9. WATER

9.1 Introduction

9.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO Ireland (MKO) to carry out an assessment of the potential effects of the Proposed Development on water aspects (hydrology and hydrogeology).

A full description of all elements of the Proposed Development is detailed in Chapter 4 of this EIAR. As detailed in Section 1.1.1 in Chapter 1, for the purposes of this EIAR, the various project components are described and assessed using the following references: 'Proposed Development', 'the Site', 'Wind Farm Site' and 'Grid Connection'. The objectives of the assessment are to:

- Produce a baseline study of the existing water environment (surface and groundwater) in the area of the Proposed Development (Wind Farm Site and Grid Connection);
- Identify likely positive and negative impacts of the Proposed Development on surface and groundwater during construction, operational, and decommissioning phases of the Proposed Development;
- Identify mitigation measures to avoid, remediate or reduce significant negative effects; and,
- Assess significant residual effects and cumulative effects of the Proposed Development along with other permitted and proposed projects and plans.

The potential Zone of Impact of the Proposed Development on the water environment is limited within the Water Study Area as defined on Figure 9-1, as these are the regional surface water catchments and groundwater bodies within which the Proposed Development is located.

9.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience include hydrology and windfarm drainage design. We routinely complete impact assessments for hydrology and hydrogeology for a large variety of project types.

This chapter of the EIAR was prepared by Michael Gill, Adam Keegan and Conor McGettigan.

Michael Gill (PGeo, BA, BAI, Dip Geol., MSc, MIEI) is an Environmental Engineer and Hydrogeologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms and renewable projects in Ireland. He has substantial experience in surface water drainage design and SUDs design and surface water/groundwater interactions. For example, Michael has worked on the EIS for Oweninny WF, Cloncreen WF, and Yellow River WF, and over 100 other wind farm-related projects.

Adam Keegan (BSc, MSc) is a hydrogeologist with three years of experience in the environmental sector in Ireland. Adam has been involved in Environmental Impact Assessment Reports (EIARs) for numerous projects including wind farms, grid connections, quarries and small housing developments.

Adam holds an MSc in Hydrogeology and Water Resource Management. Adam has worked on several wind farm EIAR projects, including Croagh WF, Lyrenacarriga WF (SID), Cleanrath WF, Carrownagowan WF (SID), and Fossy WF.

Conor McGettigan (BSc, MSc) is a recently graduated environmental scientist. In recent times Conor has assisted in the preparation of Environmental Impact Assessment Reports (EIARs) for several projects including wind farms and quarries.

9.1.3 Scoping and Consultation

The scope for this assessment has been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties as summarised in Section 2.6 of Chapter 2 of the EIAR. Consultation responses relating to the water environment were received from the Geological Survey of Ireland (GSI), the Development Applications Unit (DAU) and Health Service Executive (HSE). Matters raised by Consultees in their responses with respect to the water environment are summarised in Table 9-1 below.

Table 9-1: Summary of Water Environment Related Scoping Responses

Consultee	Description	Addressed in Section
Geological Survey of Ireland (GSI)	• GSI have identified 1 local County Geological Sites (CGS) near the Wind Farm Site; Callighstown-Milltown Esker located close to the eastern boundary of the Wind Farm Site. • GSI have identified 3 no. local County Geological Sites (CGS) near the Grid Connection underground electrical cabling route; Ballyduff Esker, Clonmacnoise Esker and Horseleap Esker. • There are several karst landforms in the vicinity of the underground electrical cabling route including 3 no. karst springs adjacent to the N52 at Durrow, Co. Offaly. • There is 1 no. groundwater abstraction (well) used by the Tullamore Ardan Public Water Supply near the underground electrical cabling route. • Assessment of groundwater characteristics/resources and groundwater protection required. • Assessment of mineral resources and aggregates required.	Geological Heritage Sites are address in Chapter 8, Section 8.3.7. Groundwater assessment addressed in Sections 9.3.8, 9.3.9, 9.3.10, 9.3.13, 9.4.1.3, 9.4.1.4, 9.4.1.5, 9.4.1.6 and 9.4.1.10. Karst Landforms addressed in Section 9.3.7. Water resources (local groundwater wells) addressed in Section 9.3.12. Refer to Chapter 8: Land, Soils and Geology for assessment of aggregate resources.

Consultee	Description	Addressed in Section
Development Applications Unit (DAU)	• Note that any impact on water table levels or groundwater flows may impact on wetland sites some distance away (*i.e* beyond 15km radius). EIAR should assess cumulative impacts with other plans or projects if applicable • A 10m riparian buffer on both banks of a waterway is considered to comprise part of the otter habitat. Therefore, any proposed development should be located at least 10m away from a waterway. • Construction work should not be allowed to impact on water quality and measures should be detailed in the EIAR to prevent sediment and/or fuel runoff from getting into watercourses which could adversely impact on aquatic species.	• Cumulative impact assessment included in Section 9.4.5. • Riparian buffer zone (10m) included within mitigation measures within Section 9.4 • Appropriate mitigation measures relating to sediment/fuel runoff are included within Section 9.4
Environmental Health Service (HSE)	• All drinking water sources, both surface and groundwater shall be identified. Any potential impacts to these drinking water sources shall be assessed	• All drinking water sources identified in Section 9.3.14 with mitigation measures outlined in Section 9.5.2.10

9.1.4 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU.

The requirements of the following legislation are complied with:

- S.I. No. 349/1989: European Communities (Environmental Impact Assessment) Regulations, and subsequent Amendments (S.I. No. 84/1994, S.I. No. 101/1996, S.I. No. 351/1998, S.I. No. 93/1999, S.I. No. 450/2000 and S.I. No. 538/2001, S.I. No. 134/2013 and the Minerals Development Act 2017), the Planning and Development Act, and S.I. No. 600/2001 Planning and Development Regulations and subsequent Amendments. These instruments implement EU Directive 85/337/EEC and subsequent amendments, on the assessment of the effects of certain public and private projects on the environment;
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment, including Circular Letter PL 1/2017:

Implementation of Directive 2014/52/EU on the effects of certain public and private projects on the environment (EIA Directive);

- Planning and Development Act, 2000, as amended;
- Planning and Development Regulations, 2001 (as amended);
- S.I. No. 296/2018: European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018 which transposes the provisions of Directive 2014/52/EU into Irish law;
- S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations;
- S.I. No. 272/2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy) and S.I. No. 722/2003 European Communities (Water Policy) Regulations which implement EU Water Framework Directive (2000/60/EC) establishing a framework for the Community action in the field of water policy and provide for implementation of 'daughter' Groundwater Directive (2006/118/EC) on the protection of groundwater against pollution and deterioration. Since 2000 water management in the EU has been directed by the Water Framework Directive (2000/60/EC) (as amended by Decision No. 2455/2011/EC; Directive 2008/32/EC; Directive 2008/105/EC; Directive 2009/31/EC; Directive 2013/39/EU; Council Directive 2013/64/EU; and Commission Directive 2014/101/EU ("**WFD**"). The WFD was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003
(S.I. No. 722/2003);
- S.I. No. 684/2007: Waste Water Discharge (Authorisation) Regulations 2017, resulting from EU Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances (the Groundwater Directive); S.I. No. 106/2007: European Communities (Drinking Water) Regulations 2007 and S.I. No. 122/2014: European Communities (Drinking Water) Regulations 2014, arising from EU Directive 98/83/EC on the quality of water intended for human consumption (the "Drinking Water Directive") and EU Directive 2000/60/EC;
- S.I. No. 9/2010: European Communities Environmental Objectives (Groundwater) Regulations 2010 (as amended by S.I. No. 389/2011; S.I. No. 149/2012; S.I. No. 366/2016; the Radiological Protection (Miscellaneous Provisions) Act 2014; and S.I. No. 366/2016); and,
- S.I. No. 296/2009: The European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (as amended by S.I. No. 355/2018)

9.1.5 Relevant Guidance

The Water chapter of the EIAR is carried out in accordance with guidance contained in the following:

- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for Preparation of Soils, Geology & Hydrogeology Chapters in Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Department of Environment, Heritage and Local Government (DoEHLG); Wind Energy Development Guidelines for Planning Authorities (2006);
- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations & Water Protection Guidelines;
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford;

- COFORD (2004): Forest Road Manual – Guidelines for the Design, Construction and Management of Forest Roads;
- Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters;
- Scottish Natural Heritage (2010): Good Practice During Wind Farm Construction;
- SEPA (2014): Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems;
- PPG1 - General Guide to Prevention of Pollution (UK Guidance Note);
- PPG5 – Works or Maintenance in or Near Watercourses (UK Guidance Note);
- CIRIA (Construction Industry Research and Information Association) 2006: Guidance on 'Control of Water Pollution from Linear Construction Projects' (CIRIA Report No. C648, 2006);
- CIRIA 2006: Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors. CIRIA C532. London, 2006;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Union, 2017).

9.1.6 Difficulties Encountered

No difficulties were encountered during the preparation of this EIAR chapter.

9.2 Methodology

9.2.1 Desk Study

A desk study of the Proposed Development site and Water Study Area was completed prior to the undertaking of field mapping and walkover assessments. The desk study involved collecting all relevant geological, hydrological, hydrogeological and meteorological data for the area. This included consultation of the following:

- Environmental Protection Agency database (www.epa.ie);
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- Met Eireann Meteorological Databases (www.met.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie);
- Water Framework Directive Map Viewer (www.catchments.ie);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 15 (Geology of Galway-Offaly); Geological Survey of Ireland (GSI, 1999);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 12 (Geology of Longford-Roscommon); Geological Survey of Ireland (GSI, 1999);
- Geological Survey of Ireland - Groundwater Body Characterisation Reports;
- OPW Indicative Flood Maps (www.floodmaps.ie);
- Environmental Protection Agency – "Hydrotool" Map Viewer (www.epa.ie);
- CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie);
- National Indicative Flood Mapping (NIFM) maps; and,
- Department of Environment, Community and Local Government on-line mapping viewer (www.myplan.ie).

9.2.2 Baseline Monitoring and Site Investigations

A hydrological walkover survey, including detailed drainage mapping, dGPS survey of the Dungolman and Mullenmeehan streams (river bed, bank faces and water levels) and baseline water quality monitoring/sampling, was undertaken by HES over several site visits carried out on 03rd May 2021, 14th May, 07th July and 14th July 2021.

Further site investigations including trial pitting were carried out by HES on 14th July 2021. Additional site visits were also completed within the Wind Farm Site and along the Grid Connection underground electrical cabling route on 18th November 2021, 22nd March 2022 and 01st December 2022.

Hydrological and hydrogeological data used in this assessment includes:

- Walkover surveys and hydrological mapping of the Wind Farm Site, Grid Connection, turbine delivery route, and the surrounding areas were undertaken whereby water flow directions and drainage patterns were recorded;
- A dGPS survey of river channel cross sections (river bed, banks and water level) were taken at 24 no. locations along the Dungolman river and Mullenmeehan stream;
- A Stage 3 Flood Risk Assessment (FRA) for the Wind Farm Site footprint area (refer to Appendix 9-1);
- A total of 8 no. trial pits were completed across the Wind Farm Site;
- PSD analysis of 5 no. subsoil samples taken from 4 no. trial pits and 1 no. exposed face;
- Additional probing at 8 no. locations was completed along the underground electrical cabling route, (refer to Chapter 8);
- 3 no. water level monitoring devices (OTT EcoLog 1000) were installed at 3 no. locations along the Dungolman river and Mullenmeehan stream which monitored water levels between 07th July 2021 – 01st December 2022;

- Field hydrochemistry measurements (electrical conductivity, pH and temperature) were taken to determine the origin and nature of surface water flows at the Wind Farm Site;
- Surface water sampling at 3 no. surface water locations were undertaken to determine the baseline water quality of the primary surface waters originating from the Wind Farm Site;
- Field hydrochemistry measurements and water quality samples were undertaken at 8 no. locations along the Grid Connection underground electrical cabling route; and,
- A WFD Assessment Report has been completed for the Proposed Development (Wind Farm Site and Grid Connection) and is included as Appendix 9-2.

9.2.3 Impact Assessment Methodology

The guideline criteria (EPA, May 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and transboundary nature (if applicable). The descriptors used in this environmental impact assessment are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1, Section 1.7.2 of this EIAR.

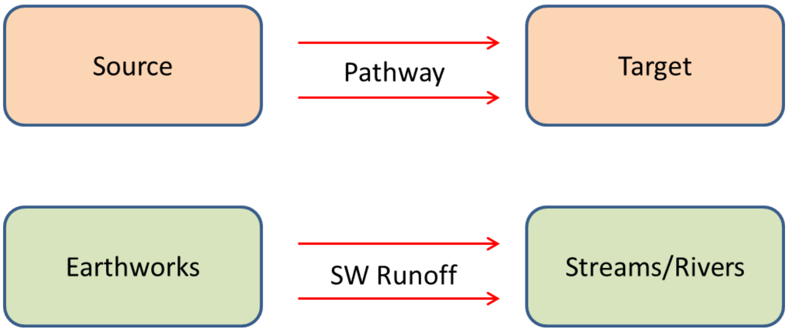
In addition to the above methodology, the sensitivity of the water environment receptors was assessed on completion of the desk study and baseline study. Levels of sensitivity which are defined in Table 9-2 are then used to assess the potential effect that the Proposed Development may have on them.

Table 9-2: Receptor Sensitivity Criteria (Adapted from www.sepa.org.uk)

Sensitivity of Receptor	
Not sensitive	Receptor is of low environmental importance (e.g. surface water quality classified by EPA as A3 waters or seriously polluted), fish sporadically present or restricted). Heavily engineered or artificially modified and may dry up during summer months. Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. No abstractions for public or private water supplies. GSI groundwater vulnerability "Low" – "Medium" classification and "Poor" aquifer importance.
Sensitive	Receptor is of medium environmental importance or of regional value. Surface water quality classified by EPA as A2. Salmonid species may be present and may be locally important for fisheries. Abstractions for private water supplies. Environmental equilibrium copes well with all natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. GSI groundwater vulnerability "High" classification and "Locally" important aquifer.
Very sensitive	Receptor is of high environmental importance or of national or international value i.e. NHA or SAC. Surface water quality classified by EPA as A1 and salmonid spawning grounds present. Abstractions for public drinking water supply. GSI groundwater vulnerability "Extreme" classification and "Regionally" important aquifer

9.2.4 Overview of Impact Assessment Process

The conventional source-pathway-target model (see below, top) was applied to assess potential effects on downstream environmental receptors (see below, bottom as an example) as a result of the Proposed Development (Wind Farm Site and Grid Connection).



Where potential effects are identified, the classification of impacts in the assessment follows the descriptors provided in the Glossary of Impacts contained in the following guidance documents produced by the Environmental Protection Agency (EPA):

- Environmental Protection Agency (May 2022): Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

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

In order to provide an understanding of the stepwise impact assessment process applied below (Section 9.4), a summary guide is presented in Table 9-3, which defines the steps (1 to 7) taken in each element of the impact assessment process. The guide also provides definitions and descriptions of the assessment process and shows how the source-pathway-target model, and the EPA impact descriptors are combined.

Using this defined approach, this impact assessment process is then applied to all aspects of the Proposed Development which have the potential to generate a source of significant adverse impact on the geological and hydrological/ hydrogeological (including water quality) environments.

Table 9-3: Impact Assessment Process Steps

Step 1	Identification and Description of Potential Impact Source This section presents and describes the activity that brings about the potential impact or the potential source of pollution. The significance of effects is briefly described.	
Step 2	Pathway / Mechanism:	The route by which a potential source of impact can transfer or migrate to an identified receptor. In terms of this type of development, surface water and groundwater flows are the primary pathways, or for example, excavation or soil erosion are physical mechanisms by which potential impacts are generated.
Step 3	Receptor:	A receptor is a part of the natural environment which could potentially be impacted upon, e.g. human health, plant / animal species, aquatic habitats, soils/geology, water resources, water sources. The potential impact can only arise as a result of a source and pathway being present.
Step 4	Pre-mitigation Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impact before mitigation is put in place.
Step 5	Proposed Mitigation Measures:	Control measures that will be put in place to prevent or reduce all identified significant adverse impacts. In relation to this type of development, these measures are generally provided in two types: (1) mitigation by avoidance, and (2) mitigation by (engineering) design.
Step 6	Post-Mitigation Residual Impact:	Impact descriptors which describe the magnitude, likelihood, duration and direct or indirect nature of the potential impacts after mitigation is put in place.
Step 7	Significance of Effects:	Describes the likely significant post-mitigation effects of the identified potential impact source on the receiving environment.

9.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Water Chapter of the EIAR.

9.3 Receiving Environment

9.3.1 Site Description and Topography

9.3.1.1 Wind Farm Site

The Wind Farm Site is located approximately 3.5km southwest of Ballymore village and 14km northwest of Athlone (distance from EIAR Site Boundary). The townlands in which the Wind Farm Site is located are listed in Table 1-1 in Chapter 1 of this EIAR.

The Wind Farm Site comprises mainly improved grassland and agricultural pastures separated by hedgerows. A small area of forestry exists in the southwest of the Wind Farm Site. The topography of the Wind Farm Site is undulating with the Wind Farm footprint layout being spread over a series of small hills that range in elevation from 55 to 98m OD (Ordnance Datum), with greatest elevation occurring in the northwest of the Wind Farm Site. The overall slope of the land is towards the east/northeast. The Dungolman River dissects the south of the Wind Farm Site before running along the eastern boundary.

All proposed turbine locations (T1-T9), with the exception of T4, are situated on improved grassland. T4 located in the southwest of the Wind Farm Site is situated in an area of coniferous forestry. The Wind Farm Site access roads are mainly located on improved grassland, but also through a small section of forestry near T4.

The Wind Farm Site measures approximately 949 hectares. The footprint of the Proposed Development measures approximately 8.2 hectares, which represents only 0.9% of the primary EIAR Site Boundary.

9.3.1.2 Grid Connection

The Grid Connection encompasses a 110kV on-site substation and associated temporary construction compound within the Wind Farm Site, including underground 110kV cabling to connect to the national grid at Thornsberry 110kV substation, in the townland of Derrynagall or Ballydaly, near Tullamore, Co. Offaly. The underground electrical cabling route is 31km in length, through the village of Horseleap and bypassing the town of Kilbeggan until its termination point at the Thornsberry 110 kV substation, 2km northeast of Tullamore. The underground electrical cabling route is located primarily within public roads, with elevation ranging between 60-80mOD.

9.3.2 Water Balance

Long term rainfall and evaporation data was sourced from Met Éireann. The long-term average rainfall (1981 - 2010) recorded at Ballymore G.S., 2.2km to the northeast of the Wind Farm Site, are presented in Table 9-4.

Table 9-4: Local Average long-term Rainfall Data (mm)

Station		X-Coord		Y-Coord		Ht (MAOD)		Opened		Closed		Total
Granard		233700		281300		N/A		N/A		N/A		
Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
117.4	88.6	98.6	75.1	77.5	79.7	82.4	94	88.6	124.1	109.9	118.8	1154.7

The closest synoptic station[1] where the average potential evapotranspiration (PE) is recorded is at Mullingar, approximately 24km northeast of the Wind Farm Site. The long-term average PE for this station is 445.8mm/year. This value is used as a best estimate of the site PE. Actual Evaporation (AE) at the Proposed Development site is estimated as 423.5mm/year (which is 0.95 × PE).

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

Effective rainfall (ER) = AAR – AE

= 1,154.7mm/year – 423.5mm/year

ER = 731.2mm/year

Based on groundwater recharge coefficient estimates from the GSI (www.gsi.ie) an estimate of 164.5mm/year average annual recharge is given for till at the Wind Farm Site (recharge coefficient of ~22.5%). While till is mapped over much of the Wind Farm Site, areas in the west are underlain by less permeable subsoils including lacustrine clays This means that the hydrology of the Wind Farm Site is

[1] *A station at which meteorological observations are made for the purposes of synoptic (large spatial scale) analysis*

characterised by high surface water runoff rates and moderate to low groundwater recharge rates. Therefore, conservative annual recharge and runoff rates for the Wind Farm Site are estimated to be 164.5mm/year and 566.7mm/year (i.e. 731.2mm/year – 164.5mm/year = 566.7mm/year) respectively.

