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9 HYDROLOGY & HYDROGEOLOGY

9.1 Introduction

This chapter assesses the impacts of the Proposed Development (Chapter 1) on the Hydrology and Hydrogeology environment associated with it. The Proposed Development refers to all elements of the application for the construction, operation and decommissioning of Oatfield Wind Farm (**Chapter 5: Description of the Proposed Development**). Where adverse effects are predicted, the chapter identifies appropriate mitigation strategies. The assessment considers the potential effects during the following phases of the Proposed Development:

- Construction
- Operation
- Decommissioning

This chapter of the EIAR should be read with reference to the **Chapter 9 Hydrology and Hydrogeology**. All figures referenced within this chapter can be found within **Appendix 9.6**.

A Construction and Environmental Management Plan (CEMP) is appended to the EIAR **Chapter 5: Description of the Proposed Development**. This document will be a key construction contract document, which will ensure that all mitigation measures as set out in this chapter, which are considered necessary to protect the environment, are implemented by relevant competent engineers at the detailed construction phase of the development. For the purpose of this assessment, a summary of the mitigation measures is included in EIAR **Chapter 21: Summary of Mitigation Measures**.

9.1.1 Assessment Structure

In line with the EIA Directive and current EPA *Guidelines on the information to be contained in Environmental Impact Assessment Reports* (2022) the structure of this Hydrology and Hydrogeology chapter is as follows:

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

9.1.2 Proposed Development Description

The Proposed Development comprises an 11-turbine wind farm on a site located within forested and agricultural lands. It also comprises a Grid Connection Route (GCR) for connection to the national grid, and temporary accommodating works along a Turbine Delivery Route (TDR) to the wind farm, to facilitate the delivery of large components from the port of delivery. The GCR and TDR are both assessed in this EIAR and form part of the planning application.

The key components that are described throughout the EIAR are listed below:

- The wind farm which consists of 11 wind turbines (4 turbines across the Eastern Development Area (Eastern DA) and 7 turbines across the Western Development Area (Western DA));
- The grid connection route and underground cables (also referred to as GCR and UGC); and,
- The turbine delivery route (TDR).

The term ‘Proposed Development’ collectively describes the above three components. Further information about the Proposed Development is presented in **EIAR Chapter 5: Description of the Proposed Development**.

9.1.2.1 Watercourse Crossings

Watercourse Crossings Proposed Development (Wind Farm)

Watercourse crossings over mapped rivers at the Proposed Development Site are listed in the following table and shown on **Figure 9.2 and 9.6**;

Table 9.1 Watercourse crossings on site

Crossing Number	Type	E ITM	N ITM
WCC_01	Clear Water Drain Diversion	556778.8	670969.8
WCC_02	New Culvert	556757.6	670922.4

Crossing Number	Type	E ITM	N ITM
WCC_03	New Culvert	557388.1	670841.4
WCC_04	New Culvert	557652.2	670816.3
WCC_05	New Culvert	556230.2	670767.5
WCC_06	New Culvert	557183.8	670765.8
WCC_07	New Culvert	557807.5	670694.6
WCC_08	New Culvert	556486.5	670648.6
WCC_09	Clear Water Drain Diversion	557007.4	670639.4
WCC_10	New Culvert	556679.2	670635.2
WCC_11	New Culvert	556988.2	670623.8
WCC_12	New Culvert	556570	670592.4
WCC_13	New Culvert	556629.2	670588.7
WCC_14	Culvert to be upgraded	556870.5	670553
WCC_15	New Culvert	556479	670486.7
WCC_16	Clear Water Drain Diversion	556447.5	670481.7
WCC_17	Clear Water Drain Diversion	556362.3	670470.4
WCC_18	Clear Water Drain Diversion	554971.3	669165
WCC_19	Clear Water Drain Diversion	554963.3	669115.9
WCC_20	New Culvert	552711.9	669086.7
WCC_21	New Culvert	554265	668989.2
WCC_22	Clear Water Drain Diversion	553670.4	668882.6
WCC_23	New Culvert	552976.7	668870.6
WCC_24	New Culvert	554145.9	668851.9
WCC_25	New Culvert	553031.7	668826.5
WCC_26	New Culvert	553153.3	668804.7
WCC_27	New Culvert	552872	668779.8
WCC_28	Clear Water Drain Diversion	553553.4	668772.3
WCC_29	New Culvert	553527.4	668759
WCC_30	New Culvert	553452.6	668737.8
WCC_31	Using bridge culvert solution	554465.2	668721.2
WCC_32	New Bridge	554504.8	668715.3
WCC_33	New Culvert	553592.3	668538.9
WCC_34	Culvert to be upgraded	553596.2	668536
WCC_35	New Culvert	553690.4	668383.6
WCC_36	New Culvert	553762.8	668358.1
WCC_37	New Culvert	553614.8	668325.3

Crossing Number	Type	E ITM	N ITM
WCC_38	New Culvert	554059	668135

A new watercourse crossing is associated with the proposed new Site Access Roads. Existing watercourse crossings are associated with existing Site Access Roads and will require upgrading.

Watercourse crossings listed above, locations are identified by means of assessing the Site layout and where it intersects existing drainage mapped as part of this assessment. There remains the potential for location of clear span bridges as part of the detailed design, particularly if associated with minor drainage which will be subject to modification and diversion in some instances.

Watercourse Crossings Grid Connection

The Grid Connection Route crosses over the Blackwater (Clare) River twice. These water crossing will either be in the existing bridge deck using the reduced cover method, or if the bridge cannot accommodate the cable, a Horizontal Directional Drill (HDD) may be required, see **Chapter 5, Section 5.5.11**.

Table 9.2: Watercourse crossings on Grid Connection Route

Crossing Number	Type	E ITM	N ITM
WCC_42	Culvert to be upgraded	554070.1	668098.8
WCC_43	Existing Bridge – HDD required	554211.288	667227.818
WCC_44	Existing Bridge – HDD required	555101.173	665328.742

The grid connection route crosses a section of the R471 southeast of the WDA, where it crosses the Gourna_010 River before splitting. They then reconverge once they cross the Cloverhill stream_010, east of Shannon.

Watercourse Crossings IPP Cabling

The IPP Cabling crosses over the Blackwater (Clare) River. These water crossing will either be in the existing bridge deck using the reduced cover method, or if the bridge cannot accommodate the cable, a Horizontal Directional Drill (HDD) may be required, see **Chapter 5 Section 5.2.6.2**.

Table 9.3: Watercourse crossing IPP

Crossing Number	Type	E ITM	N ITM
No. 10A	Crossing watercourse_unnamed culverted bridge - HDD	55079.198	667191.984
No. 19A	Crossing watercourse CL-R471-011.00 culverted bridge - HDD	556655.911	666677.463

Crossing Number	Type	E ITM	N ITM
No. 26A	Crossing watercourse CL-R471-012.00 culverted bridge - HDD	557544.827	666339.268
No. 32A	Crossing watercourse culverted bridge River Blackwater - HDD	557914.646	666227.867
No. 36A	Crossing watercourse CL-R471-014.00 culverted bridge - HDD	557914.646	666227.867
No. 43A	Crossing watercourse_unnamed culverted bridge - HDD	558311.876	667258.462
No. 47A	Typical Trenching in public road corridor along the local road at the East side of Site (Crossing watercourse_unnamed culverted bridge)	558234.814	667912.28
No. 48A	Typical Trenching in public road corridor along the local road at the East side of Site (Crossing watercourse_unnamed culverted road)	558154.7	668222.558

Horizontal Directional Drilling

Crossing the existing culverts will be implemented using open trenching with either an undercrossing (beneath) or an overcrossing (above), depending on the depth of the culvert.

Assessment of bridge locations which cross rivers along the proposed grid route indicates that there is insufficient depth of overburden in the bridge decking to achieve the required cable burial depth. As it will not be possible to install cable conduits in these bridges Horizontal Directional Drilling (HDD) will be utilized at these locations to direct the cables under the river.

Horizontal Direction Drilling (HDD) is a method of drilling under obstacles such as bridges, and water courses in order to install cable ducts below the obstacle. This method is employed where installing the ducts using standard installation methods is not possible. This is a trenchless technology technique, routinely used as an alternative to conventional open cut and cover trenching. There are two locations along the UGC route which will require HDD.

HDD will require the excavation of entry and exit pits (1m x 1m x 2m) on either side of the watercourse and the bore path will be drilled to an estimated 2000mm beneath the waterway. The crossings will comprise of 5 x 110mm High Performance Polyethylene (HPPE) pipes/ducts. The depth of the bore path has been based on locating a suitable clay/silt formation for HDD. It is noted that the required depth may increase subject to geotechnical investigations.

The launch and retrieval pits will be off road necessitating their installation in agricultural lands close to the bridge locations. As the proposed grid connection will be a double circuit a working corridor of approximately 8 m wide will be required with lands excavated being reinstated post construction. In addition, an access track comprising crushed rock along the cable route in third party lands, approximately 3.5m in width, will be required.

Watercourse Crossings Turbine Delivery Route

No new Watercourse crossings are proposed for the Turbine Delivery Route.

9.1.3 Statement of Authority

RSK Ireland was commissioned to carry out this Environmental Impact Assessment Report. 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. 10 years industry experience in the preparation of hydrological and hydrogeological reports.

Dr. Jayne Stephens - B.S.c (Environmental Science), PhD (Environmental and Infection Microbiology). Jayne is an Environmental consultant with c. 5 years' experience.

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 and effects of the Proposed Development on the hydrology and hydrogeology aspects of the environment:

- Characterise the topographical, hydrological and hydrogeological regime of the Site from the data acquired through desk study and onsite surveys.
- Water balance calculation.
- Flood risk evaluations.
- Consider hydrological or hydrogeological constraints together with development design.
- Consider drainage issues, or issues with surface water runoff quality as a result of the Development, its design and methodology of construction.
- 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 EIAR reporting requirements.

9.2.1.1 General Approach

The Environmental Impact Assessment Report (EIAR) is a comprehensive document that assesses the potential impacts of a proposed development on the environment. It includes 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 which will be incorporated into the Development design and associated management plans to minimise potential impacts to acceptable levels where possible, and to evaluate likely or expected residual impacts posed by the Development.

Mitigation measures which are prescribed in EIAR chapters will be further developed and engineered through the Proposed Development 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 measures and design considerations outlined in this report and apply it to the final detailed design and CEMP, SWMP and similar management plans.

In some cases, CEMP and SWMP developed at the planning phase of the Development can be incorporated back into the EIAR chapters with a view to adding clarity to the specific site or development. However, the CEMP or other management will be updated when the application is consented and include any planning conditions. It is recommended that CEMP and similar management plans are finalised during and as part of the final detailed design phase prior to commencement of the construction phase. Therefore, it is important to note that management plans referred to in this report are planning stage documents, and where terminology such as "has been done" with reference to mitigation measures applied in CEMP or other management plans, this does not acknowledge the full proper application measures or finalised design, but refers only to indication of what is planned and what will be refined and finalised as part of the detailed design phase. The CEMP, SWMP or other management plans have not been assessed as part of this report / chapter.

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 the Site 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 to minimise any potential for contaminants to reach sensitive receptors identified, will monitor the efficacy of mitigation measures applied, and were 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 and Net Benefit Impacts*

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 site. 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 whereby the proposed development will attenuate more than the net increase posed by the Development.

The approach to achieving objectives and net beneficial impacts is mainly through the application of Nature Based Solutions. These 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 was undertaken in accordance with following Irish legislation (transposition of the aforementioned directive):

- SI No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018.
- Planning and Development Regulations 2001 – 2023.
- In addition to this planning legislation, other environmental legislation relevant to hydrological and hydrogeological aspects of the environment were referred to:
- S.I. No. 293 of 1988: European Communities (Quality of Salmonid Waters) Regulations 1988
- S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009
- S.I. No. 477/2011 - European Communities (Birds and Natural Habitats) Regulations 2011 as amended
- S.I. No. 684/2007 - Waste Water Discharge (Authorisation) Regulations 2007
- S.I. No. 106/2007 - European Communities (Drinking Water) Regulations 2007
- S.I. No. 722 of 2003 European Communities (Water Policy) Regulations 2003 as amended
- S.I. No. 272 of 2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended
- S.I. No. 296 of 2009: European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 as amended
- S.I. No. 9 of 2010: European Communities Environmental Objectives (Groundwater) Regulations 2010 as amended
- S.I. No. 99/2023 - European Union (Drinking Water) Regulations 2023
- S.I. No. 296 of 2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018
- European Union Water Framework Directive (2000/60/EC) as amended

The fundamental objective of the Water Framework Directive as amended aims at maintaining “high status” of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least “Good” in relation to all waters by 2027 (WFD).

This study has been prepared having regard to, inter alia, the following guidance documents;

- CIRIA (2001) Control of water pollution from construction sites. Guidance for consultants and contractors (C532)
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Site Guide (C649)
- CIRIA (2015) Environmental Good Practice on Site (fourth edition) (C741)
- CIRIA (2016) Environmental Good Practice on Site pocket book (fourth edition) (C762)
- Department of Housing, Planning and Local Government (2019) Draft Revised Wind Energy Guidelines
- Enterprise Ireland (n.d.) "Best Practice Guide (BPGCS005) Oil Storage Guidelines"
- Inland Fisheries Ireland (IFI) (2016) "Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters"
- Environmental Protection Agency (EPA) (2015) Advice Notes for Preparing Environmental Impact Statements – DRAFT September 2015
- EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental Impact Statements – A Guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- NRA (2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide – Rev 1
- National Roads Authority (NRA) (2008) Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes

*as amended) Road Drainage and the Water Environment (including Amendment No. 1 dated June 2015) DN-DNG-03065.

- Office of Public Works (OPW) (2009) "The Planning System and Flood Risk Management, Guidelines for Planning Authorities"
- OPW (2019) "Construction, Replacement or Alteration of Bridges and Culverts"
- OPW (2019), Series of Ecological Assessment on Arterial Drainage Maintenance No. 13: Environmental Guidance: Drainage Maintenance and Construction
- Scottish Environment Protection Agency (SEPA) (2010) "Engineering in the Water Environment: Good Practice Guide – River Crossings"
- 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".

The Clare County Development Plan (2023-2029) was also consulted as part of the EIA process.

9.2.3 Desktop Study

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

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

- Department of Housing, Planning and Local Government, National River Basin Management Plan 2018-2021

https://www.housing.gov.ie/water/water-quality/river-basin-management-plans/river-basin-management-plan-2018-2021 [Accessed November 2023]

- Department of Housing, Planning and Local Government DRAFT River Basin Management Plan for Ireland

https://assets.gov.ie/199144/7f9320da-ff2e-4a7d-b238-2e179e3bd98a.pdf [Accessed November 2023]

- EPA Map Viewer, Water Framework Directive (WFD), surface water and hydrogeological features

https://gis.epa.ie/EPAMaps/Water [Accessed November 2023]

- EPA HydroNet, Surface water levels, flows and groundwater levels http://www.epa.ie/hydronet/#Water%20Levels [Accessed November 2023]
- Office of Public Works (OPW), Preliminary Flood Risk Assessment (PFRA)
- https://www.gov.ie/en/publication/1c7d0a-preliminary-flood-risk-assessment-pfra [Accessed November 2023]
- Office of Public Works (OPW), National Flood Information Portal

https://www.floodinfo.ie [Accessed November 2023]

- Ordnance Survey Ireland, Map Viewer

http://map.geohive.ie/mapviewer.html [Accessed November 2023]

- National Parks and Wildlife Service (NPWS), Protected Sites Map-Viewer

https://www.npws.ie/protected-Sites [Accessed November 2023]

- The Geological Survey of Ireland (GSI), groundwater data and maps

https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx [Accessed November 2023]

- The Geological Survey of Ireland (GSI), karst features database

https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/activities/understanding-irish-karst/Pages/Karst-databases.aspx [Accessed November 2023]

- Myplan.ie; National Planning Application Map Viewer

https://myplan.ie/national-planning-application-map-viewer [Accessed November 2023]

- Sustainable Energy Authority of Ireland (SEAI), Wind Atlas

https://www.seai.ie/technologies/seai-maps/wind-atlas-map/ [Accessed November 2023]

- Met Éireann Meteorological Data

https://www.met.ie/climate/available-data/historical-data [Accessed November 2023]

- Department of Housing, Planning and Local Government, EIA Portal

  https://www.housing.gov.ie/planning/environmental-assessment/environmental-impact-assessment-eia/eia-portal [Accessed November 2023]

9.2.4 Field Work

Field inspections were carried out at the site of the proposed development during 2023. These works consisted of the following:

- Site walk over including recording and digital photography of significant features.
- 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. Four baseline sampling events were carried out i.e., targeting low and high flow conditions.
- Baseline sampling and estimating of surface water flow and discharge rates during baseline surface water sampling events.

9.2.5 Evaluation of Potential Effects

9.2.5.1 Sensitivity

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

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

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

Table 9.4: Criteria for Rating Site Attributes – Hydrology and Hydrogeology Specific

Importance	Criteria
Extremely High	Attribute has a high quality 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, 2013):

Table 9.5: Criteria for Rating Site Sensitivity

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 effects arising as a product of the Development are defined in accordance with the criteria provided by the EPA, as presented in **Table 9.6** (EPA, 2022). These descriptive phrases are considered general terms for describing potential effects of the Development, and provide for considering baseline tends, for example, a "*Moderate"* impact is one which is consistent with the existing or emerging trends.

Table 9.6: Describing the Magnitude of Effects

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

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

Table 9.7: Qualifying the Magnitude of Impact on Hydrological Attributes

Magnitude of Impact	Description	Examples
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	• Loss or extensive change to a waterbody or water dependent habitat, or • Calculated risk of serious pollution incident >2% annually, or • Extensive loss of fishery
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Partial reduction in amenity value, or • Calculated risk of serious pollution incident >1% annually, or • Partial loss of fishery
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	• Slight reduction in amenity value, or • Calculated risk of serious pollution incident >0.5% annually, or • Minor loss of fishery
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	• Calculated risk of serious pollution incident <0.5% annually
Minor Beneficial	Results in minor improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is <1% annually
Moderate Beneficial	Results in moderate improvement of attribute quality	• Calculated reduction in pollution risk of 50% or more where existing risk is >1% annually
Major Beneficial	Results in major improvement of attribute quality	• Reduction in predicted peak flood level >100mm

Table 9.8: Qualifying the Magnitude of Effect on Hydrogeological Attributes

Magnitude of Impact	Description	Example
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	• Removal of large proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems, or • Potential high risk of pollution to groundwater from routine run-off.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	• Removal of moderate proportion of aquifer, or • Changes to aquifer or unsaturated zone resulting in moderate change

Magnitude of Impact	Description	Example
		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 effects, rating of significant environmental effects is carried out in accordance with relevant guidance as presented in the **Table 9.9** below (NRA, 2008). This matrix qualifies the magnitude of potential effects based on weighting factors depending on the importance and/or sensitivity of the receiving environment. In terms of Hydrology and Hydrogeology, the general terms for describing potential effects **(Table 9.5: Describing the Magnitude of Effects**) are linked directly with the development specific terms for qualifying potential effects (**Table 9.7: Qualifying the Magnitude of Impact on Hydrological Attributes** and **8: Qualifying the Magnitude of Impact on Hydrogeological Attributes**).Therefore, qualifying terms (**Table 9.9**) are used in describing potential effects of the Development.

Table 9.9: Weighted Rating of Significant Environmental Effects

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

9.2.5.4 *Scoping Responses and Consultation*

Information has been provided by a number of consultee organisations during the assessment, and this is summarised below. The response to each point raised by consultees is also presented within the table, demonstrating where the design of the Development has addressed responses to specific issues indicated by respective consultees. For further information on consultations, please refer to EIAR **Chapter 3 Scoping, Consultations, Community Engagement and Key Issues**.

Table 9.10: Scoping Responses and Consultation

Consultee	Type and Date	Summary of Consultee Response with Relevance to This Chapter	Addressed
Inland Fisheries Ireland		No response	
Office of Public Works	13th October 2023	*In line with The Planning System and Flood Risk Management Guidelines for Planning Authorities, DoEHLG and OPW, November 2009.* *"Where a development proposals include the construction of bridges, culverts or similar structures the applicant should have regard to the requirement of Section 50 of the Arterial Drainage Act, 1945."* *Regards,* *James* —— **James Fitzgerald** *Drainage Maintenance*	Section 9.4.3.15 – 9.4.3.17 has assessed all potential effects from constructed drainage, diversion or enhancement of drainage as well as instream works and all surface watercourse crossings. Section 9.5.2.9 – 9.5.2.11 has outlined mitigation measures that will be applied for these potential effects to reduce or eliminated the level of potential effects caused by the Proposed Development.
Uisce Eireann	14th September 2023	*Hope you are keeping well today.* *Uisce Éireann has received notification of your Environmental Impact Assessment (EIA) scoping request relating to Orsted Ltd.'s forthcoming planning application for a windfarm in Co Clare.* *Please see attached, Uisce Éireann's scoping opinion in relation to Water Services. On receipt of the planning referral, Uisce Éireann will review the finalised Environmental Impact Assessment Report (EIAR) as part of the planning process.*	a) Section 9.3.8 and 9.3.15 has identified all drinking water sources associated with the development. 9.4.3.10 – 9.4.3.14 has identified all potential effects that may occur from the Proposed Development in relation to ground water sources. Section 9.5.2.12 – 9.5.2.13 outlines all mitigation measures that will be applied for Groundwater. b) Assessed and mitigated in Chapter 10 soils and geology.

