoil can be pumped to a mechanical separation container. This involves drill mud being stored within a holding tank until separation of particulates can be achieve only then can the fluid be discharged to the surrounding area.

Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite at sufficient rates. To address this, it is recommended that flocculant is used to promote the settlement of finer solids prior to discharging to surface water networks. Flocculant 'gel blocks' are passive systems, self-dosing and self-limiting,

[17] Willoughby, D. A. (2005) "Horizontal Direction Drilling Utility and Pipeline Applications" *McGraw-Hill Civil Engineering Series,* ISBN: 978-0-07-150213-9.

however they still require management as per the manufactures instructions. Flocculants are made from Ionic polymers. Cation polymers (positive charge) are effective flocculants; however, their positive charge makes them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective flocculants, and are not toxic i.e., environmentally friendly.[18] Therefore, if flocculants are deployed the material used must be made from anionic polymers.

Worst Case Scenario

A worst-case scenario could possibly occur whereby the proposed works of HDD could result in a direct, negative, potentially significant, impact of the Project. This impact could result from any number of indirect anthropogenic sources, most commonly would be from: inadvertent drill returns containing drilling fluid, breakouts of drilling fluid during drilling operations (underground) and by spillages of oil, fuel, or drilling fluid. Such spillages could potentially affect either surface water or groundwater depending on the nature of the contamination issue, and to varying degrees depending on the hydrological and hydrogeological characteristics of the surrounding area along both the Interconnector Route and Grid Connection Route. Considering the proximity to surface water associated with this type of infrastructure the risk is elevated.

Mechanism/s:

- Construction activities (Earthworks, addressed under Release of Suspended Solids)
- Construction activities (Earthworks) within surface water buffer zones.
- Construction activities (Earthworks, addressed under Release of Hydrocarbons), and/or chemical spill.
- Poor design and/or installation of HDD bore path.

Impact

- Release of suspended solids, intercepted by surface water network.
- Significant surge release of suspended solids, intercepted by surface water network.
- Release of hydrocarbon and/or chemical intercepted by surface water network.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quality for the purposes of extraction.

[18] USEPA (2013) "Stormwater Best Management Practice: Polymer Flocculation" *United States Environmental Protection Agency: Office of Water*, 4203M.

An accidental contaminant spillage (also known as drill return or frack out), would have a **likely, adverse, direct, small** in scale**, slight, localised (potentially regional), long term to permanent** effect which is in contrast to baseline conditions. However, with implementing mitigation and best practice the risk of an accidental spill can be greatly reduced.

In terms of groundwater associated with the Project an accidental drilling fluid breakout is considered to be a **likely, direct and indirect, adverse, small** in scale**, moderate to significant, localised (potentially regional), temporary to long term but reversible** effect of the Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

Spoil arising from drilling activities will require temporary stockpiling and has the potential to be entrained by surface water runoff (suspended solids). Spoil arising from drilling activities could be mobilised by large volumes of water which would rapidly traverse overland if not managed appropriately and has the potential to mobilise additional solids via eroding soils, or other contaminants, and infiltrate the receiving surface water bodies, or groundwater bodies. Similar to the release of suspended solids, **Section 9.4.4.1,** the introduction of drill arisings to the receiving surface water receptor is considered a **direct, adverse, moderate to profound significance** impact of the Development.

Surface Water Crossings or Culverts over Non-Mapped Drains – Wind Farm Site

A number of existing culverts at the Wind Farm Site are associated with the Proposed Development footprint. The Proposed Development will also require a number of new drainage culverts under the proposed access tracks and areas of the Wind Farm Site where turbine hardstands intersect drains, particularly in areas of extensive existing drainage, (**Figure 9.6a**). These watercourse crossings have been identified **Table 9.13** as WCC4 and WCC4a, WCC5, WCC6, WCC7, WCC8, WCC9, WCC10, WCC11, WCC12 and WCC13. There are four new watercourse crossings where there is no existing infrastructure, which are highlighted in yellow. Although more minor in scale, such culverts must be considered similarly to watercourse crossings in terms of potential impacts associated with poor design and construction. Note; existing culverts presented in **Figure 9.6a and Appendix 9.4**, were observed during Wind Farm Site surveys and/or from desk top assessment of aerial imagery and site drainage mapping. There is potential for additional, historical, infilled or hidden culverts to be present on site which are not mapped here. Similarly, proposed new culvert locations are considered indicative locations requiring culverting based on baseline site drainage conditions overlaid with the Wind Farm Site layout. Micro-siting of culverts will likely require detailed assessment on a case by case basis as part of the Proposed Development Surface Water Management Plan (SWMP).

Mechanism/s:

- Significant changes to the hydrological regime at the Wind Farm Site.
- Construction activities (Earthworks, addressed under Release of Suspended Solids)
- Construction activities (Earthworks) within existing drainage channels and/or streams and rivers.
- Connecting new and existing drainage channels.
- Poor design and/or installation of watercourse crossings.
- Poor design and/or installation of culverts.
- Upgrading of existing culverts where necessary.
- Poor design and/or installation of drainage infrastructure including culverts attenuation features.

Impact

- Release of suspended solids, intercepted by surface water network.
- Significant surge release of suspended solids, intercepted by surface water network.
- Altering hydrological regime at a particular location. Potentially leading to erosion / deposition not in line with baseline conditions.
- Restricting water flow.

Receptor/s:

- Surface Water. Surface water quantity and flood risk. Surface water quality, ecological sensitivities and WFD status.

Pre-Mitigation Potential Effect:

- Surface Water - Negative, direct, profound, likely, long-term to permanent.

Table 9.13: Surface Water Crossings- Drainage and/or Non-Mapped Surface Water Features

Surface Water Drainage and/or Non-Mapped Surface Water Features					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
Drain / Culvert	WCC10	Existing culvert to be upgraded as required	537155.3	822183.6	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).

Surface Water Drainage and/or Non-Mapped Surface Water Features					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
Drain	WCC11	New; No existing infrastructure	536636.0	822009.3	Must apply to the OPW for consent on the construction of new watercourse crossing under Section 50 of the (EU Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). Mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC12	Existing culvert to be upgraded as required	536906.3	821550.5	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain	WCC13	New; No existing infrastructure	535387.5	822742.1	Must apply to the OPW for consent on the construction of new watercourse crossing under Section 50 of the (EU Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). Mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC4	Existing culvert to be upgraded as required	536307.9	820831.0	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC4a	Existing culvert to be upgraded as required	536287.4	820844.1	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC5	Existing culvert to be upgraded as required	536333.6	820511.8	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).

Surface Water Drainage and/or Non-Mapped Surface Water Features					
Category	**ID**	**Description/ Infrastructure**	**Easting ITM**	**Northing ITM**	**Comment**
Drain / Culvert	WCC6	New; No existing infrastructure	536248.3	821365.5	Must apply to the OPW for consent on the construction of new watercourse crossing under Section 50 of the (EU Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). Mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC7	Existing culvert to be upgraded as required	536219.8	821696.3	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC8	Existing culvert to be upgraded as required	535928.1	822525.1	Existing culvert will require inspection by certified engineer. If upgrading works necessary, mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Drain / Culvert	WCC9	New; No existing infrastructure	537144.7	822336.6	Must apply to the OPW for consent on the construction of new watercourse crossing under Section 50 of the (EU Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). Mitigation measures detailed in Section 9.5.2.8 will be adhered to along with guidance regulations published by the NRA (2008), IFI (2016), OPW (2013) and SEPA (2010).
Sub-Total	New	**4**			
Sub-Total	Existing	**6**			
Total	All	**10**			

Watercourse crossings and associated portions of access track are naturally in very close proximity to or directly within sensitive receptor buffer zones i.e., surface waters or drainage features discharging to surface water features.

Potential effects with regards to upgrading and installing watercourse crossings at the Wind Farm Site are considered to be **unavoidable, adverse, direct and indirect, small to moderate** in scale**, moderate to profound significance, localised (potentially regional** when considering the extensive downstream surface water network), and **permanent** which conforms to baseline conditions (e.g., existing bridges and roads in the area. However, with implementing mitigation and best practice the risk of an accidental spill can be greatly reduced.

9.4.6 Operational Phase Potential Effects

9.4.6.1 Increased Hydraulic Loading – Wind Farm Site

The Proposed Development has the potential to result in increased volumes of runoff during the operational phases of the Proposed Development relative to baseline conditions. This is a function of the progressive excavation and removal of vegetation cover and replacement with hardstanding surfaces (effectively or assumed impermeable) and installation of constructed drainage along the Proposed Development footprint and thus removing the hydraulic absorption / buffer control from this part of the Wind Farm Site. However, it must be noted, that the Wind Farm Site has already experienced influences to baseline hydraulic loading capacity from its historic and current peat harvesting practices. Artificial drainage networks associated with peatlands, and as seen with the Redline Boundary, coupled with the removal of the acrotelm (i.e., the layer of peat which retains a majority of rainfall), during the peat extraction process considerably alters the natural system function of healthy active peat bog[19]. Through the exposure of more decomposed catotelm peat and subsequent decreasing average pore diameter within the peat itself, results in a reduced specific yield of the altered catotelm, leading to a rapid decline in the retention to rainfall locally[12].

Increased runoff, or an increased hydrological response to rainfall has the potential to exacerbate flooding events and impact on hydro morphology of waterbodies downstream of the development, and/or to exacerbate flooding and erosion within the boundary of the Wind Farm Site. Furthermore, the installation of constructed drainage for the purposes of collecting either clean water or construction run off have the potential to also drain sensitive areas of the site, specifically areas of intact or designated peat or water dependent terrestrial ecosystems.

Considering baseline characteristics of the Wind Farm Site and the 'Very High' sensitivity and importance of the associated surface water bodies downstream, including areas with probable flood risk areas and respective flood management schemes, any net increase in runoff (<15%, or small scale impact) or hydrological response to rainfall is considered a potentially Moderate to Significant adverse impact.

[19] Price, J.S. and Ketcheson, S.J. (2009) "Water Relations in Cutover Peatlands" *Geophysical Monograph Series*

Storm water runoff is identified and qualified as a potential impact under the Wind Farm Site Flood Risk Assessment presented in **Appendix 9.1**. Water balance calculations allow for the addition of the area of hardstand required (land take) for the construction of the Proposed Development, which equates to approximately 114, 563 m^2. The resulting 1 in 100 year scenario net increase of surface water runoff associated with the Proposed Wind Farm Development is calculated to be c. 0.124 m^3/sec (or 124 l/sec). (Note: Assessment at catchment scale presumes the same environmental conditions across the entire catchment during a theoretical storm event taking into account for climate change).

This net increase relative to the scale of the Wind Farm Site or the scale of the associated catchment is considered an **unavoidable, direct and indirect, adverse, slight, permanent** effect of the Development. However, considering the cumulative impacts in regard to increased runoff generally (catchment / national scale), the potential for increasing rainfall amounts and frequency (climate change), and considering the sensitive receptors a relatively short distance downstream (probable flood risk areas), any net increase in runoff is considered a significant impact.

With appropriate environmental engineering controls and mitigation measures these potential impacts can be significantly reduced. Furthermore, if considered adequately mitigation measures have the potential to have a beneficial impact on the hydrological response to rainfall at the site, where by; if the Proposed Development can reduce discharge rates at the site below estimated *greenfield* or baseline runoff rates, the Wind Farm Development will have a beneficial impact by reducing the site hydrological response to rainfall and mitigate against potential flood events downstream.

Minimal land take is required for the Grid Connect Route, Interconnector Route and the Killybegs Turbine Delivery Route and Galway Turbine Delivery Route considering a majority of the routes will traverse already existing roadways (i.e., existing site access tracks, public and local road networks. There are some areas of the delivery route that will require the widening of existing portions of roads which traverse greenfield / green verge areas, however considering the small scale of disturbance (shallow excavation, superficial paving) the impact is considered **slight**. Similarly, there is unlikely to be an increase in the rate of runoff from the construction of both these routes due to utilization of pre-existing road infrastructure.

Mechanism/s:

- Significant changes to the hydrological regime at the Wind Farm Site.

- Replacement of vegetated land with respective recharge capacity with impermeable (assumed) hardstand surfaces. Introduction of constructed drainage intercepting greenfield runoff. Construction activities (Earthworks) within existing drainage channels and/or streams and rivers.
- Connecting new and existing drainage channels.

Impact

- Increase in runoff at the Wind Farm Site.
- Increase in hydrological response to rainfall at the Wind Farm Site and in downstream surface water bodies.

Receptor/s:

- Surface Waters. Site hydrological response to rainfall and potential downstream flood risk areas.

9.4.6.2 Increased Hydraulic Loading – Hydrogen Plant Site

Storm water runoff is identified and qualified as a potential impact under the Hydrogen Plant Site Flood Risk Assessment presented in **Appendix 9.2**.

Water balance calculations allow for the addition of the area of hardstand required (land take) for the construction of the Proposed Development, which equates to approximately 14,300 m^2. The resulting 1 in 100 year scenario net increase of surface water runoff associated with the Proposed Development is calculated to be c. 103.8 l/second, or 373.68 m^3/hour. (Note: Assessment at catchment scale presumes the same environmental conditions across the entire catchment during a theoretical storm event taking into account for climate change).

This net increase relative to the scale of the associated catchment is considered an **unavoidable, direct and indirect, adverse, slight, permanent** effect of the Development. However, considering the cumulative impacts in regard to increased runoff generally (catchment / national scale), the potential for increasing rainfall amounts and frequency (climate change), and considering the sensitive receptors a relatively short distance downstream (probable flood risk areas), any net increase in runoff is considered a significant impact.

Mechanism/s:

- Significant changes to the hydrological regime at the Hydrogen Plant Site.
- Replacement of vegetated land with respective recharge capacity with impermeable (assumed) hardstand surfaces. Introduction of

constructed drainage intercepting greenfield runoff. Construction activities (Earthworks) within existing drainage channels and/or streams and rivers.

- Connecting new and existing drainage channels.

Impact

- Increase in runoff at the Hydrogen Plant Site.
- Increase in hydrological response to rainfall at the Hydrogen Plant Site and in downstream surface water bodies.

Receptor/s:

- Surface Waters. Site hydrological response to rainfall and potential downstream flood risk areas.
-

9.4.6.3 Groundwater Abstraction – Hydrogen Plant Site

9.4.6.3.1 Groundwater Resource and Supply

The Hydrogen Plant will require relatively large volumes of water for the production of hydrogen. Multiple sources of water will be utilised including groundwater and rain water, and mains water if needed under exceptional circumstances. Groundwater is the principal source water which will be used, with rain water serving as supplementary source water.

As presented in the Groundwater Supply Assessment (GSA) Report (**Appendix 9.8**) abstraction of groundwater will lead to lowering of water levels locally, and during pumping and for a period of recovery afterward, a cone of depression or zone of contribution (ZOC) will form extending to a maximum of approximately 0.6 km from the pumping well under a relatively high volume pumping regime (*Conceptual ZOC: Assuming estimated annual abstraction of 99,000 m^3 (66,356 m^3 x 0.5 safety factor)*). This is a conservative estimation whereby the 50% '*safety factor'* allows for seasonal variation including climate change and draught conditions. The closest mapped GSI well to north of the Hydrogen Plant Site is approximately 1.1 km distance from the site.

Over pumping of the aquifer, particularly during dryer periods or during seasonal periods of low groundwater levels, has the potential to lead to depleting the aquifer and groundwater resources with medium to long term effect. This could potentially lead to serious issues for other entities reliant on groundwater supply for e.g. for agricultural purposes. As presented in the GSA Report (**Appendix 9.8**) the sustainable yield from the production wells (BH6 and BH7) equates to 232 m^3/day. The conservative estimate of water demand for the plant is 182 m^3/day, therefore it is unlikely that the Hydrogen Plant Site will exceed the sustainable yield in the underlying aquifer. However, seasonal variation particularly in light of climate change still need to be considered on an ongoing basis.

Worst case scenario includes abstracting groundwater during prolonged drought conditions, whereby the Zone of Contribution extends further than predicted and impacts adversely on groundwater yields at other wells in the area. Under these conditions, the Hydrogen Plan Development has the potential to lead to **significant to profound, adverse, direct impact** to groundwater resources on a **small to moderate**, **local** scale relative to the aquifer or catchment, but is **avoidable** with appropriate mitigation.

Mechanism/s:
- Overjumping of groundwater resources, particularly during prolonged drought conditions. .

Impact
- Depletion of groundwater resources and supplies in local area.

Receptor/s:
- Wells and community/agriculture.

9.4.6.3.2 Groundwater Quality

As presented in **Appendix 9.8**, groundwater quality observed in the 8 no. boreholes is variable with elevated nutrients (Nitrogen, Phosphorous) and faecal contamination (e. Coli) in places.

Elevated nutrients (N and P) in groundwater is indicative of the state of groundwater on a national scale whereby activities, namely agriculture and spreading of fertiliser, has led to a diffuse nutrient contamination issue. Similarly, faecal contamination is indicative of another national issue whereby wastewater systems are inadequately designed or managed, in turn leading to elevated faecal contamination, and Biological Oxygen Demand (BOD) in both groundwater and surface waters.

Abstraction of groundwater from pumping wells associated with the Hydrogen Plant Site will lead to a Zone of Contribution (ZOC) forming, and any potential ground contamination within the ZOC will gradually be pulled toward and ultimately some contaminants will end up being abstracted and pumped to the Hydrogen Plant. Water sources for the Hydrogen Plant will be treated and managed appropriately, however under a worst case scenario, the potential variability in groundwater contaminants could potentially lead to the wastewater treatment systems at the site to be overloaded, and in turn discharged to surface water. This scenario has the potential to lead to a significant adverse impact, potentially impacting on water quality and aquatic ecological attributes downstream of the Hydrogen Plant Site. However, this is unlikely and avoidable with appropriate mitigation.

Mechanism/s:
- Migration of contaminants within the ZOC towards the abstraction point.
- Abstraction of contaminated groundwater.
- Groundwater contaminants overload and by-pass treatment systems.

Impact
- Discharging of wastewater which does not meet Environmental Quality Standards.

Receptor/s:
- Surface water quality and aquatic ecological attributes. .

Assuming that such potential impacts are mitigated and managed, the abstraction of contaminated groundwater which in turn is treated before being discharged, and assuming the discharge quality meets Environmental Quality Standards (EQS), and noting that the receiving river is likely to possess a relatively significant groundwater fed baseflow normally, the discharging of treated groundwater to the surface water system can be viewed as a beneficial impact of the Development.

9.4.6.4 Storage and Release of Hydrocarbons and Other Contaminants – Wind Farm Site and Hydrogen Plant Site

Health and Safety protocols for chemical storage on the Proposed Development is outlined in **Chapter 2 Section 2.6.6.2**. There is a larger risk associated with the Hydrogen Plant Site than the Wind Farm Site but both have been assessed in terms of potential effects to soils and geology of the Project.

There will be a relatively large scale volume of various chemicals stored on the Hydrogen Plant Site, including Hydrogen itself making up a large portion during production. Other chemicals or potential pollutants include hydrocarbon fuels stored on site.

With relatively large volumes of fuel being stored on site there is the potential for a correspondingly significant worst case scenario involving a significant release of hydrocarbons into the environment. This is considered to be potentially profound adverse effect, but with proper management and mitigation the risk can be significantly reduced. Furthermore, with swift escalation of emergency response procedures in the event of a release, potential effects are reversible.

9.4.6.4.1 Environmental Impact of a hazard event – Wind Farm and Hydrogen Plant Site

Chapter 16 Section 16.2.3.2 identifies, classifies, and evaluates the risk associated with a major hazard event. Emergency response plans are in place for Mayo County and Sligo County, however impacts from the Project are assessed independently of the plans. An Emergency Response Plan (recommended, not required for lower-tier COMAH sites) will be produced for the plant. A risk management programme, ATEX Assessment and Safety Management System will be in place for the facility as outlined in **Chapter 2 Section 2.6.6.2**.

Environmental effects can range from '*Considered an imperceptible, not significant negative effect under EIA definitions; An effect capable of measurement but without significant consequences and/or an effect which causes noticeable changes in the character of the environment but without significant consequences'* to 'very heavy contamination, widespread effects of extended duration' presented in **Chapter 16 Section 16.2.3.2**.

Operational wind farms in Ireland are considered not to be vulnerable to major accidents or adverse impacts from natural disasters and therefore significant environmental effects are unlikely.

Natural Disaster Hazard

Chapter 16 Section 16.3.1 stipulates that wind turbines will be fitted with anti-vibration sensors, which will detect any imbalance caused by icing of the blades. The sensors will cause the turbine to wait until the blades have been de-iced prior to beginning operation. Safety signage will be put in place. Spoil deposition areas will store water on site and Suds measures will ensure the reduction in any runoff, this will be beneficial in drought and flood conditions.