Table 9-5 below presents return period rainfall depths for the area of the Wind Farm Site. These data are taken from https://www.met.ie/climate/services/rainfall-return-periods and they provide rainfall depths for various storm durations and sample return periods (1-year, 50-year, 100-year). These extreme rainfall depths will be the basis of the Wind Farm Site drainage hydraulic design as described further below.

Table 9-5: Return Period Rainfall Depths for the Wind Farm Site

Duration	10-year Return Period	50-Year Return Period	100-Year Return Period
15 min	14.4	23.7	29.2
1 hour	21.2	33.1	39.9
6 hour	35.0	51.0	59.6
12 hour	42.5	60.2	69.6
24 hour	51.6	71.2	81.3
48 hour	60.4	80.1	90.1

9.3.3 Regional Hydrology

9.3.3.1 Wind Farm Site

On a regional scale, the Wind Farm Site is located in the Inny River surface water sub-catchment, which is in the Upper Shannon catchment within Hydrometric Area 26 of the Irish River Basin District (SIRBD). The Inny River flows to the northwest approximately 8.2km northwest of the Wind Farm Site. The Inny River discharges into Lough Ree approximately 10.6km northwest of the Wind Farm Site. A regional hydrology map is shown as Figure 9-1.

On a more local scale, the Wind Farm Site is located in the Inny River sub-catchment (Inny[Shannon]_SC_090) with the majority of the Wind Farm Site located in the Dungolman WFD river sub basin (Dungolman_030) (refer to Figure 9-2). A small section in the southwest of the Wind Farm Site is mapped in the Dungolman_020 river sub-basin while the northwestern corner of the Wind Farm Site is located in the Inny River (Inny_110) river sub-basin. However, none of the proposed turbines are mapped in the Dungolman_020 or Inny_110 river sub-basins.

As stated above the majority of the Wind Farm Site is located in the Dungolman_030 river sub-basin. The Dungolman River (EPA Code: 26D06) flows to the northeast between T4 and T5. This watercourse then flows along the EIAR Site Boundary to the east of T2 and T3 before veering to the northeast to the east of T1. Drainage in this river sub-basin is directed towards the Dungolman River via several smaller streams and drains. The Dungolman River continues to flow to the north before discharging into the Tang River (EPA Code: 26T02) approximately 5.15km north of the Wind Farm Site. The Tang River continues to flow to the northwest and eventually discharges into the Inny River (EPA Code: 26I01) approximately 8.3km northwest of the Wind Farm Site. The Inny River drains into the eastern side of Lough Ree.

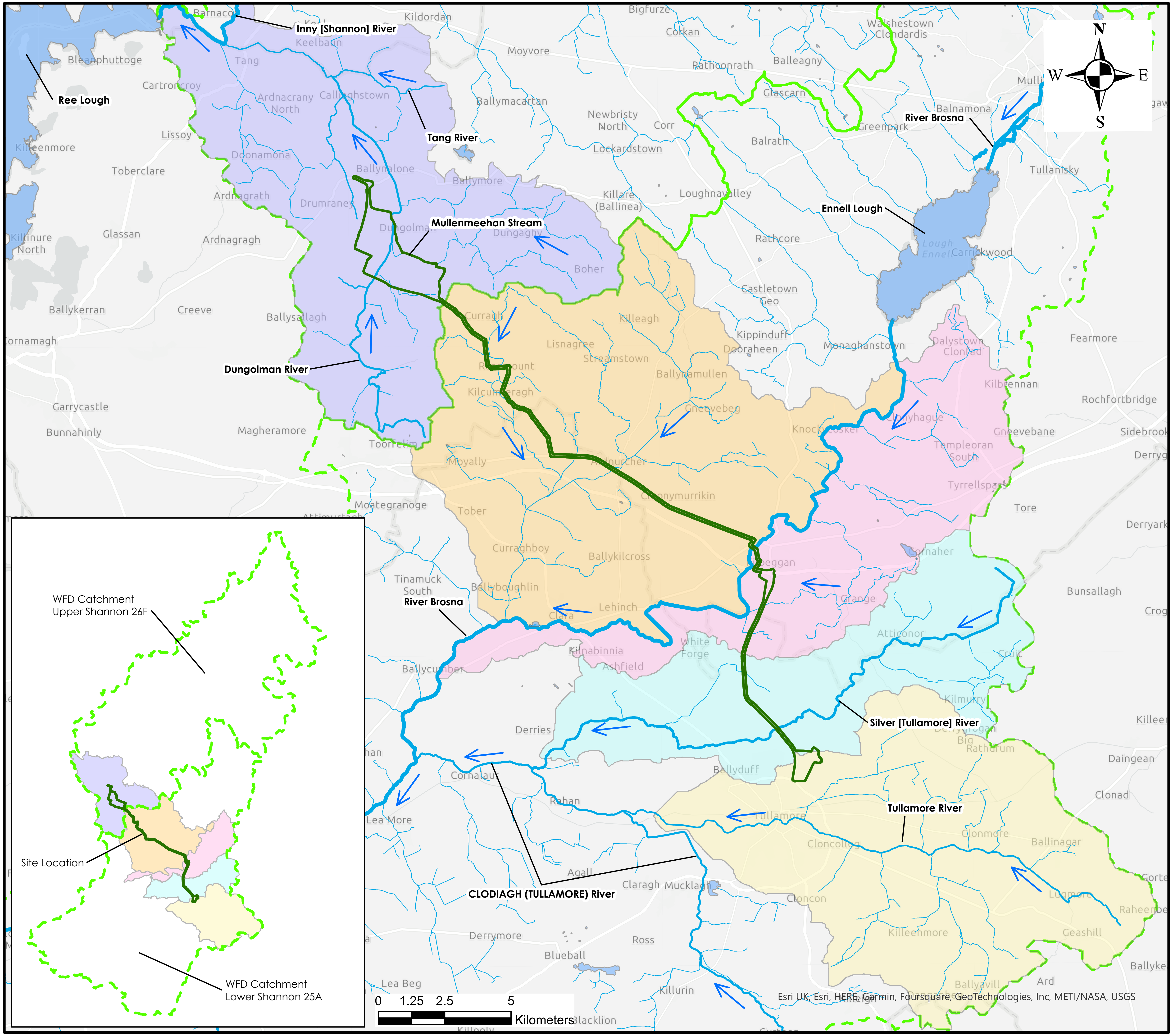
Within the Dungolman_020 River sub-basin, the southwest of the Wind Farm Site drains towards the Dungolman River via the Toorbeg stream (EPA Code: 26T25). Meanwhile within the Inny_110 River sub-basin, the northwest of the Wind Farm Site drains to the northwest via the Ardnacrany south stream (EPA Code: 26A50) which discharges into the Dungolman River approximately 4.3km north of the Wind Farm Site.

9.3.3.2 Grid Connection

The Grid Connection onsite 110kV substation and associated temporary construction compound are located within the Wind Farm Site which is detailed above.

The Grid Connection underground electrical cabling route is located within the Upper Shannon catchment (26) and Lower Shannon catchment (25A) of the Irish River basin district. A Grid Connection hydrology map is shown in Figure 9-3.

The Grid Connection underground electrical cabling route is located within the Inny (Shannon) SC_090, the Brosna_SC_030, Brosna_SC_020, Silver[Tullamore]_SC_010 and Tullamore_SC_010 subcatchments. Apart from the Inny (Shannon) SC_090 subcatchment, all the associated subcatchment rivers flow generally southwest towards the Lower Shannon catchment. The primary watercourse within this Lower Shannon catchment (of the underground electrical cabling route) is the River Brosna. The Silver River and Tullamore River drain into the River Brosna.



Legend

- EIAR Site Boundary
- Watercourses
- Lakes
- WFD Catchments

WFD Subcatchments

- BROSNA_SC_020
- BROSNA_SC_030
- Inny[Shannon]_SC_090
- Silver[Tullamore]_SC_010
- Tullamore_SC_010

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Client: MKO

Job: Umma More Renewable Energy Development

Title: Regional Hydrology Map

Figure No: 9-1

Drawing No: P1553-0-0123-A3-901-00A

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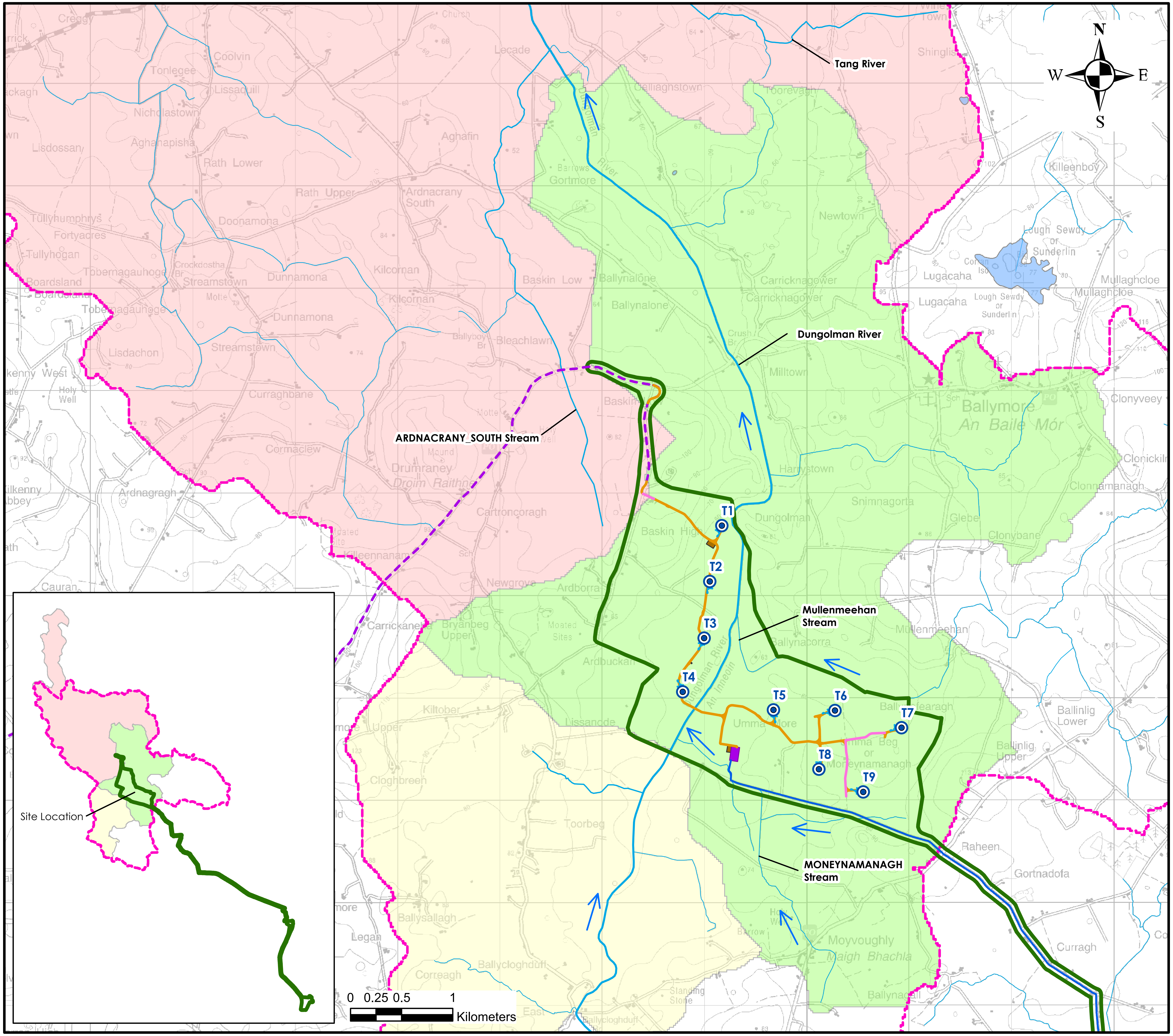
Date: 31/01/2023	Checked By: MG



Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Proposed Turbine Hardstands
- Proposed Met Mast Location
- Proposed New Roads
- Proposed Upgrades to Existing Roads
- Proposed Temporary Construction Compounds
- Proposed 110kV Onsite Substation
- Proposed Underground Electrical Cabling Route
- Proposed Turbine Delivery Route
- Watercourses
- Lakes

WFD Subcatchments

- Inny[Shannon]_SC_090

WFD River Sub-Basins

- DUNGOLMAN_020
- DUNGOLMAN_030
- INNY_110

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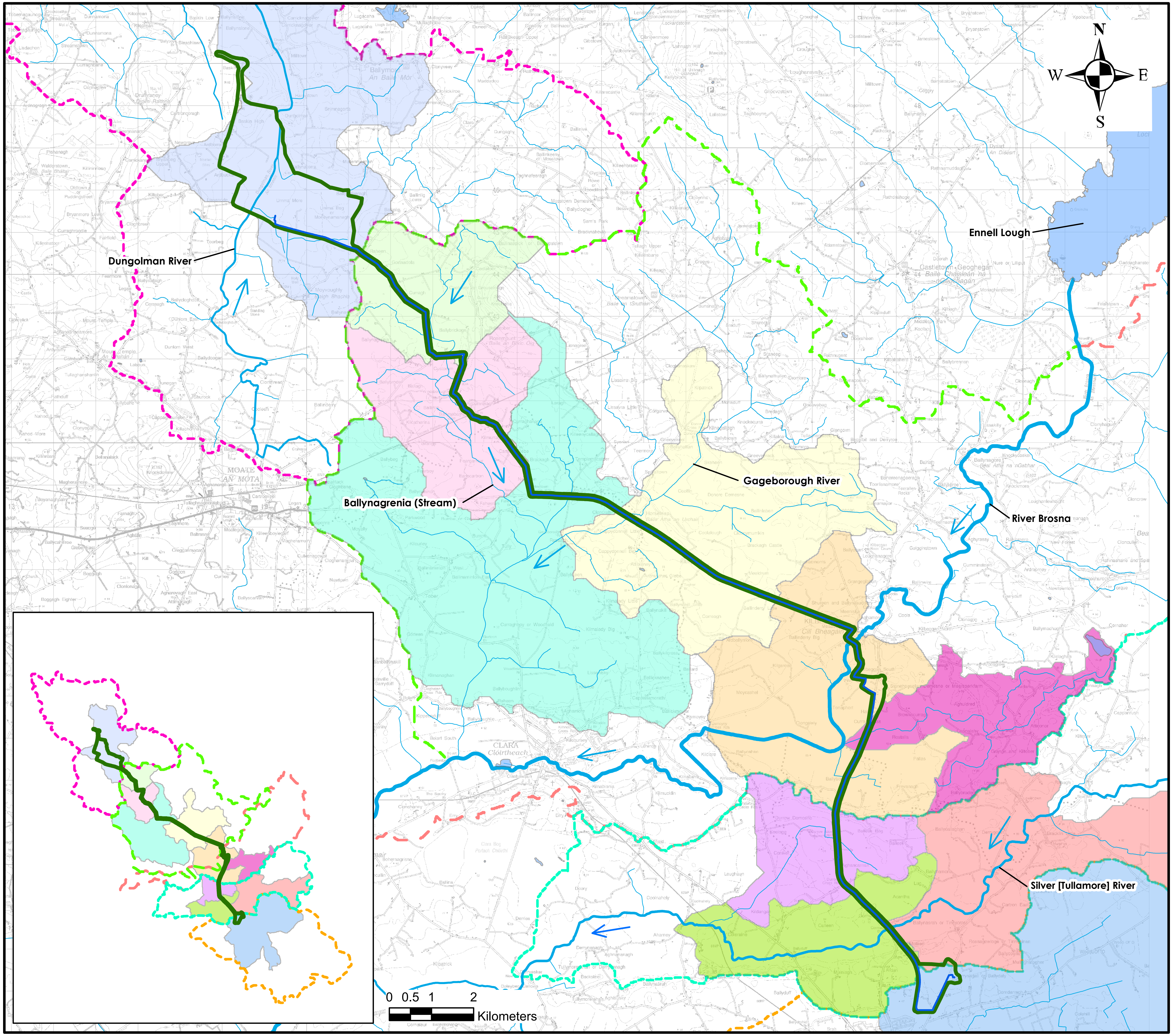
Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Local Hydrology Map (Wind Farm Site)	
Figure No: 9-2	
Drawing No: P1553-0-0123-A3-902-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:35,000	Drawn By: GD
Date: 31/01/2023	Checked By: MG



Legend

- EIAR Site Boundary
- Proposed Underground Electrical Cabling Route
- Watercourses
- Lakes

WFD River Sub-Basins

- BALLYNAGRENIA STREAM_010
- BALLYNAGRENIA STREAM_020
- BROSNA_070
- DUNGOLMAN_030
- DURROW ABBEY STREAM_010
- GAGEBOROUGH_020
- GAGEBOROUGH_030
- SILVER (TULLAMORE)_020
- SILVER (TULLAMORE)_030
- TONAPHORT_010
- TULLAMORE_030

WFD Subcatchments

- BROSNA_SC_020
- BROSNA_SC_030
- Inny[Shannon]_SC_090
- Silver[Tullamore]_SC_010
- Tullamore_SC_010

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Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Local Hydrology Map (Grid Connection)	
Figure No: 9-3	
Drawing No: P1553-0-0123A3-903-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:85,000	Drawn By: GD
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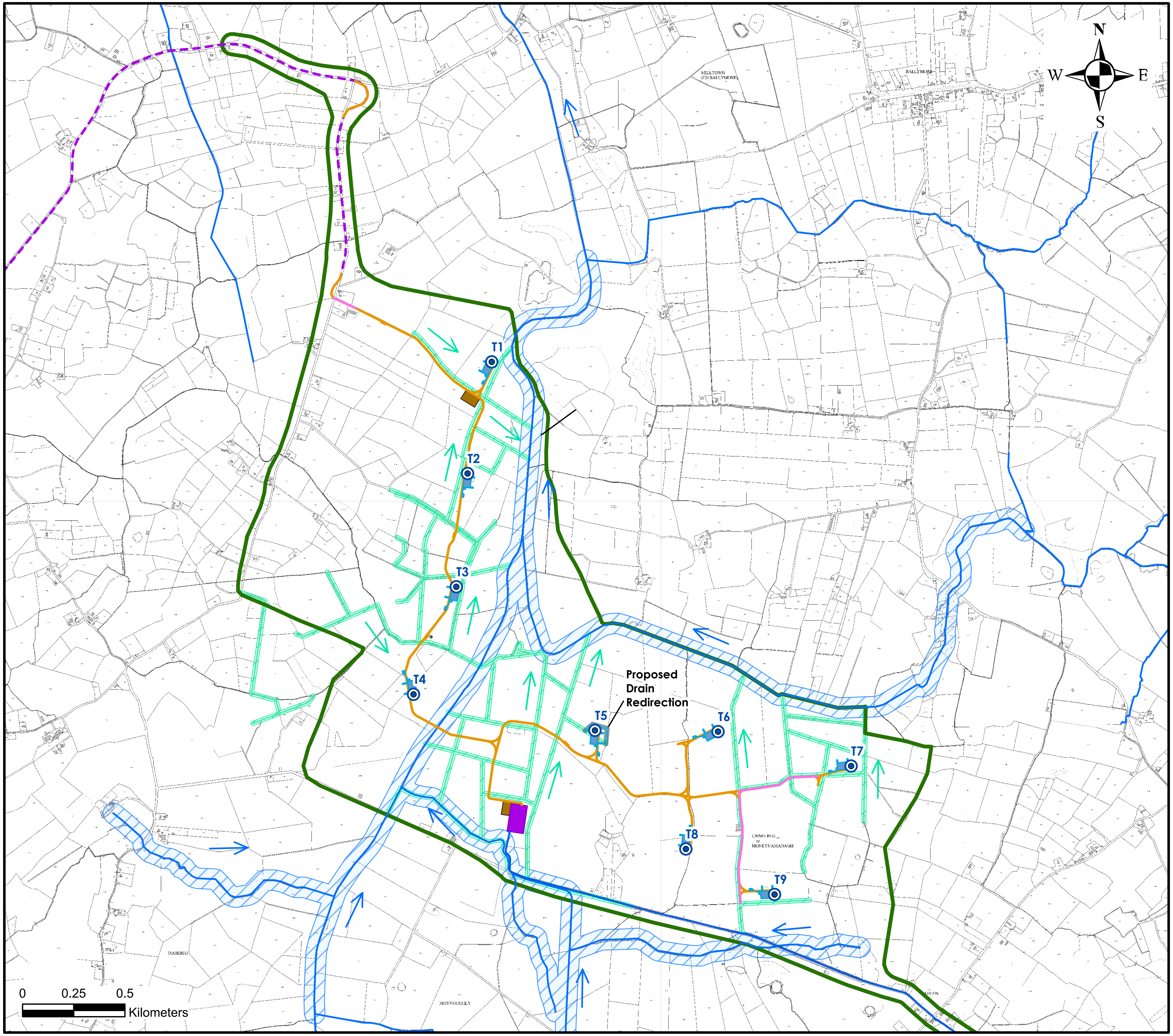
9.3.4 Wind Farm Site Drainage

As discussed above, the majority of the Wind Farm Site is located in the Dungolman_030 River sub-basin, the surface water draining towards the Dungolman River via several smaller streams and agricultural drains. In the southeast of the Wind Farm Site, the Raheen stream (EPA Code: 26R36) flows to the west approximately 150m south of T9. This waterbody discharges into the Moneynamanagh stream (EPA Code: 26M40) 1km southwest of T9 before veering to the northwest and discharging into the Dungolman River 800m southwest of T5. The EPA also map a small stream, the Mullenmeehan stream (EPA Code: 26M12) to flow along the northern EIAR Site Boundary, approximately 300m to the north of T6. The Mullenmeehan stream confluences with the Dungolman River approximately 450m northeast of T3.