Consultee	Type and Date	Summary of Consultee Response with Relevance to This Chapter	Addressed
		Queries relating to the terms and the EIA scoping opinions below should be directed to planning@water.ie **Uisce Éireann's Response to EIA Scoping Requests** *At present, Uisce Éireann does not have the capacity to advise on the scoping of individual projects. However, in general the following aspects of Water Services should be considered in the scope of an EIA where relevant;* *a) Where the development proposal has the potential to impact an Uisce Éireann Drinking Water Source(s), the applicant shall provide details of measures to be taken to ensure that there will be no negative impact to Uisce Éireann's Drinking Water Source(s) during the construction and operational phases of the development. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified as part of the report.* *b) Where the development proposes the backfilling of materials, the applicant is required to include a waste sampling strategy to ensure the material is inert.* *c) Mitigations should be proposed for any potential negative impacts on any water source(s) which may be in proximity and included in the environmental management plan and incident response.* *D) Any and all potential impacts on the nearby reservoir as public water supply water source(s) are assessed, including any impact on hydrogeology and any groundwater/ surface water interactions.*	c) Section 9.5.1 outlined mitigation by avoidance which will ensure all works takes place outside buffer zones. Section 9.5.2.14 outlines the emergency response plan. d) Public water supplies were ruled out of assessment in Section 9.3.15 and 9.3.16. 9.4.3.10 – 9.4.3.14 has identified all potential effects that may occur from the Proposed Development in relation to ground water sources. e) Mitigation measures in Section 9.5.2.8 ensures the processing of wastewater sanitation contaminants during the construction phase. f) Not applicable g) Not applicable h) Not applicable i) Not applicable j) Section 9.3.8 identifies all wells and boreholes in the vicinity of the Site and GCR. k) Not Applicable l) Section 9.3.10 outlines the recharge capacity on site, while Section 9.3.11 assesses the site run off volumes. A water balance assessment can be found in Appendix 9.1 Flood Risk Assessment. Potential impacts for surface water run-off is identified in Section 9.4.3.1 m) Section 9.4.3.9 outlines any hydrologically connected designated sites downstream of the site. Water

Consultee	Type and Date	Summary of Consultee Response with Relevance to This Chapter	Addressed
		e) Impacts of the development on the capacity of water services (i.e., do existing water services have the capacity to cater for the new development). This is confirmed by Uisce Éireann in the form of a Confirmation of Feasibility (COF). If a development requires a connection to either a public water supply or sewage collection system, the developer is advised to submit a Pre-Connection Enquiry (PCE) enquiry to Uisce Éireann to determine the feasibility of connection to the Uisce Éireann network. *All pre-connection enquiry forms are available from https://www.water.ie/connections/connection-steps/.* *f) The applicant shall identify any upgrading of water services infrastructure that would be required to accommodate the proposed development.* *g) In relation to a development that would discharge trade effluent – any upstream treatment or attenuation of discharges required prior to discharging to an Uisce Éireann collection network.* *h) In relation to the management of surface water; the potential impact of surface water discharges to combined sewer networks and potential measures to minimise and or / stop surface waters from combined sewers.* *i) Any physical impact on Uisce Éireann assets – reservoir, drinking water source, treatment works, pipes, pumping stations, discharges outfalls etc. including any relocation of assets.* *j) When considering a development proposal, the applicant is advised to determine the location of public water services assets, possible connection points from the applicant's site / lands to the public network and any drinking water*	abstraction impacts are identified in Section 9.4.3.10 – 9.4.3.11 n) Not applicable o) Section 9.5 outlines all mitigation measures that will be applied to ensure the risk to drinking water sources surface and ground water is reduced.

Consultee	Type and Date	Summary of Consultee Response with Relevance to This Chapter	Addressed
		abstraction catchments to ensure these are included and fully assessed in any pre-planning proposals. Details, where known, can be obtained by emailing an Ordnance Survey map identifying the proposed location of the applicant's intended development to datarequests@water.ie *k) Other indicators or methodologies for identifying infrastructure located within the applicant's lands are the presence of registered wayleave agreements, visible manholes, vent stacks, valve chambers, marker posts etc. within the proposed site.* *l) Any potential impacts on the assimilative capacity of receiving waters in relation to Uisce Éireann discharge outfalls including changes in dispersion / circulation characterises. Hydrological / hydrogeological pathways between the applicant's site and receiving waters should be identified within the report.* *M) Any potential effect on the contributing catchment of water sources either in terms of water abstraction for the development (and resultant potential impact on the capacity of the source) or the potential of the development to influence / present a risk to the quality of the water abstracted by Uisce Éireann for public supply should be identified within the report.* *n) Where a development proposes to connect to an Uisce Éireann network and that network either abstracts water from or discharges wastewater to a "protected"/ sensitive area, consideration as to whether the integrity of the site / conservation objectives of the site would be compromised should be identified within the report.*	

Consultee	Type and Date	Summary of Consultee Response with Relevance to This Chapter	Addressed
		o) Mitigation measures in relation to any of the above ensuring a zero risk to any Uisce Éireann drinking water sources (Surface and Ground water). *This is not an exhaustive list.* *Please note;* *• Where connection(s) to the public network is required as part of the development proposal, applicants are advised to complete the Pre-Connection Enquiry process and have received a Confirmation of Feasibility letter from Uisce Éireann ahead of any planning application.* *• Uisce Éireann will not accept new surface water discharges to combined sewer networks.*	

9.3 Baseline Description

9.3.1 Introduction

An investigation of the existing hydrologic and hydrogeologic characteristics of the study area was conducted by undertaking a desk study, consultation with relevant authorities and site-based fieldwork surveys. All data collected has been interpreted to establish the baseline conditions within the Study Area and the significance of potential adverse effects have been assessed. These elements are discussed in detail in the following sections.

9.3.2 Site Description

The Site of proposed Development is located in the Oatfield and Gortacullin areas. The area of the proposed Wind Farm is located in the area comprised of coniferous forest, mixed forest, transitional woodland scrub, pastures, agricultural lands, and peatlands, approximately 1.3km to the South of Broadford, 4.7km to the East of Sixmilebridge, 7.6km North of Ardnacrusha, 9.2km North of Limerick, and 19.7km South of Ennis. The Proposed Development wind farm Site is characterised by relatively complex (hilly) topography with associated elevations ranging between c. 130 to 270 metres Above Ordnance Datum (m AOD).

9.3.2.1 Site Walk Over and Observations

Site walk over surveys were tailored in line with the site layout and conducted between August, September and October 2023. Photographs obtained during site surveys are presented in **Appendix 9.2 Tiles.**

9.3.3 Land Use & Environmental Pressures

The principal land use in the general area is comprised of a mix of agricultural farmland, commercial forestry, residential properties. The Clare County Development Plan (2023-2029) classifies the surrounding area as Non-irrigated arable land, pasture, complex cultivation patterns, conifer forest, natural grassland, transitional woodland, peatbog, water bodies. The Clare County Development plan also outlines that in the area classed as Sixmilebridge farmlands; there is some capacity in the undulating more enclosed parts of this landscape character areas to accommodate small or medium wind farms. Any developments would have to conform to land use guidance from Shannon Airport (Clare County Development Plan (2023-2029– - Volume 5 Clare Wind Energy Strategy).

With reference to **EIAR Chapter 10: Soils and Geology - Section 10.3.3,** Mapped land uses for the Wind Farm, Underground Cable Route and Turbine Delivery Route are presented in **Figures 10.2 (a), 10.2 (b) and 10.2 (c),** respecitvely.

A review of the Corine (2018) Land Use maps (EPA) indicates the site is mainly comprised of a combination of ‘Peat Bogs’, ‘Pastures’, ‘Transitional woodland scrub’ and ‘Coniferous Forests’. As much of the site is mapped as ‘Coniferous Forests’, these areas are significantly impacted by commercial forestry practices including extensive land works involving drainage and excavation and manipulation of natural soil profiles or horizons through Forestry practices.

The Grid Connection Route 'Loopin 1' is comprised of land use classified as 'Pastures', 'Land principally occupied by agriculture with significant areas of natural vegetation' and 'Transitional woodland scrub'.

The Turbine Delivery Route (3A) from site to Foynes port crosses lands classified as 'Pastures', 'Transitional woodland scrub', 'Discontinuous urban fabric', 'Land principally occupied by agriculture with significant areas of natural vegetation', 'Peat bogs', 'Inland marshes', 'Industrial and commercial units', 'Salt marshes', 'Mixed Forests'.

9.3.4 Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development site has been assessed in terms of the following parameters:

- Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.

Potential significant storm events including events with a 1 in 100 year return period over 1 hour duration, 25 day duration and 30 day or month duration (inferred using available data).

Rain fall amounts in the three days preceding baseline sampling events are presented below. A further assessment can be found in **FRA Appendix 9.1.**

Table 9.11: Rainfall Prior to Baseline Sampling Events[5]

Event No.	Date	Rainfall on days leading up to sampling event (Day 0)				Total Rain in 3 no. days prior to sampling. (Days 1-3)	Event Category	Weather Station
No.	Sampling Date (Day 0)	Day 3	Day 2	Day 1	Day 0	mm / 3 days		
		mm/day	mm/day	mm/day	mm/day			
1	13/09/2023	0.8	0.5	0.0	0.0	1.3	Dry	Shannon Airport
2	17/10/2023	0.8	tr	23.1	17.2	41	Wet	Shannon Airport
* Sampling occurred ahead of recorded rainfall for the day. Lead up to sampling event was dry.								

9.3.5 Regional and Local Hydrology

The Surface water network draining the site is mapped and presented in **Figures 9.2 (a - c).** Surface water networks associated with particular turbine locations are presented in the Surface Water Flow Chart in **Figure 9.3** and in the FRA **Appendix 9.1**.

The Oatfield Wind Farm Development is situated within the Lower Shannon Catchment (Code:25; Area 1041.26km^2) and Shannon Estuary North (ID: 27; Area: 1,651.27km^2). The Grid Connection Route 'Loopin1' is situated solely in the Lower Shannon Catchment. The Turbine Delivery Route is situated in the Lower Shannon Catchment (Code:25; Area 1041.26km^2) and Shannon Estuary South Code:24; 2033.96 km^2).

Surface water runoff associated with the wind farm site drains into two sub catchments (five river sub basins), nine no. rivers (the rivers are the Broadford River, Owenogarney River, Gourna River, Mountrice River and Blackwater (Clare) and two Loughs (the loughs are the Duin CE and Castle CE) (**Figure 9.4a and Figure 9.5a**):

- Sub Catchment: Shannon [Lower]_SC_100, River Sub Basins: Mountrice_010, Blackwater [Clare]_010 and Owenogarney_030
- Sub Catchment: Owenogarney_SC_010; River Sub Basins: Broadford_030 and Gourna_010

The Grid Connection Route drains into one sub catchment and river sub basins, or seven no. rivers (**Figure 9.4b and Figure 9.5b**):

- Sub Catchment: Shannon [Lower]_SC_100;

  River Sub Basin: Blackwater (Clare)_010, Blackwater (Clare)_020, Shannon (Lower)_060, Ballynaclogh_010.

The Turbine Delivery Route 'Foynes' drains into ten sub catchments and twenty-eight river sub basins (**Figure 9.4c and Figure 9.5c**):

- Sub Catchment: Owenogarney_SC_010;

  River Sub Basin: Broadford_030

- Sub Catchment: Shannon [Lower]_SC_100;

  River Sub Basins: Shannon (Lower)_060, Blackwater (Clare)_020, Glenomra Wood Stream_010, Blackwater (Clare)_010, Mountrice_010

- Sub Catchment: Shannon [Lower]_SC_080;

  River Sub Basins: Kilmastulla_050, Shannon (Lower)_050, Ardcloony_010, Bridgetown (Clare)_010

- Sub Catchment: Kileengariff_SC_010;

  River Sub Basin: Ballyard_020, Ballyyard_SC_010

- Sub Catchment: Shannon [Lower]_SC_090;

  River Sub Basins: Shannon (Lower)_060, Mulkear (Limerick)_050

- Sub Catchment: Ballynaclogh_SC_010;

  River Sub Basins: Barnakyle_020, Ballynaclogh_010

- Sub Catchment: Greanagh_SC_010;

  River Sub Basins: Tobermurry_010, Tonlegee_010

- Sub Catchment: Deel[Newcastlewest]_SC_050;

  River Sub Basins: Deegerty_020, Deegerty_010, Dromlohan_010

- Sub Catchment: Deel[Newcastlewest]_SC_040;

  River Sub Basin: Deel (Newcastlewest)_140

- Sub Catchment: Shanagolden[Stream]_SC_010;

  River Sub Basins: Foynes_010, Shanagolden Stream_010, Dooncaha Stream_010, Ahacronane_020, Glenbane West Stream_010, Lismakeery Stream_010

9.3.6 Site Drainage

The 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 9.2 Tiles 12 – 21**. The existing surface water runoff is contained within natural and artificial drainage channels that include stream and river waterbodies, drainage ditches, and other minor natural and artificial manmade drainage features.

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

Drainage channels are mapped using four categories of significance;

- Historically Mapped Surface Water (Not mapped by EPA/WFD)
- Forestry Drainage
- Inferred Drainage
- Minor Drainage

Note: Aerial lidar survey data (topographical elevation data, accuracy 1m) and recent aerial photography, as well as historical maps were interrogated, and some additional drains were identified. These are discussed in the constraints section in mitigation by design.

9.3.7 Flood Risk Identification

A Site Flood Risk Assessment (FRA) Stages 1 & 2 for the Wind Farm Site is presented below. This FRA 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 the Site. A preliminary flood risk screening is presented in **Figure 9.7**.

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has identified no flood hazards for the proposed Development.

- The site is not within a probable flood zone, nor has it experienced any historical flooding.
- The development at the site will lead to a net increase in runoff equating to 0.754 m^3/second or 0.19% relative to the approximate site area (381m^2). This is considered an adverse but slight impact of the development.
- Minor in terms of effect but considering the significant cumulative effect of runoff on flood risk it is important to mitigate any potential adverse effects.
- The associated drainage will be attenuated for greenfield run-off and the proposed development will not increase the risk of flooding elsewhere in the catchment.
- The nature of the development is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a 'Less Vulnerable Development', according to FRM Guidelines. Therefore, the development is considered an 'appropriate' development for Flood Zone C.

The nearest past flood events are located c. 5km west of the Site.

Consultation with OPW Flood Maps (Accessed; October 2023) indicates that:

There is no mapped drainage along the Oatfield UGC'. There are no areas mapped as being low, medium or high probability flood areas within or immediately downgradient of the of the Site or on the Oatfield grid connection route.

The closest mapped probable flood areas are associated with:

- The Owenogarney (060) river approximately five kilometres to the west of the site.
- The Broadford (010) river approximately 2km north.

Bunratty Flood Relief Scheme and Limerick City & Environs Flood Relief Scheme are within a 20km radius.

Flood measures applicable in all areas, these are as follows:

- Sustainable Drainage Systems (SuDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream.
- Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Broad stroke objectives such as the above are relevant to the Development whereby any development within the catchment of a Flood Relief Scheme should aim for a minimal or neutral impact in terms of net change in surface water runoff and in turn impacts downstream. Furthermore, any mitigation which promotes beneficial impacts, i.e., net-decrease in runoff or delaying the hydrological response to rainfall, contributes to the objectives of the Flood Relief Schemes and ultimately the WFD.

In regard to the turbine delivery route, flood risk screening (SFRA Stage 1) indicates that the route passes through National Indicative Fluvial Mapping, CFRAM River Flood Extents, Coastal PDF tiles, it does not pass through any groundwater flooding areas. This portion of the development is temporary and therefore no significant impact to runoff rates are identified, however the risk of flooding on site is important to consider in the design and management of this part of the Development.

Consultation with the National Indicative Fluvial Mapping (NIFM)- Present Day indicates no 'low' (0.1% AEP) or 'medium' (1% AEP) and high probability for risk to flood for the Grid Connection Route.

Future River Flood Extents Scenarios maps, shows no forecasts of 'low' (0.1% AEP) or 'medium' (1% AEP) fluvial or pluvial Flood risks for the Grid Connection Route. Considering the nature of the works there will be minimal land take required and no significant impact to runoff rates, however considering the scale or length of this part of the development, future flood risk are a potential risk, particularly at watercourse crossing locations.

9.3.8 Surface Water Hydrochemistry

The Environmental Protection Agency (EPA) conducts an ongoing monitoring programme as part of Ireland's requirements under the WFD. The monitoring programme includes an assessment of biotic indices (biological quality ratings ranging from 1-5) known as Q-Values. Details of the closest EPA monitoring points relative to the Site and the latest Q-Values are outlined in **Table 9.12.**

Table 9.12: EPA Monitoring Points and Latest Available Q-Values

Station ID	RS27B020700	RS27G020100	RS25B060060	RS27O010600	RS25M030300
Station Name	Broadford – Bridge in Broadford	Gourna – Bridge N. of Corlea	Blackwater (Clare) – 1st Br u/s Trough Br	Owenogarney – Agouleen Bridge	Br u/s Blackwater R confl
WFD Waterbody Code	IEMRRS27B020700	IEMRRS27G020100	IEMRRS25B060060	IEMRRS27O010600	IEMRRS25M030300
Type	River Broadford	River Gourna	River Blackwater	River Owenogarney	River Mountrice
Latest Monitoring Year	2019	2022	1996	2022	2021
Latest Status	Good	Good	Good	Good	High
Latest Q-Value	4	4	4	4	4-5
Distance from the Proposed EIAR Boundary	c. 2,500 metres (downstream)	c. 3,000 metres (downstream)	c.6,200 metres (downstream)	c. 3,500 metres (downstream)	c. 3,500 metres (downstream)
Easting	157386	151662.14	157783	150815.16	158200.81
Northing	172713	166675.09	165354	171233.19	166123.3
Local Authority	Clare County Council	Clare County Council	Clare County Council	Clare County Council	Clare County Council

The recent assessment of the Broadford River by the EPA was carried out on 2019 which indicated that the river had a Q-Value of 4 or ‘Good’; this was consistent to the previous monitoring years which recorded a Q-Value score of 4-5 or ‘Good’ WFD Status. In consultation with the EPA’s WFD database, the Broadford River currently holds an ‘moderate’ status and is ‘At Risk’. According to the WFD Cycle 3 Sub catchment Assessment, the pressures on the Broadford River are those from Agriculture, Channelisation: Altered habitat due to hydrological and morphological changes (particularly on the Broadford_010 and _020) (2021).

The most recent assessment of the Blackwater (Clare) River by the EPA was carried out on 1996 which indicated that the river had a Q-Value of 4 or ‘Good’; this was consistent to the previous monitoring years which recorded a Q-Value score of 4 or ‘Good’ WFD Status. In consultation with the EPA’s WFD database, the Blackwater River currently holds a ‘good’ status and is ‘At Risk’. According to the WFD Cycle 3 Sub catchment Assessment, the pressures on the Blackwater River are those from Agriculture and Forestry (2021).

The recent assessment of the Gourna River by the EPA was carried out on 2022 which indicated that the river had a Q-Value of 4 or ‘Good’; this was consistent to the previous monitoring years which recorded a Q-Value score of 4-5 or ‘Good’ WFD Status. In consultation with the EPA’s WFD database, the Gourna River currently holds an ‘Moderate’ status and is ‘At Risk’. According to the WFD Cycle 3 Sub catchment Assessment, the pressures on the Gourna River are those from Agriculture, Channelisation: Altered habitat due to hydrological and morphological changes (2021).

The recent assessment of the Owenogarney River by the EPA was carried out on 2022 which indicated that the river had a Q-Value of 4 or ‘Good’; this was consistent to the previous monitoring years which recorded a Q-Value score of 4-5 or ‘Good’ WFD Status. In consultation with the EPA’s WFD database, the Owenogarney River currently holds an ‘Good’ status and is ‘Not at Risk’. According to the WFD Cycle 3 Sub catchment Assessment, the pressures on the Owenogarney River are those from Forestry, and Channelisation: Altered habitat due to hydrological and morphological changes (2021).