The Hydrogen Plant Site has been designed to withstand extreme weather events. Details of design is presented in **Chapter 16 Section 16.3.1**. Impacts in relation to Hydrology vary from drought to flood conditions of the nearby river. In these instances there are buffer tanks for rainwater harvesting and discharge water will be inkered offsite.

Health and Safety

Given the higher risk posed at the Hydrogen plan, a Quantitative Risk Assessment and Major Accidents Prevention Policy has been formed as part of the application. A person is required to be onsite of the Hydrogen Plant 24/7. Further on-site Quantitative Risk Assessments (QRA) will be prepared as the Hydrogen Plant progresses towards construction, into and during operations. Chapter 16 outlines the potential major accidents arising from the project and how they are mitigated for. The Major Accidents Prevention Policy stipulates the protocols to be followed to lower the risk of such an event occurring. HAZID workshops will aim to foresee hazards and implement. Emergency Response plans are discussed in detail in the Major Accidents Prevention Policy for the Hydrogen Plant.

Industrial Accident

No significant sources of pollution were identified in the Wind Farm with the potential to cause environmental or health effects **Chapter 16 Section 16.3.2.3**. Significant Fire risk was assessed, affecting the Wind Farm Site and causing the Wind Farm to have significant environmental effects is unlikely.

The Hydrogen Plant has a higher risk due to the production and handling of hydrogen. This has been discussed in **Chapter 2 Section 2.6.6** and **Chapter 16 Section 16.3.2.3** regarding health and safety checks. Fire water will be managed in accordance with EPA contained within the storm water drainage infrastructure before being removed from site disposed of in an appropriate manner.

The effect of any pollution event will be linked to the volumes of discharged waters, and the concentrations and types of pollutants, volumes of receiving waters, and the sensitivity of the ecology of the receiving waters. The Project has the potential to release chemicals such as Hydrocarbons, Potassium hydroxide (KOH), Sodium bisulphite and Glycol. More detail on these contaminants can be found in **Chapter 16 Section 16.3.2.10**. A major pollution event will have a knock on effect to surface water and ground water bodies which are sensitive receptors on site and downstream of the Proposed Development. The significance of any effect would also be dependent on the magnitude and duration of an industrial accident or pollution event.

9.4.6.5 Discharge of Trade Effluent – Hydrogen Plant Site

With reference to **Appendix 9.3** (pDACA) the Hydrogen Plant Site will generate volumes of trade effluent. The nature of the trade effluent is akin to 'concentrated groundwater' if groundwater is the principal raw water used in the process. When using abstracted groundwater, which is impacted to a degree as part of baseline conditions, the wastewater treatment process for the Hydrogen Plant Site will treat raw water with 70% efficiency, equating to c. 100% of the mineral or chemical constituents per volume in the raw water concentrated in 30% of the volume abstracted. The hydro chemical signature of the resulting wastewater is therefore likely to be similar to hydro chemical signature of baseline groundwater samples, but with elevated concentrations. Black and Veech have provided expected wastewater composition based on baseline groundwater samples (Appendix B), however it is important to note the potential for variable groundwater chemistry, particularly during and after periods of groundwater extraction over prolonged periods of time.

The system will be dosed with low concentrations of some cleaning and anti-scaling products. These products are not likely to cause significant adverse impact at the low concentrations they will be dosed into the system, which will further reduce following on site primary and secondary treatment. However, in their raw form these products have the potential to cause a more significant impact, and in line with typical safety datasheets associated with these products, the use of these products will be managed and monitored, and accidental release avoided through appropriate measures, including diverting away from drainage systems. The products that will be used for the Hydrogen Plant system will be not include any substances which are persistent and/or bioaccumulate.

The nature and quality of the proposed discharge of trade effluent is therefore of relatively low impact or significance, however with the potential for unforeseen concentrations of contaminants in groundwater, or accidental on site or in catchment spills or releases, unmitigated discharging to surface waters will potentially impact adversely on the receiving surface water quality. With appropriate wastewater treatment and controls, this potential impact can be mitigated ensuring surface water Environmental Quality Standards (EQS) are maintained.

9.4.6.6 On-Site Storage of Hazardous Material – Hydrogen Plant Site

During the operational phase of the Proposed Development, it is noted there will be a degree of chemical storage (e.g., alkaline solution) on the Hydrogen Plant Site, for the lifetime of the project. The risk for potential spills as outlined with potential hydrocarbon spills in **Section 9.4.3.1,** are applicable.

Any chemicals accidentally introduced to the environment will likely be intercepted by drainage and potentially surface water networks associated with the Hydrogen Plant Site.

Mechanism/s:

- Chemicals used during the Operational phase of the Proposed Development at the Hydrogen Plant Site, leaking from concrete bund.

Impact

- Release of chemicals in runoff, intercepted by surface water network.
- Release of chemical to ground, intercepted by groundwater.

Receptor/s:

- Surface Water. Surface water quality, ecological sensitivities and WFD status.
- Groundwater. Groundwater quality for the purposes of extraction.

9.4.7 Decommissioning Phase

Decommissioning of the Wind Farm Site would result in the cessation of renewable energy generation at the end of the operational life of the wind farm (c. 40 years) with the removal of various infrastructural elements. The drainage network of the Wind Farm Site will be inspected by a SuDS hydrologist prior to any works commencing. The Decommissioning phase will involve the removal of the above ground elements of the Wind Farm which will require:

- Wind turbines dismantling and removal off the Wind Farm Site
- Underground cabling removal (ducting left in-situ)
- Turbine Foundation backfilling following dismantling and removal of wind turbines (any excavated material, will be re-instated / foundations that protrude above ground level will be backfilled with soil -underground reinforced concrete remaining in-situ)
- Transport Route Accommodation Works

It is anticipated that the following elements of the Wind Farm will be left in place after Decommissioning:

- The reinforced concrete Turbine Foundations
- The crane hardstand areas adjacent to the turbines
- All Wind Farm site access roads
- Grid Connection
- Interconnection

There will not be a requirement for additional drainage measures to be implemented during the Decommissioning phase of the project . With the passage of time, the constructed drainage network will likely become full of deposited sediment and revegetation will naturally occur which will render the drainage system less effective over time. The Wind Farm Site will therefore revert over time to a more natural drainage regime. All anticipated impacts are similar in nature to those already highlighted during the construction phase of the Project , i.e., release of hydrocarbons, wase water / sanitation and suspended soils through the excavation of material in order to remove cabling from joint bay locations.

The works to be completed during the Decommissioning phase are expected to be an **imperceptible to slight, neutral, permanent impact** on the hydrological and hydrogeological setting surrounding the Site.

Restoration of the Wind Farm Site following Decommissioning of the proposed infrastructure is in its own right a phase of the Project. Restoration activities have the potential to be disruptive and hazardous to the environment, to the point that a 'benefit analysis' will likely be required to evaluate any such activity before it is permitted.[20] Decommissioning will pose similar risks as to the Construction phase, but however on a smaller scale. Baseline conditions at the site will likely fluctuate over the life of the Proposed Development, therefore it is recommended that the decommissioning phase is assessed in detail to verify conditions towards the end of the life of the Proposed Development. Ultimately the decommissioning phase poses similar risks observed during the construction phase, and application of mitigation measures will be similar where relevant.

9.4.7.1 Reinstatement of Grid Connection Route and Interconnector Route Areas

Underground cables will be removed while the ducting will be left in-situ. Excavated material removed during the Grid Connection Route, the eight foundation structures for the two met masts and Interconnector Route network installations will be temporarily stockpiled, outside of an associated surface water buffer zone, if applicable, for re-use during reinstatement. Excavated material will then later be utilized to backfill the trench where appropriate, any surplus material will be transported to and disposed of at a licensed facility. Any earthen (sod) banks to be excavated will be carefully removed and stored separately, maintained and used during reinstatement.

9.4.7.2 Reinstatement of Redundant Access Track and Hardstand Areas

Access tracks and hardstand areas associated with the Proposed Development which will become redundant following the decommissioning of the Proposed Development will be reinstated. This entails:

- Removal of some / top layer or all of hardstand / access track. The underlying Soil / Peat will be exposed.
- Depositing of soils / peat over the areas in question.
- Completion of reinstatement will produce extensive areas of exposed, unvegetated / non-stabilised soils which will be prone to erosion. Solids entrained in runoff will be intercepted by the existing (as part of the proposed Development, if granted) constructed drainage infrastructure.

[20] Schumann, M., and Joosten, H. (2008) Global Peatland Restoration Manual. Institute of Botany and Landscape Ecology. Greifswald University, Germany.

No new impacts are anticipated to arise during the reinstatement phase of the Project on the hydrological and hydrogeological environment, however the potential for solids being entrained by surface water runoff is relatively elevated. Potential impacts and respective magnitudes are considered in line with unmitigated impacts described in previous sections of this report, **Section 9.4.4.1.**

9.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

A process of "mitigation by avoidance" was undertaken by the EIA team during the design of the turbine and associated infrastructure layout at the Wind Farm Site. A similar approach was taken at the Hydrogen Plant Site. The Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route, Galway Turbine Delivery Route and Construction Haulage Route. Arising from the results of this study, a constraints map was produced that identifies areas where hydrological / hydrogeological constraints could make parts of the Wind Farm Site or Hydrogen Plant Site less suitable for development. The constraints map is presented in **Figure 9.12a Figure 9.12b**.

The identified constraints have been extensively discussed in consultation between RSK Ireland Ltd. and the design team. The final Wind Farm and Hydrogen Plant Site layout plans have been identified as the optimal layout design available for protecting the existing hydrological regime of the site, while at the same time incorporating and overlaying engineering and other environmental constraints as detailed in this EIAR.

9.5.1.2 Nature Based Solutions

Nature Based Solutions (NBS) will be adopted where possible. NBS include Sustainable Drainage Systems (SuDS), which will be employed to attenuate runoff and reduce the hydrological response to rainfall at each site. extending or maximising this approach sufficiently has the potential to attain net beneficial effects i.e., a net reduction in runoff rates at both the Wind Farm and Hydrogen Plant Site, beneficial effects to water quality and reducing flood risk to downstream flood risk areas. Coupling SuDS with ecology and biodiversity mitigation can also provide opportunities to attain net biodiversity gain.

In peatland areas, one of the main objectives of Nature Based Solutions and SuDS is to create an array of runoff stilling areas / standing water and promote diffuse discharge and recharge of runoff on peatland. Generally, and as is the case on the subject Wind Farm Site, peatlands have been subject to peat cutting and forestry operations which include extensive drainage networks and draining of peatland bogs. It is noted that peat cutting will continue adjacent to the Wind Farm for the duration of the Project. Lowering bog water levels leads to increased erosion, release of carbon to atmosphere and the receiving surface water network and reduces the productivity and general health of the bog, potentially leading to chronic degradation and decline. The objective of nature based solutions in peatlands will be to reverse this impact where there is the opportunity and where it is appropriate through surveying and risk assessment.

Runoff attenuation features or SuDS will be included as part of the Project, in particular where optimal space allows (i.e., Wind Farm Site), as detailed in the following sections of this report. It is important to follow best practice and relevant guidance in the design and construction of drainage features. The following sections outline design considerations for working towards effective nature based solutions and net beneficial impact, for example; maximising the distribution of check dams and stilling ponds and similar features where appropriate*, with the objective of attenuating as much water as possible safely, and to promote diffuse discharge to vegetated lands where valued*, and to promote and maintain high bog water levels and healthy peatland conditions.

An agreement with landowners has been formed and is subject to habitat enhancement. The agreement outlines the frequency on monitoring on these habitat enhancements and stipulates that ecologists be carrying out the monitoring. The Peatland code, UK outlines monitoring duration for a minimum of 30years is required for peatland habitat enhancements, which is line with expected lifespan of the project.

* Relevant guidance on the Wise Use of Mires and Peatlands (Joosten H, Clarke D, 2022) outlines principles for decision making through considering the cultural, or other values held by stakeholders associated with the subject peatland. It is noted that active peat cutting, and commercial forestry operations require networks of drainage channels, with the objective of reducing and maintaining relatively low bog water levels. This is on contrast to promoting and maintaining higher bog water levels for healthy peatland function. Much of the mitigation outlined in the following sections is intended to attenuate water on site and promote the diffuse discharge and recharge of runoff on peatland at the site. Nature based solutions including SuDS will be designed in a manner that respects the ongoing land uses and stakeholder values, where valid and in line with local, national, and international, law, policy and guidance. That is, where stakeholders have a right, and value the peatland, and intend to maintain existing drainage arrangements, the Wind Farm and Hydrogen Plant drainage design will

incorporate checks on suitability particular features at given locations, and to direct runoff on site to suitable locations for targeting rewetting, or the promotion and maintaining of high bog water levels.

9.5.1.2.1 Wind Farm Site

Nature based solution will be adopted at the Wind Farm Site, as detailed in **Chapter 8: Soils and Geology – Section 8.5.** Runoff attenuation features will be included as part of these works as detailed in the following sections of this report, i.e. maximising the distribution of check dams and stilling ponds and similar features where appropriate, with the objective of attenuating as much water as possible safely, and to promote diffuse discharge to vegetated lands where valued, and to promote and maintain high bog water levels and healthy peatland conditions[21].

9.5.1.2.2 Hydrogen Plant Site

With reference to **Appendix 9.3** Preliminary Discharge & Assimilative Capacity Assessment, the Hydrogen Plant will include sustainable use of several raw water sources (rainwater harvesting and groundwater) and will employ constructed wetlands to treat and discharge wastewater at the site. Stormwater attenuation will be included within the storage tanks. There will be two circular underground stormwater tanks with a depth of 5 m and a diameter of 45.66 m to capture the excess water. One of the tanks will be pure rainwater, this rainwater tank will include a 1 in 100 year attenuation capacity. In events of tank capacity being reached it will discharge at greenfield rates. Other water tanks on the Hydrogen Plant Site include two 42 m² fire water tanks outside and a buffer water tank 12,000 x 7,500 m² inside.

In the event that the storage tanks reach capacity, whilst providing for the attenuation, future rainwater will then be discharged through the constructed wetland before entering the water course. This is a conservative approach as the components of this stored water will be a mix of ground and rainwater. In events where the river is dry or in drought conditions the CEMP will be consulted.

Furthermore, the Proposed Development promotes diffuse overland discharge to adjacent peatland areas, and to promote and maintain high bog water levels and healthy peatland conditions.

[21] Joosten H, Clarke D (2022) Wise Use of Mires and Peatlands - Background and Principals including a Framework for Decision Making [Online] - Available at: ISBN 951-97744-8-3 [Accessed: n/a]

9.5.1.3 Mitigation by Design and Mitigation Objectives

The descriptive mitigation measures outlined in this report will be applied to the Proposed development design and construction methodologies with a view to avoiding and/or minimising any potential adverse impacts 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). The aims and examples of important considerations in relation to mitigation measures described in the EIAR are further clarified here.

9.5.1.3.1 Constructed Drainage:

Drainage features constructed at the Wind Farm Site have the potential to significantly adversely impact on the baseline hydrological regime, particularly in areas of intact habitat such as Wet Heath or Blanket Bog, but equally in peatland areas impacted by peat cutting there is the potential for the Wind Farm Site to have a beneficial impact to the hydrological regime and to peatland regeneration. Peatland groundwater levels are generally dependent on rainfall. Rainfall infiltrates and percolates into peat/soil (recharge), initially through vegetated / root conduits in the acrotelm peat (living vegetated layer) or upper soil horizons, however percolation and/or permeability rates in peat, particularly the catotelm (decomposing lower layer) are poor and therefore peatland areas are characterised by rapid hydrological responses to rain fall i.e. rapid surface water runoff intercepted by the receiving drainage and surface water network. Due to this characteristic, peatlands require consistent rainfall to ensure adequate wetting of water dependant blanket peat habitats such as Wet Heath and Blanket Bog.

Poor drainage design has the potential to drain excess surface water runoff and draw water away from areas of peatland, thus reducing the potential of recharge to ground in those areas, and creating an even greater hydrological response to rain fall in the receiving surface water network via more direct connections to the surface water network i.e. bypassing the peatland. Furthermore, uncontrolled surface water runoff interacting with the Wind Farm Site footprint has the potential to lead to adverse impacts including the development of new preferential pathways, erosion and peat degradation – particularly during and immediately after construction phase whereby unvegetated soils are exposed, and wetting and/or drying of peat areas potentially occurs.

The drainage design for the proposed Wind Farm Site will be such that drains are positioned adjacent to the foot print of the Project, **Appendix 9.7 – Tile 24**, therefore the proposed drainage infrastructure can be considered part of the Project foot print. The scale of the impact a shallow drain poses on the surrounding peatland area is minor particularly in areas impacted as baseline. Therefore, the potential magnitude or scale of impact to waters posed by the introduction of the proposed drainage extends to a minor extent beyond the footprint of the Project. However, it is important to consider the gradual degradation over time.

The Hydrogen Plant Site will also have constructed drainage. There an increased surface water runoff risk due to the scale of the ground which will be sealed with concrete. This excess surface water will be addressed through stormwater drainage linked to the rainwater harvesting discussed in the Section 9.5.1.2. The design of a 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 Wind Farm Site.
- The collection of surface water runoff from the footprint of the Project i.e. the construction area (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 Wind Farm site and Hydrogen Plant site.

Maintaining or improving the hydrological regime at the Wind Farm Site and Hydrogen Plant Site implies achieving the objectives of the Project SWMP i.e.; mitigating against potential adverse impacts to the hydrological response to rainfall at the site (related to flood risk), and water quality in the receiving surface water network.

9.5.1.3.2 Attenuation Features

There remains the risk of the proposed drainage to increase the rate of runoff from respective upgradient areas, to reduce potential runoff to respective downgradient areas, and to increase the rate of hydrological response to rainfall in the receiving surface water system (increase hydrological response will also be driven by introduction of nearly impermeable hardstand and the concrete apron which will seal 90% of the 'greenfield conditions' at the Hydrogen Plant Site).

Mitigation measures to address surface water runoff and drainage include in line attenuation features such as check dams, stilling ponds, constructed wetlands and buffered outfalls. Check dams, stilling ponds and constructed wetlands provide mitigation against potential impacts 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 Wind Farm Site and Hydrogen Plant footprint. Due to the large scale of surface water runoff potential at the Hydrogen plant there is also the two water tanks discussed in a previous **Section 9.5.1.2.2**.

9.5.1.3.3 Checked Dams

Check dams will be constructed along the length of constructed drainage at regular intervals in line with relevant guidance (**Appendix 9.7 – Tiles nos. 4 - 8**). 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 peat area, effectively contributing to bog water levels at that location.

9.5.1.3.4 Stilling Ponds

Stilling ponds with buffered outfalls will be constructed at drainage outfalls associated with the construction runoff drainage network. Buffered outfalls **Appendix 9.7 -Tiles 15 and 16**, will be established at intervals along the clean runoff drainage network at the Wind Farm Site. 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 **Appendix 9.7 – Tile 13**, will be permanent (for the life of the Project / 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 to settle out if present. At low velocity the runoff has increased opportunity to percolate through the coarse aggregate and into the surrounding peat area. Through both forms of discharge (buffered outfall and percolation through aggregate) the stilling ponds will contribute to bog water levels at their locations.

9.5.1.3.1 Promotion of Peatland Habitats

Excavated peat will be deposited with a view to restore infilled excavation areas associated with the site e.g. adjacent to hardstand area **Appendix 9.7 – Tile 24 - 26**. The deposition of peat, particularly in cutover peat areas, once successfully restored / revegetated will promote the recovery and development of blanket peat habitats (e.g. Wet Heath and Blanket Bog). This is considered a beneficial impact in areas of existing cutover peat and a neutral impact in areas of intact blanket peat habitats.

Improvements to the hydrological regime as a function of the Wind Farm Site will promote the recovery and development of blanket peat habitats, particularly in significantly impacted areas, such as existing cutover peat areas and areas adjacent to the Project footprint. This is worth noting in the context of the impact/s posed by the Proposed Development on blanket peat habitats i.e. range from temporarily adverse to beneficial.

The Proposed Development layout for both the sites and existing drainage network, and their interaction are assessed in detail and a detailed constructed drainage and attenuation network layout has been provided. This exercise and output will present the requirement, locations and conceptual function and objective of the drainage network and treatment train. This information has also been used to develop the SWMP and associated detailed design layout drawings have been submitted by the developer to the Planning Authority for review and approval.