The agricultural lands which cover the majority of the Wind Farm Site contain a network of manmade drains which run along the hedgerows and field boundaries and drain into Dungolman River and the Moneynamanagh and Mullenmeehan streams. The west of the Wind Farm Site in the vicinity of T4 consists of forestry with forestry drains discharging into the Dungolman River to the east. A Wind Farm Site drainage map is shown in Figure 9-4.



Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Proposed Turbine Hardstands
- Proposed Met Mast Location
- Proposed New Roads
- Proposed Upgrades to Existing Roads
- Proposed Temporary Construction Compounds
- Proposed 110kV Onsite Substation
- Proposed Underground Electrical Cabling Route
- Proposed Turbine Delivery Route
- Watercourses
- Lakes
- Proposed Drain Redirection
- Drains
- 50m Watercourse Buffer
- 10m Drain Buffer
- Flow Direction

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Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Site Drainage Map (Wind Farm)	
Figure No: 9-4	
Drawing No: P1553-0-0123-A3-904-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:17,500	Drawn By: GD
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9.3.5 Flood Risk Assessment

Wind Farm Site

A Stage III Flood Risk Assessment of the Wind Farm Site has been carried out by HES, the results of which are presented in full in Appendix 9-1 of this EIAR. To identify those areas mapped as being at risk of flooding, OPW's indicative river and coastal flood map (www.floodmaps.ie), CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie), National Indicative Flood mapping (NIFM) and historical mapping (i.e. 6" and 25" base maps) were consulted.

The OPW (www.floodmaps.ie) show several historic and recurring flood events in the vicinity of the Wind Farm Site. The closest mapped recurring flood event is found approximately 250m southwest of the Wind Farm Site at Kiltober. Here low-lying lands are reported to flood annually following intense rainfall. Similar flood events have been recorded at Tourbeg, Moate, approximately 700m south of the Wind Farm Site. A further flood event is mapped approximately 1km to the north of the Wind Farm Site along the R390 at Ballymore.

The OPW map much of the Wind Farm Site along the Dungolman River and the Mullenmeehan stream to be Benefited Land. Benefited land is land which was drained as part of the Arterial Drainage Scheme. Benefiting lands are defined as a dataset prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage.

The PFRA flood maps were queried for potential areas prone to flooding. The maps show that areas in the west and north of the Wind Farm Site are mapped in the 100-year and the Extreme Event fluvial flood zones (Zones A and B respectively) as outlined below. The majority of the Wind Farm Site is however located in Flood Zone C (Low Risk).

The 100-year flood zone is mapped along the Dungolman River within the Wind Farm Site. In the southwest of the Wind Farm Site, the flood zone extends up to 200m from the mapped river course and is mapped ~60m from T4. Further north, T2 is also mapped on the border of the Flood Zone B area, ~300m west of the main river channel. associated with flooding on the Dungolman River while T1 and T3 are located 50m and 180m west of this mapped flood zone respectively.

From the NIFM map of the Wind Farm Site, turbines T1 – T6 are located outside both the Low probability and Medium probability flood zones. Turbine T3 is located within both probability zones.

A detailed Stage III Flood Risk assessment was undertaken, based on the desk study data from the available flood mapping (PFRA/NIFM). This involved a GPS survey of river cross sections and water levels as well as detailed Lidar topographic data for the Wind Farm Site and long-term monitoring of water levels in the Dungolman and Mullenmeehan stream at 3 no. locations.

Flood level modelling for the Dungolman River was undertaken using HEC-RAS open channel flow software. HEC-RAS is a 2-dimensional flow model which can calculate channel water depth/level using parameters such as flood volumes, channel dimensions, slope and friction coefficients (Mannings n number). To investigate the potential for flooding within the Wind Farm Site, modelling of design flood volumes (i.e., 10-year,100-yr and 1000-yr) was undertaken for the river and its flood plain.

The results of the site specific flood modelling are detailed in Appendix 9-1 and are summarised below:

- There is no CFRAM mapping available for the site area.
- The PFRA mapping and NIFM is "broad scale" and based on OSI contour data. Site-specific surveying and flood modelling used in conjunction with Lidar Data is more accurate than these maps (as outlined within the technical guidance on the NIFM mapping in relation to site specific vs regional suitability of the mapping provided on www.floodinfo.ie).

- HES have completed site-specific flood modelling for the Proposed Development infrastructure within the Wind Farm Site identified as being in mapped flood zones (PFRA/NIFM mapping). The results of which are summarised as follows:
    - The assessment show there are no turbines located within mapped flood zones.
    - The onsite substation and temporary access roads are also located outside of the modelled flood zones.
    - The access roads (proposed/upgraded) are located outside of the modelled flood zones apart from 1 no. section (110m) of access road located ~300m west of T5.
    - All proposed wind farm access tracks within modelled flood pluvial zones will have the track surface raised at least 500mm above the 1000-year flood level. No mitigation is required with respect downstream flood risk as they are all outside of the modelled flood zone, apart from a 110m section of access road. There is an existing field drain which will be culverted under the proposed access track. This culvert will provide a drainage outlet for flood water following a significant flood event. This will prevent any damming effect from the proposed access road within this section.
    - Based on the iterative design process, designed around the site-specific flood modelling, any potential upstream and downstream flood impacts associated with the Proposed Development will be unmeasurable/imperceptible. Therefore, there will be no increase in flood risk to people, property, the economy or the environment during extreme flood events.

Grid Connection

The Grid Connection onsite substation and associated temporary construction compound are located within the Wind Farm Site and as such, are addressed in the section above. In addition to the Stage III Flood Risk Assessment for the Wind Farm Site, the potential for flooding along the Grid Connection underground electrical cabling route has also been reviewed.

OPW's indicative river and coastal flood map (www.floodmaps.ie), CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie), Department of Environment, Community and Local Government on-line planning mapping (www.myplan.ie) and historical mapping (i.e., 6" & 25" base maps) were consulted to identify those areas as being at risk of flooding.

The CFRAM River Flood Extents mapping was reviewed along the length of the underground electrical cabling route. There are no areas along the underground electrical cabling route mapped within the CFRAMS River Flood extent mapping.

The National Indicative Flood Mapping was also reviewed along the length of the underground electrical cabling route. There are sections of the Gaegborogh River near Horseleap which are mapped with flood extents which extend to the road carriageway. Similarly, the Silver River and Tullamore River along the N52 have modelled flood extents which extend onto the road carriageway.

Past Flood events are also recorded and available to view within www.floodinfo.ie/map. There is 1 no. flood event mapped in the townland of Dunard, near Horseleap (Flood ID – 2842). The available information at this location, from Offaly County Council meeting minutes, records that a small stream breaks its banks every ~3 years after heavy rain.

There is also 1 no. location mapped in Kilbeggan (Flood ID-2680), where the River Brosna breaks its banks and floods an existing housing estate, near the underground electrical cabling route.

In summary, there are areas along the underground electrical cabling route which may be prone to flooding, principally along the N52 near the Silver River and the Tullamore River and near the River Brosna. Due to the depth of the underground electrical cabling route, this will have no impact during the operational phase of the Proposed Development. During the construction phase, works along the underground electrical cabling route may have to be postponed following heavy rainfall events which could cause flooding in these areas.

9.3.6 Surface Water Quality

Q-rating status data for EPA monitoring points on the Dungolman River, Mullenmeehan stream and the Inny River are shown on

Table 9-6 below. The Q-Rating is a water quality rating system based on both the habitat and the invertebrate community assessment and is divided into status categories ranging from 0-1 (Poor) to 4-5 (Good/High). Most recent data available (2005 to 2020) show that the
Q-rating for the Dungolman River upstream of the Wind Farm Site at the bridge west of Umma House is of Poor status. Meanwhile, upstream of the Wind Farm Site, the Mullenmeehan stream is reported to be of Moderate status in the latest monitoring round (2020). Downstream of the site the Dungolman and Inny Rivers are both reported as being of Good status. No Q-rating is available for the Moneynamanagh stream located on the south of the Wind Farm Site.

Table 9-6: EPA Water Quality Monitoring Q-Rating Values

Waterbody	EPA Location Description	Year	Easting	Northing	EPA Q-Rating Status
Dungolman_020	Bridge West of Umma House	2020	218,660	245,466	Poor
Mullenmeehan Stream	Bridge near Mullenineehan	2020	221,427	246,572	Moderate
Dungolman_030	Bridge SE of Lecade	2020	217,655	252,059	Good
Inny_110	Red Bridge	2005	211,930	255,015	Good

Field hydrochemistry measurements of unstable parameters, electrical conductivity (µS/cm), dissolved oxygen (mg/L), pH (pH units) and temperature (°C) were taken at various locations in surface watercourses and drainage features at the Wind Farm Site on 06th July 2021, with follow up measurements on 22nd March 2022. The combined results are listed in Table 9-7.

Table 9-7: Field Parameters – Wind Farm Site Summary of Surface Water Chemistry Measurements

Location	Conductivity (µS/cm)	pH	Temp	Dissolved Oxygen (mg/L)
SW1 (06/07/2021)	524	8.15	10.9	10.29
SW2 (06/07/2021)	514	8.03	10.9	9.76
SW3 (06/07/2021)	516	8.04	10.8	10.14
SW1 (22/03/2022)	431.2	8.05	9.6	11.76
SW2 (22/03/2022)	457	7.95	9.9	11.32
SW3 (22/03/2022)	438.2	7.88	9.8	11.6
SW4 (22/03/2022)	204	7.74	11.4	11.77
SW5 (22/03/2022)	477	7.75	11.4	10.31
SW6 (22/03/2022)	463.4	7.83	12	10.62
SW7 (22/03/2022)	494.7	8.01	11.5	11.13
SW8 (22/03/2022)	477.8	7.58	11.2	10.9
SW9 (22/03/2022)	179.6	8.0	10.3	11.5

Location	Conductivity (µS/cm)	pH	Temp	Dissolved Oxygen (mg/L)
SW10 (22/03/2022)	477.0	7.88	11.4	10.92

Surface water hydrochemistry near the Wind Farm Site (SW1-SW3) and along the Grid Connection (SW4-SW10) were taken during site walkover surveys. The locations of these sampling points are shown in Figure 9-5. The electrical conductivity of the surface waters ranged between 179.6 and 516µS/cm. pH ranges between 7.58 – 8.15 indicating a slightly basic water chemistry, while dissolved oxygen ranges between 9.76 – 11.77 mg/L.

Surface water samples were also taken on 06th July 2021, in the main watercourses surrounding the Wind Farm Site (SW1-SW3), with subsequent sampling on 22nd March 2022. Electrical conductivities are within the expected range, varying from 100.3 to 660 µS/cm. The pH is typical of watercourses in the region, ranging between 7.58 and 8.15.

Results of the laboratory analysis from samples taken on 06th July 2021 are shown alongside relevant water quality regulations in Table 9-8 below. Results from follow up sampling on 22nd March 2022 are also shown in Table 9-9. In addition, the European Communities Environmental Objectives (Surface Waters) Regulations (S.I. No. 272/2009) (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy are shown in Table 9-10. Original laboratory reports are included as Appendix 9-3.

Table 9-8: Analytical Results of HES Surface Water Samples (Round 1)

Parameter	EQS	Sample ID		
		SW1 (06/07/21)	SW2 (06/07/21)	SW3 (06/07/21)
Total Suspended Solids (mg/L)	≤25(+)	6	6	7
Ammonia (mg/L)	≤0.065 to ≤ 0.04(*)	<0.02	0.03	0.14
Nitrite NO_2 (mg/L)		0.05	0.07	0.28
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	<5.0	6.5	<5.0
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10
Total Nitrogen (mg/L)	-	2.7	1.7	1.2
Chloride (mg/L)	≤ 1.3 to ≤ 1.5(*)	13.5	17.3	15.2
BOD		1	1	2

Table 9-9: Analytical Results of HES Surface Water Samples (September & October 2020)

Parameter	EQS	Sample ID									
		SW1 (22/03/22)	SW2 (22/03/22)	SW3 (22/03/22)	SW4 (22/03/22)	SW5 (22/03/22)	SW6 (22/03/2022)	SW7 (22/03/22)	SW8 (22/03/2022)	SW9 (22/03/2022)	SW10 (22/03/2022)
Total Suspended Solids (mg/L)	≤25(+)	<5	<5	<5	11	<5	<5	<5	25	<5	<5
Ammonia (mg/L)	≤0.065 to ≤ 0.04(*)	0.02	0.04	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite NO_2 (mg/L)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ortho-Phosphate – P (mg/L)	≤ 0.035 to ≤0.025(*)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate - NO_3 (mg/L)	-	10.3	12.4	9.5	<0.5	<5.0	11.5	16.7	18.9	6.6	25.3
Phosphorus (mg/L)	-	<0.10	<0.10	<0.10	0.12	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/L)	-	2.6	3.4	3.2	2.1	1.8	1.5	5.6	4.2	1.0	4.6
Chloride (mg/L)	≤ 1.3 to ≤ 1.5(*)	14.2	17.0	16.0	12.5	14.3	12.9	16.8	15.3	18.6	17.5
BOD		1	1	1	2	1	<1	<1	1	1	<1

(+) S.I. No. 293/1988: European Communities (Quality of Salmonid Waters) Regulations
(*) S.I. No. 272 /2009: European Communities Environmental Objectives (Surface Waters) Regulations 2009 (as amended by S.I. No. 296/2009; S.I. No. 386/2015; S.I. No. 327/2012; and S.I. No. 77/2019 and giving effect to Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2000/60/EC establishing a framework for Community action in the field of water policy).

Sampling Round 1

Total suspended solids ranged between 6 - 7mg/L which is relatively high, considering the samples were taken in July, when runoff would typically be low, but are below the limits for both Salmonid and Cyprinid waters.

Ammonia-N ranged between <0.02 and 0.14mg/L, the latter of which is above the limits for both Salmonid waters and Cyprinid waters.

BOD was less than 5mg/L in all samples, which is below the limits for Cyprinid waters but potentially exceeds the threshold limit for salmonid waters.

Nitrite ranged between 0.05 – 0.28 mg/L. The results are typically low which is what would be expected for surface waters with little input from intensive agriculture or other anthropogenic factors.

Nitrate ranged between <5.0 and 6.5mg/L which is relatively low and like nitrate, this is what would be expected for surface water with little input from intensive agriculture or other anthropogenic factors.

Sampling Round 2

Total suspended solids are generally <5 mg/L, but reached 11 mg/L and 25 mg/L in SW4 and SW8 respectively. These results are at or below the limits for both Salmonid and Cyprinid waters. The long-term average suspended solids level is likely well below the threshold value of 25 mg/l.

Ammonia-N generally ranged between <0.02 and 0.04mg/L, which is within the “high” status limits for both Salmonid waters and Cyprinid waters of 0.04 mg/l.

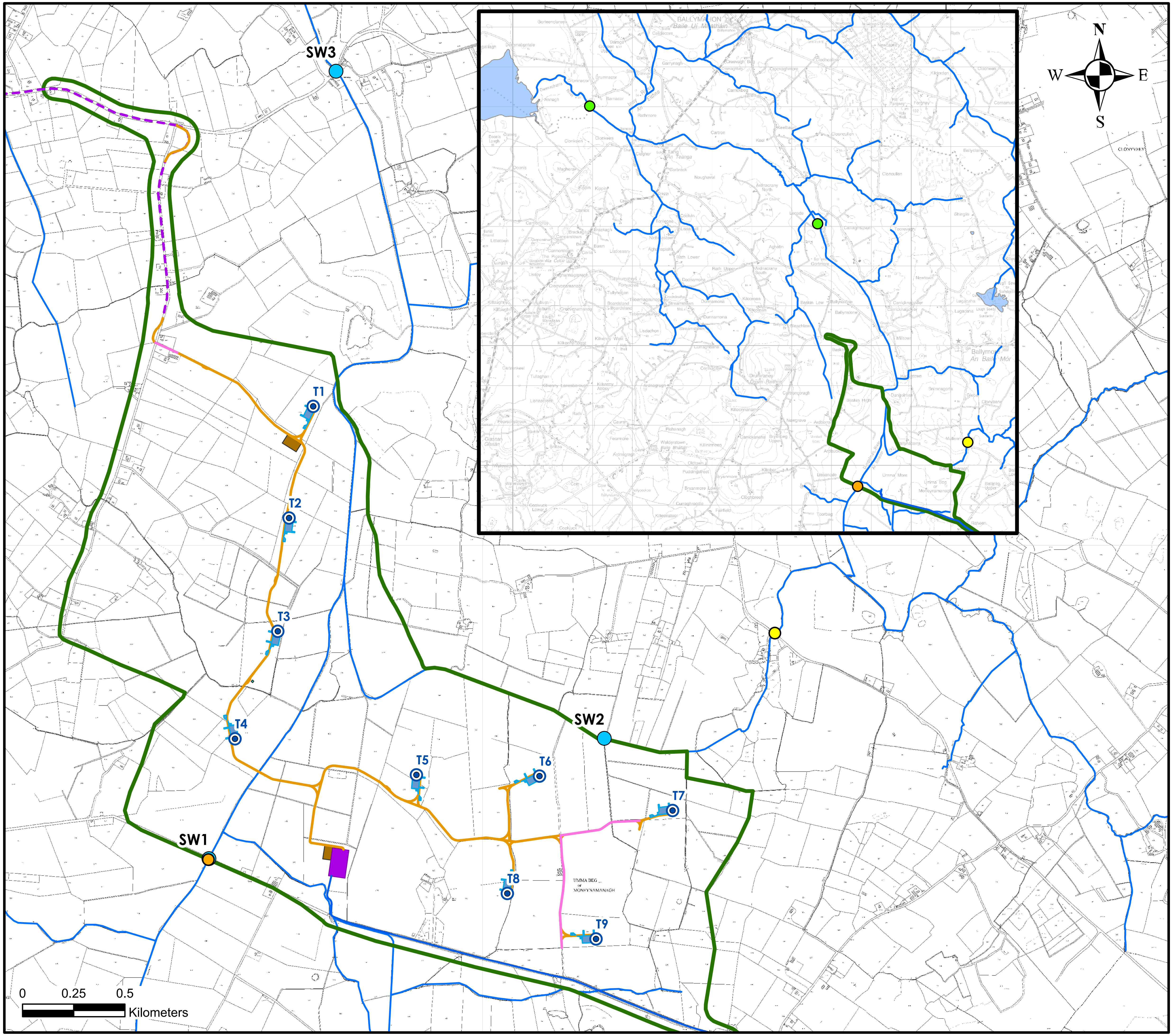
BOD was at or below 1mg/L in 9 of 10 no. samples, which is below the limits for Cyprinid and Salmonid waters. The remaining sample at SW4 measured 2 mg/l.