The recent assessment of the Mountrice River by the EPA was carried out on 2021 which indicated that the river had a Q-Value of 4-5 or ‘High’; this was consistent to the previous monitoring years which recorded a Q-Value score of 4-5 or ‘Good’ WFD Status. In consultation with the EPA’s WFD database, the Mountrice River currently holds an ‘Moderate’ status and is ‘At Risk’. According to the WFD Cycle 3 Sub catchment Assessment, the pressures on the Mountrice River are those from Channelisation: Altered habitat due to hydrological and morphological changes (2021).

Baseline surface water sampling was carried out at 11 no. locations, (during September and October 2023) at locations indicated in **Figure 9.6b,** which are representative of drainage and surface water network channels associated with the Site (**Figure 9.4).** Data on surface water flow at representative baseline sampling locations at the time of sampling is presented in **Appendix 9.3,** and laboratory certificates are presented in **Appendix 9.4**.

Surface water quality observed at all ten monitoring locations is of similar standard and is generally of good quality when screened against relevant reference concentrations presented in **Appendix 9.3,** however the following is noted:

Zinc (tot unfiltered) was elevated above relevant reference concentration (30 µg/l) at SW8 during the sampling event on the 13/09/2023.

Ammoniacal Nitrogen (N) solids were also elevated above the relevant reference (0.02mg/l) at SW2, SW4, SW7, SW11 during the 13/09/2023 sampling event.

- Copper (dissolved filtered) on the 13/09/2023 levels above the relevant reference of concentration (5 µg/l) at all SW1 - SW11.

Elevated concentrations of Nitrogen compounds (Ammoniacal Nitrogen) as observed at all monitoring locations is indicative of current land practices at the Site, commercial forestry (see Photographs in **Appendix 9.2 Tile 13**). Evidence of Iron pan can also be seen in photographs (**Appendix 9.2 Tile 13**).

It should be noted that Local Authority Water Programme have prioritised Broadford and Owenogarney catchment which contains nine (no. 9) water bodies including Castle CE lake as an area of action for restoration, as well as Castle Lake and Lower Owenogarney[1]. Blackwater catchment which has six (no. 6) waterbodies as an area of action for restoration[2].

9.3.9 Wells

Mapping and searches of the EPA Water Framework Directive (WFD) and GSI well databases during the desktop study confirms that there are a number of mapped wells located within 20km of the EIAR boundary used for agriculture and domestic use**, Figure 9.8a and Figure 9.8b.**

[1] https://catchments.ie/wp-content/files/catchmentassessments/27%20Shannon%20Estuary%20North%20Catchment%20Summary%20WFD%20Cycle%203.pdf

[2] https://catchments.ie/wp-content/files/catchmentassessments/25D%20Lower%20Shannon%20Catchment%20Summary%20WFD%20Cycle%203.pdf

- Borehole – (ID:1417SEW025) in the Townland of Kyle situated approximately 0.8km northeast of (T10).
- Spring – (ID: 1417SEW029) in the townland of Gortnaglogh situated approximately 0.4 km north of (T10).
- Borehole – (ID: 1415NEW029) in the townland of Cloontra situated approximately 1.11km southeast of (T7).
- Dug well – (ID: 1415NEW009) in the townland of Cloontra situated approximately 1.11km southeast of (T7).
- Borehole – (ID: 1415NEW030) in the townland of Cloontra situated approximately 3.53km southeast of (T7).
- Borehole – (ID: 1415NEW011) in the townland of Sallybank situated approximately 3.81km southeast of (T7).
- Borehole – (ID: 1415NWW091) in townland of Oatfield situated approximately 0.36km south of (T4).
- Borehole – (ID: 1415NEW032) in townland of Derryvinnaan situated approximately 3.85km southeast of (T4).
- Dug well – (ID: 1417SWW048) in townland of Crag situated approximately 0.61km north of (T1).
- Borehole – (ID: 1417SWW102) in townland of Snaty situated approximately 1.47km north of (T1).

Mapping and searches of the EPA Water Framework Directive (WFD) and GSI well databases confirms that there are a number of mapped wells located within 20km of the Grid connection used for agriculture and domestic use and they are as follows;

- Borehole – (ID: 1415NWW091) in townland of Oatfield situated approximately 0.36km west.
- Borehole – (ID: 1415NEW030) in the townland of Cloontra situated approximately 1.67km east.
- Borehole – (ID: 1415NEW032) in townland of Derryvinnaan situated approximately 1,44km east.
- Dug well - (ID: 1415NEW049) in townland of Trough situated approximately 1.22km east.
- Borehole – (ID: 1415NEW035) in townland of Drummin situated approximately 1.12km east.
- Borehole – (ID: 1415NEW044) in townland of Roo West situated approximately 1.15km east.
- Dug well – (ID: 1415NEW024) in townland of Ballyfinneen situated approximately 0.6km.

In addition, all Water Framework Directive (WFD) groundwater bodies have been identified as Drinking Water Protected Areas (DWPA) due to the potential for qualifying abstractions of water for human consumption as defined under Article 7 of the WFD. The DWPA designation applies to all groundwater bodies nationally, regardless of the productivity status of the underlying aquifer.

The Lough Graney GWB (IE_SH_G_157) and Tulla-Newmarket on Fergus GWB (IE_SH_G_229) underlies the EIAR Site boundary and surrounding areas. In the bedrock aquifers, groundwater predominantly flows through fractures, fissures, joints or conduits.

Given that the existing GSI groundwater well database is an incomplete dataset, it is conservatively assumed that all dwellings located within 2km of the EIAR Site boundary have the potential to maintain a groundwater well for abstraction.

9.3.10 Hydrogeology – Bedrock Aquifer

Consultation with GSI Groundwater maps (2023) indicate that the Western DA of the wind farm site (encompassing the location of T1 – T7) is underlain by a 'Poor Aquifer (Pl)' that is, bedrock which is generally unproductive except for local zones and small areas of aquifers with classifications of 'Locally Important Aquifer (Ll)'. The Eastern DA (encompassing T8 – T11) of the development is underlain by a 'Locally Important Aquifer (Ll)' that is, bedrock which is moderately productive only in local zones (**Figure 9.9a**).

The Grid connection route, is underlain by the same classification of aquifers (Pl and Ll) as the development in **Figure 9.9b**.

The Turbine Delivery Route is underlain by the same classification of aquifers (Pl and Ll) as the development but also Regionally Important Aquifer - Karstified (diffuse) (Rkd), Regionally Important Aquifer - Karstified (conduit) (Rkc) and Locally Important Aquifer - Bedrock which is Generally Moderately Productive (Lm) **Figure 9.9c.**

9.3.11 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.[3]

[3] Geological Survey Ireland (2023) Story Map Series. Available at: <https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228>

Table 9.13: 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

Consultation with the GSI Groundwater Map Viewer (2023) indicates that the Wind Farm Site is underlain by areas classified predominantly mapped as 'Extreme (E)' vulnerability rating, with some areas mapped as 'Rock at or Near Surface (X)' vulnerability rating. The proposed location of T1, T3, T6, T10 and T11 have been mapped as areas with 'Rock near surface (X)' vulnerability rating. The proposed locations of T2, T4, T5, T7, T8 and T9 are in areas of 'Extreme (E)' vulnerability. (**Figure 9.10a – Groundwater Vulnerability**). Both the Turbine Delivery Route and Grid Connections traverse land with groundwater vulnerability ratings ranging from 'Low Vulnerability' to 'Extreme Vulnerability' including 'X' which is described as "Rock at or near Surface or Karst" **Figure 9.10b – Groundwater Vulnerability**.

The potential groundwater recharge rate (recharge coefficient) for the local area, as mapped by GSI (2023), ranges significantly depending on the underlying soil / subsoil type and varies significantly relative to the thickness of overburden or aquifer vulnerability, and corresponds to the recharge capacity of the underlying bedrock aquifer as presented in **Section 9.3.9**. The underlying Locally Important bedrock aquifer will 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.

In areas associated with the Site the mapped groundwater recharge coefficient is as low as 22.5% of effective rainfall. This recharge coefficient is considered very low[4]. Whereas areas where bedrock is at or near the surface the mapped groundwater recharge coefficient is 60% of effective rainfall. This recharge coefficient is considered moderate. However, the maximum recharge capacity of the aquifer will limit recharge to groundwaters.

Areas of the Site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200mm effective rain fall. Areas underlain by Poor Aquifer possess a maximum recharge capacity of 51 - 100mm effective rainfall per annum (**Figure 9.9a**). For additional context, the maximum recharge capacity of 200mm per annum equates to a recharge coefficient of approximately 22.5% or 60% of effective rainfall respectively, in line with peat which is considered highly impermeable with a recharge coefficient <20%.

Considering all of the above, and in line with **Table 9.14** below (Williams, *et al.,* 2013) the site is characterised by three principal recharge regimes, that is; the Site is characterised by low to high recharge rates in overburden (soils/subsoils) and low to very high recharge capacity in the underlying bedrock aquifers. This implies that, particularly during

[4] Williams N. H., et al. (2011) A NATIONAL GROUNDWATER RECHARGE MAP FOR IRELAND. National Hydrology Conference 2011, Ireland.

seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the 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 Site is characterised as having a rapid hydrological response to rainfall (i.e., a flashy regime). This is indicative of lands comprising of blanket peat [5] [6].

Table 9.14: Recharge coefficients for different hydrogeological settings (Williams, et al., 2013)

Vulnerability category	Hydrogeological setting		Recharge coefficient (RC)		
			Min (%)	*Inner Range*	*Max (%)*
Extreme	1.i	Areas where rock is at ground surface	30	80-90	100
	1.ii	Sand/gravel overlain by 'well drained' soil	50	80-90	100
	1.iii	Sand/gravel overlain by 'poorly drained' (gley) soil	15	35-50	70
	1.iv	Till overlain by 'well drained' soil	45	50-70	80
	1.v	Till overlain by 'poorly drained' (gley) soil	5	15-30	50
	1.vi	Sand/ gravel aquifer where the water table is ≤ 3 m below surface	50	80-90	100
	1.vii	Peat	1	15-30	50
High	2.i	Sand/gravel aquifer, overlain by 'well drained' soil	50	80-90	100
	2.ii	High permeability subsoil (sand/gravel) overlain by 'well drained' soil	50	80-90	100
	2.iii	High permeability subsoil (sand/gravel) overlain by 'poorly drained' soil	15	35-50	70
	2.iv	Sand/gravel aquifer, overlain by 'poorly drained' soil	15	35-50	70
	2.v	Moderate permeability subsoil overlain by 'well drained' soil	35	50-70	80
	2.vi	Moderate permeability subsoil overlain by 'poorly drained' (gley) soil	10	15-30	50
	2.vii	Low permeability subsoil	1	20-30	40
	2.viii	Peat	1	5-15	20
Moderate	3.i	Moderate permeability subsoil and overlain by 'well drained' soil	35	50-70	80
	3.ii	Moderate permeability subsoil and overlain by 'poorly drained' (gley) soil	10	15-30	50
	3.iii	Low permeability subsoil	1	10-20	30
	3.iv	Peat	1	3-5	10
Low	4.i	Low permeability subsoil	1	5-10	20
	4.ii	Basin peat	1	3-5	10
High to Low	5.i	High predicted permeability subsoils (Sand/gravels)	30	80-90	100
	5.ii	Moderate permeability subsoil overlain by well drained soils	35	50-70	80
	5.iii	Moderate permeability subsoils overlain by poorly drained soils	10	15-30	50
	5.iv	Low permeability subsoil	1	5-10	20
	5.v	Peat	1	5	20

9.3.12 Baseline Site Run-off Volumes

Preliminary water balance calculations, **Table 9.15**, will use approximate 'micro-catchment' areas **(Figure 9.11)** associated with the Site upstream of baseline surface

[5] Misstear B., Brown L. (2008) Water Framework Directive – Recharge and Groundwater Vulnerability. EPA STRIVE Report, EPA, Ireland.

[6] Jennings S. (2008) Further Characterisation Study: An Integrated Approach to Quantifying Groundwater and Surface Water Contributions of Stream Flow, RPS, Ireland

water sampling locations (**Figure 9.8a)** to estimate baseline storm runoff discharge rates at the Site.

Three micro catchments have been created using the river sub basins (**Figure 9.11**).

Table 9.15: Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)

Micro Catchment	Approximate Area (m^2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balance Calc's)	Rejected Recharge/ Runoff (m/hour Rain)	Runoff Discharge Rate (m^3/hour)	Runoff Discharge Rate (m^3/sec)
SW1	22.51	0.0359	20.00%	0.02872	0.65	0.00
SW2	71.04	0.0359	20.00%	0.02872	2.04	0.00
SW3	244.43	0.0359	20.00%	0.02872	7.02	0.00
SW4	5.48	0.0359	20.00%	0.02872	0.16	0.00
SW5	36.08	0.0359	20.00%	0.02872	1.04	0.00
SW6	2.43	0.0359	20.00%	0.02872	0.07	0.00

The above runoff discharge rates provide context in terms of the hydrological response representative of the Site. Potential effects of the Proposed Development in terms of run-off and flood risk are assessed using the same meteorological and hydrogeological conditions but focus on the net increase in runoff associated with the footprint of the Proposed Development, i.e., the installation of hardstand surface area which is granular and typically has a 'c' value of 0.6 – 0.8. Net increase in runoff as a function of the Development will be compared to Baseline Runoff Volumes (1 in 100 Year Hour Storm Event).

9.3.13 Groundwater Levels, Flow Direction & Groundwater Hydrochemistry

Groundwater flow patterns, or the water table of an entire aquifer, can often mimic surface water flow patterns. Overall, groundwater will follow the regional topographical gradient of a given area, moving along flow paths from areas of recharge to areas of discharge, i.e., surface waterbodies. Therefore, groundwater flow directions at the Site are presumed to follow the topography of the area.

The majority of groundwater flow likely circulates in the upper overburden saturated zone, recharging and discharging in local zones with a high flowrate; thus, the groundwater is considered to be young. The implications for 'young' groundwater are that it will be more vulnerable in terms of water quality from a pollution incident.

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 Site is available. However, the 2016-2021 WFD Groundwater status for groundwater units underlying the Site is 'Good' (Groundwater units: Lough Graney and Tulla-Newmarket on Fergus) and is considered not at risk.

Peat depth across the Site is generally very shallow to moderately deep with some isolated pockets of deep peat (**Appendix 10.1 – App A and App B**). There was 1 no. sampling point of deep peat recorded in the surround area of T11.

9.3.14 Water Framework Directive Water Body Status, Risk & Objectives

The European Communities Directive 2000/60/EC established a framework for community action in the field of water policy known as the Water Framework Directive (WFD). Ireland has published the draft River Basin Management Plan (2022-2027) which defines the actions that will be taken to improve water quality and achieve "good" ecological status in rivers, lakes, estuaries and coastal waters by 2027. The WFD is the overarching mechanism by which water quality management areas are divided and assessed.

Details in relation to the Water Framework Directive (WFD) 2016-2021 status assigned to surface waterbodies associated with the Site are presented in **Figures 9.4a, 9.5a** and **Figure 9.3.**

The WFD status (2016-2021) for the mapped surface water bodies / rivers directly draining the Site range from 'Good' to 'High' and are detailed as follow:

- Broadford_010; 'Moderate' status, 'At risk' of deteriorating
- Owenogarney 030; 'Good' status, 'Not at risk' of deteriorating
- Gourna_010; 'Moderate' status, 'At risk' of not achieving 'Good' status
- Mountrice_010; 'Good' status, 'At risk' of deteriorating
- Blackwater (Clare)_010; 'Good' status, 'At risk' of deteriorating

As outlined in **Section 9.3.5** the above rivers and further downstream, the rivers face significant pressures in hydro-morphology, forestry and agriculture.

The lake water bodies (Duin CE; EU Code: IE_SH_27_121), (Castle CE; EU Code: IE_SH_27_74), associated with the surface water network possesses a WFD 2016-2021 status of 'Moderate' and are 'Under Review' or 'At Risk'. According to the EPA (2021), based on the 1st, 2nd, 3rd RBMPs, the WFD status associated with the lake water bodies is due to the Agriculture.

9.3.15 Designated & Protected Areas

Designated and Protected Areas associated with the Development are detailed in **Figure 9.3** and presented in **Figure 9.12a**. The Oatfield Wind Farm Site is situated c.0.1km from Gortacullin Bog NHA and c4km from Poulnalecka SAC.

The nearest downstream designated areas include the following as outlined in **Figure 9.4** and **Figure 9.12a**

- Gortacullin Bog NHA (EPA Site Code: 002401) 0.1km to the north of the EDA
- Doon Lough NHA (EPA Site Code: 000337) 3.81km to the northwest of the EDA
- Danes Hole, Poulnalecka SAC (EPA Site Code: 002401) 4km to the west of the EDA
- Ratty Cave SAC (EPA Site Code: 002316) 6.29km to the west of the WDA
- Lower River Shannon SAC (EPA Site Code: 002165) 13.2 km south of site.
- River Shannon and River Fergus Estuaries SPA (EPA Site Code: 004077) 13.2 km south of site

Proposed Natural Heritage Areas and non-hydrologically connected designated areas

- Castle Lake (EPA Site Code: 000239) 6km to the west of the WDA
- Knockalisheen Marsh (EPA Site Code: 002001) 6km to the south of the WDA
- Glenomra Wood NHA (EPA Site Code: 001013) 5.1 km southeast of the EDA
- Glenomra Wood SAC (EPA Site Code: 001013) 5.1 km southeast of the EDA
- Slieve Bernagh Bog SAC (EPA Site Code: 002312) 8.1 km northeast of the EDA

No sections of the proposed grid connection traverse designated SAC, SPA or NHAs **Figure 9.12b**.

9.3.16 Water Resources

Drinking water rivers designated in accordance with European Communities (Drinking Water) (No. 2) Regulations 2007 (SI no. 278/2007) which are protected for the purposes of drinking water abstraction are presented in **Figure 9.8a - b,** however none are located within the River Subbasin or Sub Catchment associated with the Site.

There are no surface water bodies designated for drinking water downstream, **Figure 9.4- Surface Water Flow Chart**.

Groundwater encompassing all elements of the Proposed Development is (nationally) protected under the European Communities (Drinking Water) (No. 2) Regulations 2007 (S.I. no. 278/2007).

- The nearest National Federation of Group Water Schemes (NFGWS) Group Scheme Source of Protection is Bodyke c.10.6km from the EDA but is not hydrologically connected.
- The nearest GSI Public Source of Protection is Murroe Public Water Source c.25km from the WDA again not hydrologically connected to the site.
- The nearest NFGWS Group Scheme Source of Protection is Craggs Borrigone c.1.6km from the TDR of the site but is not hydrologically connected.

9.3.17 Receptor Sensitivity

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

- Water Framework Directive (WFD) status (2016-2021) generally ranging from Good to High, with some sections ranging to Poor. The principal objective of the WFD is to achieve good status or higher in all waters and to ensure that status does not deteriorate in any waters.
- The down-stream designations (sensitive protected areas e.g., SAC, SPA) associated with the catchment and the sensitive habitats and species associated with same. Refer to EIAR **Chapter 7: Ecology** for further information on Fresh Water Pearl Mussel.
- The designation of all waterbodies within the boundary of the Site and downstream surface water bodies and all groundwater bodies as sources of drinking water.
- There are no Salmonid River Regulations or Nutrient Sensitive Rivers in the vicinity of the development.
- Designated Shellfish areas exist in the Shannon Estuary catchment; downstream of the site in the Mouth of the Shannon (Has 23;27) Code: IE_SH_060_0000
    1. West Shannon Ballylongford; Code: IE_SH_060_0000
    2. West Shannon Poulnasherry Bay; Code: IEPA2_0021
    3. West Shannon Carrigaholt; Code: IEPA2_0022
    4. West Shannon Rinevella; Code: IEPA2_0023

Ultimately, all surface waters and groundwaters associated with the Site are considered sensitive and important attributes in their own right and must be protected in accordance with the WFD to achieve and maintain at least 'Good' status. However, waterbodies associated with additional receptor sensitivities such as designated and protected areas (e.g., FWPM, SAC, SPA), should be considered at the highest level on the sensitivity scale, due to the increased risk associated with specific additional ecological attributes they possess. For instance, while a potential effect, e.g., sediment stockpile collapse into a surface waterbody, could have a temporary impact on the river or stream itself, where suspended solids would be washed away from the incident and 'diluted' with the assimilative capacity of the river; on the other hand, the effects could be long lasting and potentially lead to the collapse of a species.