9.5.1.4 Constraints

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 impacts to water quality in the receiving surface water network. Details and examples on how such measures will be applied (objectives, design considerations, layout, mitigation measures) are contained within this Chapter and in the Surface Water Management Plan.

As part of mitigation by avoidance principles applied during the design phase of the Project, self-imposed groundwater, surface water, and drainage buffer zones were established where applicable. Buffer zones intended to inform the design process by minimising or avoiding the risk to surface water receptors and by restricting construction disturbance to outside these zones in turn protecting riparian vegetation and providing potential for filtering of runoff from the Wind Farm Site and Hydrogen Plant Site, and maintaining the baseline hydrological and drainage regime at the each of the sites.

The available guidance stipulates that surface water buffer zones should be prescribed to mapped surface water bodies or aquatic zones i.e. defined as a permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map, however guidance also states any drainage features leading from the site and flowing into the receiving surface water network which may short circuit buffer zones must also be considered. The prescription of surface water, and groundwater, buffer zones (sometimes referred to as setback distances) is in line with relevant guidance relating to; forestry, agriculture, water resources, direct discharges and wind farm development guidance documents, **Section 9. 2.2.**

The available guidance stipulates varying surface water buffer widths depending on type of activity, receptor type and sensitivity, and riparian zone characteristics including topography (steepness). Recommended surface water buffer widths range from 5 m to 50 m depending on site specific and activity specific characteristics. For the purposes of this assessment the following conservative approach has been applied:

- Minimum 25 m Surface Water Buffer Zone - Mapped surface water features i.e. mapped streams, rivers, lakes (WFD, 2000) (DAFM, 2018). Source for mapped surface water features; EPA.
- 15 m Drainage Buffer Zone (WFD, 2000) (DAFM, 2018)- Non-mapped drainage features i.e. non-mapped streams, natural and artificial drainage features. Source for non-mapped surface water features; desk study and aerial photography assessment, and field observations. Note: Significant drainage features will be identified and mapped in so far as practical. Some drainage features will likely not be recorded due to issues relating to access and complexity, e.g., extensive turbary areas. Such drainage features, while not mapped or prescribed buffer zones, will be treated with the same consideration as mapped drainage during the design and construction phase of the Wind Farm Site i.e. mitigating for the potential for drainage connection to receiving surface water network.

Wind Farm Site and Hydrogen Plant Site Surface Water Buffers are presented in **Figure 9.13a.** Grid Connection Route Surface Water Buffers are presented in **Figure 9.13b.**

Groundwater buffer zones are dependent on the characteristics of the receptor e.g. private well, or public supply source protection zone, and the characteristics of the underlying geology and associated aquifer e.g. poor unproductive aquifer, or regionally important karstified aquifer. Recommended groundwater buffer zones range from e.g. 15 m (exclusion zone karst swallow holes) to entire catchments (source protection in regionally important karstified aquifer) depending on site specific characteristics. For the purpose of this assessment the following conservative approach has been applied:

- 100 m Groundwater Buffer Zone – Groundwater abstraction points in relation to proposed access roads and cable trenches i.e. shallow excavation. Source for mapped abstraction points: GSI. Applicable only to the two turbine delivery routes.
- 250 m Groundwater Buffer Zone – Groundwater abstraction points in relation to foundations. Source for mapped abstraction points: GSI. Not applicable.
- Source Protection Areas – The entire area mapped as a public or group groundwater supply protection area. Source: EPA. Not applicable.
- Entire Catchment – The entire catchment associated with a public or groundwater supply protection area which is underlain with a karstified aquifer. This will be assessed in detail as applicable. Not applicable.
- Karst Features – Karst features such as swallow holes and any associated drainage flowing into such karst features will be treated similarly to surface water features but ultimately will be assessed on a case by case basis. Not applicable.

Some of the Proposed Development infrastructure footprint will fall within buffer zones due to the unique and limiting circumstances associated with the Wind Farm Site and the Hydrogen Plant Site and the Proposed Development, including; constraints related to other environmental disciplines including; ecology, ornithology, etc.; restricted due to the proposed infrastructure itself whereby the proposed turbines require a minimum distance from each other to ensure the potential for wind turbulence impacting on downwind locations is minimised.

None of the proposed turbines or turbine hardstand areas fall within a buffer zone associated with a mapped stream / river. No watercourse crossings are required as part of the Hydrogen Plant Site, however, the drainage design takes into account a discharge point for wastewater from the Hydrogen Plant Site via a formed headwall and outfall pipe directly to the Dooyeaghny_or_Cloonloughan_010.

The proposed access road falls within buffer zones associated with mapped streams / rivers, that is; proposed new watercourse crossings. The proposed Site Access Roads and associated widening where required, watercourse crossings, etc. naturally fall within buffer zones associated with mapped streams / rivers. The proposed Site Access Roads and fill material intersect the Moyasta_010 river surface waterbody and associated buffer zone at each water course crossing (WC1, WC2, WC3) which will result in implementation of clear span bridges during construction works.

Given the extensive drainage network existing at the Wind Farm Site the construction activities associated with the Project will invariably be in close proximity to surface water / drainage features, including within the buffer zones. Following Wind Farm Site surveys significant natural and artificial drainage features observed which are relatively well connected to the mapped surface water network have been included in considering constraints. Some of the proposed turbines hardstands, and access road fall within buffer zones associated with existing natural and constructed drainage features at numerous locations **(Figure 9.12a).**

No groundwater buffer zones are required for the Proposed Development, refer to the baseline section of this report**, Section 9.3.15.**

Additional elements of the Project will fall within buffer zones due to the unique and limiting circumstances associated with the Project, including; the proposed infrastructure itself whereby the Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route or Galway Turbine Delivery Route traverse a relatively large distance and is limited to public and local road networks. Portions of the Grid Connection Route and Interconnector Route pass through numerous surface water buffers. Of note are the several watercourse crossings, which by their nature will be within surface water buffer zones, **Section 9.4.4.9.**

Careful consideration and special attention to planning is required for the identified locations within the surface water buffer zones. The SWMP will detail multiple mitigation measures for works proposed within buffer zones. Each proposed construction location will possess unique characteristics and will require assessment on a case-by-case basis to ensure adequate measures are implemented. Method statements and the proposed design of any road crossings will also require agreement from Inland Fisheries Ireland (IFI) in advance of construction which invariably must be constructed within the buffer zones. The mitigation measures described in the following sections will also be applied.

9.5.2 Construction Phase

9.5.2.1 Earthworks Proposed Mitigation Measures

9.5.2.1.1 General / Wind Farm Site Hydrogen Plant Site

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

- Management of excavated material, that is: a materials management plan will be established and form part of the Construction & Environmental Management Plan (CEMP) with a view to establishing material balance during the proposed construction phase, thus minimising the potential for, or the length of time excavated materials are exposed and vulnerable to entrainment by surface water runoff.

- No permanent, or semi-permanent stockpile will remain on either site during the Construction or Operational phase of the Proposed Development.
- Suitable locations for temporary stockpiles at the Wind Farm will be identified on a case-by-case basis. The suitability of any particular location will consider characteristics of the proposed site including; topography, drainage networks in the vicinity and proximity to same, other relevant characteristics which are likely to facilitate, increase, or compound the potential for entrainment by surface water runoff.
- Earthworks will be limited to seasonally dry periods and will not occur during sustained or intense rainfall events. Similar to measures outlined in relation to ground stability during excavation works (**EIAR Chapter 8: Soils and Geology**), an emergency response system will be developed for the construction phase of the project, particularly during the early excavation phase. This, involves 24-hour advance meteorological forecasting (Met Éireann download) linked to a trigger-response system. 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 (>25 mm/hour) issued by Met Éireann), planned responses will be undertaken. These responses will include, inter alia; cessation of construction until the storm event including storm runoff has passed over. All construction works will cease during storm events such as yellow warning (Met Éireann) rainfall events. Following heavy rainfall events, and before construction works recommence, the Wind Farm Site and/or Hydrogen Plant Site (as appropriate) will be inspected and corrective measures implemented to ensure safe working conditions, for example, 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. weekends).
- All drainage infrastructure (as per drainage design), required for the management of surface water runoff or draining peat ahead of excavation works will be established before excavation works commence. Similarly, mitigation measures related to surface water quality will be implemented before excavation works commence (**Section 9.5.2.5).**
- Conceptual and information graphics presented in **EIAR Chapter 9 – Appendix 9.7 – Tiles 9-11** as well as **Tile 14,** present indicative layout and specification for both passive treatment trains (clean water interceptor drains), active management treatment trains (management and treatment of construction water) design considerations for

watercourse crossings (**Tiles 1-3**), and SuDS elements such as: checked dams (**Tiles 4-8)**, swales (**Tile 12**), stilling ponds (**Tile 13**) and buffered outfalls (**Tile 15-16**). Also included in **Appendix 9.7** are emergency response (recycling or diversion of poor quality runoff the Active Management portion of the treatment train (**Tiles 9-11 and Tile 14**) and intervention considerations.

- Three soil deposition areas will be created as part of the Proposed Development on the Wind Farm Site and are described and mitigated for in **Chapter 8 Soils and Geology, section 8.3.2**.

9.5.2.2 Earthworks Proposed Mitigation Measures – Grid Connection Route and Interconnector Route

The Grid Connection Route and Interconnector Route will require excavation of cable trenches in existing roadways. With reference to general excavation practices discussed above, excavation of cable trenches in close proximity to surface water features will require special consideration in terms of managing movements, spoil arising from excavations, and entrainment of solids and contaminants in surface water runoff.

Mitigation measures to reduce the potential for adverse impacts arising from earth works and management of spoil on the Grid Connection Route and Interconnector Route include the following:

- In sensitive areas excavation of material will be conducted in a controlled manner whereby any temporary deposit of the material in buffer zones can be minimised. For example, vacuum excavation techniques or similar will be used for excavations within Surface Water Buffer zones and other sensitive areas (constraints) (**Figures 9.12a and b**). Excavated soil will be removed to temporary storage areas.
- Management of excavated material will adhere to the measures related to the management of temporary stockpiles outlined in **EIAR Chapter 8: Soils and Geology**, a materials management plan will be established and form part of the Construction & Environmental Management Plan (CEMP) with a view to establishing material balance during the proposed construction phase, thus minimising the potential for, or the length of time excavated materials are exposed and vulnerable to entrainment by surface water runoff. No permanent, or semi-permanent stockpile will remain during the construction or operational phase of the Project.
- All spoil from trenches in public roadways along the Grid Connection Route and Interconnector Route will be removed from the Proposed Development as it is excavated and transported to a licenced facility. This is due to the presence of bituminous material and potential hydrocarbon contaminants which will not have the

opportunity to be entrained in runoff from stockpiling, but rather removed (i.e., mitigation by avoidance).

- Suitable locations for temporary stockpiles will be identified on a case-by-case basis. The suitability of any particular location will consider characteristics of the proposed site including; slope incline and topography, drainage networks in the vicinity and proximity to same, other relevant characteristics which are likely to facilitate, increase, or compound the potential for entrainment by surface water runoff. Temporary stockpile locations will be situated outside of Surface Water Buffer Zones. Temporary Spoil stockpiles shall have side slopes battered back to a safe angle of repose, e.g. 1:1. Silt fencing (**Appendix 9.7 – Tile 18**), is to be erected around the base of the temporary mound. Soil will be reinstated on completion of drilling and jointing operations. Temporary storage areas will require bunding and management of runoff likely contaminated with suspended solids. Management of construction waters is discussed in following sections.
- Earthworks will be limited to metrologically dry periods, and will not occur during sustained or intense rainfall events. Similar to measures outlined in relation ground stability during excavation works (**EIAR Chapter 8: Soils and Geology**), and as discussed in this chapter, an emergency response system will be developed for the construction phase of the project, particularly during the early excavation phase. This, at a minimum, will involve 24 hour advance meteorological forecasting (Met Éireann download) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g. 1 in 100 year storm event or very heavy rainfall at >25 mm/hr), planned responses will be undertaken. These responses will include, inter alia; cessation of construction until the storm event including storm runoff surge has passed over. Following heavy rainfall events, and before construction works recommence, the site will be inspected and corrective measures implemented to ensure safe working conditions, for example; dewatering of standing water in open excavations, etc.

9.5.2.3 Release and Transport of Suspended Solids Proposed Mitigation Measures

Conceptual and information graphics associated with mitigating runoff quality are presented in **Appendix 9.7 – Tiles 9-11.**

In order to mitigate the impact posed by release of suspended solids to the surface water environment, the following mitigation measures will be implemented. The drainage, attenuation and other surface water runoff management systems will be installed concurrent with the main construction activities at each site to control increased runoff and associated suspended solids loads in runoff during intensive construction activities e.g. excavation of foundations. Vehicular movements will be restricted to the footprint of the Proposed Development and advancing ahead of any constructed hardstand will be minimised in so far as practical. For example, on the Wind Farm Site, excavation ahead of established hardstands will be in line with expected phases of Turbine Hardstand and site access road construction in terms of both delivery of and installation of material and site activity periods whereby excavations will not be opened ahead of site shut down periods. This will be done with a view to minimising soils / subsoils exposure to rain and runoff. Drainage infrastructure will be installed during meteorologically dry ground conditions **(Section 9.5.2.2**).

Diffuse surface water arising as a product of excavation activities will be managed as follows:

- Waters arising from dewatering practices during excavation works are highly likely to be significantly loaded with suspended solids. As such, constructed stilling ponds or buffered outfalls (**Appendix 9.7 – Tiles 13, 15 and 16**), may be insufficient in controlling the release of suspended solids to the surface water network, or have the potential to clog due to significant volumes of settled or attenuated solids. Therefore, any water pumped from excavations, or any waters clearly heavily laden with suspended solids will be contained and managed and pumped through the preestablished Active Management treatment train (**EIAR Chapter 9 – Appendix 9.7 – Tile no. 10, 11 and 14).**

Waters (likely loaded with suspended solids) intercepted by the established drainage network will be managed as follows:

- In line Stilling Ponds will buffer the run-off discharging from the drainage system during, by retaining water, thus reducing the hydraulic loading to watercourses. Stilling ponds are designed to reduce flow velocity to 0.3 m/s at which velocity silt settlement generally occurs. Note: this method of mitigation may not be feasible at some locations on the Wind Farm Site due to the complex topography. If establishing stilling ponds is not feasible at any particular location (i.e. associated with managing runoff downstream of turbine locations in particular) the collector drain associated with the area will be constructed wider and marginally deeper in these areas i.e. establish a swale **Appendix 9.7 – Tile 12,** thus facilitating the enhanced retention of runoff in the respective construction area. Stilling ponds established will be permanent (life of project at minimum). Flow control devices such as weirs and baffles will facilitate achieving better attenuation, particularly when considering fluctuating runoff rates.
- In line Check Dams will be constructed across drains at both sites **EIAR Chapter 9 – Appendix 9.7 – Tiles 4 - 8**. Check dams will reduce the velocity of run-off in turn

promoting settlement of solids upstream of the dam. Check dams will also reduce the potential for erosion of drains. Rock filter bunds may be used for check dams however, wood or straw/hay bales (**Appendix 9.7 – Tile 17**), can also be used if properly anchored. It is recommended that multiple check dams are installed, particularly in areas immediately downgradient of construction areas. Check dams will only be constructed in drainage infrastructure and not in significant surface water features i.e. streams or rivers. Check dams (comprised of rock) established will be permanent. The following will be implemented in the design of check dams and their deployment (CIRA, 2004):

  - Permanent rock filter bunds (coarse aggregate) will be used for check dams however, temporary wood or straw/hay bales can also be used if properly anchored and if the need arises. Permanent rock filter bunds are preferred as this will ensure that rapid surface water runoff is mitigated against for the life of the Proposed Development.
  - Check dams will be installed at c. 20 m intervals within the length of drainage channels. This is dependent on the slope angle and height of check dams constructed, refer to **Appendix 9.7 – Tile 4**.
  - Check dams will include a small orifice / pipe at the base to allow the flow of water during low flow conditions i.e. maintain hydrological regime during low flow conditions. Note: the use of coarse aggregate will facilitate some infiltration. (**Appendix 9.7 - Tile no. 4 - 8).**
  - Erosion protection will be established on the downstream side of the check dam i.e. cobbles or boulder (100-150 mm diameter) extending at least 1.2 m.
  - Check dams will be constructed as part of the drain i.e. reduce the potential for bypassing between the drain wall and check dam.

- Surface water runoff at the Wind Farm Site will be discharged to land via buffered drainage outfalls, **Appendix 9.7 – Tiles 15 -16**. Buffered drainage outfalls will contain hard core material of similar or identical geology to the bedrock at the site to entrap suspended sediment. In addition, these outfalls promote sediment percolation through vegetation in the buffer zone, reducing sediment loading to acceptable levels any adjacent watercourses and avoiding direct discharge to the watercourse. A relatively high number of discharge points / buffered outfalls will be established, thus decreasing the loading on any particular outfall. Discharging at regular intervals mimics the natural hydrology by encouraging percolation and by decreasing individual hydraulic loadings from discharge points.
- Buffered drainage outfalls will be located outside of 50 m surface water buffer zones. wherever possible and any outfalls required within buffer zones will be part of and

include stilling ponds and emergency intervention sumps for diversion of poor quality runoff to Active Management area of the treatment train (**Appendix 9.7**), Similarly, outfalls will not be positioned in areas with extensive existing erosion and exposed soils. Buffered outfalls will be fanned and be comprised of coarse aggregate (cobbles / boulders). These structures will be akin to rip raps (coastal erosion defences/ outfall erosion defences)**.** Silt fences (discussed above) will be established downstream of buffered outfalls with a view to ensuring the effectiveness of the attenuation train, particularly during elevated flow events. Buffered outfalls established will be permanent.

- Very fine solids, or colloidal particles, are very slow to settle out of waters and the finest of particles require near still water and relatively long periods of time to settle, therefore, such particles are unlikely to settle despite the aforementioned measures. To address this, as required flocculant will be used to promote the settlement of finer solids prior to redistributing to the treatment train and discharging to surface water networks. Flocculant 'gel blocks' are available and can be placed in drainage channels upstream of stilling ponds. Gel blocks are passive systems, self-dosing and self-limiting, however they still require management as per the manufacturer's instructions. Flocculants are made from ionic polymers. Cation polymers (positive charge) are effective flocculants, however their positive charge make them toxic to aquatic organisms. Anionic polymers (negative charge) are also effective flocculants, and are not toxic i.e. environmentally friendly[22]. Therefore, if flocculants are deployed the material used must be made from anionic polymer. Gel blocks will be a temporary measure during the construction phase **Appendix 9.7 – Tile no. 10, 11 and 14**.
- Straw bales (similar to stone check dams) and silt fences (discussed under diffuse runoff) **Appendix 9.7 – Tile 18** can also be used within drainage channels for the purposes of attenuating runoff and entrained suspended solids, however these measures should be considered temporary and will be used mainly in managing potential acute contamination incidents (e.g. additional features to control runoff during excavation works) or to facilitate temporary works (e.g. corrective actions, discussed in later sections). Note; the installation of straw bales or silt fences will require checking on a daily basis by the Contractor's Environmental Manager and supervised by the Environmental Clerk of Works (EnvCoW) to ensure the bypassing does not occur. Coarse stone / boulders could be used in conjunction with these measures to address such issues.

[22] USEPA (2013) Stormwater Best Management Practice – Polymer Flocculation (Available at: http://www.siltstop.com/pictures/US_EPA_Polymer_Flocculant_Handout__3-14.pdf)

- Attenuation lagoons or swales are in principal akin to stilling ponds but larger in scale and potentially permanently hold water (a pond). This SuDS concept will collect all runoff at the site before being discharged outside of the Wind Farm or Hydrogen Site boundary, that is; the outfall of attenuation lagoons will likely be in relatively close proximity to mapped surface water features, but will be numbered sufficiently to ultimately aim to collect all runoff from the Proposed Development.
  - In terms of the Wind Farm Site, this implies detailed assessment of Proposed Development *micro catchments* **Figure 9.11a**, with a view to collecting all runoff at the lowest point of each micro catchment (Micro catchments in line with Wind Farm Site areas used in water balance assessments in the Flood Risk Assessment, however the drainage design accompanying the SWMP will require more detailed assessment of topography and Proposed Development drainage flow patterns which will identify suitable locations and quantities of lagoons).
  - The scale of lagoons or swales will be dependent on available space and respective site constraints, however the larger the lagoon the greater the potential for attenuation whereby flow rates are minimised, solids settle out of solution, and organics can be diluted. Presuming the upstream treatment features are considered and installed adequately those features will remove gross solids from runoff/discharge, the role of the attenuation lagoon or swale will be to ensure finer solids are given opportunity to settled out of suspension. Flow control devices will likely be required, particularly at restricted locations in terms of space available for constructed lagoons.