Nitrate ranged between <0.5 and 25.3mg/L The value of 25.3 mg/L occurred in SW10 and may be related to runoff from local land spreading at the time (March 2022). Orthophosphate was below the detection limit of 0.02 mg/L in all samples.

*Table 9-10: Chemical Conditions Supporting Biological Elements**

Parameter	Threshold Values (mg/L)
BOD	High status ≤ 1.3 (mean)
	Good status ≤ 1.5 mean
Ammonia-N	High status ≤ 0.04 (mean)
	Good status ≤0.065 (mean)
Orthophosphate	High status ≤0.025 (mean)
	High status ≤0.025 (mean)
	Good status ≤0.035 (mean)

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



N
W E
S

Legend

- EIAR Site Boundary
- Proposed Turbine Layout
- Proposed Turbine Hardstands
- Proposed Met Mast Location
- Proposed New Roads
- Proposed Upgrades to Existing Roads
- Proposed Temporary Construction Compounds
- Proposed 110kV Onsite Substation
- Proposed Underground Electrical Cabling Route
- Proposed Turbine Delivery Route
- Watercourses
- Lakes
- SW Sampling points

River Q-rating

- Good
- Moderate
- Poor

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Client: MKO

Job: Umma More Renewable Energy Development

Title: Surface Water Sampling and River Q-Rating Locations Map

Figure No: 9-5

Drawing No: P1553-0-0123-A3-905-00A

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9.3.7 Hydrogeology

9.3.7.1 Wind Farm Site

The Geological Survey of Ireland (GSI) classifies the Dinantian Upper Impure Limestones (DUIL) as a Locally Important Aquifer (LI – Bedrock which is generally moderately productive only in local zones). The Wind Farm Site is underlain by the Inny Groundwater Body (GWB).

While no local hydrogeological data is available for this groundwater body, permeability will generally decrease rapidly with depth in this limestone and shale aquifer type. In general, transmissivities will be in the range 2-20m^2/d, with median values occurring towards the lower end of the range (GSI, 2004). The effective thickness of the aquifer is likely to be within 15m of the top of rock, comprising a weathered zone of 5m and a further zone of interconnected fissures of 10m below. Significantly higher permeabilities are likely to be found in fault zones and areas which have undergone structural deformation, which are associated with higher yielding wells. Aquifer storativity will be low in this bedrock unit (GSI, 2004).

Groundwater flow occurs mainly in faults and joints. Most groundwater flow probably occurs in an upper shallow weathered zone. Below this in the deeper zones water-bearing fractures and fissures are less frequent and less well connected. Groundwater in this GWB is generally unconfined. Local groundwater flow is towards the rivers and streams, and flow paths are usually between 30 and three hundred metres in length.

Groundwater within the Wind Farm Site is expected to discharge to the Dungolman River as this will be the dominant hydraulic boundary or discharge zone for groundwater flow in the area. The Wind Farm Site slopes to the east/northeast and groundwater flow will reflect this change in topography.

9.3.7.2 Grid Connection

The Grid Connection is located within several groundwater bodies, which include, from north within the Wind Farm Site to south along the underground electrical cabling route to Thornsberry 110kV substation, the Inny groundwater body (GWB), the Clara GWB, the Gageborogh-Brosna Gravels Group 1 GWB, the Kilbeggan gravels GWB and the Tullamore GWB.

The characteristics of the Inny GWB are as discussed above in Section 9.3.7.1.

The Clara GWB covers an area of 712 km^2 with elevation ranging from 40 – 200mOD. Nearly all the aquifers in this GWB are Locally Important Aquifers which are moderately productive only in local zones (LI).

The Tullamore GWB covers an area of 222 km^2 with elevation ranging between 50-120 mOD. The main aquifer categories are Regionally important karstified aquifer dominated by diffuse flow (Rkd) and Locally important aquifers (LI).

There are no further details on the Gageborogh-Brosna Gravels Group 1 or the Kilbeggan gravels GWB's.

There are 3 no. springs mapped as karst landforms by the GSI, situated along the N52 in the townland of Durrow Demense. These springs discharge into the Durrow Abbey Stream.

9.3.8 Groundwater Hydrochemistry

9.3.8.1 Wind Farm Site

There are no groundwater quality data for the Wind Farm Site and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting, as effects on groundwater quality are not anticipated.

Based on data from GSI publication Calcareous/Non calcareous classification of bedrock in the Republic of Ireland (WFD, 2004), alkalinity generally ranges from 250 to 350 mg/l (as $CaCO_3$) and hardness ranges from 380 to 450 mg/L (hard to very hard). The underlying formations largely contain calcium bicarbonate type water. Electrical conductivities in these bedrock units are high and will typically range from 650 to 800 μ S/cm (GSI, 2003).

9.3.8.2 Grid Connection

There are no groundwater quality data for the underground electrical cabling route and groundwater sampling would generally not be undertaken for this type of development in terms of EIAR reporting, as groundwater quality impacts would not be anticipated. (Surface water sampling is detailed above in Section 9.3.6.)

The differing 5 no. groundwater bodies mean that groundwater hydrochemistry will vary along the underground electrical cabling route.

9.3.9 Groundwater Body Status

9.3.9.1 Wind Farm Site

Local Groundwater Body and Surface water Body status and risk result are available from (www.catchments.ie). The GWB status are shown below in Table 9-11.

The Inny Groundwater Body (GWB: IE_SH_G_110) underlies the Wind Farm Site. It is assigned 'Good Status' under the WFD 2016-2021 (www.wfdireland.ie), this applies to both quantitative status and chemical status. This groundwater body has been deemed to be "Not at risk" and no significant pressures have been identified.

Table 9-11: Groundwater body staus (Wind Farm Site)

SWB Code	Water Body	Overall Status	Risk Status	Pressures
IE_SH_G_110	Inny	Good	Not at risk	N/A

9.3.9.2 Grid Connection

Local Groundwater Body and Surface water Body status and risk results are available from (www.catchments.ie). The GWB status for the Grid Connection are shown below in Table 9-12.

The Inny Groundwater Body (IE_SH_G_110) underlies the Grid Connection onsite substation and associated temporary construction compound which is located in the Wind Farm Site, along with the northern section of the Grid Connection underground electrical cabling route. It is assigned 'Good Status' under the WFD 2016-2021(www.wfdireland.ie), this applies to both quantitative status and chemical status. This groundwater body has been deemed to be "Not at risk" and no significant pressure have been identified.

The Clara GWB (IE_SH_G_240) underlies the underground electrical cabling route. It is assigned 'Good Status'[2] under the WFD 2016-2021(www.wfdireland.ie), this applies to both quantitative status and chemical status. This groundwater body has been deemed to be "Not at risk" and no significant pressure have been identified.

The Tullamore GWB (IE_SH_G_232) underlies the southern section of the underground electrical cabling route. It is assigned 'Good Status' under the WFD 2016-2021(www.wfdireland.ie), this applies to both quantitative status and chemical status. This groundwater body has been deemed to be "Not at risk" and no significant pressure have been identified.

The Kilbeggan Gravels GWB (IE_SH_G_242) is assigned "Good Status'[3] under the WFD 2016-2021 (www.wfdireland.ie), this applies to both quantitative status and chemical status. The risk rating for the GWB is under review.

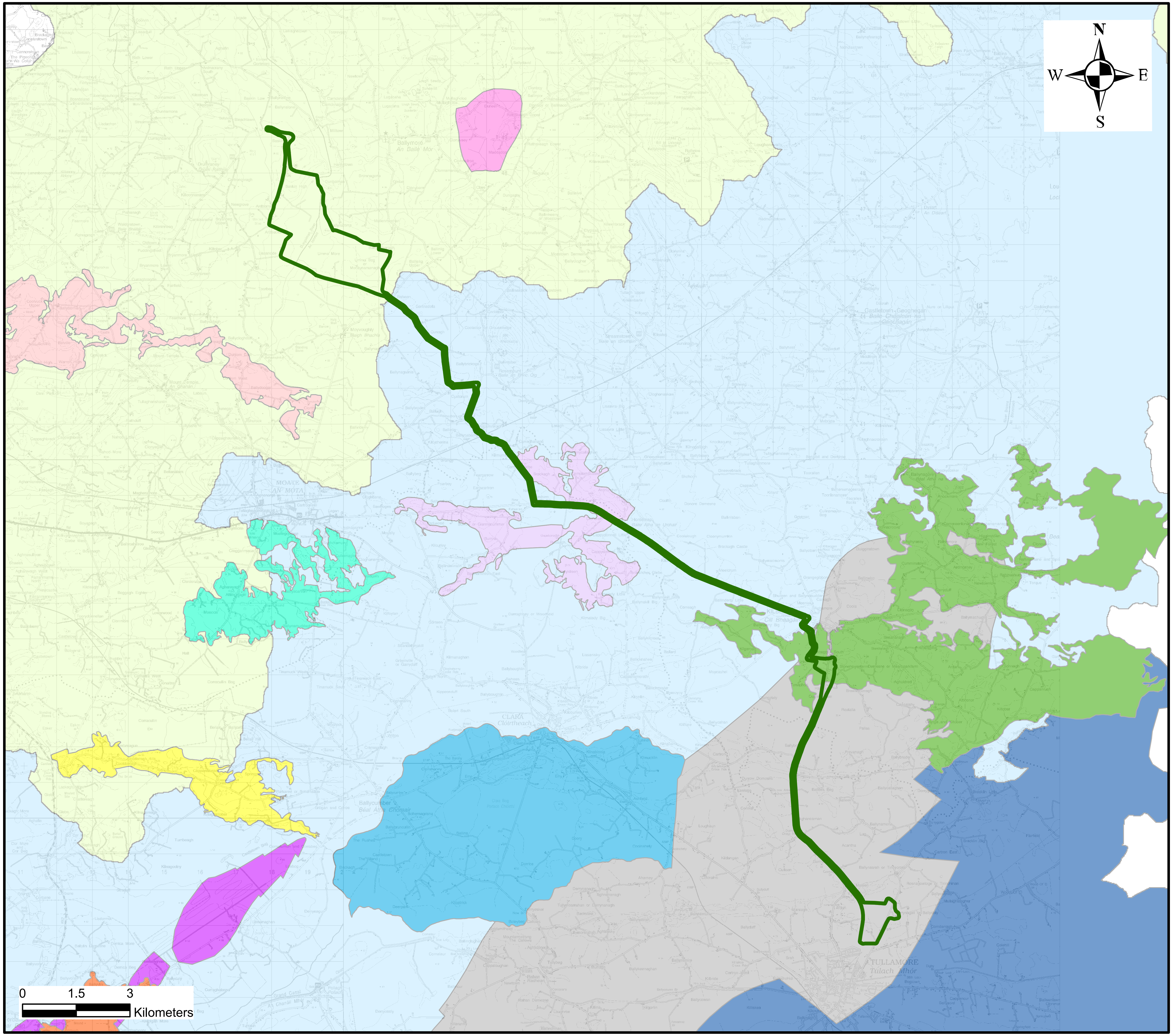
The Gageborogh Gravels Group 1 GWB (IE_SH_G_253) is assigned "Good Status' under the WFD 2016-2021(www.wfdireland.ie), this applies to both quantitative status and chemical status. The risk rating for the GWB is under review.

Table 9-12: Groundwater body status (Grid Connection)

SWB Code	Water Body	Overall Status	Risk Status	Pressures
IE_SH_G_110	Inny	Good	Not at risk	None defined
IE_SH_G_240	Tullamore	Good	Not at risk	None defined
IE_SH_G_232	Clara	Good	Not at risk	None defined
IE_SH_G_242	Kilbeggan Gravels	Good	Under review	Under Review
IE_SH_G_253	Gageborogh Gravels (Group 1)	Good	Under review	Under review

A groundwater body map is shown in Figure 9-6.

[2] *'Status' means the condition of the water in the waterbody. It is defined by its chemical status and its ecological status, whichever is worse. Waters are ranked in one of 5 classes: High, Good, Moderate, Poor and Bad (WFD, 2010).*
[3] *'Status' means the condition of the water in the waterbody. It is defined by its chemical status and its ecological status, whichever is worse. Waters are ranked in one of 5 classes: High, Good, Moderate, Poor and Bad (WFD, 2010).*



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Client: MKO	
Job: Umma More Renewable Energy Development	
Title: WFD Groundwater Bodies Map	
Figure No: 9-6	
Drawing No: P1553-0-0123-A3-906-00A	
Sheet Size: A3	Project No: P1553-0
Scale: 1:100,000	Drawn By: GD
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9.3.10 Surface Water Body Status

9.3.10.1 Wind Farm Site

A summary of the WFD status and risk result of Surface Water Bodies (SWBs) in which the Wind Farm Site is located immediately upstream or downstream of are shown in Table 9-13 below.

The surface water quality status (2016-2021) for the Dungolman River (IE_SH_26D060200) is Poor, while the Mullenmeehan stream (IE_SH_26M120080) upstream of the Wind Farm Site is classified as Moderate with a risk result of "Not at risk". In the vicinity of the Wind Farm Site the Dungolman River (IE_SH_26D060400) has been assigned Poor status with this waterbody deemed to be "At risk" and under significant pressure from urban wastewater. Further downstream the Inny River (IE_SH_26I011400) is assigned a Moderate status but is deemed to be under significant pressure from agricultural activities in the surrounding catchment. Meanwhile Lough Ree (IE_SH_26_750a) achieved Good status and is deemed to be "Not at risk".

Table 9-13: Summary WFD Information for Surface Waterbodies

SWB Code	Water Body	Overall Status	Risk Status	Pressures
IE_SH_26D060200	Dungolman_020	Poor	Not at risk	None defined
IE_SH_26M120080	Mullenmeehanstream_010	Good	Not at risk	None defined
IE_SH_26D060400	Dungolman_030	Poor	At Risk	Urban Wastewater
IE_SH_26I011400	Inny_110	Unassigned	Under review	Agriculture
IE_SH_26_750a	Lough Ree	Good	Not at risk	None defined

9.3.10.2 Grid Connection

A summary of the WFD status and risk result of Surface Water Bodies (SWBs) along the Grid Connection are shown in Table 9-14 below.

The surface water quality status (2016-2021) for the Ballynagrenia_010 and 020 waterbodies are Poor and Good respectively. Ballynagrenia_010 is identified as being "At Risk" from agricultural pressure, while Ballynagrenia_020 is "Not at Risk" from any external pressures.

Further south along the underground electrical cabling route, the Gageborogh_020 and Gageborogh_030 water bodies both achieved "Good" status during the WFD 2016-2021. Both waterbodies are classified as "At Risk" from agricultural pressures.

The Brosna_070 waterbody achieved Good status and is "Not at Risk". The Tonaphort_010 is assigned a Moderate status, but is not assigned a risk rating. The Durrow Abbey Stream_010 achieved Poor status and is considered "At Risk" from forestry and agricultural pressures.
Finally, the Silver (Tullamore)_020 waterbody achieved "Good" status and is considered "Not at risk".

Table 9-14: Summary WFD Information for Surface Waterbodies

SWB Code	Water Body	Overall Status	Risk Status	Pressures
IE_SH_25B160400	Ballynagrenia_010	Moderate	At Risk	Agriculture
IE_SH_25B160600	Ballynagrenia_020	Good	Not at risk	None defined
IE_SH_25G010500	Gageborogh_030	Good	At Risk	Agriculture
IE_SH_25G010300	Gageborogh_020	Good	At Risk	Agriculture
IE_SH_25B090450	Brosna_070	Good	Not At Risk	None defined
IE_SH_25T450930	Tonaphort_010	Unassigned	Under review	Under review
IE_SH_25D120200	Durrow Abbey Stream_010	Moderate	At Risk	Forestry, Peat workings and agriculture
IE_SH_25S030100	Silver(Tullamore)_020	Good	Under Review	Under review

9.3.11 Designated Sites and Habitats

9.3.11.1 Wind Farm Site

In the Republic of Ireland, designated sites include proposed Natural Heritage Areas (pNHAs), Natural Heritage Areas (NHAs), Special Areas of Conservation (SAC) and Special Protection Areas (SPA's). The Wind Farm Site is not located within any designated site. A designated site map for the area is shown as Figure 9-7.

Designated sites within 15km of the proposed Wind Farm Site include:

- Ballynagrenia and Ballinderry Bog NHA (Site Code: 000674), approximately 2km to the south;
- Lough Sewdy pNHA (Site Code: 000689), approximately 3.2km to the northeast;
- Ballymore Fen SAC (Site Code: 002313), approximately 4.8km to the northeast;
- Ballynagarbry pNHA (Site Code: 001717), approximately 5.2 km to the south;
- Carn Park Bog SAC and pNHA (Site Code: 000676), approximately 6.3km to the southwest;
- Waterstown Lake pNHA (Site Code: 001732), approximately 7.2km to the west;
- Crosswood Bog SAC and pNHA (Site Code: 002337), approximately 9.7km to the southwest; and,
- Lough Ree SAC, SPA and pNHA (Site Code: 000440), approximately 10.5km to the northwest;

Ballynagrenia and Ballinderry Bog NHA and the Ballynagarby pNHA are located to the south of the Wind Farm Site, however these designated sites are located upstream of the Wind Farm Site and therefore are not hydraulically connected (downgradient) to the Wind Farm Site, therefore we have excluded those sites from further impact assessment analysis.

Lough Sewdy pNHA is located ~3.2km northeast of the Wind Farm Site. This waterbody is mapped within the Inny(Shannon)_SC_070 sub-catchment and is not hydraulically connected to the Wind Farm Site due to the topographic boundary between these two subcatchments. The lake is not hydraulically connected to the Wind Farm Site, therefore it is excluded from further assessment.

The Ballymore Fen SAC is situated ~5.2km south of the Wind Farm Site on the south-eastern boundary of the Inny(Shannon)_SC_090 subcatchment. The majority of the fen is mapped in the adjoining Inny(Shannon)_SC_070 subcatchment. The location of the fen on the boundary of these two subcatchments, indicates its hydraulic nature, in that it is located on slightly higher ground and drains down towards the rivers in the lower subcatchments. It is therefore hydraulically upgradient of the Wind Farm Site and is excluded from further assessment.

The Carn Park Bog SAC and pNHA is located 6.3km southwest of the Wind Farm Site. The bog is located within the Breensford_SC_010 subcatchment which drains north towards the Inny River. The bog is located in a separate subcatchment to the Wind Farm Site at the upper reaches of a well defined basin. There is no hydrological connection between the Carn Park Bog SAC and pNHA and the Wind Farm Site, therefore it is excluded from further assessment.

The Waterstown Lake pNHA is located 7.2km west of the Wind Farm Site. The Waterstown Lake is also situated in the Inny(Shannon)_070 subcatchment, slightly downgradient of the Carn Park Bog SAC and pNHA. Again, as it is located within a separate subcatchment to the Wind Farm Site, it is excluded from further assessment.

The Crosswood Bog SAC and pNHA is located 9.7km southwest of the Wind Farm Site. The bog is located within the Shannon(Lower)_SC_010 subcatchment. This is significantly distal to the Wind Farm Site and the Inny(Shannon)_SC_090 subcatchment in which the Wind Farm Site is located. The

Crosswood Bog SAC and pNHA is hydraulically isolated from the Wind Farm Site and as such is not carried further in the assessment.