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, 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 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 range from 'Poor Aquifer' to Locally Important (LI), which can be expressed as an aquifer with relatively low to moderate production and connectivity (LI) respectively, and therefore the risk of potential adverse effects on groundwater will be a localised to regional effect. It is noted, with reference to **Section 9.3.8,** 0 no. wells -have been identified within the 100m buffer zone of shallow excavations; 0 no. within 100m buffer along the Grid Connections. The Turbine Delivery Route passes through many 250m buffer zones of wells, however any works taking place on the TDR are outside a 100m buffer zones of the wells.

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 if not mitigated against. Sensitive receptors (from WFD rivers outlined in Section 9.3.14 c.0.5km from the site, to designated shellfish areas downstream of the site c. 60km) are of variable distance from the Development and the pathways are of variable condition (slopes, soils, peat depth) for each proposed turbine location and for any part of the Development, once mitigation measures are applied (Section 9.5) these risk will be significantly reduced.

9.4 Assessment of Potential Effects

9.4.1 Assessing the Magnitude of Potential Effects

The receiving environment associated with the proposed development 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; High
- Bog Water - In areas of cut over peat, forestry or where existing drainage networks exist; Medium
- Bog Water - In areas of intact habitat and/or designated areas e.g., blanket bog / SAC; Medium

These items are discussed further in the following sections.

To account for this, the potential effects impacts associated with the proposed development will be limited to Magnitudes associated with respective environmental characteristics, as presented in **Table 9.16.**

Table 9.16: Magnitude of potential effects relative to receptor sensitivity

Sensitivity (Importance of Attribute)	Magnitude of Effect			
	Negligible (Imperceptible)	**Small Adverse (Slight)**	**Moderate Adverse (Moderate)**	**Large Adverse (Significant to Profound)**
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.

9.4.1.1 Assessing the Magnitude of Potential Effects – Surface Water

The receiving environment in terms of **SURFACE WATER** associated with the Development is considered as being of **Very High Importance** and **Highly Sensitive**, and therefore classification of any potential effects associated with the Development will be limited to Magnitudes associated with Very High Importance, as presented in the following table (**Table 9.17**).

Table 9.17: Weighted Rating of Significant Environmental Effects – Surface Water Systems – Limited to Very High

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

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

9.4.1.2 Assessing the Magnitude of Potential Effects – Groundwater

The receiving environment in terms of **GROUNDWATER** associated with the Development is considered as being of **High Importance** and **Medium Sensitivity**, and therefore classification of any potential effects associated with the Development will assume Magnitudes associated with Medium Importance as a conservative approach which is presented in the following table (**Table 9.18**).

Table 9.18: Weighted Rating of Significant Environmental Effects – Groundwater Systems –Medium Sensitivity

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

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

9.4.2 Do Nothing Impact

Assessments of the baseline hydrological and hydrogeological conditions at the site indicate that parts of the site have already experienced impacts to baseline conditions through commercial forestry across portions of the site (**Appendix 9.2 – Tile 13**), and the installation of drainage networks associated with commercial forestry purposes (**Appendix 9.2 – Tile 14, 21**).

Commercial forestry and agriculture / land reclamation activities (reconstitution of soils and drainage) have had a significant effect 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 peat cutting, or after heavy rainfall events.

Should the proposed development not proceed, the existing land-use practice of commercial forestry and agricultural activities will continue with associated gradual alteration of the existing environment and associated pressures on surface water and groundwater quality.

9.4.3 Construction Phase Potential Effects

9.4.3.1 Increased runoff from site due to earthworks

The Wind Farm Site has the potential to result in increased rates of runoff during the operational phase relative to baseline conditions. This is a function of increased hydraulic loading, the progressive excavation and removal of vegetation cover and replacement with hardstanding surfaces such as gravel/crushed rock/ clause 804 etc to allow for a level of permeability. (reduces the level of recharge and permeability) and installation of constructed drainage within the Site redline boundary and thus removing the hydraulic absorption / buffer control from this part of the Site. Such an increase in surface water 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 Site. The potential increase in runoff from site is considered an **unavoidable, direct, adverse, large** in scale, **moderate to profound significance**, **localised and potentially regional**, effect of the Development and **conforms to baseline conditions**.

Minimal land take is associated with the Grid Connection, considering all proposed works will traverse already existing public roadways to a large extent. Some of the grid connection option possess minor portions which traverse greenfield / green verge areas. Any such impact is described similarly to general land take described above, however considering the scale of disturbance (shallow cable trench) and the ducting through an existing agricultural field the effect is considered **slight to moderate**.

The IPP cable from the EDA to the WDA will be trenched (1.2m deep by 0.6m wide and backfilled and will not require an access road.

Land take may be required for the Turbine Delivery Route in the form of widening of existing portions of roads, however, considering the **small scale** of disturbance (shallow excavation, superficial paving) the effect is considered **slight to moderate**. Similarly, there is unlikely to be a significant increase in the rate of runoff from the construction of both these routes due to utilisation of pre-existing road infrastructure. None the less, mitigation and best practice construction activities will be implemented, minimising the potential effect on Hydrology and Hydrogeology from slight to moderate down to **slight**.

9.4.3.2 Clear Fell of Afforested Areas

Felling of forestry at the Site will be necessary for areas of the Development in afforested sections within the Redline Boundary. This is an **unavoidable** consequence of the Development. Turbines T1, T2, T3 and T4 are within afforested areas. Subsequently, tree felling will be required as part of the Development. To facilitate the construction of site access tracks, civil works, Temporary Construction Compound, spoil storage areas, ecological enhancement area and Turbine Hardstands, approximately 67ha of commercial conifer plantation, approximately 50.6ha of transitional woodland scrub and approximately 5.6ha of mixed forest. The likely felled area of approximately 67ha will represent approximately This represents approximately 32.3% of the (Blueline Boundary). In a spatial or land use context this is considered a **moderate** impact.

The clear fell of afforested areas is in line with baseline conditions and future activities as part of Do-Nothing impact. Therefore, in the context of the Development, the clear fell of forestry overall is considered **neutral**, however there is a range of potential **adverse** impacts associated with the activity which will require management and mitigation. Potential effects include:

- 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 (**Section 9.4.4.4 Figure 9.1a**).
- Geology: Clear-felling can cause changes in the geology of an area, leading to soil instability, landslides, and other geological hazards (**Chapter 8 Soils and Geology)**
- 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.
- 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.
- 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 in comparison to the normal forestry activities taking place at the Site (i.e., small-scale felling proposed). If the proposed Development does not take place, it is likely that the forestry at the Site will eventually either be clear felled or felled in larger volumes than the amount proposed as a function of this Development. Therefore, the resulting incremental felling of the afforested area will benefit the receiving environment, namely the receiving surface water network by means of reducing the potential magnitude of impacts, namely erosion, solids entrainment, and shock nutrient and sediment loading. With appropriate mitigation measures **Section 9.5.2.3**, planning and management this impact can be reversed, and disturbance minimised.

9.4.3.3 Ground Disturbance and diffuse sediment laden runoff

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

- Construction of site access tracks
- Temporary Construction of two site Compounds, one in the WDA and one in the EDA
- Turbine Foundations and hardstand areas
- Foundations for the proposed substation
- Foundations for the proposed Met Mast
- Construction of a clear span bridge
- Trenching for underground electrical cabling, including along the proposed Grid Connections.
- Temporary stockpiling of peat, subsoils and bedrock.

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

- Verge widening and strengthening along the Turbine Delivery Route in close proximity to roadside drainage systems along the Ardnacrusha Headrace Canal
- Verge widening along grid connection route, as well as HDD locations
- Two watercourse crossings on the River Blackwater (Clare)_010 on the Grid Connection Route.
- Turbine Hardstand and infrastructure development, particularly in close proximity to existing waterways

The potential release of elevated suspended solids to surface waters is considered to be a **direct, indirect, adverse, large** in scale **moderate to significant**, effect of the Proposed Development. This potential impact is considered to be **unavoidable** and **conforms to baseline** conditions (i.e., works associated with commercial forestry would have similar effects to the construction phase in terms of ground disturbance and release of suspended solids). 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 (**Section 9.5.2.1**) and via the implementation of environmental engineering controls, this potential risk can be significantly reduced.

9.4.3.4 Release of Suspended Solids

Excavation and construction activities, associated with the Proposed Development, such as stockpiling material and vehicular movements of plant machinery 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.

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 into the water column and / or be consumed by micro-organisms. 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 effects on ecological attributes downstream of the Site.

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.

During 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 and when in close proximity to receptors, i.e. T6 in close proximity to Blackwater (Clare) River and any works near non intercepted drainage as it flows back into the river network, **Figure 9.8a.**

The aspects of the development most likely to impact surface water quality and result in deterioration are:

Exposed soils / peat generally, including new drainage channels, temporary stockpiles.

Turbine hardstand and 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 (site tracks and internal cabling will cross buffers in a perpendicular direction i.e., so as to minimise any potential effects), and/or instream works associated with proposed watercourse crossing locations.

Earthworks in relation to reinstatement must also be considered. In addition to potentially direct adverse effects on ecological sensitivities down-gradient of the Site, runoff of suspended solids will potentially impact on the WFD status and objectives associated with the surface water networks both within and downstream of the Proposed Development. Considering the '*Moderate'* and *'Good'* quality of the baseline surface waters draining from the Site and the spoil storage areas, in addition to the sensitivity and 'Very High' importance of the associated surface water networks, any introduction of contaminants is considered an adverse impact of high significance.

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 and nutrients 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 an **unavoidable, direct and indirect, adverse, moderate to profound significance, small to moderate scale** impact of the Proposed Development, the site, GCR and TDR. This potential impact is considered to conform to baseline conditions when considering the intensive nature of the construction phase. Considering the long ranging mobility of surface waters, this potential impact **is not considered reversible** and can have indirect impacts upon receptors downstream (i.e., potential regionally). However, with the implementation of mitigation measures and appropriate environmental engineering controls, **Section 9.5.2.5**, this impact can be reduced to within water quality regulatory limits.

There is likely to be a significant effect posed by entrained solids on groundwater due to the wells and springs in close proximity to the site, there are parts of the site (peat) however, that provide a natural process of filtration associated with percolation of water through soils. This principle is particularly pertinent at a Site of this nature where a combination of low permeability subsoils beneath the peat and low recharge rates at the Site are anticipated.

The Development will invariably alter drainage at the Site 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. This is considered an **unavoidable, direct and indirect, adverse, moderate to profound significance, moderate scale** impact of the Proposed Development, the site.

9.4.3.5 Ground Stability and Compaction

During the construction phase of the proposed Development, vehicles will cross over or excavate into areas in order to construct the proposed access tracks, hardstands, and gain access to the proposed Development areas. There is the potential for soil compaction, erosion and degradation during such vehicular movements. 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. Earthworks in relation to reinstatement must also be considered.

Potential localised peat stability issues, and erosion or degradation of peat such as by vehicular movements have the potential to increase entrainment of suspended solids in surface water runoff, impact or obstruct established drainage networks, and increase the amount of excavation works required generally which in turn increases the potential for standard effects associated with earthworks. This is considered an **unavoidable, direct and indirect, adverse**, **moderate to significant**, **localised and potentially regional** effect on receiving surface waters. However, with the implementation of mitigation measures and appropriate environmental engineering controls[7][8] (**Section 9.5.2.6**), this impact can be reduced. While **small to moderate** in scale this effect is considered to **conform to Baseline** (e.g., commercial forestry).

Potential localised ground stability issues, and erosion or degradation of peat/soils such as by vehicular movements on the GCR and TDR is considered to be a **likely, indirect, adverse, small** in scale**, slight, localised, permanent but reversible** effect of the Proposed Development, which is conforms to Baseline conditions roadworks.

9.4.3.6 Release of Hydrocarbons and storage

Hydrocarbons are a pollutant risk due to their inherent toxicity to all flora and fauna organisms. Hydrocarbons chemically repel water and do not readily dissolve in polar solvents such as water. Most hydrocarbons are light non-aqueous phase liquids (L-NAPL's) that are less dense than water. If hydrocarbons are accidentally released to water, they will therefore float on the water's surface. Hydrocarbons adsorb onto the majority of natural solid objects they come in contact with, such as peat, soil, vegetation and animals. Hydrocarbons will burn most living organic tissue they come in contact with

[7] Assuming mitigation measures described in **Chapter 10 – Soils and Geology** and in this chapter are implemented and adhered to, localised stability issues are unlikely to give rise to effects on surface water networks associated with the proposed Development.

[8] With reference to **Appendix 10.1 Peat Stability Risk Assessment** and **Chapter 10 – Soils and Geology**, the risk of mass movement of peat is considered to be low. Of the 876 No. peat probe localities surveyed, under both FoS Scenario A and FoS Scenario B yield a result that the risk of a peat slide occurring at any proposed turbine or infrastructure element location are considered to be "Low" to "Very Low" with only 26 locations considered "Moderate".

due to their volatile chemistry. Hydrocarbons also represent a nutrient supply for adapted micro-organisms, this process in turn can rapidly deplete dissolved oxygen and thus result in fish kills or mortality of water based vertebrate and invertebrate life.

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

Hydrocarbons or any other forms of toxic chemicals such as paints or adhesives etc. accidentally released to the environment will likely be intercepted by drainage and surface water networks at the Site. The low permeability subsoils beneath the peat and low recharge rates at the Site will inhibit the spatial distribution and temporal variation of hydrocarbon mass and concentration on groundwaters 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.
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 Site and TDR, 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 of the Proposed Development, which is in contrast to Baseline conditions. As the GCR will have watercourse crossings/ trenched crossings an accidental hydrocarbon spillage is considered a **likely, adverse, indirect, small in scale, moderate to profound, localised (potentially regional), permanent but reversible** effect of the Development. However, with implementing mitigation and best practice the risk of an accidental spill can be greatly reduced, refer to **Section 9.5.2.7**.

In terms of groundwater associated with the Site 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 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, refer to **Section 9.5.2.7**.

9.4.3.7 *Release of Horizontal Directional Drilling Materials*

Horizontal Directional Drilling (HDD) techniques and the loss of drilling mud or waste 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[9]. Therefore, there is a risk of a potential oil leak from horizontal directional drilling (HDD) along the grid connections. 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 Site, an accidental drilling fluid breakout is considered to be a **likely, direct and indirect, adverse, small** in scale**, moderate to profound significance, localised (potentially regional), temporary to long term but reversible** effect of the Proposed Development, which is in contrast to baseline conditions. With the implementation of appropriate mitigation measures and environmental engineering, these potential risks can be significantly reduced.

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 9.5.3.3,** the introduction of drill arisings to the receiving surface water receptor is considered a **direct, adverse, moderate to profound significance** impact of the Development.

[9] 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.

9.4.3.8 *Release of Wastewater Sanitation Contaminants*

The installation of permanent sanitation facilities at the Site will not be required for the operational phase of the Development. The proposed Development does however include for temporary sanitation facilities for site workers during the construction phase. Therefore, the Development has the potential to result in the accidental leakage of wastewater or chemicals associated with wastewater sanitation onto peat/soils and ultimately into surface waters during the construction phase of the 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 effects on ecological sensitivities downgradient of the site, runoff of suspended solids and/or other contaminants could potentially impact on the WFD status and objectives associated with the receiving surface water networks associated with the 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 Development.

Potential incidents of release of contaminants at the Site will likely be short lived or temporary, however the potential effects to downstream receptors can be long term. With appropriate mitigation measures (**Section 9.5.2.9**), these potential effects can be significantly reduced.

Mechanism/s:	• Wastewater leak – minor in scale. • Chemical leak – minor in scale
Impact	• Release of wastewater / 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** effect of the Development of the site, which is in contrast to baseline. With the implementation of appropriate mitigation measures and environmental engineering controls (**Section 9.5.2.9**), these potential risks can be significantly reduced.

In terms of groundwater associated with the Site an accidental wastewater sanitation leak or spillage is considered to be a **likely, indirect, adverse, small** in scale**, moderate to profound, localised (potentially regional), permanent 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, refer to **Section 9.5.2.9.**

9.4.3.9 Release of Construction or Cementitious Materials

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

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

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 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 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 Development. 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 of the site, which is in contrast to baseline. With the implementation of appropriate mitigation measures and environmental engineering controls (**Section 9.5.2.8**), these potential risks can be significantly reduced.

In terms of groundwater associated with the Site, an accidental spillage is considered to be a **likely, indirect, adverse, small** in scale**, moderate to profound, localised (potentially regional), permanent 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, refer to **Section 9.5.2.8.**

9.4.3.10 Hydrologically Connected Designated Sites

The drainage and surface water network associated with the Site has been designed to intercept potential contaminants arising as a product of the construction or operation of the Development. The Site is hydrologically connected and situated upstream of the following designated sites which are discussed in detail in **Section 9.3.15**:

- Gortacullin Bog NHA (EPA Site Code: 002401) 0.1km to the north of the EDA
- Doon Lough NHA (EPA Site Code: 000337) 3.81km to the northwest of the EDA
- Danes Hole, Poulnalecka SAC (EPA Site Code: 002401) 4km to the west of the EDA
- Ratty Cave SAC (EPA Site Code: 002316) 6.29km to the west of the WDA
- Lower River Shannon SAC (EPA Site Code: 002165) 13.2 km south
- River Shannon and River Fergus Estuaries SPA (EPA Site Code: 004077) 13.2 km south

For this reason, maintaining surface water quality is a key component of environmental objectives, and therefore any contaminants arising could potentially adversely impact on downstream designated site. Any accidental release of potential contaminants to the environment as a result of the Development will likely be intercepted by the drainage and surface water network at the Site. Therefore, any contaminants potentially released will subsequently impact on a designated site. The potential of the Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered to be a **likely**, **indirect**, **localised (potentially regional**), **adverse, moderate to profound**, **temporary to long-term** effect of the Development which conforms to Baseline (e.g., cumulative upstream impacts), while being **small to moderate** in scale.

However, with the implementation of appropriate mitigation measures and environmental engineering controls, discussed in **Section 9.5.2** these potential risks can be significantly reduced and are considered not likely to be significant.

The Development will not compromise the ability of waterbodies affected to maintain good status or achieve any improved status or on any European site and that it has been concluded in the NIS, there will be no adverse effect on the integrity of any European site in view of their conservation objectives.

The assimilative capacity of the surface water systems will buffer against any potential contaminants introduced. In the event of accidental release of contaminants to surface waters at the Site, they will become more diluted in receiving waterbodies as the distance from the Site increases. This principle does not lessen potential adverse effects in the immediate vicinity and it does not reduce the need for robust mitigation measures to be implemented.

Drinking Water

The geographical scale of catchments upstream of designated areas and downstream of the Site (**Figure 9.8a**) should be considered in terms of the assimilative capacity of the surface water systems which will buffer against any potential contaminants introduced at the Site, that is; contaminants will be 'diluted' in receiving waterbodies. This does not lessen potential adverse impacts in the immediate vicinity of the 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 Site.

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. Similarly, potential impacts on drinking waters do not override the necessity to protect the river in its own right due to the fact that any abstracted water will be treated regardless of varying low levels of contaminants, but it is important to consider the societal impact of a catastrophic environmental incident whereby waters are potentially unsuitable for abstraction for a period of time due to excessive contaminant loading. The potential of the Development to introduce contaminants to surface waters and in turn impact on the designated areas downstream is considered to be a **likely**, **indirect**, **localised (potentially regional**), **adverse, moderate to profound**, **temporary to long-term** effect of the Development which conforms to Baseline (e.g., cumulative upstream impacts), while being **small to moderate** in scale.

Freshwater Pearl Mussel

The Freshwater Pearl Mussel (FPM), while considered to be one of the most endangered animals in Europe, also serves as a keystone species in Ireland. Known to have a disproportionately large effect on its natural environment relative to its abundance, FPMs are responsible for filtering the waters associated with their habitats and improving the quality of water for other species[10]. Highlighting the species fragility, FPMs are highly

[10] Paine, R. T. (1995) "A Conversation on Refining the Concept of Keystone Species." *Conservation Biology* 9 (4) pp.962–64.

sensitive to direct disturbance and to flow, sediment and nutrient stresses. For these reasons, it is important to draw attention to their potential as a sensitive receptor when considering works involving within and near surface waters. Direct impacts to beds of surface waters through acute disturbance can directly influence the habitat crucial to the FPMs existence and those habitat located further downstream. There are no known freshwater pearl mussel (*Margaritifera margaritifera*) records in the Owenogarney_SC_010, Owenogarney_SC_020, Shannon[Lower]_SC_100 and Ballygirreen_SC_010 river sub-catchments. This was based on an extensive literature review and also examination of NPWS sensitive species data.