The above measures, buffer zones, constructed drainage, check dams, two-stage stilling ponds design for attenuation, buffered outfalls are referred to as The Treatment Train, whereby the runoff will continuously be treated from source (construction area) to receptor (site exit, outfall of attenuation lagoon). Where necessary (>25 mg/L suspended solids) the treatment train will be augmented through the use of anionic polymer gel blocks. These measures reduce the suspended sediment and associated nutrient loading to surface water courses and mitigates potential impacts to water quality and on plant and animal ecologies downstream of the site.

The precautionary and mitigation measures listed here will ensure the risk of significant loading of suspended solids in the receiving surface water bodies is low. Therefore, the risk to sensitive receptors is low. It is considered possible to lower the potential impact to surface waters to neutral.

However, in the unlikely event of a significant discharge of suspended solids to surface waters it should also be noted that the assimilative capacity of the receiving surface water network will also act as a natural hydrological buffer in terms of suspended solids loading, therefore reducing the potential impact on sensitive receptors further downgradient. This however, is not considered a prescribed mitigation measure, but is a 'last line of defence'. Any loading of suspended solids in downstream surface waters is considered an adverse effect of the Proposed Development and a failure to implement adequate mitigation, regardless of the natural assimilative potential downstream.

A detailed design of required drainage, collector drainage, stilling ponds and other listed mitigation infrastructure has not been developed as part of this EIAR, however suitable and particularly sensitive areas are identified and presented in **Figure 9.12a and Figure 9.12b**. A detailed design of surface water mitigation infrastructure will accompany the Construction Environmental Management Plan (CEMP) in the form a Surface Water Management Plan (SWMP). The SWMP will indicate in detail the locations of treatment train features, and the specification required at each location.

9.5.2.4 Clear Fell of Afforested Areas Mitigation Measures

No new impacts or remediation measures are associated with forestry activities. However, good practices working in specific environments such as forested areas will be adhered to including working outside of surface water or other buffer zones, and risk assessing on a case-by-case basis in terms of drainage intercepting run off, ecological sensitivities, etc.

Further mitigation measures in regard to the management of forestry operations include;

- Phased felling approach
- Minimising erosion by use existing tracks and use of brash for off track areas.
- Felling and extraction of timber will, as far as possible, be undertaken in dry weather conditions.
- All Forest Service guidelines will be adhered to during all harvesting activities.
- All relevant forestry guidance and policies include;
    - Forest Protection Guidelines
    - Forestry and Water Quality Guidelines
    - Forest Harvesting and Environmental Guidelines
    - Forestry and Freshwater Pearl Mussel Requirements - Site Assessment and Mitigation Measures
    - Forest Biodiversity Guidelines
    - Forestry and The Landscape Guidelines

    - Forestry and Archaeology Guidelines
- It should be noted that the clear-felling of trees in the State requires a felling licence.
- All drains, mound drains, culverts, water crossings crossed during extraction, if necessary, will be cleared of any debris to ensure no drainage issues will occur for the remining trees, which can be a major attributor to windblow.
- Harvesting operations will be scheduled according to the nature of the soil seasonally, depending on ground conditions. Also, best practice is to suspend mechanised harvesting operations during and immediately after periods of particularly heavy rainfall. Waterways are particularly vulnerable to the effects of harvesting as silt from the movement of machinery can enter streams and rivers causing blockage of gravels which affects insect and fish life. Also, nutrients released from decaying branches, particularly from large, clear-felled sites, can cause enrichment of the waters which in turn causes pollution. To counteract these effects careful planning is required in carrying out harvesting operations. Some of the measures taken to avoid impacts include:
    - Limiting the size of the areas to be felled which reduces the amount of nutrients and silt released.
    - Minimising the crossing of drains and streams, but where necessary installing temporary structures (log bridges, pipes etc) to avoid machines entering the water.
- Establishing buffer zones around waterways from which machines are excluded and riparian zones maintained.

Once the above measures are implemented the risk of sediment release from clear felling practices being intercepting the surface water network will be significantly reduced.

9.5.2.5 Release of Hydrocarbons Proposed Mitigation Measures

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

- Refuelling of vehicles will be carried out offsite to the greatest practical extent. This refuelling policy will mitigate the potential for impacts by avoidance. Due to the location of the sites, it is unlikely that implementation of this refuelling policy will be practical in all circumstances (e.g., bulldozers, cranes, etc.). In instances where refuelling of vehicles on site (Wind Farm, Hydrogen Plant, Interconnector, Grid Connection and/or Killybegs Turbine Delivery Route/ Galway Turbine Delivery Route) is unavoidable, a designated and controlled refuelling area will be established at each Wind Farm Site and/or Hydrogen Plant. The designated refuelling area will enable low risk refuelling and storage practices to be carried out during the works. The designated refuelling area will contain the following attributes and mitigation measures as a minimum requirement:

- The designated refuelling area will be located a minimum distance of 50 m from any surface waters or site drainage features
- The designated refuelling area will be bunded to 110% volume capacity of fuels stored at the site (**Appendix 9.7 – Tile 19**)
- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund
- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis, including Decommissioning following construction.
- Location of 2 oil booms downstream of construction of Hydrogen plant to intercept any major oil spillages
- Any oil contaminated water will be disposed of at an appropriate Licensed wate disposal site.
- Any minor spillage during this process will be cleaned up immediately
- Vehicles will not be left unattended whilst refuelling
- All machinery will be checked regularly for any leaks or signs of wear and tear
- Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner.

Notwithstanding the management of refuelling and fuel storage at the designated refuelling area, the potential risk of hydrocarbon spills from plant and equipment or other general chemical spills at other areas of the Project remains. As a precautionary measure, to mitigate against potential spills at other areas of the Proposed Development, the following mitigation measures will be implemented (**Appendix 9.7 – Tile 20**):

- Oil absorbent booms and spill kits will be available adjacent to all surface water features associated with the Project. The controls will be positioned downstream of each construction area and at principal surface water drainage features. Oil booms deployed will have sufficient absorbency relative to the potential hazard.
- Spill kits will also be available at construction areas such as at turbine erection locations, the Wind Farm Temporary Construction Compound and Hydrogen Plant Temporary Construction Compound, Wind Farm Substation, Hydrogen Plant substation, spoils storage areas, Hydrogen Plant Site, and in vehicles associated with the Grid Connection and Interconnector Routes.

- Spill kits will contain a minimum of oil absorbent pads, oil absorbent booms, oil absorbent granules, and heavy-duty refuse bags for collection and appropriate disposal of contaminated matter.
- Should an accidental spill occur during the construction or operational phase of the Project, such incidents will be addressed immediately, this will include the cessation of works in the area of the spillage until the issue has been resolved.
- Spill kits will be kept in each vehicle at the site and will be readily available to all operators.
- No materials, contaminated or otherwise will be left on the site.
- Suitable receptacles for hydrocarbon contaminated materials will also be available at the site.
- A detailed spill response plan will be prepared as part of the Site-specific CEMP.

Once the above measures are implemented the risk of hydrocarbon contamination intercepting the surface water network will be significantly reduced, however there remains a level of risk, and therefore both precautionary measures and emergency response protocols will be established and specified on the CEMP.

9.5.2.6 Release of Horizontal Directional Drilling Fluid – Interconnector Route and Grid Connection Route

Excavation and installation of cable ducts within existing bridges (alteration) will require consent from the OPW and various mitigation measures. Mitigation measures outlined in this Report have been developed to minimise the environmental impacts of the Grid Connection Route and Interconnector Route on the receptors of conservation importance that have been recorded in the area. Mitigation measures mentioned in this Report will be included in the CEMP, which will be developed by the Contractor.

Detailed site investigations, method statements and risk assessments will be carried out with a view to identifying and qualifying risk associated with all watercourse crossings, and in particular mapped and non-mapped karst features in close proximity to the grid route connection corridor. In relation to directional drilling, and the general risk to groundwater during grid connection route construction, risk assessment and prescription of mitigation measures will be designed in accordance with relevant guidance and reference documents, including:

- Bennett, D. and Wallin, K. (2008) "Step by Step Evaluation of Hydrofracture Risks for Horizontal Directional Drilling Projects", In: International Pipelines Conference, Atlanta, GA. American Society of Civil Engineers. Available at: <https://doi.org/10.1061/40994(321)74>.

- EPA (2014) "Guidance on the Authorisation of Direct Discharges to Groundwater".
- Exploration & Mining Division, Minerals Ireland, Dept. of Communications, Climate Action & Environment (2019) "Exploration Drilling – Guidance on Discharge to Surface and Groundwater".
- IFI (2016) "Guidelines for the Protection of Fisheries During Construction Works in and Adjacent to Waters", Inland Fisheries Ireland.
- MDM (2018) "Rockabill System Specifications for Cable Installation", McMahon Design & Management Ltd. Consulting Engineers and Project Managers, Job no. 1319.
- Moore Group (2016) "Appropriate Assessment of Cork Lower Harbour Main Drainage Project Estuary Crossing by Horizontal Directional Drilling", Moore Group Environmental Services on behalf of Irish Water, Ref No. 15184.
- National Roads Authority (NRA) (2008) "Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes".
- Transport Infrastructure Ireland (TII) (2014) "Drainage Design For National Road Schemes - Sustainable Drainage Options".
- UnityWater (2021) "Pr9788 – Specification for Horizontal Directional Drilling", Infrastructure Technical Standards Committee, Doc No. Pr9788; Rev No. 8.

Risk assessments involved identifying pathways and receptors for each potential source of contamination. This included each directional drilling location, and is particularly important in relation to groundwater source protection zones and surface water bodies protected for the purposes of drinking water. Prescription mitigation measures are driven by the identification and qualified risk associated with each particular location and are as follow:

General Overview of Works Mitigation Measures

- The timing of Grid Connection and Interconnector cable laying will be carried out during metrologically dry seasons/periods.
- An Environmental Clerk of Works (EnvCoW) should be onsite in order to lessen environmental disruption and ensure site integrity is maintained. The EnvCoW will also be responsible for routine environmental monitoring and report writing.
- Methodology Statements of works, prepared by the Contractor, will be submitted to the local and relevant authorities associated with the Proposed Development.
- Any temporary access structures, put in place to allow machinery access to the area will be arranged in discussion with the EnvCoW and the site will be fully restored post grid route connection (GRC) works.
- All chemical fluids used in the boring process are to be inert to the environment (environmentally safe) and follow the relevant legislation. The Contractor is to retain a chemical register and have Safety Data Sheet (SDS) documents available onsite during

the operation. The Contractor will also be responsible for a Fluid Management procedure which should include:

- Drilling Fluid program and MSDS
- Management of spoil including volume on site, specialised site storage
- Management of drilling fluid displacement (expected volumes and proposed storage)

- Considering the high volumes, high flow rates and high contaminant content (drilling spoil) of water arising for drilling activities, water will be managed and treated by means of a settlement tank and/or associated infrastructure (**Appendix 9.7**). If a separation (recycling) system is to be used it must be adequately sized and bunded to handle the through-put of the drilling fluid so continuous drilling and reaming operation can be maintained. A separation system must be complete with screens and hydro - cyclones to separate the solids from liquid. Drilling fluids and drill spoils will be disposed off-site at an approved licensed location, or discharged to the local surround area with approved licencing permits.

Good Practice of Plant Machinery

All equipment used during HDD will be in good working order, checked regularly and maintained when necessary. In particular, fluid return lines used in HDD process should be tested for leaks prior to use to check their reliability. Plant machinery not in use is required to have drip trays below engines as well as at refuelling points, if necessary.

All practices involving bentonite will be monitored closely, that is: pumping pressure, drilling mud formulation i.e., drilling fluid volume and the volume of mud returns.

Fuels, lubricants and hydraulic fluids for equipment use on site will be carefully handled to avoid spillage, properly secured and provided with spill containment kits in case of incident to ensure best practice.

Spill kits, hydrocarbon mats, oil booms etc., will be maintained at areas of works for emergency use and replaced when necessary.

Contingency Plan

In the event that a drilling fluid spill or 'breakout' occurs, the Contractor shall cease drilling immediately, notify the ECoW and Emergency Service Management Personnel.

Emergency contact numbers for the Local Authority Environmental Section, Inland Fisheries Ireland, the Environmental Protection Agency and the National Parks and Wildlife Service will be displayed in a prominent position within the Wind Farm Temporary Construction Compound and Hydrogen Plant Temporary Construction Compound. These agencies will be notified immediately in the event of a pollution incident.

The Contractor is to draft and apply a Contingency Plan highlighting with the principal HDD risks. At minimum, the Contractor will identify incident response plan along with equipment and materials on standby to mitigate against the following risks associated with HDD:

- Hydro-lock (loss of fluid flow)
- A hydro-fracture incident (loss of fluid pressure)
- Fluid spill over
- Hydrocarbon/fuel spill
- Drill pipe rupture
- Borehole path failure
- Major workplace safety events in remote areas

The HDD operators will need to be equipped with straw bales, stakes to secure bails, oil booms, silt fences, sand bags, spill kits, shovels, pumps, and any other materials or equipment necessary to contain and clean up and properly dispose of unintentional releases.

9.5.2.7 Construction and Cementitious Materials Proposed Mitigation Measures

In order to mitigate the potential impact posed by the use of concrete and the associated effects on surface water in the receiving environment, the following precautions and mitigation measures are recommended:

- The acquisition, transport and use of any cement or concrete on site will be planned fully in advance of commencing works by the Contractor's Environmental Manager and supervised at all times by the Developer appointed Environmental Clerk of Works (EnvCoW). This entails minimising quantities on site, planning delivery routes and washout stations.
- Precast concrete will be used wherever possible i.e. formed offsite. Elements of the Proposed Development where precast concrete will be used have been identified and are indicated in the CEMP. Elements of the Proposed Development where the use of precast concrete will be used include structural elements of watercourse crossings (single span / closed culverts) as well as Cable Joint Bays. Elements of the Proposed Development where the use of precast concrete is not possible includes turbine foundations and joint bay pit excavations. Where the use of precast concrete is not possible the following mitigation measures will apply.

- Lean mix concrete, often used to provide protection to main foundations of infrastructure from soil biome, can alter the pH of water if introduced, which would then require the treatment of acid before being discharged to the surrounding environment. The use of lean mix concrete will be minimized, limited to the requirement of turbine foundations. The risk of runoff will be minimal, as concrete will be contained in an enclosed, excavated area.
- Vehicles transporting such material will be relatively clean upon arrival on site, that is; vehicles will be washed/rinsed removing cementitious material leaving the source location of the material (**Appendix 9.7 – Tile 21**). There will be no excess cementitious material on the vehicle which could be deposited on trackways or anywhere else on site. To this end, vehicles will undergo a visual inspection prior to being permitted to drive onto the proposed site or progress beyond the contractor's yard. Vehicles will also be in good working order.
- Drivers of such vehicles will be instructed to ensure that all vehicles are washed down in a controlled environment prior to the departure of the source site, such as at concrete batching plants.

- Any shuttering installed to contain the concrete during pouring will be installed to a high standard with minimal potential for leaks. Additional measures will be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- Concrete will be poured during metrological dry periods/seasons of minimal precipitation. This will reduce the potential for surface water run off being significantly affected by freshly poured concrete. This will require limiting these works to dry meteorological conditions i.e. avoid foreseen sustained rainfall (any foreseen rainfall event longer than 4 hour duration) and/or any foreseen intense rainfall event (>3 mm/hour, yellow on Met Éireann rain forecast maps), and do not proceed during any yellow (or worse) rainfall warning issued by Met Éireann. This also will avoid such conditions while concrete is curing, in so far as practical.
- Pouring of concrete into standing water within excavations will be avoided. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place.
- Temporary storage of cement bound sand (if required) will be on hardstand areas only where there is no direct drainage to surface waters and where the area has been bunded e.g. using sand-bags and geotextile sheeting or silt fencing to contain any solids in run-off.
- No surplus concrete will be stored or deposited anywhere on site. Such material will be returned to the source location or disposed of off-site appropriately at a suitable licensed facility. Concrete washing will be contained and managed similarly.

- Designated washout of concrete trucks shall be strictly confined to the batching facility and will not be located within the vicinity of watercourses or drainage channels. Only the chutes will be cleaned prior to departure from Proposed Development, and this will take place at a designated area at the Wind Farm Temporary Construction Compound and Hydrogen Plant Temporary Construction Compound. The contents will be allowed to settle, and the supernatant will be removed off site by licenced generator to a licenced wastewater treatment plant.
- Ground crew will have a spill kit readily available, and any spillages or deposits will be cleaned/removed as soon as possible and disposed of appropriately.

9.5.2.8 Release of Waste Water Sanitation Contaminants Proposed Mitigation Measures

9.5.2.8.1 Wind Farm Site

The Wind Farm Temporary Construction Compound will be constructed on-site to contain temporary facilities for the construction phase including 'port-a-cabin' structures. The temporary compound will be constructed on a base of geo-textile matting laid at ground level. This will be stabilized with the laying of hardcore material on top. During the construction phase, foul effluent will be periodically removed for offsite disposal.

Wastewater/sewerage from the staff welfare facilities 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. Chemicals are likely to be used to reduce odours.

All wastewaters will be emptied periodically, taken off-site by a licensed waste collector to the local wastewater sanitation plant in Ballina for treatment. There will be no onsite treatment of wastewater. A wastewater or sewerage leakage is not anticipated in a properly managed site.

9.5.2.8.2 Hydrogen Plant Site

Wastewater from the Welfare facility at the Hydrogen Plant will run through a septic tank, and then through a welfare constructed wetland (WCW), positioned in the northeast corner of the Hydrogen Plant Site. The WCW will measure approximately 80 m^2 to facilitate the required retention time of c. 12 days to adequately treat the welfare effluent loading.

A wastewater storage tank, sized c.1,500 m^3 will be located to the south of the water treatment building at the Hydrogen Plant Site. The outfall of the WCW will be combined with hydrogen process wastewater stream in storage. The combined wastewater will be pumped to a secondary series of process constructed wetlands (PCW). The PCW will achieve a minimum of 6 days retention time. It is noted that this retention time is lower than the required retention time for loading in line with welfare facilities, however the loading from process wastewater will be significantly less than that of welfare wastewater of sewage.

Any particular contaminant which is observed to be excessively high in incoming source water will be targeted with specific wastewater treatment.

9.5.2.9 Excavation Dewatering Proposed Mitigation Measures – Passive Construction Water Management

Passive management systems (**Appendix 9.7 – Tile 9**), include some of the features described in Active Management treatment trains. These include:

- Spoil bunds and/or temporary berms. Spoil bunds and/or berms will be constructed using either crushed rock or clean soils and overlain or lined with an impermeable layer e.g., geotextile or plastic membrane. This is particularly important for effective surface water management associated with both Wind Farm and Hydrogen Plant infrastructure within the 50 m surface water buffer zones. The drainage system will be permanent. These features are intended to control the movement of construction water / runoff with a view to:
    - Containing contaminated water (e.g., drilling / excavation spoil and runoff laden with solids). Temporary bunds will be used to manage spoil arising from drilling operations or saturated spoil arising from excavations in sensitive areas e.g., within SW buffer zones.
    - To divert runoff i.e., divert clean/storm runoff during construction works or contaminated construction water away from sensitive receptors such as drains/surface waters directly adjacent to construction areas.
- Silt screens. These will be utilised in a similar sense to berms whereby, silt screens will be installed between construction areas and sensitive receptors, including:
    - At the outfall of the treatment train where discharging to vegetated ground or within non-mapped drains (within redline boundary).
    - Along the permitter of construction areas which are directly adjacent to watercourses or within surface water buffer zones. This includes all watercourse crossings and sections of Grid Connection Route and Interconnector Route adjacent to watercourses and the swale along the southern boundary of the Hydrogen Plant Site.

- Multiple silt fences will be used drains / treatment trains discharging to the surface water network. Silt fences will be temporary features, but will remain in place for a period following the completion of the Construction Phase.

Passive systems are intended to function with minimal supervision, however in the management of construction water on site, in many cases the diverted water will likely require active management to ensure sensitive receptors are protected. For example, diverted storm water, if clean can discharge to the receiving vegetated areas or existing drains, but any construction waters impacted by contaminants on the site must be managed, and potentially active management / treatment is required.