Lough Ree SAC, SPA and pNHA is located approximately 10km northwest and downstream of the Wind Farm Site. This designated site is hydrologically linked with the Wind Farm Site via the Dungolman and Inny Rivers. Refer to Section 6.5.1.1.1 in Chapter 6 of the EIAR: Biodiversity regarding the Lough Ree SAC, SPA and pNHA and the Qualifying Interests/ Special Conservation Interests for which the European site has been designated. Please also refer to the Natura Impact Statement (NIS) prepared for the Proposed Development, which further considers the Lough Ree SAC, SPA and pNHA.

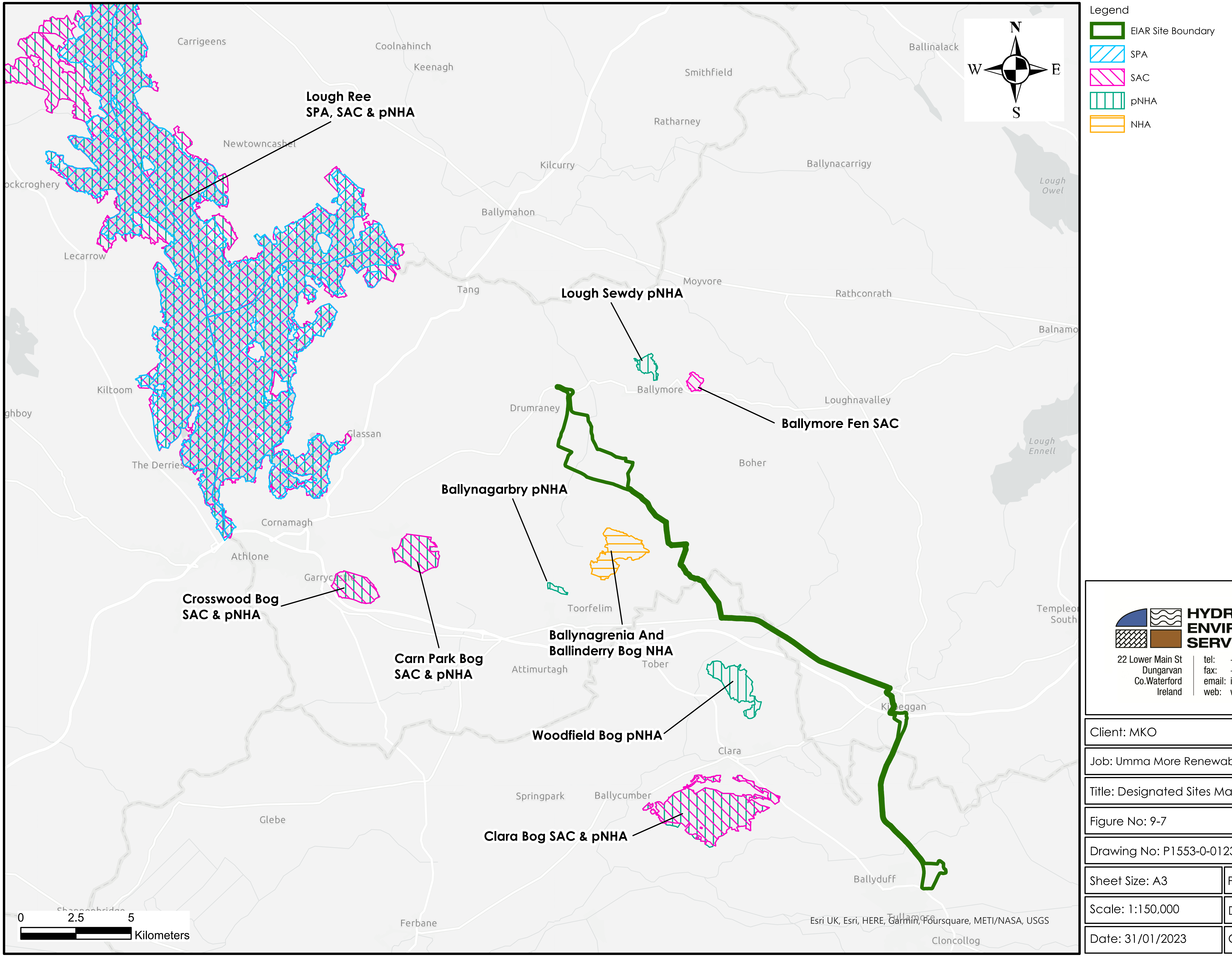
The majority of these designated sites are located hydraulically upgradient of the Wind Farm Site or in separate sub-catchments as the Wind Farm Site. Therefore, these sites are not hydrologically linked to the Wind Farm Site and are not subject to further analysis. Only one designated site is carried forward for further assessment, and this is Lough Ree SAC, SPA and pNHA (Site Code: 000440), approximately 10.5km to the northwest of the Wind Farm Site.

9.3.11.2 Grid Connection

The Grid Connection onsite substation and associated temporary construction compound are located within the Wind Farm Site and as such, are addressed in the section above. There are no designated sites mapped along the Grid Connection underground electrical cabling route. The nearest designated site is the Clara Bog SAC and pNHA, situated ~4km west of the underground electrical cabling route at its closest point. The Clara Bog SAC is a raised bog situated at an elevation of ~60mOD and is hydraulically upgradient of the Brosna and Silver Rivers. The streams and rivers which are crossed along the underground electrical cabling route south of Horseleap, drain towards the Silver River and ultimately the River Brosna. As the bog is situated upgradient of the Brosna and Silver rivers, there is no hydraulic connection between the Clara Bog SAC/pNHA and the underground electrical cabling route.

The Woodfield Bog pNHA is situated approximately 1km south of the underground electrical cabling route, south of the village of Horseleap. This pNHA site is located near Kilamady hill, on an elevated site which is significantly above the Gageborough river and the underground electrical cabling route. It is therefore not hydraulically connected with the underground electrical cabling route.

The River Shannon Callows SAC and Middle Shannon Callows SPA are situated ~38km downgradient of surface watercourses along the proposed underground electrical cabling route. Despite their significant separation distance, the designated sites are screened in, due to their hydrological connection with stream along the underground electrical cabling route. Refer to Section 6.5.1.1.1 in Chapter 6 of the EIAR: Biodiversity regarding the River Shannon Callows SAC and Middle Shannon Callows SPA and the Qualifying Interests/ Special Conservation Interests for which the European sites has been designated. Please also refer to the Natura Impact Statement (NIS) prepared for the Proposed Development, which further considers the River Shannon Callows SAC and Middle Shannon Callows SPA.



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Client: MKO

Job: Umma More Renewable Energy Development

Title: Designated Sites Map

Figure No: 9-7

Drawing No: P1553-0-0123-A3-907-00A

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9.3.12 Water Resources

9.3.12.1 Wind Farm Site

There are no mapped public or group water scheme groundwater protection zones in the Wind Farm Site. The closest mapped Group Scheme is the Tubber Scheme, located approximately 4.2km south of the Wind Farm Site and in the Clara Ground Waterbody. This protection zone is therefore not of any significance for the Proposed Development.

A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). There are no wells with an accuracy of 1 – 50m mapped in the Wind Farm Site. There is one well (2023NEW016), mapped ~200m outside the northern boundary of the Wind Farm Site. This well (GSI Name: 2023NEW029) has agricultural and domestic uses and a poor yield class of 10.9m^3/day. The GSI also map several wells in the vicinity of the southwest of the Wind Farm Site. These boreholes (GSI name: 2023NEW032 and 2023NEW033) also have poor yield classes and domestic and agricultural uses.

A map of nearby wells is included as Figure 9-8.

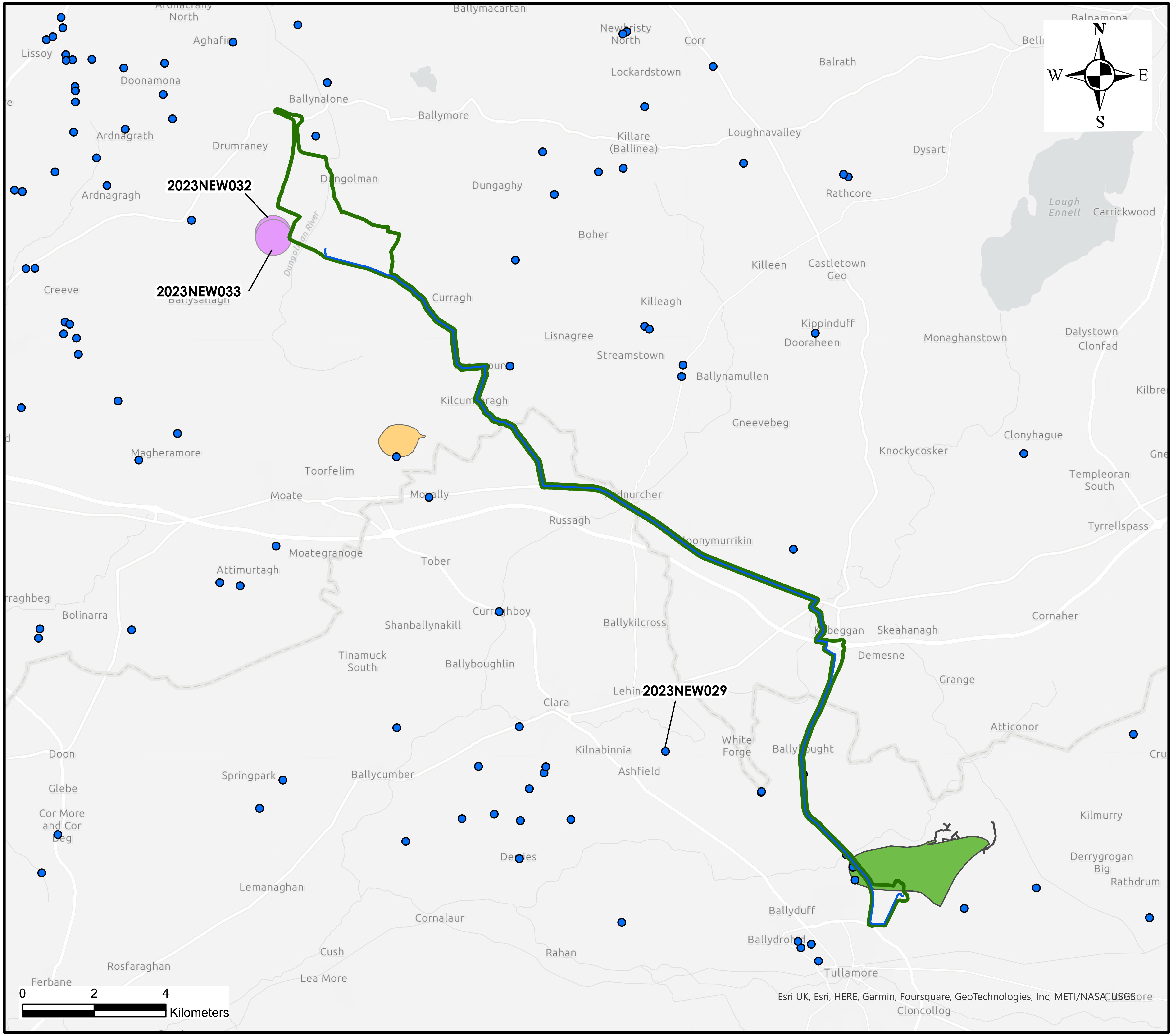
An assessment of potential effects to local groundwater wells is completed in Section 9.5.2.10 below.

9.3.12.2 Grid Connection

The Grid Connection onsite substation and associated temporary construction compound are located within the Wind Farm Site and as such, are addressed in the section above. A search of private well locations (accuracy of 1 – 50m only) was undertaken using the GSI well database (www.gsi.ie). There are 3 no. wells mapped along the Grid Connection underground electrical cabling route, within the EIAR Site Boundary.

There is 1 no. PWS source protection area mapped at the southern end of the underground electrical cabling route, near the Thornsbury 110kV substation. There are 2 no. boreholes (PW1 & PW2) used by the Tullamore Ardan PWS which are located ~50m east of the N52 and the underground electrical cabling route. The water strikes recorded in PW1 occurred between 72-103 mbgl, while the water strike in PW2 was recorded at 35mbgl. PW1 is a grout sealed borehole, while there is no grout seal noted on the construction log of PW2.

A Source Protection Report for the Ardan PWS has been prepared by the GSI. The underground electrical cabling route travels along the N52, a 1.03km section of the underground electrical cabling route is situated within the Source Protection Zone for the Ardan PWS. This is assessed in Section 9.5.2.10 below.



Legend

- EIAR Site Boundary
- Proposed Underground Electrical Cabling Route
- GSI Mapped Wells (accuracy <50m)
- GSI Mapped wells (500m - 1km accuracy)

Public Supply Source Protection Area

- SI-Inner Protection Area (TULLAMORE ARDAN PWS)

Group Scheme Preliminary Source Protection Areas

- Tubber

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Client: MKO	
Job: Umma More Renewable Energy Development	
Title: Nearby GW Wells Map	
Figure No: 9-8	
Drawing No: P1553-0-0123-A3-908-00A	
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9.3.14 Receptor Sensitivity

Due to the nature of wind farm developments, being mostly near surface construction activities, effects on groundwater are negligible and surface water is the main sensitive receptor assessed during impact assessments. The primary risk to groundwater at the Wind Farm Site and the Grid Connection would be from cementitious materials, hydrocarbon spillage and leakages during construction works. These are common potential risks on all construction sites (such as road works and industrial sites), which can be addressed by way of mitigation. All potential contamination sources are to be carefully managed at the Wind Farm Site and Grid Connection during the construction and operational phases of the Proposed Development and mitigation measures are proposed below to deal with these potential risks.

Based on criteria set out in Table 9-2 above, the Locally Important Aquifer can be classed as Sensitive to pollution. The majority of the Wind Farm Site however is subsoils which have moderate to poor recharge coefficients and are in turn is underlain by lake sediments and silty/clayey glacial deposits and these layers act as a protective cover to the underlying bedrock aquifer. However, due to the geological and hydrological regime at the Wind Farm Site, any contaminants which may be accidently released on-site are more likely to travel to nearby streams within surface runoff. Comprehensive surface water mitigation and control measures are outlined below to avoid this occurring and to ensure protection of all downstream receiving waters. These mitigation and control measures will also be utilised during works for the Grid Connection where applicable, also noting that the Grid Connection underground electrical cabling works are shallow and transient in nature and the works will mainly be completed within an existing road carriageway.

Mitigation measures will ensure that surface runoff from the developed areas of the Wind Farm Site and Grid Connection will be of a high quality and will therefore not impact on the quality of downstream surface water bodies. Any introduced drainage works at the Wind Farm Site will mimic the existing drainage regime thereby avoiding changes to flow volumes leaving the Wind Farm Site.

9.3.15 Development Interaction with the Drainage Network of the Wind Farm Site

The general design approach to wind farm layouts in existing forestry/agricultural land is to utilise and integrate new drainage with the existing drainage infrastructure where possible.

9.3.16 Proposed Drainage Management

Runoff control and drainage management are key elements in terms of mitigation against effects on surface water bodies. Two distinct methods will be employed to manage drainage water within the Wind Farm Site. The first method involves ‘keeping clean water clean’ by avoiding disturbance to natural drainage features, minimising any works in or around artificial drainage features, and diverting clean surface water flow around excavations, construction areas and temporary storage areas. The second method involves collecting any drainage waters from works areas within the Wind Farm Site that might carry silt or sediment, and nutrients, to route them towards settlement ponds (or stilling ponds) prior to controlled diffuse release over vegetated surfaces. There will be no direct discharges to surface waters. During the construction phase all runoff from works areas (i.e. dirty water) will be attenuated and treated to a high quality prior to being released. The drawings for the proposed drainage management system is included as Appendix 9-4.

9.4 Characteristics of the Proposed Development

The Proposed Development is defined in Section 4.1 of Chapter 4. The main characteristics of the Proposed Development that could impact on water and hydrogeology are:

- Establishment of the temporary construction compound, which will involve minor regrading of soil/subsoil and the emplacement of the construction compound. Welfare facilities will be provided at the temporary construction compounds. Wastewater effluent will be collected in a wastewater holding tank and periodically emptied by a licenced contractor.
- Construction of the site access tracks will use the excavate and replace technique. This will involve the use of aggregate, imported from local quarries where required. Construction of these access tracks has the potential to impact on surface water quality.
- Construction of the crane hardstand areas and turbine assemblage areas will utilise ground bearing foundations. Construction of these areas has the potential to impact on surface water quality.
- Settlement ponds where constructed will be volume neutral, i.e. all material excavated will be used to form side bunds and landscaping around the ponds. There will be no excess material from settlement pond construction. The material will also be reinstated during decommissioning.
- Construction of the onsite substation will be completed with a ground bearing foundation. Welfare facilities will be provided at the substation. Construction of the onsite substation and associated parking area has the potential to impact on surface water quality.
- Grey water will be supplied by rainwater harvesting and water tankered to site where required. Bottled water will be used for potable supply.
- Construction of the turbine foundations, which will require large volumes of concrete (approximately 700m^3 per turbine foundation plus approximately 50m^3 of lean-mix concrete for the blinding layer), placing demand on local concrete batching plants / quarries. Concrete could impact on surface water and groundwater quality.
- Cabling between turbine locations and the onsite substation will involve the excavation of a shallow trench (approximately 1.2m deep), placement of ducting and backfilling with aggregate, lean-mix concrete, and excavated material, as appropriate (depending on the location of the cable trench). These works have the potential to impact on surface water quality.
- Underground electrical cabling between the onsite substation and the Thornsberry 110 kV Substation will involve the excavation of a trench predominantly within the public road, placement of ducting and backfilling with lean-mix concrete and compacted engineered fill. These works have the potential to impact on surface water quality.
- Junction Accommodation and Public Road Works, including:
    - Location 1 – M6 Junction 10 left slip / N55 junction in Athlone
    - Location 2 – N55 / R916 Cornamaddy Roundabout
    - Location 3 – N55 / R390 Junction in Athlone
    - Location 4 – Bend on R390 at Coolteen
    - Location 5 – Bends on R390 at Beechlawn
    - Location 6 – R390 / L5363 Junction
    - Location 7 – Access junction on L5363
- Tree felling and replanting. 1 no. turbine is located in commercial forestry (T4) which will require felling, and replanting of forestry at alternative replacement lands. While this work will be done with Forestry Service licences and approvals, the works could result in soil/subsoils erosion.

9.5 Likely Significant Effects and Associated Mitigation Measures

9.5.1 Do Nothing Scenario

If the Proposed Development were not to proceed, coniferous plantation and agriculture will continue to function and may be extended to occupy a larger portion of the land. Coniferous forestry will be felled as forestry compartments reach maturity. Re-planting of these areas with coniferous plantation is likely to occur. Surface water drainage carried out in areas of forestry will continue to function and may be extended in some areas. The opportunity to capture the available renewable energy resource would be lost.

9.5.2 Construction Phase Likely Significant Effects and Mitigation Measures

9.5.2.1 Earthworks (Removal of Vegetation Cover, Excavations and Stock Piling) Resulting in Suspended Solids Entrainment in Surface Waters

Construction phase activities including access road construction, construction compound, turbine base/hardstanding construction, cabling trenching within the Wind Farm Site, and Grid Connection onsite substation construction, construction compound and underground electrical cabling route cable trench excavation will require earthworks resulting in removal of vegetation cover and excavation/landscaping of small volumes of soil and mineral subsoil where present. The soil and subsoil removed will be accommodated within identified spoil management areas within the Wind Farm Site or transported to a local licenced facility. The spoil management areas will be situated outside of all mapped flood zones and drainage buffer zones. Potential sources of sediment laden water include:

- Drainage and seepage water resulting from site infrastructure excavation;
- Stockpiled excavated material providing a point source of exposed sediment;
- Construction of the underground electrical cabling trench resulting in entrainment of sediment from the excavations during construction; and,
- Erosion of sediment from emplaced site drainage channels.