The FPM is addressed in further detail in the Biodiversity Chapter of this EIAR, there are no known potential effects from the Development.

Shellfish

As outlined in **Section 9.3.17** the designated Shellfish areas in the Shannon Estuary catchment; downstream of the site in the Mouth of the Shannon (HAs 23;27) Code: IE_SH_060_0000.

1. West Shannon Ballylongford; Code: IE_SH_060_0000
2. West Shannon Poulnasherry Bay; Code: IEPA2_0021
3. West Shannon Carrigaholt; Code: IEPA2_0022
4. West Shannon Rinevella; Code: IEPA2_0023

Shellfish is addressed in further detail in the Ecology Section of this EIAR, however given the large distances involved no potential adverse impact will occur form the proposed development.

9.4.3.11 Drilling of Boreholes and Extraction of Groundwater

Drilling of boreholes in general is not likely to have potentially significant effects on groundwater. Extraction of groundwater is considered to have potentially significant effects on groundwater and on associated sensitive receptors. The Development will not require the installation of boreholes for groundwater extraction purposes during the construction or operational phase. However, borehole drilling will likely occur in the geotechnical testing during the design phase. All fresh water required during the construction phase of the Proposed Development will be delivered to the Site via tank trucks. Therefore, there is no potential for the Development to impact on groundwater due to drilling of boreholes for extraction purposes which is not included in the works for this Development.

9.4.3.12 Local Groundwater Supplies and Bog Water

The Development 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 poor (Baseline, **Section 9.3.9**). However, the availability of groundwater in a social or agricultural sense is considered important, therefore the importance of groundwater quantities underlying the Site 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** effect of the Proposed 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. The Development and the grid connection and turbine delivery route does 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)(**Section 9.3.16**) therefore there are no potential effects.

Considering the quality of the groundwater underlying the Site (Baseline, **Section 9.3.13**), 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 Development 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 these are outlined in the design phase and discussed in **Sections 9.5.1.1** and **9.5.1.8.**

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 9.3.10**). Hydrocarbons (e.g., diesel) pose the most significant risk to groundwater quality and can persist for many years.

It is noted:

- Excavations will be of c. 3m depth for Turbine Foundations (**Chapter 5: Description of the Proposed Development)**.
- The recommended buffer distance determined by relevant Industry Guidance (**Section 9.3.2)**, for existing wells in relation to Turbine Foundations is 250m.
- Governing Industry Guidelines (**Section 9.2.2)** stipulate a groundwater buffer zone of 100 m is required of from wells used for drinking water abstraction in relation to the proposed Site Access Roads and cable trenches i.e., shallow excavations.

There are no mapped wells (GSI, 2022) within the Site, however there are numerous wells, springs and boreholes located surrounding the Proposed Development (**Section 9.3.10**). Given the incomplete nature of the GSI well database and the rural location, it has been assumed on a worst-case scenario that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography. In other words, the groundwater flow paths are expected to be from topographic high points to lower elevated discharge points at streams, flushes, bog pools, lakes and rivers. Utilising this conceptual model of groundwater flow, dwellings that are located down gradient of the Site can be identified as potential receptors. The groundwater flow direction in the area of the Site is expected to be predominantly in a north to south direction. There are no dwellings located within the Redline Boundary, numerous dwellings are located within 2km of the Site (see **Figure 9.1a)**. It is anticipated that any potential groundwater effects will have significantly attenuated across these distances in the underlying poorly productive aquifer. However, the Proposed Development does not encompass groundwater abstraction, excavations for the hardstands would be an insignificant abstraction effecting the quantity which is significantly reduced as outlined in **Chapter 10 Soils and Geology – 10.4.2.4.**

Considering the baseline data and Proposed Development characteristics, the risk of lowering groundwater levels to a significant extent is not considered likely. Furthermore, there are no mapped wells (**Figure 9.8a**) within the Blueline Boundary.

A combination of low permeability soils (i.e., peat), the temporary nature of the construction works, and moderate recharge rates at the Site is expected to result in a **likely, neutral to adverse, slight to moderate significance, localised** effect of the Development which conforms to Baseline (peat cutting drains). With appropriate mitigation measures in place, the potential effects on groundwater can be managed and reduced to Imperceptible to Slight. Mitigation measures are outlined in **Chapter 10 Soils and Geology.**

9.4.3.13 Groundwater and Surface Water Associated with Wind Farm Cabling

The Proposed Development has the potential to impact on bog water levels proximal to excavations and/or drainage channels. Existing drainage at the Site, particularly in peat cutting areas are intended to drain the respective area, however these 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.

In peat, the effect 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 Site is characterised by moderately deep and shallow peat or peaty soil with isolated minor areas of moderately deep saturated peat (**Chapter 10: Soils and Geology**). Therefore, the scale of such impact is likely limited to the extent of those isolated pockets, if impacted. Furthermore, the Site is generally characterised as having extensive existing drainage features, and therefore impacts arising from drainage can be in line with baseline conditions.

The Wind Farm Internal Cabling will follow the hardstand and road alignment and will be predominantly buried within shallow cable trenches. It has been assumed on a worst-case scenario that all dwellings in the vicinity of the Site are utilising a private groundwater well and that groundwater flow direction in the underlying aquifer mimics the local topography.

- The closest dwelling to the proposed turbine position (T2) is situated approximately 0.73Km.
- The closest dwelling is situated approximately 0.72km from (T6).
- The closest dwelling is situated approximately 0.74km from (T7).
- The closest dwelling is situated approximately 0.74km from (T9).
- The closest dwelling is situated approximately 0.75km from (T4).
- The closest dwelling is situated approximately 0.77km from (T10).
- The closest dwelling is situated approximately 0.87km from (T11).

Due to the alignment of the internal cable works with the proposed site access tracks, shallow trenching, absence of proximal groundwater wells and the sealed nature of the internal cable works at the two proposed crossings as a result of which the internal cable works are expected to result in a **likely, adverse, direct and indirect, small to moderate scale, slight significance, localised, permanent but reversible** effect which conforms to Baseline conditions (peat cutting 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 **positive beneficial** impact on bog water levels, particularly in places already impacted by drainage.

9.4.3.14 Groundwater and Surface Water Associated with Grid Connection Cable Works

The GSI well database has indicated that there are a number of mapped wells located along or within the vicinity of the Grid Connection 'Loopin1'. Shallow trenching (c. 1200mm deep) which will be backfilled is expected to be required for the Grid Connection, the shallow trenching will not breach the groundwater table. There are two locations where horizontal directional drilling will be required during the proposed works.

Due to the vast majority of the gird connection requiring shallow trenching that will be backfilled and the temporary nature of the construction works, it is expected to result in a **likely, direct and indirect, adverse, small in scale, localised, slight and permanent** effect which conforms to the 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.

9.4.3.15 Excavation Dewatering & Construction Water

The dewatering of excavations during construction is likely to have significant adverse effects on surface water runoff quality in the absence of mitigation measures. Should dewatering of open excavations, Turbine Foundations etc. be required, the receiving engineered drainage and attenuation features will likely receive water discharges elevated in suspended solids. The potential overflow of such sediment laden water into the receiving downstream surface waters is considered to be a likely, direct, adverse, potentially moderate to significant, potentially Significant / Profound weighted significance effect of the Proposed Development.

This impact is considered to be in contrast to baseline conditions although it is also **temporary**. Although temporary, considering the mobility characteristics associated with flowing surface waters, it is not considered reversible. Potential effects impacting on water quality are discussed in greater detail in the following sections of this report.

Potential dewatering through drainage in advance of excavation activities, or dewatering via pumping during excavation activities, will likely impact on groundwater and hydrogeological flow regimes at a localised scale but not at a regional scale. This is considered to be a **likely, adverse, direct and indirect localised (potentially regional), temporary to permanent** effect of the 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, **Section 9.5.2.2**), these potential risks can be significantly reduced.

Considering the nature of the site i.e., greenfield, 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.

9.4.3.16 Constructed Drainage, Diversion or Enhancement of Drainage

Drainage features constructed at a Site as part of a wind farm Development have the potential to significantly adversely impact on the baseline hydrological regime, particularly in areas of forestry impacted by artificial drainage and commercial forestry operations, there is the potential for the Development to have a beneficial impact to the hydrological regime. Interceptor drains and attenuation features will reduce increases in water volumes following intense rainfall periods.

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 peat areas are characterised by rapid hydrological responses to rainfall i.e., rapid surface water runoff intercepted by the receiving drainage and surface water network.

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 Development 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 Development will likely result in the diversion, alteration and/or enhancement of the existing drainage networks at the Site during the construction of the Proposed Development relative to baseline conditions. The existing drainage network at the Site is mapped and presented in **Figure 9.6a.** Diversion of artificial drainage channels will be required at locations where the 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 Development drainage interacts or connects with existing drainage networks.

Considering that pre-existing natural and artificially established drainage networks are present at the Site, the diversion, enhancement or introduction of additional drainage features is considered an **unavoidable, direct and indirect, adverse, localised (potentially regional**) and **permanent** effect of the Development 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 presented in **Section 9.5.2.10**), these potential risks can be significantly reduced.

The potential impacts of excavations are addressed in **Section 9.4.4.1** and in **Chapter 10: Soils and Geology**. Management of storm and construction water runoff to prevent loading of the receiving network with contaminants in detailed in the later sections, that is; these potential impacts can be mitigated.

9.4.3.17 Surface Water Crossings - Bridges & Culverts over Mapped Rivers and Non-Mapped Drains

In terms of mapped streams and rivers, the Development will require 42 culverts (existing and new) and 1 bridge presented in **Table 9.1.** In terms of non-mapped surface water features and drains, there are a number of new and existing culverts at the Site associated with the Development footprint. Although more minor in scale, and less significant in terms of ecological importance and sensitivity, such culverts must be considered similarly to watercourse crossings in terms of potential impacts associated with poor design and construction. Note: existing culverts were observed during site surveys and/or from desk top assessment of aerial imagery and site drainage mapping, including recent Lidar and Aerial Survey data (BlueSky) available for the site (**Appendix 9.2 – Tile 16**). There is potential for buried stone culverts/ land drains to be present on Site which are not mapped here, and which could be discovered during excavations.

Through the design and construction and operation of watercourse crossings, examples of associated activities or impact mechanisms include:

- Significant changes to the hydrological regime at the 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 bridges where necessary.
- Upgrading of existing culverts where necessary.
- Poor design and/or installation of drainage infrastructure including culverts and attenuation features.

Potential impacts arising from such activities include:

- Release of suspended solids or other contaminants, 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.

Receptors include Surface Water, and in terms of; Surface water quantity and flood risk, Surface water quality, ecological sensitivities and WFD status.

Mechanism/s:	• Significant changes to the hydrological regime at the 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.

Watercourse crossings and associated portions of site 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. As sited in **Chapter 10** Land, Soils and Geology it is very important to consider the potential for ground stability issues arising. Due to the close proximity to the receptor, minor, or localised stability issues arising can potentially have profound impacts on surface water features.

The design of new bridges or watercourse crossings could potentially result in significant changes in flow, erosion and deposition patterns and rates in the watercourse, which can potentially lead to flow being restricted leading to increased risk of flooding locally, or water diverting and increasing the risk of flooding elsewhere, if adequate detail is not given during the design stage. These effects would likely be significant adverse and permanent. However, with reference to the design plan drawings of watercourse crossings (**20959-NOD-XX-XX-DR-C-08301_S4_P01**), presented in **Appendix 9.5**, if the new bridge is well designed and facilitates or maintains the watercourses' characteristics, including for excessive flow events e.g., 1 in 100-year etc, such adverse effects would likely be temporary.

Potential effects with regards to upgrading and installing watercourse crossings at the 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.

Wind Farm

The Proposed Development has been assessed at EIA stage in terms of the intersection of the Proposed Development footprint and existing surface water and drainage features at the Site. The forty-two (no. 42) watercourse crossings required for the site access tracks as part of facilitating access to the proposed turbines are set out in **Table 9.1** and illustrated in **Figure 9.2**.

A number of existing minor drains along the existing and proposed site access track network within the Site (**Figure 9.6a, Appendix 9.2 – Tiles 16 and 21**) will require upgrading to accommodate the increased width of the road. These minor surface drains can be dry and receive flows only following heavy rainfall events throughout the year, however, due to their connectivity to mapped surface water network within the catchment, appropriate measures outlined in the Mitigation Section, **Section 9.5**, of this report will be required during construction to avoid siltation or other pollutants entering the drainage network. **Table 9.1** lists culvert locations of crossings over non-mapped drains**.** 42 no. water crossings are small streams or drainage channels on the Site and one (no.1) is a bridge over a mapped river. These water crossings will be constructed using precast culverts. The Proposed Development has the potential to result in the release of contaminants, particularly suspended solids during the construction phase due to the proposed instream works (i.e., culverting and clear-span bridge crossing), careful consideration will be given to potential direct effects arising from the Proposed Development when considering instream works.

Construction of any new watercourse crossing will have an inherent risk of resulting in adverse effects to surface waters due to the required ground disturbance through excavations and the movement of heavy plant and machinery and the proximity to the primary sensitive receptor, which is the watercourse itself. Release of elevated suspended solids to surface waters due to excavations or other earthworks etc., or the accidental release of any form of anthropogenic contaminant such as fuels or chemicals during construction of new watercourse crossings are both potential significant adverse effects. This is considered **a likely, adverse, significant, but temporary** effect of the Development which contrasts to baseline conditions. The effects relating to the release of contaminants during earthworks is addressed in **Section 9.4.4.2** of this chapter. Mitigation measures for this potential effect is outlined in **Section 9.5.2.9** of this chapter.

Grid Connection

The Development has been assessed at EIA stage in terms of the intersection of the Development footprint and existing surface water and drainage features at the Site. As outlined in **Table 9.2**, and illustrated in **Figure 9.6b**, the grid connection route crosses the Blackwater (Clare)_010 twice.

Construction of new, or upgrading of existing watercourse crossings will involve similar impacts as described in sections previous and following sections e.g., excavations and earthworks and entrainment of suspended solids, etc. However, considering the proximity to surface water associated with this type of infrastructure the risk is elevated.

Turbine Delivery Route

The Development has been assessed at EIA stage in terms of the intersection of the Development footprint and existing surface water and drainage features at the Site. As illustrated in **Figure 9.6c**, the Turbine delivery route to Foynes port traverses a combined 53 no. existing bridge or watercourse culvert crossings. There are no works to upgrade any existing watercourse crossings therefore there is no potential effects of the Proposed Development in terms of water course crossings.

9.4.3.18 In-stream Works

In-stream works will be avoided as far as possible by avoidance and with the use of clear span structures over significant receptors **(Appendix 9.5– Tile 1)**. However, infrastructure such as culverts over natural or artificial drainage channels and non-mapped rivers will require instream works. Works associated with the diversion, or enhancement of existing drainage features will also have similar effects.

Forty-one (41 no.) water crossings are small streams or drainage channels on the Site. There is one bridge crossing over a mapped river on the WDA. In-stream works have the potential to cause significant disturbance within the river bed, or introduce contaminants directly to the surface water feature, potentially leading to significant effects to water quality, and potentially catastrophic effects to downstream ecological attributes sensitive to contaminant loading, including suspended solids. Works associated with the diversion, or enhancement of existing drainage features will also have similar effects.

Poor design of drainage features, including culverts, can also lead to gradual effects such as erosion, or changing of hydro morphological characteristics, including bottle necks or small diameter culverts, and elevated to rapid velocity discharge in areas with no attenuation features. Potential effects with regards to upgrading and installing watercourse crossings at the 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, **Section 9.5.2.9 and Section 9.5.2.10.**

9.4.4 Operational Phase Potential Effects

The risk associated with bedrock aquifers underlying the grid connections will remain a baseline risk however there are no significant sources of contamination associated with the operational phase with the exception of infrequent maintenance works. The potential effects on groundwater during the proposed operational phase of the Development is considered to be not significant[11].

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

9.4.4.1 Increased Surface water runoff

Considering the existing infrastructure associated with the site, water balance calculations allow for the addition of the area of hardstand required (land take) for the construction of the Development. The resulting 1 in 100-year scenario net increase of surface water runoff associated with the Development is calculated to be c. 0.754 m^3/second, or 0.19% relative to the approximate Site area alone, (Note: assessment at catchment scale presumes the same environmental conditions across the entire catchment during the event).

[11] The effect is only significant if it will be likely to breach any standard in water management legislation.

This net increase relative to the scale of the Site or the scale of the associated catchment is considered an adverse but imperceptible to slight impact 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 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 Site. • Increase in hydrological response to rainfall at the Site and in downstream surface water bodies.
Receptor/s:	• Surface Waters. Site hydrological response to rainfall and potential downstream flood risk areas. • Surface Water - Negative, direct, significant, likely, permanent.

9.4.5 Decommissioning Phase Potential Effects

No new unique or additional effects are anticipated to arise during the decommissioning phase of the Proposed Development on the hydrological and hydrogeological environment**.** All anticipated impacts are similar in nature to those already highlighted during the Construction Phase of the Development, i.e., release of hydrocarbons, waste water / sanitation and suspended soils through the excavation of material in order to remove cabling from joint bay locations. However these have will be reduced where possible for example foundations will be left in-situ and covered by soils typical of the surrounding environment and then reseeded or left to re-vegetate.

In regard to cable ducting, for the Grid Connection route, cable joint bays will be left in-situ and cabling will be left in situ as they will be an ESBN asset. In regard to internal site cable ducting the ground above original pulling pits/joint bays will be excavated to access the cable ducts using a mechanical excavator and will be fully re-instated once the cables are removed. Excavated material will be temporarily stored adjacent to the site of excavation at a height of less than 1m and outside of any surface water buffer zone and will be removed from the site appropriately for reuse elsewhere on site, reused on another site or disposed of as a waste (through appropriate classification and assessment).

9.5 Mitigation Measures

9.5.1 Design Phase

9.5.1.1 Mitigation by Avoidance

The fundamental mitigation measure to be implemented during each stage of the Development will be avoidance of sensitive hydrological or hydrogeological receptors wherever possible. This principle has been adopted during the design of the Proposed

Development and associated infrastructure layout across multiple design iterations. Hydrological constraints maps have been developed which identified areas of the Site where surface water and drainage constraints resulted in areas of the Site being deemed less suitable for development. The constraints map is presented in **Figure 9.13a** for the Wind Farm and **9.13b** for the Grid connection Route. The identified constraints have been extensively discussed in consultation between RSK Ireland Ltd. and the design team. The final Site layout plan has been identified as the optimal layout design available for protecting the existing hydrological regime of the Site, with due regard to overlaying engineering and other environmental constraints.

9.5.1.2 Mitigation by Design & Mitigation Objectives

The descriptive mitigation measures outlined in this report will be applied to the development design and construction methodologies with a view to avoiding and/or minimising any potential adverse effects to water quality in the receiving surface water network. Details on how such measures will be applied (objectives, design considerations, layout) will be contained in a Surface Water Management Plan (SWMP) (appended to the CEMP in **Appendix 5.1**). The aims and examples of important considerations in relation to mitigation measures described in the EIAR are further clarified here.

9.5.1.3 Nature Based Solutions

Nature Based Solutions (NBS) will be adopted at the Wind Farm site where possible. NBS include Sustainable Drainage Systems (SuDS), which will be employed to attenuate runoff and reduce the hydrological response to rainfall at the Site. Extending or maximising this approach sufficiently has the potential to attain net beneficial effects i.e., a net reduction in runoff rates at the 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 site, peatlands have been subject to peat cutting and draining of peatland bogs. 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 Development 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.

* 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, require networks of drainage channels, with the objective of reducing and maintaining relatively low bog water levels. This is in 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 Development 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.

9.5.1.4 Constructed Drainage

The drainage design for the Proposed Development (Surface Water Management Plan in **Appendix 5.1**) will be such that drains are positioned adjacent to the footprint of the Proposed Development, therefore the proposed drainage infrastructure can be considered part of the Proposed Development footprint. The scale of the impact a shallow drain poses on the surrounding forestry area is minor particularly in areas impacted as baseline conditions are in their current form. 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 Proposed Development. However, it is important to consider the gradual degradation over time.

The design of the proposed drainage network will facilitate:

- The collection of surface water runoff from upgradient of the Proposed Development footprint (clean runoff interceptor drains) and the buffered redistribution of clean runoff downgradient of the Development footprint by means of culverts and buffered outfalls to vegetated areas with a view to maintaining or improving the hydrological regime at the Site (**Appendix 9.5 Tile 2 - 5)**.
- The collection of surface water runoff from the footprint of the Proposed Development 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 Site.

Maintaining or improving the hydrological regime at the Site implies achieving the objectives of the Proposed Development Surface Water Management Plan (SWMP) i.e., mitigating against potential adverse effects to the hydrological response to rainfall at the Site (related to flood risk), and water quality in the receiving surface water network.