9.5.2.10 Excavation Dewatering Proposed Mitigation Measures – Active Construction Water Management

In all instances where construction water, or runoff has the potential to entrain solids during excavation and other construction activities, runoff will be contained by means of temporary berms (lined geotextile of similar), bunds (lined) and sumps. This will be referred to as Dewatering. Construction water (contaminated) will be pumped to the Treatment Train (**Appendix 9.7 – Tiles 9-11**).

Contaminated water arising from construction works, namely; excavations, drilling and temporary stockpiling, will be contained and treated prior to release or discharge. The schematic presented here is a conceptual model of measures implemented to manage arisings and runoff (Letter headings align with **Appendix 9.7 – Tile no. 10**).

A. Arisings. Arisings from the launch / reception pit, or any other significant excavation (e.g., cable joint bays), will be directed the treatment train.
B. Temporary Bund. Arising control area i.e., a temporary bund. Gross solids will be temporarily deposited here. Water arsing with the material will be allowed to drain to sump.
C. Sump / Pump. Sump will discharge by gravity / pumped to stilling pond.
D. Temporary Stilling Pond. This can be constructed using soils for bunding in combination with an impermeable liner.
E. Outfall. The outfall from the stilling pond will be buffered (coarse aggregate) to dissipate energy and diffuse discharging water.
F. Silt Screen. A silt screen will be in place down gradient of the Stilling Pond outfall. This is a precautionary measure to mitigate peak loads or surcharges in the system.

G. Monitoring Location/s. Discharge quality will be monitored in real time using telemetry systems.
H. Monitoring of discharge quality will be carried out at the outfall of the stilling pond i.e., before being actually discharged to surface vegetation or surface water (licenced).
I. Sump / Pump. Discharge By-Pass. If water discharging from the stilling pond exceeds quality reference limits water will be diverted (pumped) from the stilling pond to the settlement / treatment tank. Stilling Pond By-Pass. Similar to Discharge By-Pass, if conditions dictate water can be diverted directly to Settlement / Treatment Tank.
J. Settlement / Treatment Tank. A settlement tank will in line and ready to use if required i.e., water quality at stilling pond outfall fails to meet quality reference limits. The tank will be equipped with treatment systems which will be activated as the need arises, for example; very fine particles which are very slow to settle can be treated with a flocculant agent to promote settlement of particles.
K. GAC Vessel/s. As a precautionary measure, GAC (Granulated Activated Carbon) vessel/s will be in line and ready to use if required. GAC vessels are used to filter out low concentrations of hydrocarbons. Significant hydrocarbon contamination is only envisaged under accidental circumstances. If a hydrocarbon spill does occur, normal operations will pause and the treatment train will be utilised to remediate captured contaminated runoff.
L. GAC Vessel By-Pass. If the quality of the water is acceptable in terms of hydrocarbon contamination.
M. Treated water will be discharge by gravity / pump to the stilling pond for additional clarification, monitoring and buffered discharge to vegetated area.
N. Silt Bag. A silt bag can be used as alternative to stilling ponds. However, silt bags must only be used as primary method in lower risk areas i.e., outside of buffer zones, etc. Stilling ponds will be the primary method (D, N) is circumstances where risk is elevated, however a gate vale and silt bag can be included in the treatment train and used as an emergency discharge route in the event that the stilling pond needs remediation or maintenance.

In all instances, stilling ponds (D), Silt Bags (N) and outfalls (E) will be situated outside of surface water buffer zones. At many locations, particularly at HDD locations works will be within buffer zones. In these instances, waters can be pumped to the treatment train which can be positioned upgradient along the road (Grid Connection Route and Interconnector Route) where discharge to vegetated areas / roadside drains can be managed.

Discharge of non-contaminated storm runoff to vegetated land within the Redline Boundary is not a licenced activity however, particularly in relation to the Grid Connection and Interconnector this methodology is possible only under relatively low flow conditions (e.g. <2 litres per second (l/sec) typical of runoff over a relatively small site area. Due to the constricted nature of the grid connection works, in the event that the expected incoming flow rate or dewatering rate is relatively high (>2 l/sec, for example; HDD locations, culvert crossing locations) a discharge licence will be acquired and trade effluent will be discharge directly to the surface water network. The latter will include all works associated with HDD.

The discharge points will be identified during the licence application process. As discussed previously, the main components of the treatment will be positioned outside of the 50 m surface water buffer zone where possible. The Developer will identify suitable locations for the establishment of temporary infrastructure taking into account other variable such as traffic and access management. Similarly, the preferred location of discharge points will be outside of buffer zones and into minor or non-mapped surface water / drainage features where possible. The subject drain will be inspected to ensure connection to the mapped network (not blocked).

The quality of the water being discharged will be monitored. If discharge water quality is poor (e.g. >25 mg/L) additional measures will be implemented, for example; pausing works as required and treating construction water by dosing with coagulant to enhance the settlement of finer solids – this can be done in a controlled manner by means of a suitably equipped settlement tank. Collected and treated construction water will be discharged by gravity / pump to a vegetated area of ground within the Wind Farm Site or Hydrogen Plant Site. Silt fences will be established at the discharge area to ensure potential residual suspended solids are attenuated and the potential for erosion is reduced. The discharge area will be outside of 50 m surface water buffer areas (similar to dewatering of excavations. The quality of water discharged will be in line with licence discharge limits assigned by the county council, and will be monitored in real time (telemetry with 15 min sampling rate), as well as laboratory samples taken, analysed and reported and the frequency indicated in the licence. Daily sampling is recommended given the short duration and temporary nature of the works.

Discharging of construction water (trade effluent) directly to surface waters or groundwater is a licenced activity. (This is in accordance with Local Government (Water Pollution) Act, 1977 as amended).

Active Construction Water Management will be utilised for all works within surface water buffer zones, and for all over pumping.

9.5.2.11 Watercourse Crossings Proposed Mitigation Measures – Design Specific

The Proposed Development of the Wind Farm, Grid Connection Route and Interconnector Route will require upgrades or installations of watercourse crossings, identified in **Section 9.4.4.9**. The Hydrogen Plant does not require a watercourse crossings. These crossings require detailed planning and consideration to ensure potential impacts are assessed adequately and in turn mitigated against. In relation to the design and construction of watercourse crossings the following is a non-exhaustive list of relevant guidance documents:

- NRA (2008) Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes
- Inland Fisheries Ireland (IFI) (2016) Guidelines on the Protection of Fisheries During Construction Works in and Adjacent to Waters
- Office of Public Works (OPW) (2013) Construction, Replacement or Alteration of Bridges and Culverts
- Scottish Environment Protection Agency (SEPA) (2010) Engineering in the water environment: good practice guide – River Crossings

Regulation 50 of the European Communities (Assessment and Management of Flood Risks) Regulations 2010 SI 122 of 2010 requires that: "No Person, including a body corporate, shall construct any new bridge or alter, Reconstruct, or restore any existing bridge over any watercourse without the Consent of the Commissioners or otherwise than in accordance with plans previously approved of by the Commissioners."

The word "watercourse" includes rivers, streams, and other natural watercourses, and also canals, drains, and other artificial watercourses.

The word "bridge" includes a culvert or other like structure.

The OPW is responsible for the implementation of the regulations and consent to construct any bridge will be sought from the OPW via their application process. Details on the application process and guidance / requirements of the bridge design and considerations in terms of flow can be found in the OPW guide Construction, Replacement, or Alteration of Bridges and Culverts (A Guide to Applying for Consent under Section 50 of the EU (Assessment and Management of Flood Risks) Regulations SI 122 of 2010 and Section 50 of The Arterial Drainage Act, 1945). This application and consent process will mitigate against the potential for the design of the new bridge leading to significant adverse impacts.

Single span structures are structures which span the width of the channel with no associated instream support and do not affect the bed of the river or water body. This ensures that the bank and instream habitats are maintained and the river bed is not impacted. Furthermore, in stream works will be minimal if not avoided completely, thus reducing the risk of construction works leading to adverse impacts. This crossing method is considered low impact. However, it should be noted that this methodology, single span structures require significant engineering and construction works, and are relatively expensive in comparison to other methods. Single span structures are of most benefit to ecological sensitivities and therefore the sensitivity and importance of the baseline ecological conditions should also be considered when considering single span structures for water course crossings.

The closed culvert design implies that the watercourse crossing will possess an artificial invert (floor). This in turn implies that the watercourse crossing infrastructure itself will adversely impact on the existing bank and instream habitats, and instream works are likely to lead to adverse impacts e.g. release of suspended solids. This crossing method is considered high impact.

However, it should be noted that where existing closed culverts are in place at existing watercourse crossings, pending the results of a condition survey, extending the existing closed culvert will minimise construction activities required and in turn minimise potential impacts when compared to replacing the entire watercourse crossing. Where existing crossings are upgraded or replaced, opportunity should be taken to improve any environmental impact the existing feature may have. None of the existing watercourse crossings are considered to significantly adversely impact on the hydrological regime at the site.

The proposed watercourse crossings at the Wind Farm Site are relatively near the head waters of the surface water network therefore, bridge or culvert specification and construction are envisaged to be of relatively low significance in terms of expected flow, etc. However, watercourse crossings must be designed to facilitate peak, or storm discharge rates so as to avoid localised flooding and associated issues during storm events.

In accordance with Engineering in the water environment: good practice guide – River Crossings (SEPA, 2010) and Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes (NRA, 2008) it is recommended that the category of watercourse crossing employed over river waterbodies in upland or transitional river segments is a **single span structure**.

The type of watercourse crossing employed will be in line with good practice as defined by relevant guidance (SEPA, 2010) whereby; the course of action serves a demonstrated need, minimises the potential for ecological harm, and at a cost which is not disproportionally expensive. This approach will also consider the condition of the existing structure, where relevant by means of a competent engineer's assessment.

With reference to ecology, none of the proposed watercourse crossing locations are associated with areas, or immediately proximate to surface water features with significant ecological sensitivity or importance. The principal risk to ecological sensitivities associated with proposed watercourse crossing works is the potential for adverse impacts to water quality downstream of the Wind Farm Site and Hydrogen Plant Site, namely the potential for mobilisation of solids. It is also noted that watercourse crossing methodologies employed will ensure potentially long term / permanent impacts downstream (e.g. scouring etc) or upstream (e.g. passage of fish) will be avoided.

Considering all of the above, and considering baseline conditions – including ecological sensitivity and importance of surface water features associated with each of the watercourse crossings, the following water course crossings and upgrades are proposed for the Proposed Development:

- **New Watercourse Crossings WCC03 – Single Span Structures**.
  This is in line with good practice as defined by relevant guidance (SEPA, 2010) whereby; the course of action serves a demonstrated need, in relation to slope of surrounding environment, **Chapter 8 Figure 8.7b**, and minimises the potential for ecological harm.
- **Existing Watercourse Crossings Ex. WCC1 and WCC2** – Upgraded Closed Culverts (If upgrading required).
  This is in line with good practice as defined by relevant guidance (SEPA, 2010) whereby; the course of action serves a demonstrated need (single span structure will facilitate maintaining the hydrological regime. Relatively large catchment and high discharge rates). However, the ecological sensitivity and importance at the location of the crossing/s is minimal. Furthermore, to work within a cost which is not disproportionally expensive, and therefore is recommended, a closed culvert could be utilised here, particularly if the crossing is required to be replaced following an engineer's assessment.
- All other new watercourse crossings (drainage network) will be closed culvert, or the upgrading of existing culverts.

- Considering the width of all waterbodies associated with crossings discussed here (<2 m width) it is not envisaged that in stream supports will be required for the construction of single span structures.
- Guidance documents, and in turn this EIAR are not intended to be referred to as technical design manuals. The principles described here address aspects of the water environment that should be considered. In line with relevant guidance the following design considerations will be made and the design tailored accordingly on a case by case basis.
- Ensure the design facilitates adequate hydraulic capacity. This ensures that the design will maintain the existing channel width – including proposed new closed culverts, and will facilitate peak discharge events (storm events) without flow being constrained and contributing to flooding or other issues. Values presented **Appendix 9.2 and Appendix 9.3** indicate the potential discharge rate associated with each watercourse crossing during a 1 in 100 year storm event taking into account for climate change. For existing crossings the channel width will be maintained.
- In line with the above design consideration, allowance will be made for the transport of sediment through the crossing, not just hydraulic capacity.
- Ensure the design facilitates adequate freeboard. The design facilitates passage of woody debris. Freeboard to facilitate navigation and recreation is not applicable in relation to the proposed development and associated surface water features.
- For single span structures (**Appendix 9.7 – Tile 3**) set abutments will be back from the river channel and banks to allow the continuation of the riparian corridor underneath the structure. This helps to minimise or prevent the need for bed and bank reinforcement, reduces the risk of creating a barrier to fish passage and allows mammal passage under the structure. The distance between the bridge abutments will be as wide as possible and will maintain the bank habitat, maximising the riparian corridor and allowing the river some space to move. Bury foundations (of abutments) deep enough to minimise or prevent the need for bed or bank reinforcement or bridge weirs or aprons. This maintains the natural bed material and bed levels, protecting habitat and allowing fish passage. The foundations should be buried deep enough to allow for scour during high flows. A suitably qualified engineer or geomorphologist should be consulted to advise on an appropriate depth.
- Ensure the design minimises the potential for localised bank and bed erosion.
- For closed culverts the diameter or sectional area of the culvert is oversized to maintain the existing width of the channel. In addition, the invert of the culvert should be buried under the original bed level – refer to guidance for recommended depths based on culvert dimensions. Culverts will also require assessment on a case by case basis to

establish the degree of slope to be maintained (will not exceed 0.5% for a culvert >24 m length and will not exceed 1.0% for a culvert <24 m length), maintaining average daily flow (will not exceed 1.2 m/s for culverts <24 m length and 0.9 m/s for culverts >24 m length). Where such requirements cannot be met additional measures will be required e.g. notched baffles, this is to ensure the potential ecological impact is minimised e.g. facilitate movement of fish.

- For closed culverts pools should be formed at each end of the culvert to provide for transmission from shape of the pool to shape of the river. The pools will be constructed using natural rock and the purpose of such pools is to reduce the potential for erosion while also facilitating ecological factors (**Appendix 9.7 – Tile 2).**

There remains the potential for the actual construction of such crossings to have significant adverse impacts on the receiving watercourse/s. Relevant guidance documents have been consulted and applicable mitigation measures i.e. applicable to the consented detailed design of proposed bridges and construction methodology of same, will be adhered to with a view to mitigating and reducing any potential impact on the receiving watercourse.

9.5.2.12 Watercourse Crossings Proposed Mitigation Measures – General Construction

The following mitigation measures are suggested to ensure any potential impacts during the construction of the proposed watercourse crossing are minimised:

- Proposed bridges will be designed in such a way as to minimise, in so far as practical but to the extent deemed acceptable by the competent authority, the disturbance or alteration of water flow, erosion and sedimentation patterns and rates. This will be done following and adhering to relevant available guidance as described in this report, and will be reviewed and consented by the OPW.
- A detailed construction management plan, and detailed method statement and risk assessment (RAMS), will be drafted by the contracted operator at the commencement phase of the proposed development and will include details of the bridge design and construction methodology, including the environmental risk/s involved (as identified in this report) and how each can be minimised using best practice techniques, in line with the mitigation set out in this report.
- Construction methodology will be designed and planned with a view to minimising the potential for contaminating the receiving watercourse, in particular the potential for the release of suspended solids into the receiving watercourse in line with the mitigation set out in this report.

- Plant machinery used in the construction of proposed bridges, or any part of the Proposed Development, will only be refuelled at an established refuelling station or suitable off site locations e.g. commercial filling stations.
- During use of heavy plant machinery there is an inherent risk of accidental leaks or spillages of fuel/hydrocarbons. This will be incorporated in the RAMS, including an emergency response plan for such incidents. An emergency spill kit will be kept onsite at all times and within 50 m of ongoing construction works. The spill kit will contain oil absorbent pads and booms, and heavy-duty refuse bags (for collection and appropriate disposal of contaminated matter) at a minimum. An oil absorbent boom will be installed downstream (within 25 m) of construction works, before works commence.
- All construction works associated with watercourse crossings and within surface water buffer zones are considered with additional detail in terms of mitigating acute risk given the proximity to a sensitive receptor. This includes additional precautionary measures e.g. double / triple silt screens, and emergency response and intervention. For further detail refer to **Appendix 9.7.**

9.5.2.13 Culverts & Instream Works

Infrastructure such as culverts will require instream works in all aspects of the Project. Where in stream works are required as identified in **Section 9.4.4.9**, the following will be implemented:

- Contracted operators will draft method statements and risk assessments in line with mitigation outlined in this report and in consultation with relevant guidance **Section 9.2.2,** prior to commencing works (as part of the watercourse crossing consent application), Relevant guidance referenced here includes:
    - Inland Fisheries Ireland (IFI) (2016) Guidelines on Protection of Fisheries During Construction Works In and Adjacent to Waters.
    - Scottish Environmental Protection Agency (SEPA) (2009) Engineering in the Water Environment Good Practice Guide – Temporary Construction Methods
    - National Roads Authority (2008) Guidelines for the Crossing of Watercourses During the Construction of National Roads Schemes.
- The construction area will be isolated, this means; the water feature (streams / drains) will be temporarily dammed upstream of the watercourse crossing and flow will be diverted by means of a flume / pipe by gravity, or pumped (this is referred to as over pumping, **Appendix 9.7 – Tile no. 1**) downstream of the watercourse crossing and construction area. Following the successful upstream damming, a downstream dam or barrier will also be established. The downstream barrier will ensure contaminated runoff in the isolated work area can be contained and managed, and will block surface water

back flow in lower lying or flatter areas. **Appendix 9.7 – Tile no. 1,** presents a conceptual plan view of an isolated construction area within a surface water feature. Over pumping of a surface water feature is considered diversion of water runoff only and therefore considered similar to discharge of storm water runoff only to sewer (exempt from licensing), however it is imperative that controls are in place to ensure environmental impacts are minimised, particularly in relation to ecological sensitivities (for further information refer to Chapter 5 Terrestrial Ecology and Chapter 6 Aquatic Ecology), and also in relation to water quality.

- In order to ensure isolation and over pumping is carried out effectively, the methodology must ensure that dams are secure / sufficiently supported, and that pumping of water can continue uninterrupted and that pumps are capable of keeping up with the discharge rate of the surface water feature. Pumping systems will require backup and fail safe protocols e.g. backup pumps and generator. At significant surface water features e.g. non-mapped streams, isolation and diversion of drainage will be implemented.
- Provided the construction water within the isolation area is managed effectively, over pumping of the surface water feature does not pose a significant risk to surface water quality down stream of the watercourse crossing. The passage if fish in the surface water feature is to be considered also, and will be temporarily impacted by the works if fish species are present.
- Water ingress into the construction area will be managed and collected by established sumps immediately downstream of the works (upstream of the downstream barrier) (**Appendix 9.7 – Tile 1**). Runoff within the construction area will likely be heavily laden with suspended solids. Where required, dewatering (pumping out or extracting) of such waters will be discharged to an inline settlement tank, or preestablished stilling pond to remove suspended solids before being discharged, **Appendix 9.7 – Tile 14 and 13**. The quality of the water being discharged will be monitored. If discharge water quality is poor (e.g. >25 mg/L) additional measures will be implemented, for example; treating construction water (Active Treatment, **Section 9.5.2.9**) by dosing with coagulant to enhance the settlement of finer solids – this can be done in a controlled manner by means of a suitably equipped settlement tank. Collected and treated construction water will be discharged by gravity / pump to a vegetated area of ground within the Site **Appendix 9.7 – Tiles 15 and 16**. Silt fences will be established at the discharge area to ensure potential residual suspended solids are attenuated and the potential for erosion is reduced, **Appendix 9.7 – Tile 18**. The discharge area will be outside of 50 m surface water buffer areas (similar to dewatering of excavations). For further details refer to **Appendix 9.7 – Tiles 9 - 11**.

- Discharging of construction water (trade effluent) directly to surface waters is a licenced activity. No extracted or pumped or treated construction water from the isolated construction area will be discharged directly to the surface water network associated with the Site (This is in accordance with Local Government (Water Pollution) Act, 1977 as amended). It is noted that all runoff on the site will eventually discharge to the receiving surface water network, however with appropriate management the quality of runoff discharging to the surface water network will be acceptable e.g. <25 mg/L Suspended Solids.
- Operation of machinery in-stream will be kept to an absolute minimum and avoided where possible. Where in stream works are required the area will be isolated by means of over pumping or drainage diversion.
- Works in relation to watercourse crossings will be carried out during periods of sustained dry meteorological conditions, and will not commence if sustained wet conditions or if wet conditions are forecast.
- Works in relation to watercourse crossings will be planned and carried out as efficiently as possible. This means work plans are agreed fully and all equipment and materials are prepared fully before in stream works commence. Works will be completed as quickly as possible and will not pause for the duration of the in stream works e.g. Installation of culverts (24 hour as necessary), with the exception of circumstances related to meteorological and/or health and safety conditions.
- Only precast concrete will be used for in stream works.
- Precautions will be made to mitigate the potential risk of a hydrocarbon spill. Further to measures outlined in **Section 9.5.2.4**, settlement tanks (will be adequately equipped with hydrocarbon removal functionality on standby, for example; hydrocarbon absorbent booms, oil skimmers, and GAC (granulated activated carbon) filters.