These activities can result in the release of suspended solids to surface watercourses and could result in an increase in the suspended sediment load, resulting in increased turbidity which in turn could affect the water quality and fish stocks of downstream water bodies. Potential effects are significant if not mitigated against.

Pathways: Drainage and surface water discharge routes.

Receptors:

Wind Farm Site: Down-gradient rivers (Dungolman River, Inny River, Moneynamanagh stream and Mullenmeehan stream) and dependent ecosystems. Lough Ree is also located downstream of the Wind Farm Site and is hydrologically linked to the Wind Farm Site via the Dungolman and Inny Rivers.

Grid Connection: Down-gradient surface watercourses

Pre-Mitigation Potential Effects: Indirect, negative, significant, temporary, unlikely impact.

Proposed Mitigation Measures:

Wind Farm Site

The key mitigation measure during the construction phase is the avoidance of sensitive aquatic areas where possible, by application of suitable buffer zones (i.e. 50m to main watercourses, and 10m to main drains). From Figure 9-4 it can be seen that all of the key development components within the Wind Farm Site are located significantly away from the delineated 50m watercourse buffer zones with the exception of the upgrading of the existing watercourse crossing, new drain crossing and upgrades to existing site tracks. Spoil management areas for removed soil/subsoil will be localised to spoil management areas outside of these buffer zones and will be designed and constructed with the minimal amount of surface area exposed. In these spoil management areas, the vegetative top-soil layer will be removed and re-instated or reseeded directly after construction, allowing for re-vegetation which will mitigate against erosion. Additional control measures, which are outlined further on in this section, will be undertaken at the proposed watercourse and drain crossing locations.

It should be noted that an extensive network of agricultural and forestry drains already exists, and these will be integrated and enhanced as required and used within the Wind Farm Site drainage system. The integration of the existing drainage network and the Wind Farm Site network is relatively simple. The key elements being the upgrading and improvements to water treatment elements, such as in line controls and treatment systems, including silt traps, settlement ponds and buffered outfalls.

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

- Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the Wind Farm Site drainage into the existing site drainage network where possible. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion;
- Silt traps will be placed in the existing drains upstream of any streams where construction works / tree felling is taking place, and these will be diverted into proposed interceptor drains, or culverted under/across the works area;
- Buffered outfalls which will be numerous over the Wind Farm Site which will promote percolation of drainage waters across vegetation and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the Wind Farm Site; and,
- Drains running parallel to the existing roads requiring widening will be upgraded. Velocity and silt control measures such as check dams, sand bags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works. Regular buffered outfalls will also be added to these drains to protect downstream surface waters.

Grid Connection

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above.

More than 95% of the underground electrical cabling connection route is >50m from any nearby watercourse, sections within 50m of the route are confined to existing watercourse crossings at bridges. It is proposed to limit any works in any areas located within 50m of any watercourse/waterbody including the stockpiling of excavated soils and subsoils.

There are a total of 34 no. watercourse crossings along the underground electrical cabling connection route, as shown in Figure 4-29 of Chapter 4. There are 11 no. river/stream crossings (watercourses mapped by EPA), with the remaining crossings being classified as culverts. All the crossings are existing bridges and culverts along the public road.

No in-stream works are required at any of these crossings, however due to the proximity of the streams to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work. Mitigation measures are outlined below.

A constraint/buffer zone will be maintained for all crossing locations where possible. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse.

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

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

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

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

Silt Bags:
Silt bags will be used where small to medium volumes of water need to be pumped from excavations. As water is pumped through the bag, most of the sediment is retained by the geotextile fabric allowing filtered water to pass through. Silt bags will be used with natural vegetation filters.

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

The following forecasting systems are available and will be used on a daily basis at the site to direct proposed construction activities:

- General Forecasts: Available on a national, regional, and county level from the Met Eireann website (www.met.ie/forecasts). These provide general information on weather patterns including rainfall, wind speed and direction but do not provide any quantitative rainfall estimates;
- MeteoAlarm: Alerts to the possible occurrence of severe weather for the next 2 days. Less useful than general forecasts as only available on a provincial scale;
- 3 hour Rainfall Maps: Forecast quantitative rainfall amounts for the next 3 hours but does not account for possible heavy localised events;

- Rainfall Radar Images: Images covering the entire country are freely available from the Met Eireann website (www.met.ie/latest/rainfall_radar.asp). The images are a composite of radar data from Shannon and Dublin airports and give a picture of current rainfall extent and intensity. Images show a quantitative measure of recent rainfall. A 3 hour record is given and is updated every 15 minutes. Radar images are not predictive; and,
- Consultancy Service: Met Eireann provide a 24 hour telephone consultancy service. The forecaster will provide interpretation of weather data and give the best available forecast for the area of interest.

Using the safe threshold rainfall values will allow work to be safely controlled (from a water quality perspective) in the event of forecasting of an impending high rainfall intensity event.

Works will be suspended if forecasting suggests any of the following is likely to occur, or if on-site monitoring indicates any of the following has occurred:

- >10 mm/hr (i.e. high intensity local rainfall events);
- >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or,
- >half monthly average rainfall in any 7 days.
- Prior to, and after, works being suspended the following control measures will be undertaken:
    - All open excavations will be secured and sealed off;
    - Provide temporary or emergency drainage to prevent back-up of surface runoff; and,
    - Avoid working during heavy rainfall and for up to 24 hours after heavy events to ensure drainage systems are not overloaded.

Management of Runoff from Spoil Management Areas:
It is proposed that excavated soil will be used for landscaping where required.

During the initial construction of roads, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from works areas.

Where applicable, the vegetative top-soil layer of the spoil management areas will be rolled back to facilitate placement of excavated spoil up to a maximum height of 1.0 metres, following which the vegetative-top soils layer will be reinstated. Where reinstatement is not possible, spoil management areas will be sealed with a digger bucket and seeded as soon possible to reduce sediment entrainment in runoff.

Management of Runoff from underground electrical cabling route and existing and proposed access roads:
Where construction is undertaken along sections of the underground electrical cabling connection route, proposed access road or existing roads requiring upgrade, the drainage management infrastructure (as outlined above) will be in place to manage and control runoff from the trench excavation area. Where the internal electrical cable trench is to be constructed off-road (within the Wind Farm Site) or for the Grid Connection underground electrical cabling route along public roads, surface water control measures such as silt fences will be employed when work is required within hydrological buffer zones.

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

Monitoring:
An inspection and maintenance plan for the on-site drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended. Inspections will also be undertaken after tree felling.

Any excess build up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

During the construction phase field testing and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event based).

Post-Mitigation Residual Effect The potential for the release of suspended solids to watercourse receptors is a risk to water quality and the aquatic quality of the receptor. Proven and effective measures to mitigate the risk of releases of sediment have been proposed above and will break the pathway between the potential sources and the receptor. The residual effect is considered to be - Negative, indirect, imperceptible, temporary, unlikely effect on the water environment within the Wind Farm Site (Dungolman River, Inny River, Moneynamanagh stream and Mullenmeehan stream) and along the underground electrical cabling route

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

9.5.2.2 Construction Phase Tree Felling

As part of the Proposed Development, tree felling will be required within and around the Proposed Development footprint to allow for the construction of the turbine bases, access roads underground cabling, and the other ancillary infrastructure.

Further details on tree felling required within and around development footprint on the Wind Farm Site is detailed in Chapter 6 of this EIAR. A small section of the Wind Farm Site is located on commercial forestry, namely Turbine no. 4 and its associated infrastructure. A total of 6.4 hectares of commercial forestry will be permanently felled within and around Turbine No. 4 and its associated infrastructure, along with existing treeline boundaries as detailed in Chapter 6, Section 6.6.3.1.2. Keyhole felling to facilitate groundworks will be undertaken during the construction phase. Any further felling (related to turbulence) will be carried out during the construction phase of the Proposed Development.

The commercial forestry felling activities required as part of the Proposed Development will be the subject of a Felling Licence application to the Forest Service, in accordance with the Forestry Act 2014 and the Forestry Regulations 2017 (SI 191/2017) and as per the Forest Service's policy on granting felling licenses for wind farm developments.

Potential impacts during tree felling occur mainly from:

- Exposure of soil and subsoils due to vehicle tracking, and skidding or forwarding extraction methods resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface watercourses;
- Entrainment of suspended sediment in watercourses due to vehicle tracking through watercourses;
- Damage to roads resulting in a source of suspended sediment which can become entrained in surface water runoff and enter surface watercourses;
- Release of sediment attached to timber in stacking areas; and,
- Nutrient release.

Pathways: Drainage and surface water discharge routes.

Receptors: Surface waters and associated dependent ecosystems (Dungolman River, Inny River, Moneynamanagh stream and Mullenmeehan stream).

Pre-Mitigation Potential Effect: Indirect, negative, moderate, temporary, unlikely effect.

Proposed Mitigation Measures:

Best practice methods related to water incorporated into the forestry management and mitigation measures have been derived from:

- Department of Agricultural, Food and the Marine (2019): Standards for Felling and Reforestation;
- Forestry Commission (2004): Forests and Water Guidelines, Fourth Edition. Publ. Forestry Commission, Edinburgh;
- Coillte (2009): Forest Operations and Water Protection Guidelines;
- Coillte (2009): Methodology for Clear Felling Harvesting Operations;
- Forest Service (Draft): Forestry and Freshwater Pearl Mussel Requirements – Site Assessment and Mitigation Measures; and,
- Forest Service (2000): Forestry and Water Quality Guidelines. Forest Service, DAF, Johnstown Castle Estate, Co. Wexford.

Mitigation by Avoidance:
There is a requirement in the Forest Service Code of Practice and in the FSC Certification Standard for the installation of buffer zones adjacent to aquatic zones at planting stage. Minimum buffer zone widths recommended in the Forest Service (2000) guidance document "Forestry and Water Quality Guidelines" are shown in Table 9-15.

Table 9-15: Minimum Buffer Zone Widths (Forest Service, 2000)

Average slope leading to the aquatic zone		Buffer zone width on either side of the aquatic zone	Buffer zone width for highly erodible soils
Moderate	(0 – 15%)	10 m	15 m
Steep	(15 – 30%)	15 m	20 m
Very steep	(>30%)	20 m	25 m

During the Wind Farm Site construction phase a buffer zone of 50m will be maintained for all streams and rivers where possible, and a 10m buffer will be applied to main drains.

All proposed tree felling areas are located outside of imposed buffer zones. The large distance between proposed felling areas and sensitive aquatic zones means that potential poor quality runoff from felling areas can be adequately managed and attenuated prior to even reaching the aquatic buffer zone and primary drainage routes. Where tree felling is required in the vicinity of streams, the following additional mitigation measures will be employed.

Mitigation by Design:
Mitigation measures which will reduce the risk of entrainment of suspended solids and nutrient release in surface watercourses comprise best practice methods which are set out as follows:

- Machine combinations will be chosen which are most suitable for ground conditions at the time of felling, and which will minimise soils disturbance;
- Checking and maintenance of roads and culverts will be on-going through any felling operation. No tracking of vehicle through watercourses will occur, as vehicles will use

road infrastructure and existing watercourse crossing points. Where possible, existing drains will not be disturbed during felling works;

- Ditches which drain from the proposed area to be felled towards existing surface watercourses will be blocked, and temporary silt traps will be constructed. No direct discharge of such ditches to watercourses will occur. Drains and sediment traps will be installed during ground preparation. Collector drains will be excavated at an acute angle to the contour (~0.3%-3% gradient), to minimise flow velocities;
- Sediment traps will be sited in drains downstream of felling areas. Machine access will be maintained to enable the accumulated sediment to be excavated. Sediment will be carefully disposed of in the spoil management areas. Where possible, all new silt traps will be constructed on even ground and not on sloping ground;
- In areas particularly sensitive to erosion, it may be necessary to install double or triple sediment traps. This measure will be reviewed on site during construction;
- All drainage channels will taper out before entering the aquatic buffer zone. This ensures that discharged water gently fans out over the buffer zone before entering the aquatic zone, with sediment filtered out from the flow by ground vegetation within the zone. On erodible soils, silt traps will be installed at the end of the drainage channels, to the outside of the buffer zone;
- Drains and silt traps will be maintained throughout all felling works, ensuring that they are clear of sediment build-up and are not severely eroded. Correct drain alignment, spacing and depth will ensure that erosion and sediment build-up are minimized and controlled;
- Brash mats will be used to support vehicles on soft ground, reducing mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur. Brash mat renewal should take place when they become heavily used and worn. Provision should be made for brash mats along all off-road routes, to protect the soil from compaction and rutting. Where there is risk of severe erosion occurring, extraction should be suspended during periods of high rainfall;
- Timber will be stacked in dry areas, and outside a local 50m watercourse buffer. Straw bales and check dams to be emplaced on the down gradient side of timber storage/processing sites;
- Works will be carried out during periods of no, or low rainfall, in order to minimise entrainment of exposed sediment in surface water run-off;
- Checking and maintenance of roads and culverts will be on-going through the felling operation;
- Any diesel or fuel oils stored at the temporary site compounds will be bunded. The bund capacity will be sufficient to contain 110% of the storage tank's maximum capacity;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse. Mobile bowser, drip kits, qualified personnel will be used where refuelling is required; and,
- Branches, logs or debris will not be allowed to build up in aquatic zones. All such material will be removed when harvesting operations have been completed, but care will be taken to avoid removing natural debris deflectors.

Silt Traps:

Silt traps will be strategically placed down-gradient within forestry drains near streams. The main purpose of the silt traps and drain blocking is to slow water flow, create attenuation, and allow settling of silt in a controlled manner.

Drain Inspection and Maintenance:

The following items shall be carried out during inspection pre-felling and after:

- Communication with tree felling operatives in advance to determine whether any areas have been reported where there is unusual water logging or bogging of machines;

- Inspection of all areas reported as having unusual ground conditions;
- Inspection of main drainage ditches and outfalls. During pre-felling inspection, the main drainage ditches shall be identified. Ideally the pre-felling inspection shall be carried out during rainfall;
- Following tree felling all main drains shall be inspected to ensure that they are functioning;
- Extraction tracks near drains need to be broken up and diversion channels created to ensure that water in the tracks spreads out over the adjoining ground;
- Culverts on drains exiting the site will be unblocked; and,
- All accumulated silt will be removed from drains and culverts, and silt traps, and this removed material will be deposited away from watercourses to ensure that it will not be carried back into the trap or stream during subsequent rainfall.

Surface Water Quality Monitoring:

Sampling will be completed before, during (if the operation is conducted over a protracted time) and after the felling activity. The 'before' sampling will be conducted within 4 weeks of the felling activity, preferably in medium to high water flow conditions. The "during" sampling will be undertaken once a week passes, or after rainfall events. The 'after' sampling will comprise as many samplings as necessary to demonstrate that water quality has returned to pre-activity status (i.e. where an impact has been shown).

Criteria for the selection of water sampling points include the following:

- Avoid man-made ditches and drains, or watercourses that do not have year round flows, i.e. avoid ephemeral ditches, drains or watercourses;
- Select sampling points upstream and downstream of the forestry activities;
- It is advantageous if the upstream location is outside/above the forest in order to evaluate the impact of land-uses other than forestry;
- Where possible, three downstream locations should be selected: one immediately below the forestry activity, the second at exit from the forest, and the third some distance from the second (this allows demonstration of no impact through dilution effect or contamination by other land-uses where impact increases at third downstream location relative to second downstream location); and,
- The above sampling strategy will be undertaken for all on-site sub-catchments streams where tree felling is proposed.

Also, daily surface water monitoring forms (for visual inspections and field chemistry measurements) will also be utilised at every works site near any watercourse. These will be taken daily and kept on site for record and inspection.

Post-Mitigation Residual Effects: Forestry works are completed in accordance with guideline standards that all aim to protect surface water quality and aquatic habitats. With the application of the mitigation outlined above, the residual effect is considered to be: Indirect, negative, slight, temporary, unlikely effect.

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

9.5.2.3 Excavation Dewatering and Potential Impacts on Surface Water Quality

Wind Farm Site

Groundwater seepages may occur in turbine base excavations, particularly those on lower elevations *i.e* T1-T4 and this will create additional volumes of water to be treated by the drainage management system.

Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted at the site and therefore pollution issues are not anticipated in this respect.

Grid Connection

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above. Some minor groundwater/surface water seepages will likely occur in trench excavations and substation foundation excavations and this will create additional volumes of water to be treated by the runoff management system. Inflows will likely require management and treatment to reduce suspended sediments. No contaminated land was noted along the underground electrical cabling route therefore pollution issues are not anticipated.

Pathway: Overland flow and site drainage network.

Receptor: Surface water bodies downgradient of Wind Farm Site (Dungolman River, Inny River, Moneynamanagh stream and Mullenmeehan stream) and water bodies downgradient of underground electrical cabling route (as listed above in Section 9-12 and Section 9-30).

Pre-Mitigation Potential Effect: Indirect, negative, significant, temporary, unlikely effect on surface water quality.

Proposed Mitigation Measures (By Design)
Management of excavation seepage and subsequent treatment prior to discharge into the drainage network will be undertaken as follows:

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

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

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

9.5.2.4 Potential Release of Hydrocarbons

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

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water at the Wind Farm site and Grid Connection.

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect on local groundwater quality.

Indirect, negative, significant, short term, unlikely effect on surface water quality.

Proposed Mitigation Measures (by Design):

- Onsite re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double-axel custom-built refuelling trailer will be re-filled off Site (Wind Farm Site and Grid Connection), and will be towed around the Site by a 4x4 jeep to where machinery is located. The 4x4 jeep will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the temporary construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant on Site. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations;
- Refuelling or maintenance of machinery will not occur within 100m of a watercourse;
- Fuels stored on site will be minimised;
- Any diesel or fuel oils stored at the temporary construction compound will be bunded. The bund capacity will be sufficient to contain 110% of the storage tank's maximum capacity;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction and Environmental Management Plan (Appendix 4-2). Spill kits will be available to deal with accidental spillages.

Post-Mitigation Residual Effects: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be – Negative, indirect, imperceptible, short term, unlikely effect on surface water quality and groundwater quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

9.5.2.5 Groundwater and Surface Water Contamination from Wastewater Disposal

Release of effluent from on-site temporary wastewater treatment systems has the potential to impact on groundwater and surface water quality if site conditions are not suitable for an on-site percolation unit. Impacts on surface water quality could affect fish stocks and aquatic habitats.

Pathway: Groundwater flowpaths and Grid Connection /Wind Farm Site drainage network.

Receptor: Down-gradient well supplies, groundwater quality and surface water quality.

Pre mitigation Potential Effect:

Indirect, negative, significant, temporary, unlikely effect on surface water quality.

Indirect, negative, slight, temporary, unlikely effect on local groundwater.

Proposed Mitigation Measures (By Avoidance)

- The temporary construction compound adjacent to the onsite substation located within the Wind Farm Site will be used for the construction of the northern section of the underground electrical cabling route;
- Port-a-loos with an integrated waste holding tank will be used at the temporary construction compounds, maintained by the providing contractor, and removed from Wind Farm Site on completion of the construction works;
- Mobile welfare units will be used during the construction of the underground electrical cabling route, particularly towards the south of the route;
- Water supply for the Wind Farm Site office and other sanitation will be brought to the Wind Farm Site and removed after use from the Wind Farm Site to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the Wind Farm Site, or discharged to the Wind Farm Site.

Post-Mitigation Residual Effects: The release of wastewater at the Wind Farm Site and along the Grid Connection underground electrical cabling route can pose a risk to down gradient groundwater wells, groundwater quality and surface water quality. Proven and effective methods to mitigate against these potential impacts have been outlined above which will break the potential pathways between any source and receptor. The residual effect is considered to be - No residual effect.

Significance of Effects: For the reasons outlined above, no significant effects on down gradient wells, surface water or groundwater quality will occur.