9.5.1.5 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).

Mitigation measures to address surface water runoff and drainage include in line attenuation features such as check dams and stilling ponds and buffered outfalls. Both check dams and stilling ponds (Surface Water Management Plan in **Appendix 5.1)** provide mitigation against potential effects to water quality, erosion, and discharge velocity, however they also facilitate buffered and diffuse percolation of surface water runoff into the receiving environment along the permitter of the Development footprint. Attenuation features have been designed to take into consideration for a 1 in 100-year rainfall event, including an additional 20% to account for climate change, **Appendix 9.1**.

9.5.1.6 Check Dams

Check dams will be constructed along the length of constructed drainage at regular intervals in line with relevant guidance (**Section 9.2.2**). Check dams (**Appendix 9.5– Tile 6 - 10**) Surface Water Management Plan in **Appendix 5.1**), will be permanent (for the life of the Proposed Development / 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.

9.5.1.7 Stilling Ponds

Stilling ponds with buffered outfalls will be constructed at drainage outfalls associated with the construction runoff drainage network (**Appendix 9.5 – Tile 11 and Tile 12,** Section 5.7 Surface Water Management Plan in **Appendix 5.1**)**.** Buffered outfalls will be established at intervals along the clean runoff drainage network. Multiple outfalls along the drainage routes facilitates the strategic management of runoff with a view to maintaining the baseline hydrological regime in so far as possible. Similar to check dams; stilling ponds will be permanent (for the life of the Proposed Development / 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. Stilling ponds are designed to provide attenuation to greenfield run-off rates. A smaller version of stilling ponds, velocity reduction ponds will be included up and down stream of all culverts included in the Development design.

9.5.1.8 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 Turbine Hardstand areas and spoil storage areas. The peat layers Acrotelm and Catothelm will be stored separately until reinstatement and then the Acrotelm layer will be placed on top. 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 Proposed Development 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 Development. 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 and existing drainage network, and their interaction, are assessed in detail and a detailed constructed drainage and attenuation network layout has been provided (see Surface Water Management Plan and Drawings appended to the CEMP, **Appendix 5.1**). 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 Proposed Developer to the planning authority for review and approval. The Proposed Development will be required to adhere to the CEMP during the construction phase.

9.5.1.9 Constraints

The descriptive mitigation measures outlined in this report will be applied to the Development design and construction methodologies with a view to avoiding and/or minimising any potential adverse effects to water quality in the receiving surface water network. Details on how such measures will be applied (objectives, design considerations, layout) are contained in the Surface Water Management Plan (contained in **Appendix 5.1**). The aims and examples of important considerations in relation to mitigation measures described in the EIAR are further clarified here.

As part of mitigation by avoidance principles applied during the design phase of the Development, self-imposed groundwater, surface water, and drainage buffer zones were established where appropriate. Buffer zones intended to inform the design process by minimising or avoiding the risk to surface water receptors and by restricting construction disturbance in these zones. Buffer zones will in turn provide enhanced potential for filtering capacity of runoff and will protect riparian zone vegetation.

The available guidance stipulates that surface water buffer zones should be prescribed to mapped surface waterbodies 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 intersect the 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 agriculture, water resources, direct discharges and wind farm development guidance documents **(Section 8.2.2).**

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 5m to 50m depending on Site specific and activity specific characteristics. For the purposes of this assessment, the following conservative approach has been applied:

- 50m Surface Water Buffer Zone - Mapped surface water features i.e., mapped streams, rivers, lakes. Source for mapped surface water features; EPA.
- 15m Drainage Buffer Zone - Non-mapped drainage features i.e., non-mapped streams, significant natural and artificial drainage features. Source for non-mapped surface water features includes desk study and aerial photography assessment, Lidar topographic data and field observations.

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

Significant drainage features have been identified and mapped in so far as practical. Some drainage features will likely not be recorded due to the extended frequency of these forest drains. 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 development i.e., mitigating for the potential for drainage connection to receiving surface water network and with mitigation they are not likely to have a significant effect.

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., 15m (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:

- 100m Groundwater Buffer Zone – Groundwater abstraction points in relation to proposed access tracks and cable trenches i.e., shallow excavation. Source for mapped abstraction points: GSI. Applicable to the Site, Grid Connection and Turbine Delivery Routes.

- 250m Groundwater Buffer Zone – Groundwater abstraction points in relation to proposed borrow pit and foundations. Source for mapped abstraction points: GSI. Not applicable, none within 250m of the Site.

Not applicable to this Site:

- Source Protection Areas – The entire area mapped as a public or group groundwater supply protection area. Source: EPA. This is not applicable.
- Entire Catchment (Karst aquifer) – 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.
- 15m Karst Features – No karst features identified on Site, depressions, sink holes, swallow holes etc.

While not applicable to this Development, some of the Development infrastructure footprint could typically fall within buffer zones due to the limiting circumstances associated with the Site and the Development, such as 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.

Some portions of the Development footprint fall within assigned buffer areas, including;

- One new Surface Water Crossing i.e., bridge, and associated access track and infrastructure is within a surface water 50m buffer.
- Forty-one new Surface Water Crossings i.e., culverts, and associated access track and infrastructure is within a surface water 15m buffer.
- Some sections of access track and Turbine Hardstands are within a drainage water 15m buffer.
- Cut and Fill around T4 falls within the 50m buffer of a mapped river; Blackwater (Clare), however it is kept out of the minimum requirement of 25m buffer.

Careful consideration and special attention to planning is required for the identified locations within the surface water buffer zones. The Surface Water Management Plan **(Appendix 5.1)** details 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 be agreed within Inland Fisheries Ireland (IFI) and the Local Authority in advance of any construction necessary 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 Increased Runoff Proposed Mitigation Measures – General / Wind Farm

Management and mitigation for earthworks is covered in further detail in **Chapter 10: Soils and Geology**. Mitigation measures to reduce the potential for adverse effects arising from earthworks and management of spoil include the following:

- Management of excavated material – A Peat and Spoil Management Plan has been prepared in **Appendix 5.1**. This Plan incorporates provision on materials management with a view to establishing material balance (reuse of excavation arisings) 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.
- Temporary stockpile locations are identified and will be used to avoid the temporary placement of any excavation arisings outside of the footprint of the Development. Temporary stockpile areas will be managed to facilitate the orderly segregation of material types, be isolated from the receiving surface water network by the use of silt screens etc., are limited in height, and are covered in plastic sheeting during extended temporary periods and ahead of storm alerts.
- 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 (**Chapter 10: Soils and Geology**), an emergency response system has been developed for the construction phase of the Proposed Development (see Environmental Response Plan and Section 5.10 **Appendix 5.1**), particularly during the early excavation phase. This involves 24-hour advance meteorological forecasting (downloadable from Met Éireann) linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g., sustained rainfall (any foreseen rainfall event longer than 4-hour duration) and/or any yellow or greater rainfall warning (>25mm/hour) issued by Met Éireann, planned responses will be undertaken. These responses will include:
- Cessation of all construction works during and until such storm events (yellow warning, Met Éireann), including storm runoff passing over;
- Following heavy rainfall events, and before construction works recommence, the Site construction areas and infrastructure will be inspected by an Environmental Clerk of Works to confirm no additional escalation of response is required; and
- measures will be implemented to ensure safe working conditions, for example, dewatering of standing water in open excavations and repair works to drainage features if necessary.
- Exposed soils/peat (exposed temporary stockpiles) will be covered with plastic sheeting during all heavy rainfall / storm events and during periods where

works have temporarily ceased before completion at a particular area (e.g., weekends, overnight, etc.).

- Sediment fencing will be erected along proximal and paralleling areas of watercourses, channels and drains spanned by the works to reduce the potential for sediment laden run-off to reach sensitive receptors.
- No direct flow paths between stockpiles and watercourses will be permitted at the Site.
- All drainage infrastructure (as per drainage design, **Sections 4 and 5** of the Surface Water Management Plan, **Appendix 5.1**) 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.
- Conceptual and information graphics presented in **Appendix 9.5 – Tile no. 13, 14 and 15** present indicative layout and specification for both passive treatment trains (clean water interceptor drains), active management treatment trains (management and treatment of construction water) and emergency response and intervention.

9.5.2.2 Increased Runoff Proposed Mitigation Measures – Grid Connections

The Grid Connection Route Option will require excavation of cable trenches in existing roadways and HDD. With reference to general excavation practices discussed above, excavation of cable trenches in close proximity to surface water features (Oatfield UCG), 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 effects arising from earth works and management of spoil 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) (**Figure 9.13a Figure 9.13b)**. 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 **Chapter 10: Soils and Geology**, a Peat and Spoil Management Plan has been established and forms part of the Construction & Environmental Management Plan (CEMP, **Appendix 5.1**) 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.
- All spoil from trenches in public roadways will be removed from Site as it is excavated and transported to a licensed 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). All spoil from trenches in public roadways will be removed from Site as it is excavated and reused as a by-product or transported to an authorised facility for soil and stones.

- Earthworks will be limited to meteorologically dry periods and will not occur during sustained or intense rainfall events. Similar to measures outlined in relation to ground stability during excavation works (**Chapter 10: Soils and Geology**), and as discussed in this chapter, an emergency response system has been developed for the construction phase of the Proposed Development (see CEMP in **Appendix 5.1**), particularly during the early excavation phase. This, at a minimum, will involve 24 hours 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 >25mm/hr), planned responses will be undertaken. These responses will include 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 and transfer to treatment train.

9.5.2.3 Clear Felling of Forestry

No new effects 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.

A felling licence will be obtained and in line with licence requirements and conditions, mitigation measures in regard to the management of forestry operations will include:

- Phased felling approach,
- Minimising erosion by use existing tracks and use of brash for off track areas,
- Follow all relevant forestry guidance and policies, including:
  - 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
- The permanent felling of forestry is subject to replacement obligations.
- Harvest site plans including extraction routes, fueling areas, stacking areas, turning areas and drain crossings etc. and HIRA will be designed and implemented during all harvesting operations.
- All drains, either 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.
- Felling and extraction of timber are to be undertaken in dry weather conditions.
- Harvesting operations are scheduled according to the nature of the soil with sites being categorised into winter and summer sites 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 effects include:
  - Limiting the size of the areas to be felled 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.
  - Riparian zones (25m) along mapped surface water features, streams and rivers, will be maintained to prevent erosion or destabilisation, and to enhance buffer or attenuation capacity in the vegetated riparian zone. This can include establishing buffer zones around waterways from which

machines are excluded from. In some instances, this will not be possible, for example; watercourse crossings, and felling excavations associated with T4. In locations where the riparian zone cannot be maintained, particular attention will be given to ensuring active monitoring and management by suitably qualified persons i.e. EnvCoW, and additional temporary measures such as straw bales and silt screens will be deployed where necessary on a case by case basis. This will be detailed in the CEMP and SWMP.

9.5.2.4 Construction Water Management, Dewatering, Treatment & Discharge of Trade Effluent

Mitigation measures to reduce the potential for adverse effects arising from earth works / management of spoil and associated entrainment of solids in runoff and construction water will include the following:

- Conceptual and information graphics presented in **Appendix 9.5 – Tiles no. 13, 14 and 15** present indicative layout and specification for active management treatment trains (containment, management and treatment of construction water) and emergency response and intervention (recycling or diversion of poor-quality runoff to the active management portion of the treatment train). Continuous real time monitoring is also detailed.
- Management of excavations, that is areas of soil / subsoils to be excavated will be drained ahead of excavation works by sumps, in a stepped / phased approach whenever necessary, with the aim of temporarily lowering groundwater levels to allow excavation to be carried out in dry and stable conditions. For example, saturated areas of peat, thus reducing the volumes of water encountered during excavation works.
- Engineered drainage and attenuation features will be established concurrent with excavation works.
- Dewatering flow rate or pumping rate will be controlled by an inline gate valve or similar infrastructure (**Appendix 9.5- Tile 16**) This will facilitate reduction of loading on the receiving drainage and attenuation network, thus enhancing the attenuation and settlement of suspended solids. All pumped water will be discharged to constructed drainage and in line treatment train or to a vegetated surface through a silt bag (**Appendix 9.5 – Tile 12**) outside of surface water buffer zones (**Figure 9.13a**, Surface Water Management Plan, **Appendix 5.1 and Appendix 9.5 – Tiles 13 and 14**). Dewatering is a dynamic process and will require continuous monitoring and modification depending on conditions encountered (**Appendix 9.5 – Tile 16**).
- In some areas of the Development constraints related to construction activities within the prescribed buffer zones, will likely limit the potential for installation of engineered attenuation features. In such instances water arising from dewatering activities will be directed or pumped to a settlement tank (**Appendix 9.5 – Tile 11**) before being discharged to the receiving drainage network or pumped to an area of the Site where the installation of attenuation features is

suitable. Areas with such constraints are presented in **Figure 9.13a Figure 9.13b.**

- No extracted or pumped water will be discharged directly to the drainage or surface water network associated with the Site (This is in accordance with the Local Government (Water Pollution) Act, 1977 as amended).
- All pumps, tanks, settlement ponds, dewatering bags and check dams used in the dewatering process will be regularly inspected and maintained as necessary to ensure surface water run-off is appropriately treated.

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 9.5 Tiles 13-15**).

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 9.5 – Tile 15**):

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 arising 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. 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).

H. 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.

I. Stilling Pond By-Pass. Similar to Discharge By-Pass, if conditions dictate water will be diverted directly to Settlement / Treatment Tank.

J. Settlement / Treatment Tank. A settlement tank will in line and ready to use if required e.g., if., 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 will 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. 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 will 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 will 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, works will be within buffer zones. In these instances, waters will be pumped to the treatment train which can be positioned upgradient along the road (Grid Connection route) where discharge to vegetated areas / roadside drains can be managed.

Discharge of non-contaminated storm runoff to vegetated land within the Redline Boundary will be made in relatively low flow conditions (e.g., <2 litres per second (l/sec) typical of runoff over a relatively small site area. In the event that the expected incoming flow rate or dewatering rate is relatively high (>2 l/sec) a discharge licence will be acquired and all conditions adhered to.

The discharge points will be located outside of buffer zones and into minor or non-mapped surface water / drainage features. The main components of the treatment will be positioned outside of the 50m surface water buffer zone where possible. Suitable locations for temporary infrastructure will be identified having due regard to variables such as traffic and access management. 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., >25mg/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 will 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. 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 50m surface water buffer areas (similar to dewatering of excavations). The quality of water discharged will comply with discharge limits in any water discharge licence and will be monitored in real time (telemetry with 15 min sampling rate).

Excavation Dewatering Proposed Mitigation Measures - Passive Construction Water Management

Passive management systems (**Appendix 9.5 – Tile 13,** refer also to diagrams in **Surface Water Management Plan, Appendix 5.1**) 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. 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, (**Appendix 9.5 -Tile 17**). 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 perimeter 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 alongside adjacent watercourses.

Passive systems are intended to function with minimal supervision, however in the management of construction water on this Site or Development, in many cases the diverted water will likely require active management to ensure sensitive receptors are protected. For example, diverted stormwater, 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.

9.5.2.5 Release and Transport of Suspended Solids Proposed Mitigation Measures

Conceptual and information graphics associated with mitigating runoff quality are presented in **Appendix 9.5 – Tiles 13 - 14.**

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 to control increased runoff and associated suspended solids loads in runoff during intensive construction activities e.g., excavation of Turbine Foundation. 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, excavations will be completed in line with expected phases of Turbine Hardstand and site access track construction, in terms of both delivery of and installation of material. 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 9.5.2.1)**.

Diffuse surface water runoff will be managed as follows:

- With reference to Section 5, Surface Water Management Plan in **Appendix 5.1,** collector drains and/or soil berms will be established to direct/divert surface water runoff from development areas, including temporary stockpiles, and direct same into established treatment trains including stilling ponds, buffered discharge points or other surface water runoff control infrastructure as appropriate. This is particularly important for effective surface water management associated with proposed infrastructure within the varied surface water buffer zones. The drainage system will be permanent (see also **Appendix 9.5** for conceptual graphics).
- Silt fences will be established along the perimeter of source areas e.g., stockpiles, within the drainage network, and in existing natural drains and degraded peat areas which are likely to receive surface water runoff. **Appendix 9.5 – Tile 17,** Section 5.5 of the Surface Water Management Plan in **Appendix 5.1,** describes this in more detail. This will reduce the potential for surface water runoff loaded with suspended solids to rapidly infiltrate towards and be intercepted by drainage or significant surface water features. Where possible multiple silt fences will be installed at multiple locations in drains / treatment trains discharging to the surface water network. Double silt fences / screens will be deployed at outfalls within surface water buffer areas. Silt fences will be temporary features but will remain in place for a period following the completion of the construction phase until such time that Site conditions are stable.

Waters arising as a product of excavation activities will be managed as follows:

- Waters arising from dewatering practices during excavation works will be significantly loaded with suspended solids. As such, constructed stilling ponds followed by buffered outfalls may be insufficient in controlling the release of suspended solids to the surface water network. Routine monitoring will prevent the possibility of clogging from 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 **(Appendix 9.5 – Tile no. 13 and 14).** This will include continuous active monitoring of water quality by turbidity measurement on an hourly basis.

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 construction, by retaining water, thus reducing the hydraulic loading to watercourses. Stilling ponds are designed to reduce flow velocity to 0.3m/s at which velocity, silt particle settlement occurs. Stilling ponds will be permanent (life of Development at minimum). The locations of stilling ponds have been specified as a part of the drainage design, refer to planning drawings. 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 (**Appendix 9.5 - Tiles 6 – 10,** Section 5.6 of Surface Water Management Plan in **Appendix 5.1**). Check dams will reduce the velocity of run-off in turn facilitating the 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 9.5 – Tile 10**) will also be used if properly anchored, that is; supported with rock or fitted timber to reduce potential for material to be swept away by incoming water. Multiple check dams will be 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 are preferred as this will ensure that rapid surface water runoff is mitigated against for the life of the Development.
    - Check dams will be installed at c. 20m intervals within the length of drainage channels. This is dependent on the slope angle and height of check dams constructed, refer to **Appendix 9.5 – Tile no. 3 and 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.

  - 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 1.2m.
  - Check dams will be constructed as part of the drain i.e., reduce the potential for bypassing between the drain wall and check dam.
  - Further details and design considerations are presented in **Appendix 9.5 – Tile 5 to 7,** refer also to Section 5.6 of Surface Water Management Plan, **Appendix 5.1.**

- Surface water runoff will be discharged to land via buffered drainage outfalls **(refer to Appendix 9.5 Tiles 4 and 5, see also Figure 3 in Surface Water Management Plan, Appendix 5.1)**. 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, removing sediment loading to acceptable levels any adjacent watercourses and avoiding direct discharge to the watercourse. A relatively high number of discharge points / buffered outfalls have been established as part of the design, 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.
- 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) (**Appendix 9.5 – Tile 5**). These structures will be akin to rip raps (coastal erosion defences/ outfall erosion defences). Silt fences **(Appendix 9.5 – Tile 17** Section 5 of Surface Water Management Plan, **Appendix 5.1**) 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, **Appendix 9.5 – Tile 13**. 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 (by the Contractor's Environmental Manager and supervised by the Developer appointed Environmental Clerk of Works (EnvCoW) as per the manufacturer's instructions. Flocculants are made from ionic polymers. Cationic 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. Therefore,

when flocculants are required, the material used will be made from anionic polymer. Gel blocks will be a temporary measure during the construction phase.

- Straw bales (similar to stone check dams) (**Appendix 9.5 - Tile 18)**, and silt fences (discussed under diffuse runoff) 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 be checked 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.

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 (>25mg/l suspended solids) the treatment train will be augmented through the use of anionic polymer gel blocks. These measures will reduce the suspended sediment and associated nutrient loading to surface water courses and mitigates potential effects to water quality and on plant and animal ecologies downstream of the Site.