9.5.2.14 Diversion of Drainage

Diversion of artificial drainage channels will be required at locations where the proposed development layout intercepts existing artificial drainage networks for the Project (**Figure 9.6a**), for example; T9 and associated hardstand area is overlain on an existing drainage feature.

Diversion of drainage will be done under similar conditions to that described above for instream works. Many of the existing constructed drainage channels are observed to be dry during sustained dry meteorological conditions which implies that over pumping or diverting of water flow may not be necessary, nonetheless the methodology described for instream works will be implemented to mitigate the risk of any flow through the construction area or for unforeseen wet meteorological events.

Any newly installed drain will be fully formed prior to the diversion of existing drainage.

Erosion control will be incorporated into the design (**Appendix 9.7**), this requires minimising the area of exposed soil in existing and newly established channels. This will include a combination of the use of coarse aggregate / crushed rock (non-friable / non-weak), engineered solutions and/or revegetation.

A series of temporary silt fences will be installed to mitigate against the entrainment and mobilisation of solids during key events during the construction process, for example; the initial use of the new diverted channel, or the infilling of the original channel made redundant. The use of silt screens as a form of mitigation during watercourse crossing works is considered a precautionary last defence measure, provided measures detailed above will be made effective. Refer to **Appendix 9.7** for further information on the recommended ordering of control measures.

9.5.2.15 Groundwater Contamination Proposed Mitigation Measures

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

- In the first instance, no fuel storage should occur at the Proposed Development whenever feasible and refuelling of plant and equipment should occur off the Proposed Development a controlled fuelling station.
- In instances where on site refuelling is unavoidable, then the bunded on the Proposed Development designated refuelling area must be used. The designated refuelling area must be bunded to 110% volume capacity of fuels stored at the Proposed Development. **(Appendix 9.7 – Tile 19)**
- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund.

- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis.
- Any oil contaminated water will be disposed of at an appropriate oil recovery plant.
- Any minor spillage during this process will be cleaned up immediately.
- Vehicles will not be left unattended whilst refuelling.
- For large machinery such as cranes, a drip tray will be used, and spill kits will be on hand.
- A Site-specific CEMP will be enforced to ensure that equipment, materials and chemical storage areas are inspected and maintained as required on a regular basis.

The following mitigation measures will be implemented in relation to non-hydrocarbon potential contamination:

- All other liquid-based chemicals such as paints, thinners, primers and cleaning products etc. will be stored in locked and labelled bunded chemical storage units.
- Wastewater from temporary sanitation facilities (Wind Farm Site and during construction phase) will be mitigated by use of temporary and portable sanitary facilities that are self-contained and supplied by tank trucks. These facilities will not interact with the existing hydrological environment in any way and they will be maintained, serviced and removed from site at the end of the construction phase.
- As outlined in **Appendix 9.3 pDACA Section 2.9** The Hydrogen Plant will require volumes of treated water for use. The proposed facility design team (Black and Veatch) have provided indicative predictive wastewater quality data, and predicted water demand and peak production flow rates. The Hydrogen Plant will require volumes of wastewater to be treated water for discharge to surface waters. Mitigation measures and recommendations is outlined further in **Appendix 9.3 pDACA.**
- The controlled attenuation of suspended solids in settlement ponds and check dams etc. at the Wind Farm Site will result in inorganic nutrients (if present in elevated concentrations) such as phosphorus and nitrogen being absorbed and retained by the solids in the water column. This will allow for a reduction of peak inorganic discharges in a controlled and stable run off rate.
- Bacteriological contamination arising from availability of nutrients (e.g. sanitation, livestock etc.) will be mitigated by appropriate self-contained sanitation facilities (above) and livestock grazing control on the site overall, but particularly on areas zoned for excavation and proposed development.
- There is low risk of mobilising trace metals that may naturally be present. The potential impact may arise from introduced water percolation with excavated bedrock substrate. Concentrations of trace metals are usually low in the natural environment; however,

water quality will be checked for metals concentration before, during and after the construction phase as part of monitoring at river monitoring locations.

9.5.2.16 Groundwater Extraction Proposed Mitigation Measures

No significant potential effect has been identified. No boreholes will be used on the Wind Farm Site. With reference to the Minerex Environmental Limited Groundwater Supply Assessment for the Hydrogen Plant (**Appendix 9.8**), it was determined that two boreholes drilled on the Hydrogen Plant Site are able to supply the expected water demand of the Hydrogen Plant Site without depleting the aquifer or impacting the wells in the region.

No potential effects have been identified on the Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route.

9.5.2.17 Construction Phase Monitoring

To ensure effective implementation of mitigation measures, environmental auditing, and monitoring of environmental obligations of the Developer, an Environmental Clerk of Works (EnvCoW) will be assigned to carry out monitoring during the construction and operational phases of the Proposed Development. The role of the EnvCoW will be to actively and continuously monitor site conditions and advise on environmental issues and monitoring compliance, and will not be responsible for implementing measures, the due duty of implementing measures will be held by the Developer / contracted construction operator. The EnvCoW will have the authority to temporarily stop works in a particular area of the site to ensure corrective measures are implemented and adverse environmental impacts are minimised if not avoided.

Monitoring of pollution prevention and mitigation undertaken by the EnvCoW assigned by the Developer will include:

- Monitoring site pollution prevention plan.
- Water quality monitoring.
- Advising on required pollution prevention measures (as described in this EIAR) and monitoring their effectiveness.
- Liaison with local authorities in relation to pollution instances if applicable.
- Considering the EnvCoW will be responsible for monitoring a broad range of environmental factors at the Site, technical monitoring and advice will be sought such as from specialist consultants as the need arises e.g. installation and website for telemetry.

The following measures will be implemented for site monitoring in relation to the hydrological and hydrogeological impacts:

- The baseline monitoring undertaken at the Wind Farm Site and Hydrogen Plant Site as part of this study will be repeated periodically before, during and after the construction phase of the Proposed Development to monitor any deviations from baseline water quality that occur at either the Wind Farm Site or Hydrogen Plant Site. This monitoring along with the detailed monitoring outlined below will ensure that the mitigation measures that are in place to protect water quality are working. Specifically, a construction period and post construction monitoring programme for the Site will include the following:
    - During the construction phase; daily inspection of silt traps, buffered outfalls and drainage channels and daily measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations on the Wind Farm Site and Hydrogen Plant Site. Monitoring of the aquifer underlaying the Hydrogen Plant will be required during the construction phase. Monitoring of same during times when excavations are being dewatered (likely high in solids) will be done in real time. In this regard, physiochemical properties will be monitored in real time by means of alarmed telemetry e.g. telemetric monitoring at baseline sampling locations and alarm thresholds established in line with water quality reference concentrations/limits which will be set using relevant instruments for example; Surface Water Quality Regulations, <25 mg/L Total Suspended Solids (TSS).
- Continuous Monitoring will be carried out as part of Active Management of construction water management and treatment (**Appendix 9.7**). These monitoring systems will travel with the active construction areas / remain with the Active Management infrastructure. The purpose of this is to recycle water if quality is unfavourable and adjust the dewatering and treatment train accordingly until discharge quality is observed to be acceptable. A small degree of tolerance above reference concentrations is acceptable at this location but only if the discharge from the Active Management train discharges to another Passive Management system or to a non-sensitive vegetated area. If discharging within sensitive areas or buffer zones, the quality of discharge from the Active Management train will be in line with prescribed reference limits (e.g. 25 mg/L TSS).
- Continuous Monitoring at downstream Baseline SW Monitoring Locations (**Figure 9.6**) will be carried out using telemetry during the construction phase of the Proposed Development. Triggering of the threshold at these locations will trigger emergency response and escalation of measures including immediate full Proposed Development

inspection to ascertain to the potential unknown source (baring in mind that the quality of managed runoff at the site will be known by means of live telemetry and hand held meters). Continuous monitoring at Baseline SW Monitoring Locations will continue into the operational phase until stable conditions are observed e.g. stable conditions in line with baseline conditions for 6 months.

- Post construction; inspection of silt traps, buffered outfalls and drainage channels, measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations at the Site will be carried out at a reasonable frequency (weekly initially gradually reduced based on observed stability of conditions), and will also be scheduled following extreme metrological events (**Section 9.5.2.1**). During the operational phase of the project the stilling ponds and buffered outfalls will be periodically inspected e.g. weekly during maintenance visits to the Wind Farm Site and Hydrogen Plant Site initially and gradually reduced based on observed stability of conditions.
- During the construction phase of the project, the Proposed Development areas will be monitored daily for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system so that it does not become blocked, eroded or damaged during the construction process. This monitoring will continue at a reasonable frequency (weekly initially gradually reduced based on observed stability of conditions) during the operational phase of the Proposed Development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.
- During the construction phase of the project, the Proposed Development areas and adjacent receiving drainage systems will be monitored daily for evidence of erosion and other adverse impacts to natural drainage channels and existing degraded areas whereby soils/peat are exposed and prone to enhanced degradation. This monitoring will continue at a reasonable frequency during the operational phase of the Proposed Development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.
- During both the construction and operational phases of the project watercourse crossings will be monitored frequently (daily during construction and intermittently during operational phase i.e. weekly / monthly inspections initially and reduced gradually in line with observed stability and confidence in longer term data obtained. The water course crossings will be monitored in terms of structural integrity and in terms of their impact on respective watercourses.

- A detailed inspection and monitoring regime, including frequency is specified in the Construction Environmental Management Plan (CEMP). This will include the development of an environmental risk register e.g. constraints linked to the development construction schedule, routine reporting on the performance and effectiveness of drainage and attenuation infrastructure, and any actions taken to rectify or enhance the system.
- Site water runoff quality at all surface water monitoring locations will be monitored on a continuous basis during the construction phase of the Proposed Development. Monitoring will continue into the operational phase until such time that each of the Wind Farm Site and Hydrogen Plant Site and water quality have stabilised (stable conditions in line with baseline conditions for e.g. 8 consecutive quarterly monitoring events). This monitoring will be carried out at the downstream surface water baseline sampling location **(Figure 9.6a Figure 9.6b**)
- Continuous monitoring systems will be in place, particularly in principal surface water features draining the site. For example; remote sensing, or telemetric monitoring sensors (turbidity) will be employed in this regard.
- At construction areas requiring drilling (HDD) and/or significant excavations (launch pits, cable joint bays), and in the management of general excavations, arisings will be managed carefully with a view to containing and treating all drained water and runoff which will likely be laden with suspended solids. Active continuous monitoring will be required at these locations in line with the conceptual model presented in Appendix D – Tile 2. The monitoring location will be at the outfall or discharge point of the treatment train at any respective location. Continuous monitoring will include telemetry.
- Continuous Monitoring Locations or Telemetric Monitoring Stations (TMS) will use probes to monitor the following parameters:
  - Electrical Conductivity
  - Turbidity (Data obtained can be equated to estimated Total Suspended Solids (TSS) through calibration)
  - pH
  - Temperature
  - Capacity for additional probes.
- TMSs will be self-powered and will be comprised of the following components at a minimum:
  - Remote Telemetry Unit (RTU) – Modem / data hub and transmission.
  - Solar panel
  - Sensor – pH
  - Sensor – Turbidity

  - Sensor – Electrical Conductivity
  - Sensor Cleaning Device (SCD)(Turbidity probe)
  - Power Management Unit (PMU)
  - Power Bank (PB)
  - Website – presenting data trends over time.
  - Metal stand / frame and protective fencing.
  - The TMS will have capacity for additional parameters.
- Telemetric continuous monitoring sampling frequency is generally set at one data point per 15 minutes, however considering the intensive nature of the proposed works, particularly drilling activities, if possible it is recommended that sampling frequency is set at 5 minutes or less with a view to escalating responses to potential discharge quality issues in good time. Data is transmitted to a project website which will display data trends over time. Access to the website can be gained and shared via a website link.
- Telemetric Monitoring Systems will be used a key part of Active Management of runoff and construction water at the site, as presented in **Appendix 9.7 – Tiles 9 - 11**.
- A handheld turbidity meter will be available and used to accurately measure the quality of water discharging from the site at any particular location. The meter will be maintained and calibrated frequently (per the particular unit's calibration requirements / user manual), and will also be used to check and calibrate remote sensors if they are employed. Quality thresholds will be established for the purposes of escalating water quality issues as they arise.
- Rainfall will be monitored (1 no. rainfall gauge required). This unit will be connected with and displayed with other site water quality telemetry data via the telemetry website.
- Surface water runoff control infrastructure will be checked and maintained on an on-going basis, and stilling ponds and check dams will be maintained (de-sludge / settle solids removed) on an ongoing basis, particularly during the construction phase of the Proposed Development. It is important to minimise the agitation of solids during these works, otherwise it will likely lead to an acute significant loading of suspended solids in the drainage network. This can be achieved by temporarily reducing or blocking inkling flow and vacuum extracting settled solids or *sludge*. Where the drainage feature possess relatively significant flow rates, isolating and over pumping is the best course of action.
- As part of the Construction Environmental Management Plan (CEMP) regular checking and maintenance of pollution control measures are required (in line with frequencies outlined above), with an immediate plan for repair or backup if any breaches of design occur. In the event that established infrastructure and measures are failing to reduce

suspended solids to an acceptable level, construction works will cease until remediation or upgrading works are completed.

- All details in relation to monitoring will be included in the Surface Water Management Plan (SWMP). Consultation with relevant stakeholders will be sought prior to the SWMP being reviewed and approved by the planning authority.

Monitoring of potential hydrological impact of the Proposed Development, particularly during the operational phase will be inherently linked to the ecological health of the blanket peat on the Wind Farm Site (as a functioning ecosystem) and therefore both hydrology and ecology will be considered, and monitored in tandem. For example, impacts to the hydrological regime at the Site can potentially impact on the ecological health or characterisation of the Site, and vice versa. Ecological indicators can potentially provide useful data in relation to the long-term impact of changes to the hydrological regime at the Site. However, as discussed in earlier section of this report (**Section 9.4**), changes to the management of runoff and in turn the hydrological regime at the site will lead to a positive impact overall when compared to the baseline conditions associated with the site e.g. introduction of intermittent buffered outfalls along the length of the drainage network is in contrast to baseline, this will promote a more even distribution runoff, attenuate runoff and reduce the hydrological response to rain fall, enhanced potential for recharge to ground, and in turn raising bog water levels wetting of blanket peat at the Wind Farm Site.

The hydrogen Plant has been designed so that it can be in operation 24 hours a day, seven days a week and will be manned with a dedicated team providing maintenance and servicing. Site specific management systems and operating procedures will be developed in accordance with industry procedures and policies. In the event planning is granted for the Proposed Development, the CEMP provides a commitment to mitigation and monitoring, and reduces the risk of pollution whilst improving the sustainable management of resources.

9.5.2.18 Emergency Response

Monitoring of the Proposed Development during the construction and operational phase will potentially indicate weaknesses of the drainage and attenuation design, and/or the potential for excessive loading at particular locations etc. In such instances corrective actions will be taken to mitigate against any potential adverse impacts. Depending on the severity of the issue there is the potential that immediate action will be required, for example; the introduction of straw bales to reduce flow / enhance attenuation at a particular location, erect silt fences etc., however such measures will be temporary, another example is the underground attenuation water storage tanks on the Hydrogen Plant site. Any issue observed will require assessment by a specialist consultant and alternative mitigation design (in line with measures described in this EIAR) will be implemented to ensure the efficacy of the system during both the construction and operational phases of the Proposed Development. Scenarios where corrective action may be required, and proposed corrective mitigation measures include:

- Potential issue; Elevated concentrations of suspended solids in runoff during excavation activities during an unforeseen or low probability storm event, for example; a 1 in 100 year event. Proposed measure; Cover exposed stockpiles in plastic sheeting and placement of straw bales and silt fences in associated drainage channels.
- Potential issue; Failure or degradation of stone check dam during a storm event with associated elevated runoff volumes. Proposed measure; Introduction of straw bales and silt fences in order to regain attenuation capacity of the drainage channel until the maintenance can be completed.
- Potential issue; Localised peat stability issue leading to deposit of peat within an active drainage channel. Proposed measure; Introduction of straw bales and silt fences directly downstream, of the area in order to attenuate gross solids isolate the area and over pump until remedial works and maintenance can be completed, divert all runoff from the area to Active Management area of the treatment train (**Appendix 9.7 – Tile 9 to 11**).
- Potential issue; Management of unexpected runoff patterns leading to excessive drying or wetting in a particular area, potentially leading to enhanced erosion and / or adversely impacting on the ecological health of ecosystems such as blanket peat in the case of the Wind Farm and the neighbouring river adjacent to the Hydrogen Site. Proposed measure; This type of issue will require assessment on a case by case basis. Solutions might include; decommission, modification, introduction or relocation of buffered outfall, or diversion of runoff volumes to or away from the area. In regard to the potential for erosion and similar physical processes, any such issues will become apparent through monitoring relatively rapidly, whereas in regard to ecological sensitivities and such issues will become apparent relatively slowly. It is noted that much of the Site is impacted as part of baseline in this regard e.g. extensive existing artificial drainage networks.

Prior to commencement of construction, the Environmental Clerk of Works will prepare a register of corrective action and emergency response sub-contractors that can be called upon in the event of an environmental incident, and/or to give training on escalating incident where useful, including e.g.; specialist hydrocarbon spill response, specialist hydrological and/or water quality response.

Mitigations measures as outlined in the previous sections will reduce the potential for contamination of waters during the construction phase of the proposed development, however there remains the risk of accidental spillages and or leaks of contaminants, and excessive loading of surface water mitigation infrastructure.

Emergency responses to potential contamination incidents will be established and form part of the CEMP. Potential emergencies and respective emergency responses include:

- Hydrocarbon spill or leak – Hydrocarbon contamination incidents will be dealt with immediately as they arise. Hydrocarbon spill kits will be prepared and kept in vehicles associated with the construction phase of the proposed development. Spill kits will also be established at proposed construction areas, for example; a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for hydrocarbon contaminated materials will also be at hand.
- Significant hydrocarbon spill or leak – In the event of a significant hydrocarbon spillage, emergency responses will be escalated accordingly. Escalation can include measures such as; installation of temporary sumps, drains or dykes to control the flow or migration of hydrocarbons and contaminated runoff will be contained, managed and pumped to a controlled area in line with Active Management including treatment through a suitably equipped treatment tank and Granular Activate Carbon (GAC) vessels. This process will be managed by the EnvCoW in conjunction with a preidentified consultant (EnvCoW specialist register) in regard to effective remediation, treatment and removal of hydrocarbon contaminated water and soils Excavation and appropriate disposal of contaminated soils will be required in this instance. a
- If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer will have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill. The faster the containment or clean-up starts, the greater the success rate, the lower the damage caused and the lower the cost for the clean-up.
- Cementitious material – Cement / concrete contamination incidents will be dealt with immediately as they arise. Spill kits will also be established at proposed construction areas, for example; a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for cementitious materials will also be at hand.
- Other construction and general waste – Wastes which are dispersed by construction activities or by natural causes such as wind will be collected and dealt with immediately.

In the event of a significant contamination or polluting incident the relevant authorities will be informed immediately.

9.5.2.19 Managing and Reporting Environmental Incidents

Environmental incidents including accidental spillages on soils (e.g., fuel), breeches of licence limits if applicable (discharge of trade effluent), and significant environmental incidents (e.g., landslide) on the Proposed Development will be reported to the Local Authority as part of emergency responses to such incidents. Incident notification will be escalated to relevant third parties where relevant e.g., Inland Fisheries Ireland (IFI) if surface water receptors are intercepted.

9.5.2.20 Construction Phase Residual Impacts

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

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

Mitigation measures outlined in this report lay down the framework to reduce all potential impact of the Proposed Development on Hydrological and Hydrogeological receptors. The *Mitigated Potential Impacts* lay down the achievable benchmarks provided measures are considered and implemented adequately.