9.5.2.6 Release of Cement-Based Products

Concrete and other cement-based products are highly alkaline and corrosive and can have significant negative impacts on water quality. They generate very fine, highly alkaline silt (pH 11.5) that can physically damage fish by burning their skin and blocking their gills. A pH range of $\geq 6 \leq 9$ is set in S.I. No. 293 of 1988 Quality of Salmonid Water Regulations, with artificial variations not in excess of $\pm$ 0.5 of a pH unit. Entry of cement based products into the site drainage system, into surface water runoff, and hence to surface watercourses or directly into watercourses represents a risk to the aquatic environment. Batching of wet concrete at the Wind Farm Site/ Grid Connection and washing out of transport and placement machinery are the activities most likely to generate a risk of cement based pollution. Placed concrete in turbine bases and foundations can have minor local impacts on groundwater quality over time. However, due to limited surface area of exposed concrete, the anoxic conditions below ground, and the high rate of dilution from the wider groundwater system relative to the small volumes of groundwater that would come in contact with the concrete, the potential for impacts are low.

Pathway: Site drainage network, groundwater flow.

Receptor: Surface water and groundwater chemistry.

Pre-Mitigation Potential Effect:

Indirect, negative, moderate, short term, unlikely impact on surface waters such as the Dungolman River, Inny River, Moneynamanagh stream and Mullenmeehan stream.

Indirect, negative, imperceptible, long term, unlikely impact on local groundwater quality.

Proposed Mitigation Measures
Mitigation by Avoidance:

- No batching of wet-cement products will occur on the Wind Farm Site/along the underground electrical cabling route works or near other ancillary construction activities. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- Where possible pre-cast elements for culverts and concrete works will be used;
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site;
- Where concrete is delivered on Site, only the chute will need to be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be directed into a dedicated concrete wash out pit. Decommissioning of this pit will occur at the end of the construction phase and water and solids will be tanked and removed from the site to a suitable, non-polluting, discharge location;
- All concrete will be paced in shuttering and will not be in contact with soils or groundwater until after it has set;
- Use weather forecasting to plan dry days for pouring concrete; and,
- Ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.

No mitigation required for potential groundwater impacts as these are imperceptible at the outset.

Post-Mitigation Residual Effects: The potential for the release of cement-based products or cement truck wash water to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases cement-based products or cement truck wash water have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be - Negative, Indirect, imperceptible, short term, unlikely effect on surface water, Indirect, negative, imperceptible, long term, unlikely effect on local groundwater quality.

Significance of Effects: No significant effects on surface water or groundwater quality will occur.

9.5.2.7 Morphological Changes to Surface Watercourses and Drainage Patterns

Diversion, culverting, road and underground electrical cabling route crossing of surface watercourses can result in morphological changes, changes to drainage patterns and alteration of aquatic habitats.

Construction of structures over watercourses has the potential to interfere with water quality and flows during the construction phase.

The following watercourse crossings are proposed as part of the Proposed Development:

- 1 no. watercourse crossings will be constructed across the Dungolman river within the Wind Farm site.
- Minor culverts within existing artificial (field) drains across the site will be required at 11 no. locations across the proposed Wind Farm Site. These crossing are further described in Section 4.6.4 of Chapter 4 and included in Figures 4-30 to 4-33.
- Along the underground cable route there are 34 no. watercourse crossings along the existing road carriage. 11 of these 34 no. crossings are mapped as EPA watercourses. The remaining 23 are smaller unmapped drains.

Section 4.7.7 in Chapter 4 of this EIAR details the water crossing locations along the proposed Grid Connection underground electrical cabling route, and describes the proposed crossing construction methodology. Additional details are presented below.

Pathway: Site drainage network.

Receptor: Surface water flows and stream morphology (Surface watercourses along the underground electrical cabling route, Dungolman River and minor field drains).

Pre-Mitigation Potential Impact: Negative, direct, slight, long term, high probability effect on surface watercourses near the watercourse crossings.

Proposed Mitigation Measures (By Design):

Wind Farm Site:

- Where possible all proposed new stream crossings will be bottomless culverts and the existing banks will remain undisturbed. No in-stream excavation works are proposed and therefore there will be no impact on the stream at the proposed crossing location;
- Within the Wind Farm Site where the site underground cabling runs adjacent to a proposed access road or an existing access road proposed for upgrade, the cable will pass over the culvert (where one exists or is proposed) within the access road;
- Within the Wind Farm Site, where a proposed access road crosses an existing field drain, the crossing will include a suitably sized piped at the correct invert level to maintain the existing flow regime and prevent ponding.
- Any guidance / mitigation measures proposed by the OPW or the Inland Fisheries Ireland will be incorporated into the design of the proposed crossings. A 10m buffer is applied to main drains to allow for future OPW maintenance;
- Works will be completed in accordance with the requirements of "*Inland Fisheries Ireland (2016): Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters";* and,
- All new river/stream crossings will require a Section 50 application (Arterial Drainage Act, 1945). The river/stream crossings will be designed in accordance with OPW guidelines/requirements on applying for a Section 50 consent.

Grid Connection:

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above.

With respect to the Grid Connection underground electrical cabling route watercourse crossings, 4 construction crossing methods are proposed that will avoid in-stream works and these include:

- **Option A:** Where adequate cover exists above a culvert, the standard aforementioned trench arrangement will be used where the cable ducts pass over a culvert without any contact with the existing culvert or water course. The cable trench will pass over the culvert in a standard trench. Where no crossing currently exists, the cable will pass over the watercourse in a bottomless box culvert or pre-cast concrete slab in a standard trefoil arrangement. Where required existing culvert crossings will be extended using appropriately sized corripipe.
- **Option B:** Where the culvert consists of a socketed concrete or sealed plastic pipe and sufficient depth is not available over the crossing, a trench will be excavated beneath the culvert and cable ducts will be installed in the standard formation 300mm below the existing pipe.
- **Option C:** Where cable ducts are to be installed over an existing culvert and sufficient cover cannot be achieved, the ducts will be laid in a much shallower trench, the depth of which will be determined by the cover available at the culvert crossing location. The ducts within the shallow formation trench will be encased in 6mm thick steel galvanized plates and backfilled with 35N concrete. Where sufficient deck cover is not available to fully accommodate the required ducts, it may be necessary to locally raise the pavement level. Any addition of a new pavement will be tied back into the existing road pavement at grade.
- **Option D:** Directional Drilling (DD) is a method of drilling under obstacles such as bridges, culverts, railways, water courses, etc. in order to install cable ducts under the obstacle. This method is employed where installing the ducts using standard installation methods is not possible. The DD method of duct installation will be carried out using Vermeer D36 x 50 Directional Drill (approximately 22 tonnes), or similar plant, for the directional drilling at watercourse/culvert crossings. During the drilling process, a mixture of a natural, inert and fully biodegradable drilling fluid such as Clear Bore™ and water is pumped through the centre of the drill rods to the reamer head and is forced in to void and enables the annulus which has been created to support the surrounding subsoil and thus prevent collapse of the reamed length.

Mitigation Measures relating to the use of a mixture of a natural, inert and fully biodegradable drilling fluid such as Clear Bore™ and water for directional drilling include:

- The area around the Clear Bore™ batching, pumping and recycling plants will be bunded using terram and sandbags in order to contain any spillages;
- One or more lines of silt fences will be placed between the works area and adjacent rivers and streams on both banks;
- Accidental spillage of fluids will be cleaned up immediately and transported off site for disposal at a licensed facility; and,
- Adequately sized skips will be used for temporary storage of drilling arisings during directional drilling works. This will ensure containment of drilling arisings and drilling flush.

Post-Mitigation Residual Effects: With the application of the best practice mitigation outlined above, and through compliance with the Section 50 consenting process, the residual effect is considered to be - Neutral, direct, negligible, short term, unlikely effect on stream flows, stream morphology and surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on stream morphology or stream water quality will occur at crossing locations.

9.5.2.8 Potential Effects on Hydrologically Connected Designated Sites

Possible effects include water quality impacts which could be significant if mitigation is not put in place. Dewatering of construction sites, such as within the Wind Farm Site can also effect nearby designated sites, however this will not be undertaken as part of the Proposed Development. The implementation of piling construction methods also eliminates the requirement for dewatering. The turbine foundation may be formed using piling methods or on competent strata (i.e bedrock or subsoil of sufficient load bearing capacity).

Wind Farm Site

Lough Ree SAC/SPA/pNHA is situated hydraulically downgradient of the Wind Farm Site. Lough Ree is fed by the Inny River, which is in turn fed by the Dungolman River as one of its tributaries. The remaining designated sites, namely Ballynagrenia and Ballinderry Bog NHA, Lough Sewdy pNHA, Ballymore Fen SAC, Ballynagarbry pNHA, Carn Park Bog SAC and pNHA, Waterstown Lake pNHA, Woodfield Bog pNHA and Crosswood Bog SAC and pNHA are all hydraulically upgradient of the Wind Farm Site, and are therefore hydraulically disconnected from the Wind Farm Site.

Grid Connection

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above. The Grid Connection underground electrical cabling route passes within existing public roads close to Ballynagrenia and Ballinderry Bog NHA, Woodfield Bog pNHA, Clara Bog SAC and Ballyduff Wood pNHA. However all these designated sites/proposed designated sites are located hydraulically upgradient of the underground electrical cabling route, therefore there is no hydraulic connection between these sites and the underground electrical cabling route. The River Shannon Callows SAC and Middle Shannon Callows SPA are situated ~20km downgradient of surface watercourses along the proposed underground electrical cabling route. Surface water mitigation measures employed during the construction of the underground electrical cabling route will ensure there are no effects on these designated sites.

Pathway: Surface water and shallow groundwater flowpaths.

Receptor:

Wind Farm Site- Down-gradient water quality and designated sites (Lough Ree SAC).

Grid Connection underground electrical cabling route – (River Shannon Callows SAC and Middle Shannon Callows SPA).

Pre-Mitigation Potential Effect: Indirect, negative, negligible, temporary, unlikely effect.

Impact Assessment and Proposed Mitigation Measures

Wind Farm Site:

The proposed mitigation measures for protection of surface water quality which will include buffer zones and drainage control measures (i.e. interceptor drains, swales, settlement ponds) will ensure that the quality of runoff from Wind Farm Site areas will be very high.

As stated in Section 9.5.2.1 above, there could potentially be a "negative, temporary, unlikely effect" on local streams and rivers but this would be very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect effects on downstream designated sites (Lough Ree SAC/SPA/pNHA) distant from the Wind Farm Site will not occur.

Grid Connection:

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above.

As the designated sites mentioned above are hydraulically upgradient of the Grid Connection underground electrical cabling route, there is no surface water pathway between the underground electrical cabling route and the named designated sites.

Nonetheless, the River Shannon Callows SAC and Middle Shannon Callows SPA are situated ~20km downgradient of surface watercourses near the underground electrical cabling connection route. This is a significant separation distance between the proposed works and the downgradient receptor. Mitigation measures to protect surface watercourses will be put in place during works along the underground electrical cabling route. The proposed mitigation measures which will include drainage control measures, sediment control measures and mitigation measures related to spills/chemical releases will ensure that the quality of runoff from along the underground electrical cabling route during construction will be good. The closest point of intersection between the underground electrical cabling route and a designated site is near the northeast corner of Ballynagrenia and Ballinderry Bog NHA where the underground electrical cabling route passes along the N52, 1.2km east of the bog. Due to the shallow nature of the trench (~1.2m) and the location of the underground electrical cabling route hydraulically downgradient of the Ballynagrenia and Ballinderry Bog NHA, there will be no hydrological impact on the designated site.

As stated in Section 9.5.2.1 above, there could potentially be an "imperceptible, short term, likely impact" on local streams and rivers but this would be very localised and over a very short time period (i.e. hours). Therefore, significant direct, or indirect impacts on the SACs, SPAs, NHAs, and pNHAs will not occur.

The hydrological regime locally will not be affected by the Proposed Development works and so the regime of the SACs, SPAs, NHA and pNHAs will not be affected.

- No significant dewatering is proposed during construction. Any pumping required will be temporary and at a very shallow depth. The turbine foundation may be formed using piling methods or on competent strata (i.e bedrock or subsoil of sufficient load bearing capacity).
- All building and trenching works are proposed at or very near existing ground levels with minimal ground disturbance proposed.
- No deep foundations are required or are proposed. As such there will be no interruption or blocking of shallow or deep groundwater pathways below the Site.

Post-Mitigation Residual Effects: For the reasons outlined above, and in conjunction with the implementation of the mitigation measures, no hydrological or hydrogeological effects on designated sites will occur.

Significance of Effects: For the reasons outlined above, no significant effects on designated sites will occur.

9.5.2.9 Potential Effects on Groundwater and Surface Water due to Temporary Junction Works

Minor haul route works are required at 7 no. locations listed below, however all proposed road works are small-scale and localised, they include:

- Location 1 – M6 Junction 10 left slip/N55 junction in Athlone
- Location 2 – N55/R916 Cornamaddy Roundabout

- Location 3 – N55/R390 Junction in Athlone
- Location 4 – Bend on R390 at Coolteen
- Location 5 – Bends on R390 at Beechlawn
- Location 6 – R390/L5363 Junction
- Location 7 – Access Junction on L5363

Due to the shallow nature of the temporary junction works effects on groundwater flows and levels will not occur, however there is a potential for effects on groundwater quality from fuels and other chemicals during the construction phase. Mitigation measures are outlined below.

Pathway: Surface water and groundwater flow paths.

Receptor: Down-gradient water quality.

Pre-Mitigation Potential Effect: Indirect, negative, slight, temporary, unlikely effect on surface water quality.
Indirect, negative, slight, temporary, unlikely effect on groundwater quality.

Proposed Mitigation Measures
The following mitigation measures are proposed:

Mitigation by Avoidance:

A constraint/buffer zone will be maintained for all upgrade works locations where possible. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse.

The purpose of the constraint zone is to:

- Avoid physical damage to surface water channels;
- Provide a buffer against hydraulic loading by additional surface water run-off;
- Avoid the entry of suspended sediment and associated nutrients into surface waters from excavation and earthworks;
- Provide a buffer against direct pollution of surface waters by pollutants such as hydrocarbons; and,
- Provide a buffer against construction plant and materials entering any watercourse.

General Best Practice Pollution Prevention Measures will also include:

- No stock-piling of construction materials will take place within the constraints zone. No refuelling of machinery or overnight parking of machinery is permitted in this area;
- No concrete truck chute cleaning is permitted in this area;
- Works shall not take place at periods of high rainfall, and shall be scaled back or suspended if heavy rain is forecast;
- Plant will travel slowly across bare ground at a maximum of 5km/hr.
- Machinery deliveries shall be arranged using existing structures along the public road;
- All machinery operations shall take place away from the stream and ditch banks, although no instream works are proposed or will occur;
- Any excess construction material shall be immediately removed from the area and taken to a licensed waste facility or the on-site spoil management areas;
- No stockpiling of materials will be permitted in the constraint zones;
- Spill kits shall be available in each item of plant required; and,
- Silt fencing will be erected on ground sloping towards watercourses at the stream crossings if required.

Mitigation Measures relating to the use and storage of fuels and chemicals in terms of groundwater protection:

- Onsite re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser, as described in Section 9.5.2.4. No maintenance of construction vehicles or plant will take place along the temporary junction works areas;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- Spill kits will be available to deal with accidental spillage.

Post-Mitigation Residual Effect: The temporary junction improvement works has the potential to negatively impact the local surface water and groundwater, through increased sediment supply to the river channel, and the potential for fuel/oil spills which could impact surface water and groundwater. Proven and effective measures to mitigate the risk of excess runoff and fuel/oil spills have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be - Indirect, negative, imperceptible, temporary, unlikely effect on surface water quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

9.5.2.10 Potential Effects on Local Groundwater Wells (Wind Farm Site and Grid Connection)

As stated in Section 9.3.7.1 above, the groundwater flow in the mineral soil deposits (silts, sands and gravels) beneath Wind Farm Site will discharge into the local surface waterbody network, i.e. the Dungolman River, and groundwater flow in the north of the Wind Farm Site will discharge to the Mullenmeehan stream, which ultimately discharge into the Dungolman River at their confluence. Therefore within the Wind Farm Site groundwater flows towards the local watercourses, and therefore the potential for any of the proposed wind farm works to effect any local water well is minimal (as all local wells are upstream of the wind farm footprint).

Temporary dewatering of turbine bases during construction has the potential to impact on local groundwater levels. Due to the nature of the quaternary sediments at the Wind Farm Site, detailed during the trial pit excavations (refer to Chapter 8), it is expected that dewatering will not be required, or will be very limited in extent.

<u>Wind Farm Site</u>
As outlined in Section 9.3.12.1, there are no public or group groundwater scheme protection zones mapped near the Wind Farm Site. There are no mapped wells situated within the Wind Farm Site, however there are several wells mapped nearby by the GSI, with varying location accuracies.

All mapped GSI wells, and any unmapped wells, are situated hydrologically upgradient of the Wind Farm Site. From a surface water perspective they drain towards the Dungolman River, but are situated further upgradient than the Wind Farm Site. The groundwater regime at the Wind Farm Site will reflect this, with groundwater hydraulic gradients in the direction of the Dungolman River (away from mapped and unmapped wells).

<u>Grid Connection</u>

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above.

The Ardan PWS boreholes are situated 50m east of the N52. The Grid Connection underground electrical cabling route passes along the N52 in this area, within a 1.03km section of the road which is situated within the Tullamore Ardan PWS Source Protection Area.

No groundwater level effects will occur from the construction of the Grid Connection underground electrical cabling trench due to the shallow nature of the excavation (i.e. ~1.2m), the excavation of the trench within the road carriageway and the unsaturated nature of the subsoil/bedrock to be excavated. The static water level in the Ardan PWS boreholes ranges between 11.78mbTOC and 14.11mbTOC from dip data within the Source Protection Report[4]. These static water levels are >10m below the invert of the underground electrical cabling route channel along the road carriageway, and at that depth the grid connection works cannot cause any impact.

Pathway: Groundwater flow paths.

Receptor: Down-gradient domestic and public groundwater wells (mapped GSI wells listed in Section 9.3.12, and any unmapped wells, and also including the Tullamore Ardan PWS).

Pre-Mitigation Potential Impact: Indirect, negative, slight, temporary, unlikely effect on groundwater quality and quantity.

Proposed Mitigation Measures
Mitigation measures to protect and ensure the quantity and quality of groundwater during the construction phase of the Proposed Development has been outlined in Sections 9.5.2.4, 9.5.2.5, 9.5.2.6 and 9.5.2.9. These broadly include:

Mitigation Measures relating to the use and storage of fuels and chemicals in terms of groundwater protection:

- Onsite re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser, as described in Section 9.5.2.4. No maintenance of construction vehicles or plant will take place along the temporary junction works areas;
- The plant used will be regularly inspected for leaks and fitness for purpose; and,
- Spill kits will be available to deal with accidental spillage.

Mitigation measures related to the use and storage of concrete products:

- No batching of wet-cement products will occur on site/along the Grid Connection underground electrical cabling route works. Ready-mixed supply of wet concrete products and where possible, emplacement of pre-cast elements, will take place;
- Where possible pre-cast elements for culverts and concrete works will be used;
- No washing out of any plant used in concrete transport or concreting operations will be allowed on-site; and,
- Where concrete is delivered on-site, only the chute will need to be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be directed into a dedicated concrete wash out pit. Decommissioning of this pit will occur at the end of the construction phase and water and solids will be tanked and removed from the site to a suitable, non-polluting, discharge location.

Mitigation measures related to potential impacts from wastewater disposal:

- The Grid Connection temporary construction compound located within the Wind Farm Site will be used for the construction of the Grid Connection underground electrical cabling route along the northern section of the route (i.e near the Wind Farm Site);
- Welfare cabins and port-a-loos will be used during the construction of the underground electrical cabling route, particularly towards the south of the route;

[4] *GSI (2014): Establishment of Groundwater Source Protection Zones -Tullamore Water Supply Scheme: Ardan Boreholes*

- Port-a-loos with an integrated waste holding tank will be used at the site compounds, maintained by the providing contractor, and removed from Wind Farm Site on completion of the construction works;
- Water supply for the Wind Farm Site office and other sanitation will be brought to Wind Farm Site and removed after use from the Wind Farm Site to be discharged at a suitable off-site treatment location; and,
- No water will be sourced on the Wind Farm Site, or discharged to the Wind Farm Site.