Particularly sensitive areas are identified and presented in **Figure 9.13a.** Refer also to specific constraints relating to drainage, outfalls and stability in **EIAR Chapter 10 Land, Soils and Geology.** Sensitive areas include identified Site constraints / buffer zones, but also particular areas with elevated soil or slope stability risk results. Drainage design will not include outfalls discharging to those particular sensitive areas without proper consideration and tailored mitigation in buffer zones and will be avoided outright in areas of elevated risk. Constraints highlighted along proposed Grid Connection Routes are presented in **Figure 9.13b and Appendix 10.2.**

The precautionary and mitigation measures listed here will avoid, reduce or remedy all potential adverse effects on water quality and will ensure that the sensitive receptors in the catchment of the Development do not suffer any deterioration in water quality, either during construction, operation, or Decommissioning. .Proposed mitigation measures will ensure that, the risk of elevated suspended solids to surface waters is **neutral to slight**. This in turn will ensure that potential risks to sensitive receptors is also **neutral to slight**. Nevertheless, should a significant discharge of suspended solids to surface waters occur, the absence of an immediate proximity to designated sites and the assimilative capacity of the localised surface waters will act as a natural hydrological buffer in terms of suspended solids loading. Should such a discharge occur, the dilution and retention time of suspended solids in the localised surface water network will reduce potential likely effects on highly sensitive downstream designated sites. It should be noted that this natural mitigation measure is not to be adopted as a first principle and is not to be relied upon to prevent adverse effects on designated sites, it should be considered as a last line of defence. Where required i.e., unfavourable site conditions detected through monitoring (**Section 9.5.2.14**), escalation of mitigation including active management of construction water (**Section 9.5.2.2**) will be employed before favourable conditions permit using passive or nature based systems.

9.5.2.6 *Ground stability and compaction Proposed Mitigation Measures*

Vehicular movements will be restricted to the Development footprint (**Figure 9.1**) and advancing ahead of any constructed hardstand will be minimised in so far as practical. This will include any temporary stockpiling. For example, excavation ahead of established hardstands will be in line with expected phases of Turbine Hardstand and site access track 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.

The only exception to limiting vehicular movements to the footprint of the Proposed Development will be for peat cutting. Peat cutting is in line with baseline conditions / Do Nothing impact, will be carried out in line with peat cutting operations best practice guidance, and in line with relevant mitigation measures set out in this report in terms of monitoring ground stability locally and managing potential sources of contamination. The management vehicles used for tree felling will align with measures set out in this report, for example; spill kits to hand, etc. During construction down time / overnight, vehicles will be stored in suitable locations on the Proposed Development footprint and not left un-manned on vegetated / tree felling / soils areas, or within sensitive areas / receptor buffers.

Where vehicular movements are necessary outside of the Proposed Development footprint, ground conditions will be maintained and reinstated. This includes for example replacing sods, smoothing over with excavator bucket etc. Where ground conditions are poor, or prolonged works, temporary access measures will be deployed, for example floating platforms / floating access track.

For the Grid Connection route, before starting construction, the area around the edge of each joint bay which will be used by heavy vehicles will be surfaced with a terram cover (if required) and stone aggregate to minimise ground damage.

Implementation of proposed mitigation measures described will minimise the adverse effects posed by vehicular movements, and any localised unforeseen impacts will trigger escalation of response ensuring locations are restored and any potential pathways to receptors are isolated.

9.5.2.7 *Release of Hydrocarbons Proposed Mitigation Measures*

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

- Refuelling of vehicles will be carried out off Site to the greatest practical extent. This refuelling policy will mitigate the potential for effects by avoidance. Due to the remote location nature of the Site, occasional on-site refuelling may be necessary (e.g., bulldozers, cranes, etc.). In instances where refuelling of vehicles on Site is unavoidable, a designated and controlled refuelling area will be established at the Site. The designated refuelling area will enable low risk refuelling and storage practices to be carried out during the works. The designated refuelling area will contain the following attributes and mitigation measures as a minimum requirement:

- The designated refuelling area will be located a minimum distance of 50m from any surface waters or Site drainage features
- The designated refuelling area will be bunded to 110% volume capacity of fuels stored at the Site
- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund
- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis, including Decommissioning following construction.
- Any oil contaminated water will be disposed of as appropriate and disposal will comply with all relevant legal requirements. licensed waste 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 will be reused, recycled or disposed of offsite in an authorized facility .

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

- Oil absorbent booms and spill kits will be available adjacent to all surface water features associated with the Development. The controls will be positioned downstream of each construction area and at principal surface water drainage features. Oil booms deployed will have sufficient absorbency relative to the potential hazard.

- Spill kits will also be available at construction areas such as at turbine erection locations, the Temporary Construction Compound, Electrical Substation, spoil storage areas and Met Mast location etc.
- Spill kits will contain a minimum of oil absorbent pads, oil absorbent booms, oil absorbent granules, and heavy-duty refuse bags for collection and appropriate disposal of contaminated matter.
- Should an accidental spill occur during the construction or operational phase of the Development, such incidents will be addressed immediately under emergency protocols, 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.

Further precautionary measures and emergency response protocols have been established and specified in the CEMP, **Appendix 5.1** and **Section 9.5.3** of this Chapter. The above mitigation measures will ensure that there will not be a significant effect on the environment.

9.5.2.8 Release of Horizontal Direction Drilling Fluid Proposed Mitigation Measures

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 associated and 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, Section 9.2.3.

Risk assessments will identify pathways and receptors for each potential source of contamination are identified in EIAR **Volume III, Appendix 10.2a & 10.2b** and this is particularly important in relation to groundwater source protection zones and surface water bodies. Prescription mitigation measures are driven by the identification and qualified risk associated with each particular location and are as follow:

- All chemical fluids used in the HDD boring process will be inert to the environment (environmentally safe) and follow the relevant legislation. The contractor is to retain a chemical register and have the Material Safety Data

Sheet (MSDS) documents available onsite during the operation. The contractor will also be responsible for a Fluid Management procedure which will include:

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

Only environmentally acceptable drilling fluids will be used in the HDD process e.g., Biodegradable with low to no bentonite concentrations. Section 9.5.2.15 outlines a contingency plan in the event that a drilling fluid spill or 'breakout' occurs.

9.5.2.9 Release of Wastewater Sanitation Contaminants

A Temporary Construction Compound area will be constructed on-site to contain temporary facilities for the construction phase including 'port-a-cabin' structures. The Temporary Construction Compound will be constructed on a base of geo-textile matting laid at ground level. This will be stabilised 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 located in the Temporary Construction Compound will be collected and held in a sealed storage holding tank, fitted with a high-level alarm. The high-level alarm is a device installed in the storage tank that is capable of sounding an alarm during a filling operation when the liquid level nears the top of the tank. Chemicals are likely to be used to reduce odours.

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

9.5.2.10 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 procurement, transport and use of any cement or concrete 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 (EnCoW). This entails minimising quantities on Site, planning delivery routes and washout stations.
- Precast concrete will be used wherever possible. Elements of the 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. 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 cement or concrete to the Site will be visually inspected for signs of excess cementitious material prior to being granted access to the Site **Appendix 9.5 – Tile 21**. This will prevent the likelihood of cementitious material being accidentally deposited on the site access tracks or elsewhere at the Site or on the public road network.
  - 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.

- Concrete will be poured during metrological dry periods/seasons in so far as practical and reasonably foreseeable. 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 (>3mm/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 not be done. Excavations will be prepared before pouring of concrete by pumping standing water out of excavations to the buffered surface water discharge systems in place.
- Any required shuttering installed to contain the concrete during pouring will be fully secured around its perimeter to minimise any potential for leaks. Additional measures will be taken to ensure this, for example the use of plastic sheeting or other sealing products at joints.
- No surplus concrete will be stored or deposited anywhere on Site.
- Raw or uncured waste concrete will be disposed of by removal from the Site and returned to the source location or disposed of appropriately at a suitably licensed facility.
- 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 Site and this will take place at a designated area at the 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.
- Temporary storage of cement bound sand (if required for construction of the substation building) 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.

- Spill kits will be readily available to site personnel, and any spillages or deposits will be cleaned up as soon as possible and disposed of appropriately.

9.5.2.11 Watercourse Crossings Proposed Mitigation Measures

The Development of the wind farm includes the construction of forty one (No. 41) watercourse crossings culverts and 1 No. bridge to be constructed as part of facilitating access to the proposed turbines. The required bridge crossing is a proposed clear span structure over the Blackwater (Clare) River, the locations of the proposed crossings are mapped in **Figure 9.2a.** These crossings require detailed planning and consideration to ensure potential effects are assessed adequately and in turn mitigated against.

All watercourse crossings must be designed to facilitate peak, or storm discharge rates so as to avoid localised flooding and associated issues during storm events. Data presented in **Appendix 9.1 – Oatfield Flood Risk Assessment,** indicate potential surface water discharge rates during a 1 hour storm event and a 24 hour storm event with a 1 in 100 year return period along with 20% to include for climate change. Note: Upstream catchment areas are estimated and delineated by assessment of mapped catchment boundaries, topographical contours and existing infrastructure and associated drainage. The above assessment is a conservative estimation which does not consider evapotranspiration or recharge to ground, or base flow and groundwater discharge to the respective surface water features.

In relation to the design and construction of watercourse crossings risk assessment and prescription of mitigation measures have been designed in accordance with relevant guidance and reference documents **(Section 9.2.2).**

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). The requirements of OPW have been incorporated into the design of the proposed watercourse crossings. Preliminary design details are included in drawings (**20959-NOD-XX-XX-DR-C-08301_S4_P01, 20959-NOD-XX-XX-DR-C-08050**).

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.

Where existing closed culverts/pipes are in place at existing watercourse crossings (WCC12, WCC17, WCC19, WCC36, WCC42, WCC43, WCC44 AND WCC45 from **Table 9.1 and Table 9.2** extending the existing closed culvert will minimise construction activities required and in turn minimise potential impacts when compared to removal and replacing the entire watercourse crossing.

The discussion to use single span structures is 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) for river waterbodies in upland or transitional river segments.

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 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, in line with 'good practice' defined by SEPA.

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, all crossings over mapped rivers will be Clear Span Bridges.

This is 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.

Considering the width of all waterbodies associated with crossings discussed here (<2m width) in stream supports will not be required for the construction of single span structures.

The design facilitates adequate hydraulic capacity (**Volume III**). This ensures that the design will maintain the existing channel and will facilitate peak discharge events (storm events) without flow being constrained and contributing to flooding or other issues. Values presented **Section 9.3.7** indicate the potential discharge rate associated with each watercourse crossing during a 1 in 100 year storm event. 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.
- The design facilitates adequate freeboard to OPW requirements. The design facilitates passage of woody debris. Freeboard to facilitate navigation and

recreation is not applicable in relation to the development and associated surface water features.

- For single span structures, abutments will be set back from the river channel (**Appendix 9.5 – Tile 1**) 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. Foundations (of abutments) will be deep enough to minimise or prevent the need for bed or bank reinforcement or bridge weirs or aprons. This will maintain the natural bed material and bed levels, protecting habitat and allowing fish passage. Foundations will be buried deep enough to allow for scour during high flows. Construction will be supervised by a suitably qualified engineer who will confirm that the depth is as per the design.
- The design minimises the potential for localised bank and bed erosion, refer to Planning Drawing No. **20959-NOD-XX-XX-DR-C-08301_S4_P01**, **20959-NOD-XX-XX-DR-C-08050**

In regard to the Turbine Delivery Route:

- There are no culvert crossings proposed for the Turbine Delivery Route.

In regard to the Grid Connection:

- There are two watercourse crossings proposed for the Grid Connection.
- One existing culvert to be upgraded and one bridge. These are outlined in **Table 9.2**

(* **Note:** Likely to be additional minor culverts).

  - With reference to **Section 9.3.13** Flood Risk Identification some portions of the Grid Connection are within a mapped probable flood zone. To mitigate against any potential for onsite flood risk and consequences, it will be a strict requirement to carry out works at this location during seasonally dry conditions. Exposed soils and fill materials will be reinstated and/or will have erosion control installed as part of the design and sufficient time as to be in place prior to the next seasonally wet period. This will minimise the potential for flood events to impact on the construction works, plant machinery or operators etc, and will minimise the potential for entrainment of soils or other materials in high water flow during potential flood events.

In regard to the Site Underground Cabling:

- There are eight culvert crossings proposed for the Site Underground Cabling.

The potential for the actual construction of such crossings to have significant adverse impacts on the receiving watercourse/s through general construction activities such as those outlined in **Section 9.5.2.2 and 9.5.2.4** i.e., the release of suspended solids and hydrocarbons for example. Relevant guidance documents **(Section 9.2.2)** have been consulted and applicable mitigation measures have been incorporated into the design of the culverts and construction methodology of same. These will be adhered to with a view to mitigating and reducing any potential impact on the receiving watercourse.

9.5.2.12 In-stream Works

Infrastructure such as culverts over natural or artificial drainage channels and non-mapped rivers will require in-stream works. Where culverts are required and the subsequent in-stream works are necessary, 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 prior to commencing works (as part of the watercourse crossing consent application). Relevant guidance referenced is presented in **Section 9.2.2**. Method statements will be included in the CEMP, **Appendix 5.1.**
- 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 9.5 – Tile 16**) 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 9.5 – Tile 16** 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), 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 downstream of the watercourse crossing. With reference to **Chapter 7: Ecology**, clear span design of the bridges/crossings will not affect instream aquatic habitat or interfere with the passage of fish or aquatic fauna
- 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 9.5 – Tile no. 16**). 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 9.5 Tiles 11 and 12**). The quality of the water being discharged will be monitored. If discharge water quality is poor (e.g., >25mg/l) additional measures will be implemented, for example 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 Site (an example is provided in **Appendix 9.5 – Tile 12**). 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 the surface water buffer areas (similar to dewatering of excavations). For further details refer to **Appendix 9.5 – Tiles 11 to 12, 19**.

- 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 (**Appendix 9.5 Tile 16**), discussed further below.
- 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 (**Section 9.5.2.1**).
- 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, should they become necessary (**Appendix 9.5 – Tile 20**).

9.5.2.13 Diversion of Drainage

Diversion of artificial drainage channels will be required at locations where the development layout intercepts existing artificial drainage networks (**Figure 9.6a**), for example T1, T2, T6 and T8, T9, T10 and T11 and their 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 9.5– Tile 2**), 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 (**Management Plan 3, Appendix 5.1).** The use of silt screens as a form of mitigation during watercourse crossing works is considered a precautionary measure. Refer to **Appendix 9.5 – Tile 17 and 19** for further information on the recommended ordering of control measures.

9.5.2.14 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 Development 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 Development. In order to mitigate against potential groundwater contamination by hydrocarbons, implementation of the following mitigation measures is recommended:

- In the first instance, no fuel storage should occur at the Site whenever feasible and refuelling of plant and equipment should occur off Site at a controlled fuelling station.
- In instances where on Site refuelling is unavoidable, then the bunded on Site designated refuelling area must be used. The designated refuelling area must be bunded to 110% volume capacity of fuels stored at the Site.
- The bunded area will be drained by an oil interceptor that will be controlled by a pent stock valve that will be opened to discharge storm water from the bund.
- Management and maintenance of the oil interceptor and associated drainage will be carried out by a suitably licensed contractor on a regular basis.
- Any oil contaminated water will be disposed of at an appropriate oil recovery plant.
- 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 are recommended in relation to non-hydrocarbon potential contamination of groundwater:

- All other liquid-based chemicals such as paints, thinners, primers and cleaning products etc. will be stored in locked and labelled bunded chemical storage units.
- Sanitation facilities used during the construction phase will be self-contained and supplied with water by tank trucks. These facilities will not interact with the existing hydrological environment in any way and wastewater will be removed off-site weekly, by a licensed wastewater disposal company and disposed at an appropriate licenced facility throughout the construction phase.
- The controlled attenuation of suspended solids in settlement ponds and check dams etc. will result in inorganic nutrients (if present in elevated concentrations) such as phosphorus and nitrogen being absorbed and retained by the solids in the water column. This will allow for a reduction of peak inorganic discharges in a controlled and stable run off rate. It is noted that the presence of elevated contaminants was detected during the four surface water quality monitoring rounds.
- It is considered that there is a low risk of mobilising trace metals that may naturally be present in low concentrations in the baseline environment. The potential for mobilising trace metals is most likely to result from enhanced water percolation associated with excavated bedrock substrate. To mitigate against

this potential impact, water quality should be monitored for trace metal concentrations prior to, during and after the construction phase.

- The potential for livestock such as cattle and sheep which have been observed grazing in the vicinity of the Site to cause bacteriological contamination of groundwater will be controlled through the implementation of strict grazing control zones, Site perimeter fencing and exclusion zones around all open excavations.

9.5.2.15 Groundwater Extraction Proposed Mitigation Measures

The extraction of groundwater from boreholes for the purpose of potable water supply will not be required for either the construction or operational phase of the Proposed Development.

9.5.2.16 Water Quality Monitoring

Monitoring (Wind Farm Site)

The appropriate monitoring of peat, subsoils, and bedrock, alongside material management during the construction phase of the Development will be fundamentally important in ensuring that potential suspended solid entrainment in surface waters is minimised. With comprehensive planning, preparation, and implementation of relevant mitigation measures contained in the CEMP, the potential for elevated suspended solids to be released to surface waters via runoff is likely to be minimal and the effects are not likely to be significant. Monitoring of surface water quality is discussed in greater detail in **Section 9.5.2** of this chapter.

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 by the Developer to carry out monitoring at the Site during the construction phase of the Development, and for the monitoring period that follows completion of the Development. The role of the EnvCoW will be to actively and continuously monitor Site conditions and advise on environmental issues and monitoring compliance, but will not be responsible for implementing measures, as 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 effects are minimised if not avoided. The following wind farm Site monitoring recommendations will be undertaken by the EnvCoW assigned by the Developer to mitigate against potential effects on the surface water and groundwater receiving environment:

- 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 Site (locations close to active working zones). 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, <25mg/l Total Suspended Solids (TSS).

- Telemetric continuous Monitoring will be carried out as part of Active Management of construction water management and treatment for the duration of the construction phase of the Development (**Appendix 9.5**). 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., 25mg/l TSS)
- Telemetric continuous Monitoring at downstream Baseline SW Monitoring Locations will be carried out using telemetry for the duration of the construction phase. Triggering of the threshold at these locations will trigger emergency response and escalation of measures including immediate full Site inspection to ascertain to the potential unknown source (bearing in mind that the quality of managed runoff at the Site will be known by means of live telemetry and handheld meters). Telemetric continuous monitoring at Baseline SW Monitoring Locations will continue into the operational phase until such time it is confirmed the construction phase is complete and there are no further construction activities required on site, and when stable conditions are observed i.e., stable conditions in line with baseline conditions observed for 2 months following the completion of the construction phase.
- 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 Development, the stilling ponds and buffered outfalls will be checked on a weekly basis during maintenance visits to the Site. This will continue but will be reduced when stable conditions are observed. The frequency of monitoring will be aligned with ecological monitoring in enhancement areas, following storm events, and otherwise on a quarterly basis at minimum.
- During the construction phase of the Proposed Development, the 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 Development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.

- A programme of water quality monitoring outlining the selected parameters and monitoring frequency should be agreed with Inland Fisheries Ireland and Clare County Council prior to the commencement of construction. During the construction phase of the Proposed Development, the Development areas and adjacent receiving drainage systems will be monitored daily for evidence of erosion and other adverse effects to natural drainage channels and existing degraded areas whereby soils/peat are exposed and prone to enhanced degradation. This monitoring will continue initially on a weekly basis during the operational phase of the Development, and gradually reduced based on observed stability, 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 Proposed Development 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 CEMP in **Appendix 5.1.** This includes 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 Development. Monitoring will continue into the operational phase until such time that the 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 locations.

- 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.
- 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, 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 Proposed Development 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 9.5 – Tiles no. 13 to 15.**
- 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 have been 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 ongoing 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 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 poses relatively significant flow rates, isolating and over pumping is the best course of action.
- As part of the CEMP contained in **Appendix 5.1** 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 as per the CEMP, until remediation or upgrading works are completed by the Developer.
- All details in relation to monitoring will be included in the Surface Water Management Plan **(Appendix 5.1).**

Monitoring of potential hydrological impact of the Development, particularly during the operational phase will be inherently linked to the ecological health of the blanket peat (as a functioning ecosystem) and therefore both hydrology and ecology will be considered and monitored in tandem. For example, effects 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, 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 rainfall, enhanced potential for recharge to ground, and in turn raising bog water levels resulting in wetting of blanket peat at the Site.

Active Monitoring on Site

Handheld meters (Turbidity / Total Suspended Solids (TSS)) will used by the EnvCoW / competent operators during construction works. This will be done with a view to managing water treatment and anticipating potential surcharges in water or TSS loading within the treatment train. Handheld meters will also be used to monitor outfall/discharge quality in the event telemetry systems fail or during system maintenance. Handheld probes will be checked and calibrated regularly.

Monitoring Under License

Where discharge licence is required, monitoring in line with the licence will be done in addition to the other monitoring regimes undertaken as described in sections above. Sampling will include obtaining physical samples at an agreed discharge sampling point and will be sent an accredited laboratory for analysis. Monitoring under licence conditions will not negate the requirement for the other regimes described.

Tailoring Monitoring Requirements

Monitoring will be tailored at each location in terms of requirements set out in trade effluent discharge licence/s where relevant.