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures – Wind Farm Site

The principles of the mitigation measures described under **Section 9.5.1** (check dams, stilling ponds, attenuation lagoons etc.) are based on the control and management of runoff discharge rates, which ensure the regulating the speed of runoff within the drainage network, buffering the discharge from the drainage network where possible, and maintaining the natural hydrological regime. As such, the measures described with a view to controlling the release of suspended solids also mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall potentially leading to flooding and erosion of the drainage network or downstream of the proposed development.

The same measures will be implemented with a view to mitigating against net increase surface water runoff arsing from the proposed development. For example, the following conceptual model will be applied at a proposed turbine hardstand location:

- Collector drains; allowing for and estimated 0.5 m depth, 1.0 m width, presume semi-circular, sectional area; c. 0.4 m^2. Presume 100 m length of collector drain; up to 40 m^3 capacity per 100 m, by 50% allowing for gradient equates to 20 m^3. Collector drains are not intended to store runoff, however the in line attenuation features, such as check dams and flow regulators will serve to reduce discharge rates dramatically, effectively backing up water and regulating the rate of discharge The actual attenuation capacity of the drainage network and treatment trains will be calculated during the detailed design phase of the proposed development.
- Check dams at regular intervals throughout the drainage network (existing, new clean collector and new dirty collector drains) will attenuate runoff intercepted by respective drainage channels.
- Dirty water collector drains (associated with construction areas) will direct runoff to established stilling ponds. Stilling ponds will reduce the velocity of runoff, further reducing the hydrological response to rainfall.
- Buffered outfalls to vegetated areas will utilise the infiltration capacity of the ground prior to the rejected rainfall eventually being intercepted by the receiving surface water system.
- Clean water collector drains will intercept clean runoff (upgradient of construction areas) and will direct runoff around construction areas. The runoff will be attenuated by means of check dams and intermittent buffered outfalls (**Appendix 9.7**).

The potential combined attenuation capacity of the proposed drainage infrastructure is designed to attenuate net increase in water runoff during extreme storm events i.e. 1 in 100 year storm event (**Appendix 9.1** and **Appendix 9.2 Site Flood Risk Assessments for Firlough Wind Farm** and **Hydrogen Plant**, respectively). The conceptual model described above indicates that the attenuation capacity is easily achievable with proper consideration, however the effectiveness of attenuation is also dependent on the inclusion of other attenuation features such as check dams, stilling ponds and intermittent buffered outfalls.

9.5.3.2 Increase in Hydraulic Loading Proposed Mitigation Measures – Hydrogen Plant Site

With reference to **Appendix 9.3**, Preliminary Discharge & Assimilative Capacity Assessment, the Hydrogen Plant will harvest and store all rain water intercepted on the site including from roofs and hardstand surfaces on site. The net land sealing at the site is approximately 97%. Furthermore, water storage of 15,057 m^3 (including 1 in 100 year rain fall attenuation) has been sized to maximise storage potential, given physical constraints at the Hydrogen Plant Site, in order to capture as much rain water as possible, supplementing groundwater abstraction, to provide the raw water required for the hydrogen production process. One tank which will consist solely of rainwater (including 1 in 100 year rain fall attenuation) will discharge at greenfield rates to constructed wetlands when capacity is reached. In addition, wastewater arising at the Hydrogen Plant Site will be discharged to surface water (receiving river; Dooyeaghny_or_Cloonloughan) via a series of constructed wetlands with a minimum retention rate of 6 days. The discharge rate will also be reduced as required depending on water chemistry or other environmental variables, namely insufficient assimilative capacity in the river during dry weather flow or prolonged drought conditions. This effectively equates to a >6 day lag to the hydrological response to rainfall at the Hydrogen Plant Site and a beneficial impact in terms of reducing potential flood risk downstream of the site.

During extreme weather events (1 in 100 year) runoff in the order of 373.68 m^3/hour will be attenuated on site. The rainwater storage of 15,064 m^3 equates to approximately 40 hours of rain during a 1 in 100 year storm event. The management of rainwater storage on site will include limiting volumes in storage to allow excess emergency space for attenuation up to 6 hours rain during a 1 in 100 year storm event. This equates to approximately 2,238 m^3 or approximately 15% of rain water storage will be left empty in expectation of future storm events.

In the event storage does reach capacity, the storm system will be equipped with an overflow diverting excess water (>6 hours during a 1 in 100 year event) to waste water storage and the secondary constructed wetlands (if rainwater storage is mixed with untreated abstracted groundwater, and only if not treating / discharging wastewater) for eventual discharge to surface waters, or direct to surface waters.

9.5.3.3 Chemical Storage On Site

Storage of chemicals includes:

- Potassium hydroxide for electrolysis process (lye) (25% Concentration, storage required = 200 m^3).
- Nitrogen gas (produced on site).

- Sodium bisulphite for de-chlorination of mains water (Typically provided in 1 m^3),
- Oils used by hydraulic systems, compressors and transformers (Typically relatively minor volumes).
- Diesel.
- Antiscalant used to prevent/reduce scaling of water treatment equipment (Typically provided in 1 m^3).
- Glycol for coolant (In closed system).

These substances will be stored and used on the Hydrogen Plant Site during the operational phase of the Project which will include a degree of risk depending on the chemical and volume in storage or use at any particular time. The degree of risk extends to potential accidental releases, including those detailed in **Chapter 16** therefore specific detailed design is necessary to ensure adequate storage methods are implemented. This will include plastic bunding or cement bunding of hazardous materials to 110% volume, as well as specific requirements set out in specific Safety Material Data Sheets routine inspections and maintenance of the areas. Handling is in line with the best practices to avoid accidental discharge. In addition, storm water systems will include oil water interceptors to ensure mitigation against accidental releases. Chemicals will be managed in accordance with European Chemicals Agency's Guidance for Downstream Users (2014).

Chemicals on the Wind Farm Site will be limited to minor quantities of hazardous materials used for maintenance purposes, or household materials e.g. bleach including in canteens and welfare facilities.

Chemical Storage on the Hydrogen Plant Site is outlined in **Chapter 2 Section 2.6.6.2.** The selection of bulk chemicals will be subject to an assessment of trace elements to ensure that they are within acceptable limits. Secondary containment, for example a bund, will be used to store the large volumes of oils and other hazardous substances, to prevent hydrocarbon contamination to land/water. Operational staff will receive training on the handling, containment, use, and disposal requirements for all potentially polluting products such as chemicals and oil rags etc, on the Hydrogen Plant Site.

Maintenance and monitoring in itself, during the operational phase of the Wind Farm Site and Hydrogen Site poses similar hazards and risks associated with the construction phase but to a far lesser extent, for example; the potential for fuel spills from vehicles, etc. Emergency procedures and spillage kits will be available and construction staff will be familiar with emergency procedures (CEMP).

9.5.3.4 Operational Phase Water & Wastewater Systems – Hydrogen Plant Site

The operational Hydrogen Plant Site will require ongoing monitoring and active management to ensure source water and wastewater treatment systems perform adequately, and discharge rates and quality are in line with discharge licence conditions. The Preliminary Discharge & Assimilative Capacity Report (pDACA, **Appendix 9.3**) indicates that assuming treatment systems are designed, managed and perform adequately, assessed parameters (e.g. BOD) discharging to the river at concentrations in line with indicative discharge licence conditions, the river assimilative capacity will be adequate with the potential exception of prolonged dry weather flow. Under dry weather flow the management and restriction of discharge will ensure downstream water quality achieves relevant Environmental Quality Standards (EQS). To achieve this the reports describes and lists measures to be taken to ensure adequate oversight and sustainable management of environmental resources and receptors, and process and treatment systems.

The following will be carried out with a view to managing wastewater quality and volumes on site, and minimizing potential for discharge to have adverse impacts on receiving surface water quality:

- Groundwater quality will be monitored on a routine / continuous basis with a view to establishing site specific baseline water quality ranges managing source water and process water chemistry.
- Surface water quality will be monitored on a routine / continuous basis with a view to establishing site specific Q95 and baseline water quality ranges, and managing source water and process water chemistry.
- Groundwater levels will be monitored continuously.
- Surface water levels and discharge rate in the receiving river will be monitored continuously.
- Water sources (groundwater and harvested rainwater) will be utilized and combined at the beginning of the process to minimize contaminant loading in the process source water generally with a view to minimizing loading on downstream wastewater treatment systems.
- Groundwater abstraction volumes will be monitored and recorded continuously. It is likely that the Proposed Development will exceed abstraction volumes of 25 m^3/day. Therefore, the facility will be required to register with the EPA and follow any associated guidance or legislated responsibility.
- 'Water Environment (Abstractions and Associated Impoundments) Act 2022', the Act sets out a process for the registration, assessment and licensing of both surface water

and groundwater abstractions although at the time of writing the Act has yet to be commenced.

  - All abstractions, including group water schemes, that reach a minimum daily threshold of abstraction (25 m^3 per day) will be required to register its abstraction in a similar fashion. Those that abstract 2,000 m^3 or more will automatically require an abstraction license.
  - EPA will assess abstractions and if deemed necessary due to potential environmental risk certain development will require EIA. EIAs for these abstractions will reviewed at least once every six years.
  - For groundwater, recharge times and impacts on connected surface waters are among the elements assessed.
  - There is onus on stakeholders to ensure sustainable use of water, and in light of climate change and potential for extreme meteorological conditions, to work towards water sustainability gains.

- In line storage throughout the process will facilitate buffering flow through and discharge rates. This includes wastewater storage with a view to buffering inflow and regulating discharge from wastewater treatment works on site.
- Process water treatment will include at minimum the proposed design features i.e. Filtration, Reverse Osmosis, and Deionization. The process water treatment facility will be designed to include additional treatment features where required, for example; with the potential for increasing concentrations of contaminants being extracted from the Zone of Contribution (ZOC) over time, the engineered process source water treatment facility will be equipped when and if required to remove elevated concentrations of any particular contaminant which may overload or adversely impact on performance of downstream wastewater treatment facilities.
- All engineered water and wastewater treatment systems will be designed and specified by competent, qualified and experienced engineers.
- Two wastewater streams identified i.e. process wastewater and foul sewage arising from welfare facilities (toilets, canteen etc.) will be dealt with separately initially.
- Wastewater will be treated and managed through passive but managed nature-based solutions, including constructed wetlands (Note; engineered treatment solutions for waste water will be included upstream in the process source water treatment facilities.
- All nature based water and wastewater treatment systems (constructed wetlands) will be designed and specified by competent, qualified and experienced environmental engineers. It is recommended that this item is executed at an early stage of the detailed design. Constructed wetlands will be designed with particular characteristics and ecological attributes based on the expected contaminant loading, achievable retention

time, and performance / discharge quality objectives. The wetland systems will likely take some time to become established and therefore will be required at an early stage of the construction stage of the proposed development. The detailed assessment and design of constructed wetlands will follow the Department of Agriculture, Fisheries and Food guidance document (2011), Minimum Specification for Integrated Constructed Wetlands and Ancillary Works.

- Without advanced assessment of the site hydrogeological properties, including soil infiltration rates and potential for natural attenuation of contaminants, it is recommended that constructed wetlands are lined and do not permit infiltration or recharge to groundwater bodies. There is merit in including assessment for the potential for use of unlined systems. If appropriate (soil infiltration rates, distance to saturated zone) and safe (no dangerous chemicals / contaminants) to do so, allowing treated wastewater to infiltrate to ground will provide beneficial impacts to groundwater in the area (assuming loading reduced to acceptable levels) in terms of both quality and recharge to and replenish groundwater levels following extraction.
- Foul sewage will undergo primary treatment by septic tank. The septic tank will be emptied by tanker in line with standard practices. The outfall of the septic tank will be transferred to the foul sewage constructed wetland (FCW) for secondary treatment. The FCW will be positioned in the northeast corner of the site and will be approximately 80 m^2 to facilitate the optimal retention time of c. 12 days to adequately treat the welfare effluent loading. The outfall of the FCW will be combined with process wastewater in storage before being transferred to the second constructed wetland configuration.
- The outfall of the foul constructed wetland (FCW) will be monitored and sampled in line with sampling frequency and reporting requirements set out in the discharge licence conditions, discussed in later points.
- The combined wastewater will be pumped to a secondary series of process constructed wetlands (PCW). The remaining area on the site will be utilized to maximize area of PCW and associated retention time. This includes a linear feature within the 5 m easement along the southern boundary. Based on initial high level calculations, with the approximate space left available on site, and with regulation of loading and discharge rates, the PCW will achieve a minimum of 6 days retention time. This is lower than the required retention time for loading in line with foul sewage arising from welfare facilities, however the loading from process wastewater will be significantly less than that of welfare wastewater of sewage under normal circumstances*.

  *Potential for variable source water / groundwater quality
- Wastewater storage will be adequately sized (e.g. c. 1,500 m^3) to achieve ability to significantly reduce (e.g. 50%) discharge rates to surface water, or in emergency

situations to completely halt discharging for a minimum duration of one month. Emergency situations in the context of this report includes observing prolonged drought conditions and prolonged low dry weather discharge rates in the receiving river, for example; under Scenario B described in this report, discharging under such conditions could significantly adversely impact on water quality in the receiving river. Therefore, this is an important piece to consider in the management of wastewater and effluent discharge.

- A Industrial Emissions (IE) licence will likely be applied for from the EPA, to ensure safe discharge processes and assuming obtained, the facility will include and adhere to all license conditions as part of the site water and wastewater management plan. In the event an IE licence is not required, at minimum the Project will apply for a Section 4 Discharge Licence from the Local Authority.

A Detailed Discharge & Assimilative Capacity (DACA) and Detailed Water & Wastewater Management Plan will be developed post consent for the Proposed Development incorporating the mitigation and control measures identified, during the detailed design and consenting stage, and prior to construction / operational phase a more detailed assessment of surface water discharge and baseline chemistry will be carried out and more detailed wastewater management plan will be developed. A preliminary Detailed Discharge & Assimilative Capacity (pDACA) is presented in **Appendix 9.3** This will be done with a view to applying for an Industrial Emissions license to discharge a trade effluent to surface waters.

Continuous monitoring through the life of the project will be used to review and update methodologies wherever appropriate on an ongoing basis, that is; the detailed water and wastewater management plan which will be developed prior to the construction phase of the proposed development will be live document and procedures will be amended where relevant based on ongoing continuous and/or routine monitoring.

9.5.3.5 Operational Phase Monitoring – Wind Farm Site

Monitoring at the Wind Farm Site during the Construction phase will continue into the operational phase and at a similar frequency until such time as conditions stabilize and revert to baseline or objective benchmarks in terms of improvement works. This will include monitoring associated with ecology, including in the revegetating of improvement or reinstatement areas. The frequency of monitoring will gradually reduce when conditions are observed to be stable, but will continue for the life time of the Project. This will include, but is not limited to:

- Routine checks and maintenance of storm drainage systems, including permanent stilling ponds and outfalls.
- Routine surface water monitoring repeated at baseline monitoring locations.
- Routine checks and maintenance of welfare and chemical storage facilities.

9.5.3.6 Operational Phase Monitoring – Hydrogen Plant Site

The following section is an overview of the conceptual graphics detailing monitoring requirements during the operational phase of the Hydrogen Plant. As discussed and mentioned throughout this report, monitoring will be required at numerous locations to facilitate and ensure adequate management of a dynamic process in terms of expected source water, wastewater, and receiving water qualities. Detailed monitoring plans will be developed for the following:

- Input and Sources
    - Groundwater levels will be monitored continuously.
    - Ambient groundwater chemistry will be monitored in boreholes. As per likely licence conditions, a minimum of quarterly monitoring of groundwater chemistry will be required.
    - Rainfall at the site will be monitored continuously.
    - Harvested Rainwater & Storm Water volumes.
    - The use of storm water as a raw material requires pre-treatment via oil water separation during storage to prevent contamination of process by hydrocarbons. This will require regular monitoring and maintenance in line with standard practices.
    - Continuous monitoring of water sources being input to the facility and process water treatment works. Establishing site specific water quality ranges will be necessary to ensure consistent and appropriate loading in wastewater.
- Process Water Treatment & Output
    - It is assumed that the engineered water and wastewater treatment facilities will require a degree of continuous monitoring as standard. However, at minimum the works will monitor flows and concentrations of key parameters in wastewater streams. This will be carried out on an ongoing basis to ensure that the water treatment systems are functioning adequately, and to monitor the contaminant loading in wastewater transferred to nature-based treatment systems downstream i.e. constructed wetlands.
    - Welfare and Foul Sewage
    - Septic tanks will require monitoring and maintenance in line with standard practices.

  - The outfall of the Foul Constructed Wetland (FCW) will be monitored continuously for key chemical parameters and physically sampled in line with likely licence conditions.
  - FCW outfall volumes will be monitored on a continuous basis with a view to monitoring chemistry of combined FCW outfall and Process Wastewater.
- Wastewater Treatment
  - Volumes within wastewater buffer storage will be monitored continuously.
  - Quality data obtained from process water treatment and FCW outfall monitoring will be utilized to infer water quality within wastewater buffer storage, if chemistry in storage is monitored directly. This will be done on a continuous basis for key parameters.
  - The outfall / pumped volume from wastewater storage to the Process Constructed Wetland (PCW) will be monitored continuously.
  - Health and performance of all constructed wetlands will be monitored on an ongoing basis.
- Discharge & River
  - Routine and continuous monitoring of surface water quality in line with licence conditions and advised Environmental Quality Standard (EQS) chemical parameters including but not limited to; temperature, pH, turbidity, electrical conductivity, dissolved oxygen, nitrogen, phosphorous, and other key EQS parameters. This will be done with continuous monitoring equipment for a select key parameters and those which can practically be monitored in situ in real time. Other parameters which require physical sampling e.g. Biological Oxygen Demand (BOD) will be monitored on a routine basis, with high frequency e.g. weekly to inform the proposed development of the detailed water management plan, that is; adequate data to establish representative baseline concentration trends of key parameters and to adjust assimilative capacity calculations accordingly.
  - Monitoring described above will be conducted at three monitoring locations on the river; upstream (FHP-SW-US), the discharging effluent at the discharge point (DP) or at a representative (of end of pipe) sampling location on the discharge line, and downstream (FHP-SW-DS) of proposed development. Continuous real time monitoring data obtained at these locations will be used to manage and calibrate the wastewater and discharge regime at the site.
  - Discharge rates in the river will be monitored on a continuous basis. Data obtained will be used to establish a hydrograph and associated discharge (Q) percentiles (similar to EPA HydroTool) for the river at the point of monitoring i.e.

DP. Dray weather flow will also be qualified. Continuous real time monitoring data will be used to manage and calibrate the wastewater and discharge regime at the site e.g. restricting discharge during dry weather discharge rates will inadequate assimilative capacity.

- Overall Environmental Impact
  - All data obtained will be compiled, reviewed, assessed and used to inform ongoing review and assessment of overall impacts to the receiving environment in terms of sustainable use and interaction e.g. ongoing monitoring of effects on groundwater quality and levels, ongoing monitoring of river water discharge rates and quality.

9.5.4 Development Decommissioning & Restoration Phase

No new impacts are anticipated during the decommissioning phase of the Project on the hydrological and hydrogeological environment therefore no additional mitigation measures are required, however the decommissioning of major infrastructure including proposed turbines, poses similar hazards and risks to the environment compared to that of the construction phase. Mitigation measures similar to the construction phase will be implemented.

In regard to Wind Farm Site, excavation of material is not anticipated, similarly vehicular movement on soil is not anticipated considering adequate hardstand will have been established, therefore the risk of release of suspended solids is **slight**, however the risk of fuel or other contaminant spillages, or management of waste are valid hazards during the decommissioning phase of the proposed development.

Deconstruction works during the decommissioning phase of the Proposed Development pose similar hazards and risks associated with the construction phase but to a far lesser extent, for example; the potential for fuel spills from vehicles is valid but there will likely be less vehicles required, for example, no excavators. The principles mitigation measures described in this EIAR chapter will be implemented by means of a Decommissioning Phase Management Plan.

Restoration of the Wind Farm Site following decommissioning of infrastructure is in its own right a phase of the Proposed Development. Restoration activities have the potential to be disruptive and hazardous to the environment (similar impacts to construction), to the point that a 'benefit analysis' will likely be required to evaluate any such activity before it is permitted (Schumann, M., and Joosten, H., 2008). Baseline conditions will likely change over the life of the project, therefore repeat assessments will be carried out prior to decommissioning and restoration with a view to tailoring and implementing site specific measures which will be reviewed and agreed with the planning authority prior to the commencement of decommissioning.