Post-Mitigation Residual Effect: The construction of the turbine bases, the potential for dewatering during construction and other elements of the construction process as outlined above have the potential to negatively impact on local groundwater wells, both private and public. Proven and effective measures to mitigate the risk from fuels/oils, concrete products and wastewater have been proposed. The residual effect is considered to be - Indirect, negative, imperceptible, temporary, unlikely effect on local groundwater wells.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur.

9.5.2.11 Assessment of Potential Health Effects

Wind Farm Site

Potential health effects are associated with negative impacts on public and private water supplies and potential flooding. There are no mapped public or group water scheme groundwater protection zones in the area of the Wind Farm Site. Notwithstanding this, the proposed site design and mitigation measures ensures that the potential for impacts on the water environment will not be significant.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues. A detailed Stage III Flood Risk Assessment has been caried out for the proposed Wind Farm Site, summarised in Section 9.3.5. This Flood Risk Assessment, combined with the assessment of changes in permeable surfaces (Section 9.5.3.1) demonstrates that the risk of the Wind Farm Site works contributing to downstream flooding is insignificant. On-site (construction phase) drainage control measures will ensure no downstream increase in local flood risk.

Grid Connection

Potential health effects from the Grid Connection underground electrical cabling route are associated with negative impacts (i.e. contamination) on public and private water supplies and potential alteration of flooding risks. An assessment of potential impacts on private and public water supplies is completed at Section 9.3.12, and no significant effects will occur. Therefore, no health effects are likely to occur.

Flooding of property can cause inundation with contaminated flood water. Flood waters can carry waterborne disease and contamination/effluent. Exposure to such flood waters can cause temporary health issues. The Flood Risk Identification (undertaken at Section 9.3.5) has also shown that the risk of the Grid Connection works contributing to downstream flooding is also very low, as the works footprint is small, the works are for the most part along existing roads, and the duration of the works is short. On-site (construction phase) drainage control measures along the Grid Connection underground electrical cabling route will ensure no downstream increase in local flood risk.

9.5.2.12 Assessment of Potential Impacts on WFD Objectives

WFD status for Groundwater Bodies and Surface Water Bodies are defined within Sections 9.3.9 and 9.3.10. The Groundwater Bodies within the Wind Farm Site and Grid Connection are all assigned "Good" Status. The Surface Water Bodies within the Wind Farm Site and Grid Connection have an assigned status ranging from "Good" to "Poor" with 2 no. SWB's listed with Undefined statuses.

Changes in surface water or groundwater flow regimes and water quality has the potential to impact on the objectives and status of the associated Groundwater Bodies and Surface Water Bodies.

A detailed WFD Assessment Report has been completed in combination with this EIAR chapter (9) and is included within Appendix 9-2.

Pathway: Groundwater flowpaths and Surface Water Flowpaths within the Wind Farm Site and Grid Connection.

Receptor: WFD Groundwater Bodies and Surface Water Bodies.

Pre-mitigation Potential Effect:
Indirect, negative, moderate, temporary, unlikely effect on Surface Water Bodies.
Indirect, negative, slight, temporary, unlikely effect on Groundwater Bodies.

Proposed Mitigation Measures (By Avoidance)

- Mitigation measures relating to surface water drainage regimes and water quality protection have been detailed within Sections 9.5.2.1to 9.5.2.9;
- Similarly, concise mitigation measures relating to the protection of groundwater quality, quantity and the groundwater flow regime have been detailed within Sections 0, 9.5.2.4, 9.5.2.5, 9.5.2.6, 9.5.2.8 and 9.5.2.9 above.

Post-Mitigation Residual Effects:
There is no direct discharge from the Proposed Development site to downstream receiving waters. Mitigation for the protection of surface water during the construction phase of the Proposed Development will ensure the qualitative status of the receiving waters will not be altered by the Proposed Development.

There will be no change in GWB or SWB status in the underlying GWB or downstream SWBs resulting from the Proposed Development. There will be no change in quantitative (volume) or qualitative (chemical) status, and the underlying GWB and downstream SWBs are protected from any potential deterioration.

The residual effect on Groundwater Bodies is considered to be - No residual effect.
The residual effect on Surface Water Bodies is considered to be - No residual effect.

Significance of Effects: For the reasons outlined above, no significant effects on WFD Groundwater Bodies and Surface Water Bodies status, risk or future objectives will occur as a result of the Proposed Development.

9.5.3 Operational Phase Likely Significant Effects and Mitigation Measures

9.5.3.1 Progressive Replacement of Natural Surface with Lower Permeability Surfaces

Progressive replacement of the vegetated surfaces with impermeable surfaces could potentially result in an increase in the proportion of surface water runoff reaching the surface water drainage network. The footprint comprises 9 no. turbine bases and hardstanding, new and upgraded access roads, site entrance, met mast, temporary construction compounds and the 110kV onsite substation. During storm rainfall events, additional runoff coupled with increased velocity of flow could increase hydraulic loading, resulting in erosion of watercourses and impact on aquatic ecosystems.

The emplacement of the permanent development footprint within the Wind Farm Site, assuming emplacement of impermeable materials as a worst-case scenario, could result in an average total site increase in surface water runoff of 2,392m^3/month at the Wind Farm Site (Table 9-19). This represents a potential increase of 0.29 % in the average daily/monthly volume of runoff from the Wind Farm Site in comparison to the baseline pre-development site runoff conditions. This is a very small increase in average runoff and results from a relatively small area of the site being developed, the proposed total permanent development footprint being approximately 8.2ha, representing ~0.84 % of the EIAR Site Boundary area of 949ha.

The water balance undertaken in this section is for baseline characterisation purposes along with an assessment of potential runoff changes as a result of the permanent development footprint within the Wind Farm Site. The rainfall depths presented in this section, which are long term averages, are not used in the design of the sustainable drainage system for the Wind Farm Site. A 1 in 10 year 6 hour return period will be used for design purposes.

The water balance calculations are carried out for the month with the highest average recorded rainfall minus evapotranspiration, for the current baseline site conditions (Table 9-16 - Table 9-18). It represents therefore, the long term average wettest monthly scenario in terms of volumes of surface water runoff from the Wind Farm Site pre-wind farm development. The recharge co-efficient for the Wind Farm Site is estimated to be 22.5% based on the predominant till coverage.

The highest long term average monthly rainfall recorded at Ballymore occurs in October, at 124.1mm. This is a monthly average for the period 1981-2010. The average monthly evapotranspiration for the synoptic station at Mullingar over the same period in October was 16.2mm. The water balance indicates that a conservative estimate of surface water runoff for the Wind Farm Site during the highest rainfall month is 805,794m^3/month or 26,859m^3/day.

Table 9-16: Water Balance and Baseline Runoff Estimates for Wettest Month (October)

Water Balance Component	Depth (m)
Average October Rainfall (R)	0.124
Average October Potential Evapotranspiration (PE)	0.0162
Average October Actual Evapotranspiration (AE = PE x 0.95)	0.0154
Effective Rainfall (ER = R - AE)	0.1086
Recharge (22.5% of ER)	0.0244
Runoff (77.5% of ER)	0.0842

Table 9-17: Baseline Runoff for the Wind Farm Site

Approx. Area (ha)	Baseline Runoff per month (m^3)	Baseline Runoff per day (m^3)
949	805,794	26,859

Table 9-18: Wind Farm Site Baseline Site Runoff V Development Runoff

Development Type	Site Baseline Runoff/month (m^3)	Baseline Runoff/day (m^3)	Permanent Hardstanding Area (m^2)	Hardstanding Area 100% Runoff (m^3)	Hardstanding Area 77. 5% Runoff (m^3)	Net Increase/month (m^3)	Net Increase/day (m3)	% Increase from Baseline Conditions (m^3)
Wind Farm	805,794	26,859	98,025	10, 645	8,253	2,392	79.73	0.29

The additional volume is low due to the fact that the runoff potential from the Wind Farm Site is naturally high (77.5%). Also, the calculation assumes that all hardstanding areas will be impermeable which will not be the case as access tracks will be constructed of permeable stone aggregate. The increase in runoff from the permanent development footprint within the Wind Farm Site will therefore be negligible. This is even before mitigation measures will be put in place. Therefore, there will be no risk of exacerbated flooding down-gradient of the Wind Farm Site.

The Grid Connection onsite substation and temporary construction compound are located within the Wind Farm Site and as such, are discussed above.

The Grid Connection underground electrical cabling route will not result in the emplacement of lower permeability surfaces as all excavations will be within the existing road hardstanding. The tarmac/harstanding will be excavated to facilitate the laying of the electrical cabling and will be reinstated with a new road surface with equivalent permeability. In this way, there will be no net change in permeability along the underground electrical cabling route.

Pathway: Site drainage network, Grid Connection underground electrical cabling route (road) drainage network.

Receptor: Surface waters and dependent ecosystems.

Pre-Mitigation Potential Effect: Direct, negative, moderate, permanent, unlikely effect on downstream surface water bodies (River Inny, Ballynagrenia river, Gageborogh river, River Brosna, Silver river).

Effects Assessment

As determined in Table 9-17 above there could be a potential increase in runoff of 0.29 % in the average daily/monthly volume of runoff from the Wind Farm Site in comparison to the baseline pre-development Wind Farm Site runoff conditions. This is a very small increase in average runoff and results from a relatively small area of the study area being developed, the proposed total permanent development footprint being approximately 8.2ha, representing 0.84% of the total EIAR Site Boundary area of 949ha.

The increase in runoff from the Proposed Development will therefore be negligible. This is even before mitigation measures will be put in place. Therefore, there will be no risk of exacerbated flooding down-gradient of the Wind Farm Site or Grid Connection underground electrical cabling route.

Proposed Mitigation Measures

Mitigation by Design:

The operational phase drainage system will be in place from the construction stage. Drainage from the operational site will comprise:

- Runoff from individual turbine hardstanding areas will not be discharged into the existing drain network, but discharged locally at each turbine location through settlement ponds and buffered outfalls onto vegetated surfaces;
- Interceptor drains will be installed up-gradient of all proposed infrastructure within the Wind Farm Site to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed over the ground by means of a level spreader;
- Swales/road side drains will be used to collect runoff from access roads and turbine hardstanding areas of the Wind Farm Site, likely to have entrained suspended sediment, and channel it to settlement ponds for sediment settling;
- On steep sections of access road transverse drains ('grips') will be constructed where appropriate in the surface layer of the road to divert any runoff off the road into swales/road side drains;
- Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock;
- Settlement ponds, emplaced downstream of road swale sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to watercourses; and,
- Settlement ponds will be designed in consideration of the greenfield runoff rate.

Post-Mitigation Residual Effects: With the implementation of the Wind Farm Site drainage measures as outlined above, and based on the post-mitigation assessment of runoff, it is considered that the residual effect will be - Negative, imperceptible, indirect, long-term, unlikely effect on all downstream surface water bodies.

Significance of Effects: For the reasons outlined above, no significant effects on surface water quality or quantity will occur.

9.5.3.2 Potential Release of Hydrocarbons

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

Pathway: Groundwater flowpaths and site drainage network.

Receptor: Groundwater and surface water at the Wind Farm Site and Grid Connection.

Pre-Mitigation Potential Effect:

Indirect, negative, slight, short term, unlikely effect on local groundwater quality.

Indirect, negative, significant, short term, unlikely effect on surface water quality.

Proposed Mitigation Measures (by Design):

- Onsite re-fuelling of machinery will not be carried out during the operational phase of the development. All plant/machinery will be refuelled offsite;
- Fuels stored on site will be minimised and any diesel or fuel oils stored on-site will be bunded. The bund capacity will be sufficient to contain 110% of the storage tank's maximum capacity;
- The electrical control building at the Wind Farm Site will be bunded appropriately to the volume of oils likely to be stored, and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- Any plant used during the operational phase of the proposed development will be regularly inspected for leaks and fitness for purpose; and,
- Spill kits will be available to deal with accidental spillages.

Post-Mitigation Residual Effects: The potential for the release of hydrocarbons to groundwater and watercourse receptors is a risk to surface water and groundwater quality, and also the aquatic quality of the surface water receptors. Proven and effective measures to mitigate the risk of releases of hydrocarbons have been proposed above and will break the pathway between the potential source and each receptor. The residual effect is considered to be – Negative, indirect, imperceptible, short term, unlikely effect on surface water quality and groundwater quality.

Significance of Effects: For the reasons outlined above, no significant effects on surface water or groundwater quality will occur during the operational phase of the Proposed Development.

9.5.3.3 Assessment of Impacts on WFD Objectives

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

9.5.4 Decommissioning Phase Likely Significant Effects and Mitigation Measures

The wind turbines proposed as part of the Wind Farm Site are expected to have a lifespan of approximately 30 years. Following the end of their useful life, the equipment may be replaced with a new technology, subject to planning permission being obtained, or the Wind Farm Site may be decommissioned fully.

Upon decommissioning of the Wind Farm Site, the wind turbines will be disassembled in reverse order to how they were erected. The turbines will be disassembled with a similar model of crane that was used for their erection. The turbine will likely be removed from Site using the same transport methodology adopted for delivery to Site initially. The turbine materials will be transferred to a suitable recycling or recovery facility.

The underground electrical cabling connecting the turbines to the on-site substation will be removed from the cable ducts. The cabling will be pulled from the cable ducts using a mechanical winch which will extract the cable and re-roll it on to a cable drum. This will be undertaken at the original cable jointing pits which will be excavated using a mechanical excavator and will be fully re-instated once the cables are removed. The cable ducting will be left in-situ as it is considered the most environmentally prudent option, avoiding unnecessary excavation and soil disturbance. The cable materials will be transferred to a suitable recycling or recovery facility.

All above ground turbine components would be separated and removed off-site for recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. Leaving the turbine foundations in-situ is considered a more environmentally prudent option, as to remove that volume of reinforced concrete from the ground could result in unnecessary environment emissions such as silt laden run-off entering the receiving watercourses), erosion, dust, noise, traffic and an increased possibility of contamination of the local water table.

Site roadways could be in use for purposes other than the operation of the Proposed Development by the time the decommissioning of the Wind Farm Site is to be considered, and therefore it may be more appropriate to leave the Site roads in situ for future use. It is envisaged that the roads will provide a useful means of extracting the commercial forestry crop which exists on the Site, and as agricultural roads. If it were to be confirmed that the roads were not required in the future for any other useful purpose, they could be reinstated where required (left in place, covered over with soil/subsoil).

Removal of this infrastructure would result in considerable disturbance to the local environment in terms of disturbance to underlying soils and an increased sedimentation (if turbine foundations, access tracks and hardstandings are being reinstated there is a risk of silt laden run-off entering the receiving watercourses), erosion, dust, noise, traffic and an increased possibility of contamination of the local water table.

The Grid Connection underground electrical cabling route and onsite substation will remain in place as it will be under the ownership of the ESB. There are no impacts associated with this.

A Decommissioning Plan has been prepared (Appendix 4-6) the detail of which will be agreed with the local authority prior to any decommissioning. The Decommissioning Plan will be updated prior to the end of the operational period in line with decommissioning methodologies that may exist at the time and will agreed with the competent authority at that time. The potential for effects during the decommissioning phase of the Proposed Development has been fully assessed in the EIAR.

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

9.5.5 Cumulative Impacts

Construction Phase

A detailed cumulative assessment has been carried out for all planning applications (granted and awaiting decisions) within a combined river sub-basin zone within the vicinity of the Wind Farm Site defined in Section 2.7 of this EIAR and within Appendix 2-3. This combined sub basin area encompasses the area of the Inny[Shannon]_SC_090 subcatchment. There will be no potential for cumulative impacts beyond Inny[Shannon]_SC_090 due to increases in flow volume (as the catchment area increases) and increasing distance from the Proposed Development. A further assessment has been completed within a 2km buffer zone of the turbine locations and within a 200m buffer zone of the proposed underground electrical cabling route. Due to the narrow nature of the underground electrical cabling connection trench (~0.6m wide), a 200m buffer zone is an appropriate scale when considering potential cumulative effects on the water environment.

A total of 422 planning applications have been identified within the sub-basin zone. More than 95% of these applications are for new dwellings or renovations of existing dwellings, as well as for the erection of farm buildings. The other non-dwelling/farm related planning applications include 1 no. planning applications for a replacement of a 15m telecommunications pole with a 21m telecommunications pole (PL 21656) near Ballymore and an above ground water storage reservoir (3150m^3) is also included in the assessment (PL 187011). The planning applications have been reviewed based on their type, scale and proximity to the proposed Wind Farm Site. Based on the scale of the works, their proximity to the Proposed Development and the temporal period of likely works, no cumulative effects will occur as a result of the Proposed Development.

A desk study of planning applications within 200m of the underground electrical cabling route was undertaken. 81 no. planning applications were identified during this study. Again, the majority of applications relate to the construction or renovation/extension of domestic dwellings, which will not generate potential cumulative effects due to their scale.

3 no. solar farms were identified within Offaly/Westmeath situated within 200m of the proposed underground electrical cabling route. These include a 10 year permission for a solar farm on lands adjacent to the N52 near the townland of Gormagh (PL 22387), a 10 year permission for a solar farm at Dawn Meats near Kilbeggan (PL 22350) and a 10 year planning permission for the construction of a solar farm in the townland of Derries, Co. Offaly, of which the approved underground electrical cable is situated within 200m of the underground electrical cabling route of the Proposed Development. As the construction of the underground electrical cabling connection will be a relatively short construction project, which will be broken up into sections of ~100 to 150m works length (meaning that only ~100m of open trench will exist at any one time during the construction), the potential for cumulative effects with these nearby energy developments are not significant from a hydrological/hydrogeological perspective. It is also likely that the construction phases of these projects will not overlap with the construction phase of the Proposed Development, within the buffer zone. The construction of the underground electrical cabling connection route for the Proposed Development would be subject to a Road Opening License, as would any other similar nearby grid connection works. The timing of these works would therefore be controlled by the road opening licensing process and would not overlap.

Operational Phase

During the operational phase of the Proposed Development, the main sources of potential environmental effects will not exist. There will be no exposed excavations and spoil management areas will not be in operation. There will be no sources of sediment to reach watercourses. There will be no use of cementitious materials. Fuels/oil will be kept to a minimum at the site. Any oils for turbine maintenance will be stored within bunded areas.

The underground electrical cabling route will be backfilled at the end of the construction phase and will remain in-situ during the operational phase. No maintenance of the electrical cabling is envisaged, however any minor maintenance will be completed from inspection points along the route.

During the operational phase of the Proposed Development, there will be no cumulative effects with other planned projects (as listed in Appendix 2-3) within the sub-basin catchment zone or along the underground electrical cabling route (200m buffer).

Decommissioning

During the decommissioning phase, the potential cumulative effects are similar to the construction phase, but to a lesser degree with less ground disturbance. Please note that the Grid Connection onsite 110kV substation and underground electrical cabling route will remain in-situ and will not be decommissioned. There would be increased trafficking and an increased risk of disturbance to underlying soils at the Wind Farm Site, during the decommissioning phase. Any potential effects would be likely to be less than during the construction stage as the drainage swales would be fully mature and would provide additional filtration of runoff. Any diesel or fuel oils stored on site would be bunded. In the event of decommissioning of the Wind Farm Site, the proposed access tracks may be used in the decommissioning process.

During the decommissioning phase, there will be no cumulative effects within the sub-basin zone or within the 200m buffer of the underground electrical connection cabling route.

The hydrological impact assessment undertaken above in this chapter outlines that significant effects will not occur during the construction, operational and decommissioning works.

No significant cumulative effects on the hydrology and hydrogeology environment will occur as a result of the proposed development within the Wind Farm Site and the associated underground electrical cabling route.