- The baseline monitoring undertaken at the Site as part of this study will be repeated periodically before, during and after the construction phase of the Development to monitor any deviations from baseline hydrochemistry that occur at the Site. This monitoring along with the detailed monitoring outlined below will help to 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 Development should 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 site. Monitoring of same during times when excavations are being dewatered (likely high in solids) should be done in real time.
- 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 (weekly initially gradually reduced based on observed stability of conditions), and will also be scheduled following extreme metrological events. During the operational phase of the Proposed Development the stilling ponds and buffered outfalls will be inspected on a weekly basis during maintenance visits to the Site. This may be gradually reduced to fortnightly checks at minimum, based on observed stability of conditions during maintenance visits to the Site.
- During the construction phase of the Proposed Development, the development areas should 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.
- During both the construction and operational phases of the Proposed Development, watercourse crossings should be monitored frequently (daily during construction and weekly to fortnightly, during operational phase, until such time as conditions prove stable). 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 has been specified in the Construction and Environmental Management Plan (CEMP in **Appendix 5.1**).

Emergency Response

Mitigation measures outlined in the previous sections of this chapter will significantly reduce the potential for contamination of surface water or groundwater associated with the Development to insignificant. Nevertheless, as is the case with all construction Proposed Development, a risk of accidental chemical spillages, sediment overloading of control measures or leaks of contaminants from plant or equipment remains a possibility. Emergency response procedures to potential contamination incidents will be prepared as part of the site specific CEMP and will be implemented at the Site prior to the commencement of the construction phase. The following is a non-exhaustive list of potential emergency scenarios where corrective action may be required, and proposed corrective mitigation measures are included:

- 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 9.5 – Tile no. 13 to 15**).
- 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 blanket peat ecosystems. 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 effects to ecological sensitivities will become apparent relatively slowly in comparison. It is noted that much of the Site is impacted as

part of baseline (**Section 9.3.7 and Section 9.4.4.1**) in this regard e.g., extensive existing artificial drainage networks.

Prior to commencement of construction, the EnvCoW 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.

Compliance with mitigation measures as outlined in the previous sections will mean that any effects on the environment during the construction phase of the proposed Development are not likely to be significant, 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 in **Appendix 5.1.** 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.
- 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.

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

9.5.3 Operational Phase

9.5.3.1 Increase in Hydraulic Loading Proposed Mitigation Measures

The principles of the mitigation measures described under **Section 9.5** (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 Development.

The same measures will be implemented with a view to mitigating against net increase surface water runoff arising from the Development. For example, the following model will be applied at a proposed Turbine Hardstand locations:

- Collector drains; allowing for 0.5m depth, 1.0m width, presume semi-circular, sectional area; c. 0.4m^2. Presume 100m length of collector drain; up to 40m^3 capacity per 100m, by 50% allowing for gradient equates to 20m^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 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 9.5 – Tile 3, 13 and 14, 19).**

The Development will lead to an increase in impermeable surface area through the construction of hardstand areas within the Site. This in turn will lead to an increase in hydraulic loading by surface water runoff. Preliminary water balance calculations indicate that the worst-case net increase in surface water runoff volumes will be approximately

13.58m^3/hour or 3770 l/sec (or 0.19%) relative to the approximate area of the Site (381m^2), therefore this is considered an imperceptible, or not significant impact. The combined attenuation capacity of the proposed drainage infrastructure, checked dams, stilling ponds, etc. (**Appendix 5.1**) has been designed to attenuate net increase in water runoff during extreme storm events i.e., 1 in 100-year storm event plus a 20% allowance for global warming, as set out in **Appendix 9.1 – Oatfield Flood Risk Assessment.**

In line with the approach laid out in Section 9.2.1.2***,*** mitigation measures have been designed to reduce Proposed Development specific residual impacts to neutral or slight. With appropriate environmental engineering controls and measures, these potential risks will be significantly reduced and are considered likely to be insignificant.

9.5.4 Development Decommissioning & Reinstatement

As discussed in **Section 9.4.5**, no new significant effect on the surface water and groundwater receiving environment are anticipated during the Decommissioning phase of the Proposed Development. The Decommissioning phase of the Proposed Development, as outline in the Decommissioning Plan (contained in the CEMP in **Appendix 5.1)**, would result in the removal of Site infrastructure such as wind turbine blades, towers, transformers, etc. Decommissioning the proposed development will take approximately 6 months to complete.

The excavation of peat is expected during the Decommissioning phase, but, however, to a far lesser extent when compared to that of the construction phase. For instance, it is proposed some of the turbine foundations will remain in situ and upon turbine dismantling and redressed with peat. Similarly, the movement of plant, vehicles and equipment is expected to be required during the Decommissioning phase, but to a far less extent than during the construction phase. As a result, there remains a risk of elevated suspended solids being discharged in surface water run-off to the downstream receiving environmental during the decommissioning phase. Additionally, the potential risk remains for spills of fuels /hazardous chemicals which is a common risk to all developments. The mitigation measures outlined in this EIAR will be implemented during the Decommissioning phase, as well as those outlined in the Decommissioning Plan (contained as part of the CEMP in **Appendix 5.1**), to reduce the potential for such effects.

This is considered a **direct, neutral** effect of the Development, which contrasts to the baseline conditions.

9.6 Residual effects

The unavoidable residual effects on the hydrology and hydrogeology environment as a function of the Proposed Development is that there will be a change in the hydrological regime at the Site with changes in flow, drainage, increase in runoff and potential release of suspendered solids from construction activities, such as peat, subsoil and bedrock being replaced by concrete, subgrade and surfacing materials. This is a **direct, localised, adverse, moderate significance at a local scale, direct permanent** change to the hydrological regime at the Site.

9.6.1 Construction Phase

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

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

The residual effects after implementation of all mitigation measures for the construction phase of the development are summarised below.

9.6.1.1 Increased run off from development works due to earthworks

Mitigation measures outlined above 9.5.2.1 and 9.5.2.2 will ensure the effect arising from earthwork activities to the surrounding receptors are minimised to a **direct, adverse**, **neutral to slight** effect of the Proposed Development.

9.6.1.2 Clear fell of afforested areas

Following the mitigation measure outlined in 9.5.2.3 the residual effects associated with felling are **slight to beneficial** and **permanent / reversible**.

9.6.1.3 Construction Water Management, Dewatering, Treatment and discharge of trade effluent

Mitigation measures outlined in 9.5.2.4 will ensure the effect arising from excavation dewatering processes to the surrounding receptors are minimised to a **direct, adverse, neutral to slight** effect of the Proposed Development.

9.6.1.4 Release and Transport of suspended soilds

Mitigation measures outlined in 9.5.2.5, will ensure the effect arising from a potential release of suspended solids are minimised to **neutral or slight.**

9.6.1.5 Ground Stability and Compaction

Mitigation measures outlined in 9.5.2.6, will ensure the effect arising from earthwork activities to the surrounding receptors are minimised to a **direct, adverse**, **neutral to slight** effect of the Proposed Development.

The residual effects following mitigation associated with vehicular movement are considered to be **not significant** and **long term to permanent.**

9.6.1.6 *Release of Hydrocarbons and storage*

Mitigation measures outlined in 9.5.2.7, will ensure the effect arising from a potential hydrocarbon spill to the surrounding receptors are minimised to a **direct, adverse, neutral to slight** effect of the Proposed Development.

9.6.1.7 *Release of HDD materials*

In line with the approach laid out in Section 9.2.2, mitigation measures have been designed to reduce Proposed Development specific residual impacts to **neutral or slight** as outlined in Section 9.5.2.8.

9.6.1.8 *Release of Wastewater sanitation contaminants*

Mitigation measures outlined above will ensure the effect arising from a potential wastewater or sanitation contaminant spill to the surrounding receptors are minimised to a **direct, adverse, neutral to slight** effect of the Proposed Development. This are outlined in 9.5.2.9.

9.6.1.9 *Release of Construction or cementitious materials*

In line with the approach laid out in Section 9.2.1.2***,*** mitigation measures have been designed to reduce Proposed development specific residual impacts to **neutral or slight** as outlined in 9.5.2.10. With appropriate environmental engineering controls and measures, these potential risks will be significantly reduced and are considered likely to be insignificant.

9.6.1.10 *Watercourse crossings*

In line with the approach laid out in Section 9.2.1.2***,*** mitigation measures have been designed to reduce Proposed Development specific residual impacts to **neutral or slight** as outlined in 9.5.2.11. With appropriate environmental engineering controls and measures, these potential risks will be significantly reduced and are considered likely to be insignificant.

9.6.1.11 *Instream works*

In line with the approach laid out in Section 9.2.1.2***,*** mitigation measures have been designed to reduce Proposed Development specific residual impacts to **neutral or slight** as outlined in 9.5.2.12. With appropriate environmental engineering controls and measures, these potential risks will be significantly reduced and are considered likely to be insignificant.

9.6.1.12 *Diversion of drainage*

In line with the approach laid out in Section 9.2.1.2*,* mitigation measures have been designed to reduce Proposed Development specific residual impacts to **neutral or slight** as outlined in 9.5.2.13. With appropriate environmental engineering controls and measures, these potential risks will be significantly reduced and are considered likely to be insignificant.

9.6.1.13 Groundwater contamination

Mitigation measures outlined above as well as Sections 9.5.2.14 and 9.5.2.15 will ensure the effect arising from the construction phase on the groundwater underlying the Site are minimised to a **direct, adverse**, **neutral to slight** effect of the Proposed Development.

9.6.2 Operational Phase

9.6.2.1 Operational Phase Residual Effects

The residual impact on the receiving surface water environment during the operational phase of the Development is anticipated to be neutral i.e., no increase in runoff and no increase in drainage discharge.

Furthermore, the drainage and attenuation network deployed will also need to consider effective passive treatment of runoff (re. suspended solids), considering this the finalised drainage and SuDS design will include attenuation capacity in excess of the values listed above. Of note is the absence of any attenuation features as part of baseline conditions. However, following the development of the Site, attenuation features will be created and reduce the level of surface water runoff.

Depending on the exact area of the Site in question, the finalised drainage design may result in some areas becoming more saturated, particularly at lower elevations, whilst other predominantly upland areas may result in a net drying effect being observed. This will require monitoring and maintenance.

This is considered a **direct, neutral to beneficial** effect of the Development, which contrasts to the baseline conditions.

9.6.3 Decommissioning Phase

Residual effects after the Decommissioning phase are to include all effects classified as being long-term to permanent effects of the Proposed Development, that is, there will remain a change in ground conditions under the footprint of the development with the replacement of natural materials such as peat, subsoil and bedrock by concrete, subgrade and surfacing materials. Leaving the turbine foundations in situ is considered a more environmentally sensible option as to remove the reinforced concrete associated with each turbine would result in adverse environmental effects such as, runoff or release of suspended solids. This is a **localised, adverse, significant / moderate** weighted significance, **direct permanent** change to the materials composition at the Proposed Development.

However, should the option to not repower the proposed wind farm, the residual effects associated with Decommissioning includes waste generation, hydrocarbon leakage and erosion of soil and rock. In general, effects will be similar to those at construction and operation, but of a greatly reduced magnitude. The carefully managed reintroduction and/or reuse of soils and peat at the Proposed Development in place of turbine hardstand areas, and successful habitat management, revegetating and rewilding of those areas will have **beneficial effects**, or **revert to baseline conditions** of the preconstruction phase.

9.6.3.1 *Reinstatement of redundant access track and hardstand areas*

Where possible, redundant access tracks, turbine bases and hardstand areas will be reinstated. Some of the site access tracks and hardstand areas, if not required during operation will be reinstated. Areas of excess soil and rock will be reused in order to match the surrounding land as near as possible. Drainage and slopes will be restored as close to the original ground as possible if it is geotechnically and environmentally beneficial to do so.

After Decommissioning of the wind farm, all site access tracks and areas of hardstands will be returned to as close to their natural state as possible, again if it is geotechnically and environmentally feasible. Site access tracks will likely be left in-situ for use by the landowners.

9.6.3.2 *Reinstatement phase residual effects*

An assessment of the effects likely to result from the Proposed Development have been determined by RSK. The effect avoidance and mitigation measures outlined in this report lay down the framework to reduce the significance of all identified potential effects of the Development on Hydrology and Hydrogeological receptors. These measures minimize what might otherwise be very significant adverse effects on the environment as a function of the Proposed Development. The mitigated potential effects are achievable benchmarks, following implementation of the specified measures.

On completion of reinstatement works, following the construction phase, it is expected that the wind farm will be returned as close to its present condition as possible. In particular areas of peat and current drainage regimes will be reinstated and left to revegetate naturally with the passage of time and the Site will revert over time to a more natural drainage regime. It is expected that the long-term residual effects associated with the wind farm Proposed Development will therefore be **insignificant, adverse** and **permanent** effect on the Site**.**

9.7 Cumulative Effects

Cumulative effects as defined by the EPA (2022[12]), is the addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects. Considering the discipline under investigation, hydrology and hydrogeology, and the fact that potential effects of the development on same are localised and potentially regionalised, the cumulative effects of the development are not considered to vary dramatically or behave synergistically when considering the site as a unit, or indeed when considering in conjunction with other developments in the vicinity or downstream of the site.

On a national scale the importance of hydrology and hydrogeology (i.e., habitats in general, drinking water), in terms of ecological and human values must be considered. Aim and objectives for surface water and groundwater quality have been outlined in the

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

EU Water Framework Directive and the Drinking water Regulations (EC, 2021). To name a few:

- All EU mapped rivers maintain or improve their WFD status and can therefore continue to provide their crucial services.
- No reduction in water quality of mapped rivers.
- Protecting and reducing degradation of rivers, as well as sustainable management practices.

These will be implemented by means of several key actions. Assuming other, similar developments, construction activities and potential adverse effects in the area, there is the potential for such incidents to have a cumulative effect 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.

9.7.1 Construction Phase

There are no **significant cumulative effects** anticipated from other projects during the construction phase of the Proposed Development. When considering cumulative effects of pressures on the surface water networks it is advised to look at this by catchment areas. The Development is not considered likely to significantly contribute to cumulative effects in terms of water quality nor flood risk, however if another Wind farm was to be in a construction phase in the same catchment at the same period this will likely raise the cumulative effect to slight on surface water networks and groundwater systems.

The residual effects from other construction projects would be similar to this development i.e., would lead to **slight** residual effects on the hydrology and hydrogeological environment with the protection of waterbodies such as buffer zones, silt screens and active management treatment rains.

9.7.2 Operational Phase

Residual cumulative effects from other nearby wind farms in terms of land take which is generally localised and is expected to have a **not significant to slight residual effect** provided mitigation measures are implemented and monitored in line with the relevant guidelines and legislation.

9.7.3 Decommissioning Phase

There are **no significant cumulative effects** anticipated from other projects during the Decommissioning Phase of the Proposed Development. However should another project commence decommissioning in the same catchment area as this wind farm this may increase the cumulative effect to **slight**.

In conclusion, with the implementation of the design phase utilising mitigation by avoidance, along with nature based solutions and mitigation and monitoring measures to be taken in the construction phase, there is not likely to be a significant adverse effect on surface and groundwater quantity and quality from the proposed development. Provided the mitigation measures are adhered to, the proposed development is not likely to cause a deterioration in surface or groundwater quality status. The proposed development is not likely to compromise the ability of any surface or groundwater to meet the objectives of the WFD or the Birds and Habitats Directives. Given the mitigation measures there is not likely to be any discharges of pollutants from priority or other polluting substances to groundwater or surface water therefore the chemical status of the surface and groundwater will not deteriorate.

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Table 9.19: Residual Impact Summary

		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation Applied**	**Quality**	**Significance**
Increased Runoff - Earthworks	Construction	Direct and Indirect *	Adverse	Large	Moderate to Significant	Development Footprint, Localised	Contrast to Baseline	Unavoidable	Long Term	Yes; **Section 9.5.2.1 & 9.5.2.2**	Adverse	Neutral to Slight
Release of Suspended Solids	Construction	Direct and Indirect *	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Conforms to baseline e.g., forestry operations)	Unavoidable	Temporary	Yes; **Section 9.5.2.4**	Adverse	Neutral to Slight
Release of Hydrocarbons	Construction	Direct and Indirect *	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Medium to Long Term	Yes; **Section 9.5.2.6**	Adverse	Neutral to Slight
Release of Horizontal Directional Drilling Materials	Construction	Direct	Adverse	Small	Slight	Localised (Potentially Regional)	Contrast to Baseline	Likely	Long Term to Permanent	Yes; **Section 9.5.2.7**	Adverse	Neutral to Slight
Release of Wastewater Sanitation Contaminants	Construction	Direct and Indirect *	Adverse	Small	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary to Long Term / Permanent but Reversible	Yes; **Section 9.5.2.9**	Adverse	Neutral to Slight

		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation Applied**	**Quality**	**Significance**
Release of Construction or Cementitious Materials	Construction	Direct	Adverse	Small	Moderate to Significant	Localised (Potentially Regional)	Contrast to Baseline	Likely	Temporary / Short term	Yes; **Section 9.6.2.8**	Adverse	Neutral to Slight
Local Groundwater Supplies (Wells)	Construction / Operational	Direct and Indirect *	Adverse	Small	Slight	Localised	Conforms to Baseline e.g., other shallow excavations.	Unlikely	Temporary	Yes; **Section 9.5.1.9**	Adverse	Neutral
Groundwater or Bog Water Associated with Wind Farm	Construction	Direct and Indirect *	Neutral to Adverse	Small to Moderate	Slight to Moderate	Localised	Conforms to Baseline e.g., forestry drains. .	Likely	Permanent / Reversible	Yes; **Section 9.5.1.3, 9.5.1.8**	Slight Adverse / Small Beneficial	Slight / Neutral / Beneficial
Groundwater and Surface Water Associated with Wind Farm Cable Works	Construction	Direct and Indirect *	Adverse	Small to Moderate	Slight	Localised	Conforms to Baseline e.g., public roads and services.	Likely	Permanent but Reversible	Yes; **Section 9.5.2.13, 9.5.2.14**	Adverse	Neutral to Slight
Groundwater and Surface Water Associated with Grid Connection Cable Works	Construction	Direct and Indirect *	Adverse	Small	Slight	Localised	Conforms to Baseline e.g., public roads and services.	Likely	Permanent but Reversible	Yes; **Section 9.5.2.13, 9.5.2.14**	Adverse	Neutral to Slight

		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation	
Effect / Impact Description	Phase	Type	Quality	Scale	Significance	Extent	Context	Probability	Duration / Frequency	Mitigation Applied	Quality	Significance
Reinstatement of Redundant Access Track, Hardstand Areas and Borrow Pit	Decommissioning	Direct and Indirect *	Adverse	Small	Slight	Development Footprint, Localised	Contrast to Baseline.	Likely	Permanent	Yes; **Section 9.5.4**	Adverse	Neutral to Beneficial
Excavation Dewatering & Construction Water	Construction	Direct and Indirect *	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Contrast to Baseline.	Likely	Temporary to Permanent	Yes; **Section 9.5.2.3**	Adverse	Neutral to Slight
Diversion and Enhancement of Drainage	Construction	Direct and Indirect *	Adverse	Small to Moderate	Moderate	Localised (Potentially Regional)	Conforms to Baseline e.g., forestry drains.	Likely	Permanent	Yes; **Sections 9.5.2.10, 9.5.2.12**	Adverse	Neutral to Slight
Watercourse Crossings - Mapped Rivers	Construction	Direct and Indirect *	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Conforms to Baseline e.g., existing bridges and roads in area.	Unavoidable	Permanent	Yes; **Section 9.5.2.4 and Section 9.5.2.10**	Adverse	Slight
Watercourse Crossings - Drainage Features	Construction	Direct and Indirect *	Adverse	Small to Moderate	Moderate to Profound	Localised (Potentially Regional)	Conforms to Baseline e.g., agri / peat drains / forestry drains. .	Unavoidable	Permanent	Yes; **Section 9.5.2.4 and Section 9.5.2.10**	Adverse	Neutral to Slight

		Qualifying Criteria Pre-Mitigation									Qualifying Criteria With Mitigation	
Effect / Impact Description	**Phase**	**Type**	**Quality**	**Scale**	**Significance**	**Extent**	**Context**	**Probability**	**Duration / Frequency**	**Mitigation Applied**	**Quality**	**Significance**
Increased Hydraulic Loading & Flood Risk	Operational	Direct and Indirect *	Adverse	Small	Slight	Localised (Potentially Regional)	Conforms to Baseline e.g., existing forestry tracks.	Likely	Permanent	Yes; **Section 9.5.3.1**	Adverse	Neutral to Beneficial

Note:
*** Includes Indirect / Secondary impacts to receptors downstream of the Proposed Development. 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.**