Examples of difficulties impeding restoration highlighted by means 'benefit analysis' in terms of hydrology and hydrogeology include the following:

- Removal of Hardstand / access roads – Significant disturbance due to operations associated with excavation and removal of hardstand materials. Removal of such materials will leave an exposed area of ground in situ, which will lead to erosion and entrainment of suspended solids in surface water runoff traversing these exposed areas. The drainage network established for the purposes of the construction phase of the Proposed Development will likely not be sufficiently suitable to manage such contamination instances, and Active Management will be required similar to the construction phase.
- Removal of Turbine Foundations – The removal of concrete foundations is a challenge in itself, however it also increases the potential for surface water contamination via concrete dust and other debris. If water accumulates within open foundation removal excavations, and concrete dust is entrained, the water arising from dewatering activities will likely have an elevated pH. Discharging such water to the receiving surface water network could potentially have significant adverse effects. The water would likely require treatment before discharging. For this reason, and the disproportionate effort required to remove buried foundations, they will likely be left in situ.
- The material required to reinstate any areas where infrastructure is removed will need to be sourced from elsewhere on the site. This will lead to similar issues as described in the points above.

It is the intention that the Hydrogen Plant will continue operations indefinitely. The source of electricity for the Hydrogen Plant would change upon the decommissioning of the Wind Farm and be changed to one of the following options;

- Subject to planning consents, the repowering of Firlough Wind Farm.
- Reinforced electricity network with a corporate Power Purchase Agreement with a green electricity producer.
- Connection to an offshore wind power generator off the west coast.

If these alternatives are not viable then the process equipment would be decommissioned; all plant, machinery and equipment will be emptied and dismantled to be sold or recycled or, where these are not possible, disposed of through a licenced waste contractor. If required, all machinery will be cleaned prior to removal and all necessary measures implemented to prevent the release of contaminants. All waste will be removed from the facility and recycled wherever possible, disposal operations will be controlled by licenced waste contractors.

Ultimately, any such restoration activities will need to be assessed under the scope of multiple environmental disciplines, similar to this EIAR, and the potential synergistic effects at the end of life of the project (c. 40 years). Given that the condition of the environment will likely change over the course of the operational phase of the Proposed Development, particularly in terms of the health and degree of establishment of environmental attributes including land use, ecology and ornithology etc., it is recommended that the potential for restoration following the decommissioning phase of the Proposed Development is evaluated closer to the time.

9.5.4.1 Restoration Phase Residual Impacts

Benchmark for restoration will be neutral (revert to baseline) to positive (better than baseline). It is anticipated that the appropriate reinstatement of redundant hardstand areas will result in a net beneficial impact. This will be achieved through passive continuous improvements at the areas in question. Over time, the reinstated areas will become revegetated and will recover to become similar in appearance to the surroundings of the wider Wind Farm Site.

The reinstatement of the Wind Farm Site areas will likely result in enhanced peatland/bog water levels at the Site. This will occur through the reintroduction of permeable layers at former hardstand areas which will in turn promote the filtration of potentially contaminated surface water runoff which may originate from reinstated areas. Therefore, the residual impact of reinstatement at former Turbine Hardstand areas is considered to be a **positive, localised and permanent** impact of the Proposed Development. However, it is important to note that reinstatement will be required to be managed similar to the construction phase, including appropriate construction phase mitigation and monitoring.

9.5.5 Cumulative Effects

9.5.5.1 Water Quality – Wind Farm

The phasing/commencement of any other permitted developments in the locality could potentially result in the scenario where a number of other construction sites are in operation at the same time as the Project.

Considering the mitigation measures outlined in this report and the expected residual effect pending successful implementation of those measures i.e. neural impact to receptors, the Proposed Development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of water quality.

In the event of accidental or temporary contamination incidents, water quality in downstream receptors can potentially be adversely impacted, particularly during the construction phase. Such incidents will demand an emergency response on site and escalation of Active Management on site (**Appendix 9.7 – Tiles 7-9**). Assuming other, similar developments, construction activities and potential adverse impacts in the area, there is the potential for such incidents to have a cumulative impact on water quality to some degree if such incidents occur on multiple sites in a short period of time and within the same hydrological catchments. However, it must be noted that similar sporadic natured impacts are part of baseline conditions at the site, including; land reclamation, excavation of drainage, commercial forestry, agricultural practices.

Allowing for worst case whereby a contamination incident occurs, the incident will likely be minor and temporary and therefore will unlikely contribute significantly to cumulative effects in the associated surface water network. The risk of a major landslide or mass movement to occur as a function of the Proposed Development at the site is generally low (**Chapter 8**).

9.5.5.2 Hydraulic Loading

Due to a net increase in impermeable surface at each of the Wind Farm Site and Hydrogen Plant Site as part of the Proposed Development, a reduction in recharge to groundwater, and rapid transmission of runoff to surface water systems has the potential to significantly contribute to the cumulative / catchment hydrological response to rainfall.

Considering the mitigation measures outlined in this report and the expected residual effect pending successful implementation of those measures, the Proposed Development is not considered to significantly contribute to cumulative adverse impacts to the associated hydrological network in terms of hydraulic loading. In the event that there was no attenuation features included as part if the Proposed Development, due to the low recharge rates associated with the site, the net increase in runoff would be low relative to the scale of the associated catchments. However, with reference to **Appendix 9.1 – Firlough Wind Farm FRA**, the cumulative ground sealing nature of the entire built environment needs to be considered and therefore the Proposed Development in combination with other similar developments have the potential to have significant cumulative impacts to flood risk areas.

9.5.5.3 Groundwater Resource

The Project is not likely to significantly impact groundwater quantities or availability. The Wind Farm Site will not extract any groundwater for use during the Operational phase.

Ground Water Assessment Report established sustainable yields of 2.25 l/s (194 m^3/d) and 0.44 l/s (38 m^3/d) for Boreholes 6 and 7, respectively, with a cumulative yield of 232 m^3/d (84,680 m^3/yr) which is consistent with the two boreholes being able to meet the water demand of the plant (annual water budget of 66,256 m^3 or 182 m^3/d).

Groundwater abstraction will be reduced through the implementation of rainwater harvesting. Preliminary calculations suggest that an average of 18,275 m^3/yr would be a reasonable estimate from the roofed areas alone. An additional 22,535 m^3/yr could be harvested from the remaining non-roofed area leading to a combined 40,800 m^3/yr from rainwater, accounting for approximately 62% of the entire annual water demand.

Monitoring the effect of abstraction on neighbouring wells and springs will be conducted as outlined in Section 3.7 of the **Appendix 9.3** and Section 8 of **Appendix 9.8**.

With reference to the Minerex Environmental Limited Groundwater Supply Assessment for the Hydrogen Plant (**Appendix 9.8**), it was determined that two boreholes drilled on the Hydrogen Plant Site are able to supply the expected water demand of the Hydrogen Plant Site without depleting the aquifer or impacting the wells in the region.

9.6 SUMMARY OF SIGNIFICANT EFFECTS

This chapter comprehensively assesses all scenarios within the Turbine Range at the Wind Farm Site and the 80MW electrolyser capacity at the Hydrogen Plant Site. A summary of unmitigated and mitigated impacts are presented in **Table 9.14: Summary of Potential Effects on receiving environment from the Wind Farm and Grid Connection Route in the absence of and with mitigation measures,** and **Table 9.15: Summary of Potential Effects on receiving environment from the Hydrogen Plant and Interconnector Route in the absence of and with mitigation measures.** During both the construction and operational phases of the Proposed Development, activities will take place at the Wind Farm Site, Hydrogen Plant Site, along the Grid Connection Route, Interconnector Route, Killybegs Turbine Delivery Route or Galway Turbine Delivery Route that will have the potential to significantly affect the hydrological regime and surface water quality within the vicinity of each element. The significant potential impacts that could generally arise from the Proposed Development during the construction of infrastructure elements including the excavation activities associated with foundations, cable trenches, and works in close proximity to surface water or drainage network including watercourse crossings and culverts, Operational and Decommissioning phases relate to sediment input from runoff and in the case of onsite works other pollutants such as hydrocarbons and cementitious substances, with hydrocarbons or chemicals spills to surface waters having the most potential for impact.

This chapter identified the likely hydrological, and hydrogeological impacts of the Project. By summarising relevant guidance and legislation and outlining baseline information, it allowed for the assessment of the potential effects to be identified and their significance rated. The potential impacts that could arise from the Proposed Development during the construction, operational and decommissioning phases relate to the potential for increased suspended sediment concentrations associated with both Wind Farm and Hydrogen Plant Site preparation activities and excavations, groundwater abstraction and wastewater discharge.

The implementation of mitigation through avoidance principles, choice of best alternatives for location of works, pollution control measures, surface water drainage measures and other preventative measures incorporated into the project design in order to minimise potential significant adverse effects on water quality at the Wind Farm Site, Hydrogen Plant Site and along the Interconnector Route, Grid Connection Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route. A self-imposed 50 m stream buffer zone will be implemented at the Site which will likely result in the avoidance of sensitive hydrological features.

Layout design amendments along with application of the specified mitigation during each phase of the Project have reduced the potential significance to all receptors related to the Proposed Development to 'neutral' or 'positive'. The Project will not impact upon any surface water or groundwater body as it will not cause a deterioration of the status of the body and/or it will not jeopardise the attainment of a WFD 'Good' status. It is not likely that the Project will have a significant effect alone or cumulatively to the conservation status of ecological habitats and terrestrial mammals occurring in the surrounding area or downstream of the sites.

The drainage plan Surface Water management Plan (SWMP) for the Site will be a key method through which sediment runoff arising from construction activities will be reduced and through which runoff rates will be controlled.

Overarching objectives of the CEMP and SWMP are to adopt and implement Nature Based Solutions including the provision of extensive Sustainable Drainage System (SuDS) features. This approach will be adopted to the extent that mitigating against likely effects such as net increase in surface water runoff and potential adverse effects to surface water quality, will over shoot net adverse losses and provide beneficial effects compared to baseline conditions.

Implementation of the control measures outlined in this EIAR will result in a robust environmental management plan which will target and mitigate likely sources and pathways of contaminant arising at the site, and to actively manage and monitor systems on site to achieve no significant impact to the receiving surface water network. The monitoring and management, will identify and deal with any potential issue arising from threatened or actual releases and ensure that they will be remedied as soon as possible.

The Project as a whole, including the Wind Farm Site, Hydrogen Plant Site, Interconnector Route, Grid Connection Route, Killybegs Turbine Delivery Route and Galway Turbine Delivery Route are not likely to significantly impact groundwater quantities, quality or availability. The principal residual risk to groundwater posed by the Proposed Development is the use, storage and transfer of hydrocarbons (fuel) on site for plant equipment. In the unlikely event a spill occurs, the contaminant will be contained, managed and removed immediately.

There is no residual flood risk on either the Wind Farm or Hydrogen Plant Site. Flood Risk Assessments conclude that the likelihood of exacerbating flood risk or behaviours at the Site is very low, and the potential to exacerbate effects on local receptors including dwellings is very low.

Table 9.14: Summary of Potential Effects on receiving environment from the Wind Farm Site and Grid Connection Route in the absence of and with mitigation measures.

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Probability**	**Significance**
Release of Suspended Solids	Construction	Direct and Indirect*	Adverse	Large	Moderate to Significant	Localised (Potentially Regional)	Conforms to Baseline (peat harvesting)	Unavoidable	Temporary	Sections 9.5.2.1, 9.5.2.1.1	Yes	Adverse / Beneficial	Likely	Slight / Neutral / Beneficial
Clear Felling of Afforested Areas	Construction	Direct and Indirect*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary	Section 9.5.2.4	Yes	Adverse / Beneficial	Likely	Slight / Neutral / Beneficial
Demolition of House and sheds	Construction	Indirect	Adverse	Small	Slight	Localised	Contrast to Baseline	Unavoidable	Permanent	Section 9.5.2.3, 9.5.2.15	Yes Adverse / Beneficial		Likely	Slight / Neutral
Release of Hydrocarbons Surface Waters	Construction	Direct and Indirect*	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Permanent but Reversible	Section 9.5.2.4	Yes	Adverse	Low	Slight / Neutral
Release of Hydrocarbons Groundwater	Construction	Indirect	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Permanent but Reversible	Section 9.5.2.4	Yes	Adverse	Low	Slight / Neutral
Release of Horizontal Directional Drilling to Surface Water	Construction	Direct*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term to Permanent	Section 9.5.2.5	Yes	Adverse	Low	Slight / Neutral
Release of Horizontal Directional Drilling to Groundwater	Construction	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.5	Yes	Adverse	Likely	Slight
Release of Construction or Cementitious Material to Surface Water	Construction	Direct and Indirect*	Adverse	Small to Moderate	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary to Medium term	Section 9.5.2.6	Yes	Adverse	Low	Slight / Neutral
Release of Construction or Cementitious Material to Groundwater	Construction	Indirect	Adverse	Small to Moderate	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary to Medium term	Section 9.5.2.6	Yes	Adverse	Low	Slight
Release of Waste Water Sanitation Contaminants to Surface Waters	Construction	Direct and Indirect*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Low	Slight
Release of Waste Water Sanitation Contaminants to Groundwater	Construction	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Low	Slight/neutral

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Probability**	**Significance**
Release of Hazardous Material	Operational	Direct*	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term	Section 9.5.3.3	Yes	Adverse	Low	Moderate
Impact Hydrologically Connected Sensitive Receptors	Construction	Direct *	Adverse	Large	Moderate to Profound	Localised	Conforms to baseline e.g. TSS from peat harvesting)	Unavoidable	Temporary?	All above outlined Mitigation Measures	Yes	Adverse	Low	Slight/neutral
Groundwater Levels and Supplies	Construction	Indirect *	Adverse	Moderate to Large	Slight to Moderate	Localised	Contrasts to Baseline	Likely	Temporary	Section 9.5.2.15	Yes	Neutral	Low	Slight/neutral
Groundwater or Bog Water Associated with Wind Farm Site	Construction	Direct and Indirect*	Adverse	Small to Moderate	Neutral to Slight	Localised	Conforms to baseline e.g. peatland access tracks and operations / drainage)	Likely	Permanent but Reversible	Section 9.5.3.4 9.5.5.3	Yes	Adverse	Likely	Slight / Neutral / Beneficial
Groundwater Associated with Grid Connection Route Cable Works	Construction	Direct and Indirect *	Adverse	Small	Slight	Localised	Conforms to baseline e.g. existing road network)	Likely	Temporary	Section 9.5.2.14	Yes	Adverse	Low	Slight/neutral
Excavation Dewatering & Construction Water	Construction	Direct and Indirect*	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Contrasts to Baseline	Likely	Temporary to Permanent	Sections 9.5.2.8, 9.5.2.9	Yes	Adverse	Likely	Slight/neutral
Constructed Drainage, Diversion and Enhancement of Drainage	Construction	Direct *	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Conforms to Baseline e.g. peatland drainage.	Unavoidable	Permanent	Section 9.5.2.13	Yes	Adverse	Likely	Slight / Neutral / Beneficial
Watercourse Crossings	Construction	Direct *	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Conforms to Baseline e.g. existing drainage network	Likely	Permanent	Sections 9.5.2.10, 9.5.2.11	Yes	Adverse	Likely	Slight/neutral
Increase Hydraulic Loading Wind Farm Site	Operational	Direct and Indirect*	Adverse	Small	Slight	Development Footprint; Localised	Contrast to Baseline	Unavoidable	Permanent	Section 9.5.3.1	Yes	Adverse to Beneficial	ikely	Neutral / Beneficial

Wind Farm Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Probability**	**Significance**
Reinstatement of Redundant Areas Wind Farm	Decommissioning	Direct *	Adverse	Small	Slight	Development Footprint;	Contrast to Baseline	Likely	Permanent	Section 9.5.4	Yes	Adverse	Likely	Neutral / Beneficial
	Note: *** Includes Indirect / Secondary impacts to receptors downstream of the Project. For example: Contaminants intercepted by surface water features or groundwater bodies can have a potential effect on downstream sensitive receptors or regional groundwater aquifers depending on the environmental circumstances.**													

Table 9.15: Summary of Potential Effects on receiving environment from the Hydrogen Plant Site and Interconnection Route in the absence of and with mitigation measures.

Hydrogen Plant Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Probability**	**Significance**
Release of Suspended Solids	Construction	Direct and Indirect*	Adverse	Large	Moderate to Significant	Localised (Potentially Regional)	Conforms to Baseline (peat harvesting)	Unavoidable	Temporary	Sections 9.5.2.1, 9.5.2.1.1	Yes	Adverse	Likely	Slight/neutral
Release of Hydrocarbons Surface Waters	Construction	Direct and Indirect*	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Permanent but Reversible	Section 9.5.2.4	Yes	Adverse	Low	Slight/neutral
Release of Hydrocarbons Groundwater	Construction	Indirect	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Permanent but Reversible	Section 9.5.2.4	Yes	Adverse	Low	Slight/neutral
Release of Horizontal Directional Drilling to Surface Water	Construction	Direct*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term to Permanent	Section 9.5.2.5	Yes	Adverse	Low	Slight/neutral
Release of Horizontal Directional Drilling to Groundwater	Construction	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.5	Yes	Adverse	Low	Slight/neutral
Release of Construction or Cementitious Material to Surface Water	Construction	Direct and Indirect*	Adverse	Small to Moderate	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary to Medium term	Section 9.5.2.6	Yes	Adverse	Low	Slight/neutral
Release of Construction or Cementitious Material to Groundwater	Construction	Indirect	Adverse	Small to Moderate	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary to Medium term	Section 9.5.2.6	Yes	Adverse	Low	Slight/neutral
Release of Waste Water Sanitation Contaminants to Surface Waters	Construction	Direct and Indirect*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Low	Slight/neutral
Release of Waste Water Sanitation Contaminants to Groundwater	Construction	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Low	Slight/neutral
Hydrologically Connected Sensitive Receptors	Construction	Direct *	Adverse	Large	Moderate to Profound	Localised	Conforms to baseline e.g. TSS from peat harvesting)	Unavoidable	Temporary?	All above outlined Mitigation Measures	Yes	Adverse	Likely	Slight / Neutral / Beneficial
Groundwater Levels and Supplies	Construction and Operational	Indirect *	Adverse	Moderate to Large	Slight to Significant	Localised (ZOC)	Contrasts to Baseline in terms of volumes, but other wells in area.	Likely	Temporary	Section 9.5.2.15	Yes	Neutral	Likely	Slight

Hydrogen Plant Site		Qualifying Criteria Pre-Mitigation										Qualifying Criteria With Mitigation		
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation**	**Mitigation Applied**	**Quality**	**Probability**	**Significance**
Groundwater or Bog Water Associated with Hydrogen Plant Site	Construction	Direct and Indirect*	Adverse	Small to Moderate	Neutral to Slight	Localised	Conforms to baseline e.g. peatland access tracks and operations / drainage)	Likely	Permanent but Reversible	Section 9.5.3.4 9.5.5.3	Yes	Adverse	Low	Slight / Neutral
Groundwater Associated with Interconnector Route Cable Works	Construction	Direct and Indirect *	Adverse	Small	Slight	Localised	Conforms to baseline e.g. existing road network)	Likely	Temporary	Section 9.5.2.14	Yes	Adverse	Low	Slight / Neutral
Excavation Dewatering & Construction Water	Construction	Direct and Indirect*	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Contrasts to Baseline	Likely	Temporary to Permanent	Sections 9.5.2.8, 9.5.2.9	Yes	Adverse	Likely	Slight / Neutral
Increase Hydraulic Loading Hydrogen Plant Site	Operational	Direct and Indirect*	Adverse	Small	Slight	Development Footprint; Localised	Contrast to Baseline	Unavoidable	Permanent	Section 9.5.3.1	Yes	Adverse to Beneficial	Likely	Neutral / Beneficial
Release of Wastewater Sanitation Contaminants to Surface Waters	Operational	Direct and Indirect*	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Likely	Slight/neutral
Release of Waste Water Sanitation Contaminants to Groundwater	Operational	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.2.7.1	Yes	Adverse	Low	Slight/neutral
Chemical Storage on Hydrogen Plant Site	Operational	Indirect	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long term but Reversible	Section 9.5.3.3	Yes	Adverse	Likely	Slight/neutral
Discharge of Trade Effluent to Surface Waters	Operational	Direct	Adverse	Moderate	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Unavoidable	Long term but Reversible	Multiple Sections	Yes	Adverse	Likely	Slight/neutral

Note:
*** Includes Indirect / Secondary impacts to receptors downstream of the Project. For example: Contaminants intercepted by surface water features or groundwater bodies can have a potential effect on downstream sensitive receptors or regional groundwater aquifers depending on the environmental circumstances.**